NATURE

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"*To the solid ground*
Of Nature trusts the mind that builds for aye."—WORDSWORTH

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THURSDAY, MAY 1, 1873

THE WILD BIRDS PROTECTION ACT

"SAVE me from my foolish friends," ought to be a stave in the spring-song of each fowl of the air, from the Nightingale which warbleth in darkness to the Dotterel which basketh at noonday. Last year, as is well known, a bill for the protection of "Wild Fowl" was brought into Parliament at the instance of the "Close-time" Committee of the British Association,* and the various changes and chances which befell it before it became an Act were succinctly recounted in the Committee's report at the Brighton meeting, printed in NATURE, vol. vi. p. 363.

This bill, as at first prepared and introduced to the House of Commons, was framed entirely on the Sea-birds Preservation Act, which became law in 1869, and only differed from that successful measure where difference was needed, and the penalties and procedure it proposed were the same as those which have proved to be so thoroughly efficient in the former case. The minute care, the practical knowledge, and the consideration of various interests with which it was originally drawn, may be gathered from a few facts. Many of the birds it intended to protect are known in various parts of the country by various names, and accordingly all these names were introduced, for it was clear to the promoters of the bill, though not, as shown by the sequel, to the public at large, that a man summoned for killing (let us say) a Lapwing would never be convicted if he brought, as he easily might bring, credible witnesses who in good faith swore that it was a Peewit, and that they never heard it called anything else. At the same time, that the measure might not be needlessly severe, care was taken that of those species which bear different names in Scotland and England and do not breed in the latter, they should only appear under the name by which they are known in the former. A few species too, though coming strictly under the category of "Wild Fowl," were omitted because of their making themselves obnoxious to farmers. But the great feature of the bill was its being directed to a definite point—the preservation during the breeding season of those birds which, beyond all others, were and are subjected to cruel persecution at that time of year—thousands of Wild Ducks, Plovers, and Snipes, being constantly to be found in the poulterers' shops throughout the spring months, not only killed while they are breeding, but killed, it is not too much to say, because they are breeding, since during that season they put off much of their natural shyness and fall easy victims to the professional gunners. Furthermore, all who really know anything of birds know that it is just these kinds which are most rapidly diminishing in number—some of them, which in bygone days were most abundant, are now only seen as stray visitors. There is, for example, the Avocet, the disappearance of which can be plainly traced to its destruction by gunners,* and had we space we could cite many similar cases. Then too, nearly all these birds are of no small importance as an article of food, and their supply to our markets has produced a trade of considerable extent.

Now, on the other hand, there are a good many enthusiastic persons, of whom we desire to speak with all respect, who have long been under the belief that in this country the number of birds generally, and of small birds in particular, has been gradually diminishing, and these persons wished for a much wider extension of the principle of protection than seemed to the "Close-time" Committee necessary or expedient. Whether their zeal is according to knowledge may be judged from what we have further to relate, but it is very plain that they disregard the widespread belief in the mischief popularly supposed to be caused by many of even our most useful small birds, and the fact, which no observer of experience can deny, that under certain circumstances, certain birds do a very considerable amount of harm—witness Song-thrushes and Blackbirds in the strawberry-beds—as well as that it is

*This Committee in 1871-72 consisted of Mr. Barnes, one of the secretaries of the Association for the Protection of Sea-birds, Mr. Dresser (reporter), Mr. Harting, Prof. Newton, and Canon Tristram, and it may be doubted whether five gentlemen more thoroughly conversant with the subject could have been selected. Mr. Harland, the other secretary of the Sea-birds' Association, has since been added to their number.

*See Stevenson's "Birds of Norfolk," vol ii. p. 237 and following pages.

only careful observation which will convince an unprejudiced man that the harm so done is outweighed by the general good. Further, too, these persons overlook the impossibility of making people change their opinions by Act of Parliament, and it could be only when they become better acquainted with the great truths of natural history, that the desired results would follow. An attempt to force public opinion in this country generally fails.

Now this being the state of things when the "Wild Fowl Protection Bill" was introduced by Mr. Johnston, the enthusiasts at once tried to make it meet their ends. The history of the bill being, as we have said, accessible to our readers, there is no need for us to enter upon details, and we content ourselves by reminding them that, in an almost deserted House, Mr. Auberon Herbert, on the motion for going into committee, succeeded in carrying, by a majority of 20 to 15, an "instruction" to extend the protection accorded under the bill to "Wild Fowl" to other wild birds, and thereupon the spirit of the Bill was entirely changed, and it was converted from the reasonable measure originally contemplated into one of indefinite and general scope. Persons of common sense at once saw that in its new shape it would be impracticable, not to say tyrannical, and notice was speedily given of its rejection. Its introducer, however, contrived to get it referred to a Select Committee, by whom it was still further modified, the objections naturally urged against its sweeping clauses being overcome by limiting its effects to certain birds named in a schedule, while the penalties were diminished. The schedule, it is true, contained the names of all those birds originally included in the Bill, but many others were added, though on what principle some were omitted and others introduced we cannot profess to say. No ornithologist whose opinion could carry the slightest weight appears to have been consulted, and it is needless to say that no ornithologist was among the twenty-three members forming the Select Committee.*

We need not dwell further on historic details. It is now evident that the efforts of the enthusiasts—well intended as they doubtless were—have produced a law which is on all sides admitted to be virtually inoperative, instead of the effective measure which the results of the Sea-birds Act warrant us in believing that the original Bill would have proved. Substantial fines, which would have been resonable enough where professional gunners and poulterers were concerned, would have been manifestly cruel in the case of schoolboys. Accordingly the penalties were, to use the forcible expression we have heard applied, "sweated away" to suit the minor offenders, and the Act is almost a dead letter. Mr. Herbert, on the 21st of June last, laid a cuckoo's egg in the carefully-built nest of the British Association Committee, and the produce is a useless monster—the wonder alike of the learned and the layman, and an awful warning as an example of amateur legislation. The forebodings of the "Close-Time" Committee have proved but too true. In its last Report we read—

"Your Committee cannot look with unmixed favour on this measure. It appears to them to attempt to do too much, and not to provide effectual means of doing it. In their former Reports they have hinted at, if not expressed, the difficulty or impossibility of passing any general measure, which, without being oppressive to any class of persons, should be adequate to the purpose. Further consideration has strengthened their opinion on this point. They fear the new Act, though far from a general measure, will be a very inefficient check to the destruction of those birds, which, from their yearly decreasing numbers, most require protection, its restraining power having been weakened for the sake of protecting a number of birds which do not require protection at all. Your Committee have never succeeded in obtaining any satisfactory evidence, much less any convincing proof, that the numbers of small birds are generally decreasing in this country; on the contrary they believe that from various causes many, if not most, species of small birds are actually on the increase. They are therefore of opinion that an Act of Parliament proposing to promote their preservation is a piece of mistaken legislation, and is mischievous in its effect, since it diverts public attention from those species which, through neglect, indifference, custom, cupidity or prejudice, are suffering a persecution that will, in a few years, ensure their complete extermination."

We believe that this opinion is entirely correct, but our space would not allow us to adduce evidence in support of it. Mr. Herbert has now confessed the inutility of his handy-work, and some time since gave notice of a motion for the appointment of a Committee of the House of Commons to examine witnesses on the question. Before this article appears in print, our readers will know whether he gets what he wants. If he succeeds we suspect that not much good will follow. The eloquence of the enthusiasts is likely to overpower the reason of the true naturalists—a race not prone to sentimentality or given to sensationalism.

We would observe that the destruction of "Wild Fowl" stands on a very different footing from the destruction of "Small Birds," and if either is to be stopped it must be by different means. To check the first we believe no measure can be devised so complete as that which was last year spoilt by Mr. Herbert, but, since his unhappy success has taught Leadenhall Market that an Act of Parliament may be set at nought with impunity, it is quite possible that a new Act to be effectual should absolutely prohibit, within certain days, the possession or sale of the birds to be protected, irrespective of whether they can be proved to have been received from abroad or not. The destruction of "small birds" is chiefly caused by professional bird-catchers, for the numbers killed by the gun is in most cases comparatively trifling. The outcry that would be raised by farmers and market-gardeners, were they hindered from shooting the birds they find rifling their crops, would quickly repeal any Act which Parliament might inconsiderately pass to that effect. But we certainly should have no objection to putting the bird-catchers under some restriction, and we believe it would be to their own advantage if they were restrained from plying their art during the breeding-season. We shall no doubt be condemned by many excellent persons, but we cannot look upon bird-catchers as a class that should not be suffered to exist. The vocation of a bird-catcher may or may not conduce to the practice of all the virtues, but there is no reason for regarding it as essentially and necessarily vicious. Good and bad exist in every trade, bird-catching among the rest. We conceive that Mr. Sweedlepipes had a right to

* The printed "Proceedings" of the Select Committee do not throw much light on the subject. The schedule was proposed by Mr Samuelson. On a division the Owl was saved by 14 votes to 4, the Hedge-Sparrow and Whinchat by the casting vote of the chairman, the Thrush was lost by 9 to 6. All the birds added are included only under their book-names, which of course are, as every practical naturalist is aware, very different from those by which they are commonly known.

make his living—nay, to be protected in doing so as long as he did not exercise his calling to the detriment of the community. Of course this view will not suit the spasmodic writers of letters to the *Times* and other newspapers with their passionate appeals on behalf of the harmless Hedge-Sparrow and the unappreciated Tomtit. Who is there that systematically persecutes either? Certainly not the bird-catcher even of the blackest dye, begrimed with the soot of Seven Dials or Spitalfields. Are there not just as many Hedge-Sparrows and Tomtits in this country as there is room or food for? Are there not now many more Skylarks and Chaffinches than there were before heaths were broken up and bogs drained, plantations made and "vermin" killed by the game-keepers? But our excellent enthusiasts cannot see this: with them are alike despicable and detestable the gardener who will not believe that the Bullfinch is actuated by the purest and most benevolent motives in nipping off his apple-buds, and the farmer who doubts whether the Sparrow's ravages in his ripening grain are counterbalanced by that saucy bird's services in the cabbage-garden. To them all birds are at all times bent on benefiting the human race. No statement in this direction is too gross for such people to swallow. The last we have met with is one of the most absurd. In the *Quarterly Review* for the present month (p. 402), we read that from some nameless moors the sportsman has been driven by the vipers, and the abundance of the vipers is owing to the extermination of "their natural enemy, the beautiful peregrine falcon"! Such a story is not worth refutation; its original teller has said "that which is not," and the man who gravely repeats it is an idiot or worse.*

But now to conclude, we beg leave to offer the following suggestions:—

1st. That the "Wild Fowl Protection Bill" be passed as originally introduced, with the possible exception of the sentence whereby fowls proved to have been imported from any foreign country are exempted.

2nd. That a "Bill for the Regulation of Bird-catchers" be brought in—its chief feature being the absolute prohibition of bird-catching by means of traps, springes, or nets during the spring months—say from April 1 to July 1, and that at other times of the year such engines should not be used within (say) 50 yards of any highway.

3rd. That the "sport" of Swallow-shooting be absolutely and at all times prohibited; and finally we may add that if a Chancellor of the Exchequer should ever take a hint from North Germany and lay a tax on birds in cages, we in the name of our Nightingales shall thank him.

FAUNA DER KIELER BUCHT

Fauna der Kieler Bucht. Zweiter Band: *Prosobranchia und Lamellibranchia, nebst einem supplement zu den Opisthobranchia.* Mit 24 tafeln. Von H. A. Meyer und K. Möbius. Small folio, 139 pp. (Leipsic, 1872.)

WE are rejoiced to see the second volume of this excellent "*ouvrage de luxe*." Like the first volume, the second bears evident marks of having been prepared with the greatest care. The illustrations are inimitable and life-like: we venture to say that no such figures of Mollusca and their shells have ever been published in any country.

The introduction to the present volume contains an account of the currents, saline ingredients, and temperature of the water in Kiel Bay, together with elaborate tables of the latter properties in comparison with those in some other parts of the North Atlantic and in North Japan, as well as a notice of the peculiarities, distribution, and frequency of occurrence of the Kiel Bay Mollusca, and relative abundance of the genera and species in proportion to that of the Mollusca in Great Britain, Christianiafiord, and the Sound.

The body of the work embraces the subclass Prosobranchia (comprising the orders Cyclobranchiata, Pectinibranchiata, and Siphonobranchiata) of the class Gastropoda, a supplement to the first volume in respect of the other sub-class Opisthobranchiata (orders Pleurobranchiata and Pellibranchiata), and the Lamellibranchia (order Lamellibranchiata of the class Conchifera), with short diagnoses in Latin, and full descriptions in German of all the species given in the work. The admirable figures amply illustrate every character of the living animal and its shell, some being of the natural size, and others magnified 300 times.

We are not told whether any Brachiopod, marine Pulmonobranch, or Cephalopod inhabits Kiel Bay; but assuming the list to be complete, we find 23 species of Conchifera, and 40 of Gastropoda, being altogether 63 species. There are 562 species of Mollusca in the British seas. This great difference may arise from the brackish nature of the water in Kiel Bay; and to the same cause may be attributable the small size of all the Mollusca, except *Mytilus edulis*, which is usually stunted on the open sea coast.

The authors have satisfactorily shown that the genus *Triforis* (erroneously changed by Deshayes to *Triphoris*) is distinct from *Cerithium*, although belonging to the same family, between which and *Cerithiopsidæ* it appears to be intermediate. The principal difference consists in the animal of *Triforis* having a retractile proboscis; and Lovén's description of *T. perversa* was doubtful on that point. Other writers on the Mollusca have done nothing to help us in the classification of this difficult group. The shells are distinguishable by the shape of the mouth, which is very peculiar in *Triforis*; and the sculpture of the apex differs from that of *Cerithium*—an important character which might have been advantageously represented in the plate before us.

We hope the authors will not take amiss a few slight criticisms. Their *Rissoa inconspicua* is not Alder's species, but *R. albella* of Lovén. *R. octona* of Linné is probably a variety of *Hydrobia ulvæ*, judging from his description and the habitat "in Sveciæ subpaludosis." The species described and figured by Meyer and Möbius as *R. octona* has two more (viz. ten) whorls; it is not horn-colour, but variegated; the mouth is oval, and not "fere orbiculata;" and Linné does not mention the ribs which characterise the Kiel Bay species. The figures of *Rissoa striata* do not show the foot-appendage or caudal cirrus, although it is described in the work. *Amphisphyra* should be *Utriculus*.

* It is painful, however, that such folly should be countenanced by reviews which in other respects are deservedly of high repute. But in no department of criticism is there such a want of competent writers as in Zoology. We are not exaggerating when we say that nine out of ten reviews of zoological works are written by men who have no sound knowledge of the elements of the science.

We wish the authors could have given us some information as to the *modus operandi* of the *Teredo* in excavating its cylindrical tube, instead of merely quoting Kater's opinion that the shell is the boring organ. One thing is certain, and indeed has been admitted by Kater, that the foot of *Teredo* is in front, occupying the bottom of the tube, while the shell at the same time occupies that part of the tube which lies immediately above the foot, and is closely pressed against the sides of the tube. To suppose that the position of the foot and shell could be reversed by the animal, so as to make the shell lie at the bottom of the tube and the foot on one side during the process of excavation, is quite inconsistent with our knowledge of the *Teredo* and of the habits of other boring and burrowing Mollusca. *Solen*, *Cardium*, *Natica*, *Actæon*, and many other kinds burrow in sand by means of their strong muscular foot; *Pholas dactylus* occasionally does the same; and the limpet uses its foot only for excavating the hard rock in which it is sometimes more or less deeply imbedded. The gradual enlargement throughout of the tube of *Teredo*, especially at the opening (where the siphons are placed), cannot possibly be caused by the shell, which invariably lies at the other end; and the prickles which cover the surface of the shell, and enable it to act as a fulcrum or *point d'appui*, could not be renewed if they were continually employed in rubbing away the wood. There can scarcely be a question that the foot is the sole instrument of perforation in *Teredo*, as it is in *Solen*, *Pholas*, and *Patella*.

J. GWYN JEFFREYS

OUR BOOK SHELF

The Student's Manual of Comparative Anatomy and Guide to Dissection. Part I. (Mammalia). By G. H. Morrell, M.A. (Longman and Co.)

THIS work is in two parts, which are of such different characters that they must be considered separately. The first is intended to include a short and complete summary of the main facts of the anatomy of Mammalia. This is a large undertaking, and one which a resident in Oxford has not full opportunities of completing; for the advantages in any place other than London, are not sufficient to enable any single student, however enthusiastic, to get familiar with many of the subjects discussed. There is a want of vividness and point in many of the statements, several of which are too inclusive. Referring to the lobulation of the kidneys, the seals and whales are mentioned as presenting it, but why are the ox, otter, and rhinoceros omitted? The peculiarity of the stomach of the chevrotain is not referred to, and all we can possibly infer as to that of the peccary or hippopotamus is that it is constricted into two or three portions, which is undoubtedly not enough. Half a page only is devoted to the peculiarities of the liver throughout the class, and that of man is called simple, while that of the Ruminants is included among the multifid. The spleen of the marsupials is stated erroneously to be bent or bilobed.

But the great and inexcusable imperfection of the work is the omission of the description of the generative system, which no amount of argument could persuade us will prove of the slightest good in any way. It only engenders a mystery and curiosity in the mind of the younger students, as to peculiarities of structure, which if they were treated in the ordinary routine, would, as they undoubtedly are among medical students, be looked upon in nothing but a common-place manner.

The second portion of the work, the guide to the dissections of the brain, heart, &c., of the sheep are excellent, and will be found of great value; they have long been wanted by teachers. A carefully compiled synopsis of the cerebral convolutions in man and the higher apes, from the work of M. Gratiolet, terminates the book.

Académie Royale de Belgique. Centième Anniversaire de Fondation. Two vols. (Brussels: F. Hayez, 1872.)

THESE two stout volumes, intended as a memoria of the celebration of the hundredth anniversary of the Belgian Academy, treat of a great variety of interesting and valuable matters. The Belgian Academy of Science, Literature, and Art was founded by Maria Theresa on December 16, 1772, but as December is not a very suitable month for a great public gathering of men from all parts of Europe, the Academy held its centenary fête on May 28 and 29, 1872, and it did it very royally, in presence on both days of His Majesty the King of the Belgians, who gave the opening address, and entertained members and friends on the second day in his palace at Brussels. There took part in the celebration distinguished deputies from all the countries of Europe and from America, and altogether it seems to have been a great success. In these volumes will be found a detailed account of all that was said and done, verbatim reports of all the speeches made, and of all the interesting papers read. The Academy began to make preparations for the centenary celebration in 1869 by the appointment of a commission. This commission appointed members of the various classes of science, literature and art to prepare papers giving accounts of the work done in these classes from the commencement, and others to do the same for the various literary, antiquarian, artistic and scientific subjects with which the Academy deals. From this it may be surmised that these two volumes contain matter of very great value indeed. The first paper is by M. A. Quetelet, giving a sketch (170 pages) of the history of the first century of the Academy. But the second volume will be the more interesting of the two to scientific men; we can only indicate its contents:—Astronomy in the Royal Academy of Belgium from 1772 to 1872, by M. E. Mailly; Report on the Mathematical works of the Academy during the same period, by M. J. M. de Tilly; Report on works in the Physical Sciences, Meteorology, and Physical Geography, by M. J. Duprez; Report on works in Chemistry, by M. L. G. de Koninck; Report on works in Zoology, by P. J. van Beneden; Report on works in Botany and Vegetable Physiology, by M. E. Morren; Report on works in Geology and Mineralogy, by M. G. Dewalque.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Biela's Comets

THE present note is designed to show that several comets move in nearly the same orbit with that of Biela; that they probably entered the solar system *as a group;* and that, after making their first perihelion passage in close proximity to each other, they were, when receding from the sun, thrown into their present orbits by the disturbing influence of Jupiter.

1. *Was the comet of* 1772 *identical with that of Biela*?—The mean of the seven consecutive periods between January 2, 1806, and September 23, 1852, is 2437·7 days. Counting five periods of the same mean length from February 17, 1772, brings us to July 2, 1805—six months before the perihelion passage of 1806. In other words, the mean period between 1772 and 1806 was greater by about thirty-seven days than that between 1806 and 1852. The perturbations during the half century succeeding the apparition of 1772 have not been computed. It seems very unlikely, however, that the difference of periods

could thus be accounted for. We conclude, therefore, that the comet of 1772 was not that of Biela.

2. The first comet of 1818 is regarded by Dr. Weiss as a probable member of the Biela group.* This body, discovered by Pons, was visible only four days. Its elements, as computed by Pogson, have a striking resemblance to those of Biela's comet, the longitudes of the ascending nodes differing by only 1°. There can be little doubt that it was connected, in its origin, with the comet of Biela.

3. The companion of Biela, observed in 1846 and 1852, is another comet of the same cluster. The fact that several cometary masses move in orbits almost identical, may afford a plausible explanation of the division of Biela's comet. Was one member of the group overtaken by another as they were approaching perihelion in 1845, and was their separation after imperfect collision the phenomenon observed at that epoch?

4. The comet detected by Pogson, at Madras, on December 2 and 3, 1872, may have been another member of the same family. Its perihelion passage occurred nearly three months after the time computed for that of Biela. Prof. Newton has remarked † that so great a lengthening of the period could not probably be explained by planetary perturbation.

M. Hoek has shown ‡ that certain comets have been associated in groups before entering the solar domain. When the members of such cometary systems are widely separated, they may pass round the sun in very different orbits. The comets, however, which constitute the Biela cluster must have entered our system at small distances from each other, since their orbits are nearly coincident. These orbits, between longitude 255° and 265°, pass within no great distance of that of Jupiter. The group had perhaps made its first perihelion passage in a parabolic orbit. Receding from the sun, it fell under the controlling influence of Jupiter; the comets had various positions in relation to the planet, and hence the orbits resulting from the attraction of the latter were slightly different.

We might regard the comet of 1772, the companion of Biela, and Pogson's comet of 1872, as probably identical, but for the small increase of distance between the two Biela-comets in the interval from 1846 to 1852. The period would be about 2456 days.

That the comets of this cluster have been moving in their present orbits but a comparatively short time is rendered probable by the fact that no two of the members hitherto detected have become widely separated, and that, notwithstanding the frequency of the return to perihelion, the meteoric *débris* is much less diffused than in the case of other known streams.

Were all the members of this cluster originally united in a single comet, or did they *enter the solar system* as a group? To this question, perhaps, no satisfactory answer can yet be given. It seems probable, however, that the united masses would have formed a somewhat conspicuous object, too brilliant to have entirely escaped observation.

DANIEL KIRKWOOD

Bloomington, Indiana, April 15

Earthquake in Dumfries

WHILE sitting in my lonely house in a retired but beautiful glen of Dumfriesshire, I was aroused on the evening of Wednesday 16th current, at ten minutes to ten o'clock, by one of the most singular noises ever I had listened to. The tone of it was somewhat like thunder, but it did not rise and fall in pitch. It lasted, perhaps, for twenty seconds, and was accompanied by a slight tremor. At first I thought it was a two-horsed carriage coming, and at a lumbering pace, and then, with some hesitation, I took it for thunder, but next day I found that it was generally recognised as an earthquake. The shaking was very perceptible in some localities. It extended through the parishes of Closeburn, Morton, Penpont, Glencairn, and Tynron, over a length, I am safe to say, of ten miles. Dr. Grierson of Thornhill Museum felt it as a rude shock. In Tynron village there was some alarm, as one family thought it was the wall of the churchyard that had fallen. On December 24, last year, a similar shock was felt in some parts of Upper Nithsdale. Although I have resided for many years in Dumfriesshire, these are the only occasions on which there was any surmise of an earthquake. The local papers have said almost nothing about it, but I am sure this will interest some of your readers.

Tynron School, April 23 J. SHAW

* Astr. Nach., No 1710.
† American Journal of Science, April 1873.
‡ Monthly Notices of the R.A.S., vol. xxv. p. 243.

East India Museum

ALLOW me to make yet another suggestion (in addition to those of P.L.S. and Prof. Newton), with regard to the disposal of the natural history collections at the India House. It seems to me to be one of the greatest popular delusions, that specimens of natural history necessarily require lofty halls and spacious galleries for their preservation and exhibition in a useful manner. I hold, on the contrary, that, with few exceptions, they far better serve educational and scientific purposes when arranged in ordinary apartments. All the scientific work in the British Museum is done in small rooms; and the palatial galleries with their crowded myriads of specimens and miles of glass cases, however instructive they may be (or might be made) to the public, are a positive hindrance to scientific work. I am very much mistaken if all the India House natural history collections might not be suitably placed in two or three ordinary sitting rooms, and so arranged in cabinets and boxes as to be far more convenient for reference and study than they have ever been. The rent of a moderate-sized house in an airy situation, say 250/. with an equal sum for the salary of an efficient Curator, and a small grant for cabinets and the necessary books of reference, is all the expense required to make this interesting collection completely accessible to all who wish to consult it. Every one interested in Indian natural history would then visit it. It would again receive gifts of collections from travellers, Indian Officers, and other persons interested in the natural history of the East; and its increase in value from this source alone might go far towards furnishing a tangible equivalent for the expense incurred, while it would certainly render the collection a better representation of the Indian fauna than it is at present, and more worthy of a place, at some future time, in the proposed grand Indian Museum.

Such a modest establishment would also, I believe, do much good by showing at how small an expense a really useful scientific museum may be kept up, and would thus encourage the formation of local museums in cases where 20,000/. or 30,000/. cannot be raised for a building. It would not, of course, be a show museum for the uneducated public to wander and gaze in; —the British Museum serves that purpose. But it would prove greatly superior to any such mere exhibition, as a means of furnishing definite information on Indian zoology, and enabling any intelligent inquirer to obtain some idea of the many wonderful and beautiful forms of life which characterise, what is at once the smallest and the richest in proportion to its extent, of the great zoological regions of the globe.

ALFRED R. WALLACE

IT will be greatly to be regretted if even your suggestions are adopted as a remedy for the present neglect, and the claims of scientific men and of the public at large for a Government museum be abandoned. It is very desirable for Indian interests that the Museum shall be, as before, connected with the Indian department.

It is quite true accommodation in the sky-parlours, with casual access by a lift, is given for the industrial collections so well conducted by Dr. Forbes Watson, and which collections, as chairman of the Indian Committee of the Society of Arts, I feel bound to contend for as of great value to England and to India.

There is no solid ground for letting the Government go. They acquired in the like way the property of the Levant Company, and attempted to shirk the rights and obligations, but were compelled to maintain the public buildings, churches, hospitals and burial-grounds at Constantinople, Smyrna, &c. It must be owned they constantly attempt to evade the obligations.

They are now engaged in paying off the stock of the old East India Company, of which they have acquired the territory, houses, property, prerogatives, &c., and they must simultaneously accept every obligation, pecuniary and moral.

This was a museum for the service of England and the service of India, and there is no reason why it should not be kept up. There is, it is true, a growing licence in this day for representing us as usurpers and oppressors of India, whereas the peace, prosperity, and progress of India have been created by us, and were we to withdraw, would be destroyed by the sanguinary conflicts of the various races of conquered and conquerors constituting the populations.

We ought to stand on our right to share in the prosperity of India as a prerogative belonging to us. Besides, for the benefit of India, the collections are kept up by Englishmen, for there is

not the requisite knowledge among natives in India; the work must be done in this safer climate, and the specimens can be better preserved here than in the museums of the hot plains, or those which may be formed in the damp regions of the hills.

HYDE CLARKE

St. George's Square, S.W.

Instinct

Moving in a Circle

IN your last week's number a letter appeared with the initials N. Y., in which it was stated that it is believed in North America that a lost man always strays in a circle towards the left. I may mention that whilst walking in a woody and hilly part of the New Forest, I found, to my great astonishment, that I had described a complete circle, and it was towards the left. My father also tells me that he has been informed (although under what circumstances he does not recollect) that the same idea obtains in Australia. It has been suggested that the reason of this fact (if fact it is) is, that the right side of the body is stronger than the left; in confirmation of the truth of this explanation, it is worthy of notice that Dr. Wm. Ogle (in a paper on Dextral Pre-eminence, Medico-Chirurgical Transactions, vol. liv.) finds that men are right-legged as well as right-handed, although the rule has not so universal an application. One of the points adduced by him in evidence is that bootmakers generally find the right foot larger than the left.

If any of your readers who have strayed in a similar manner, would take the trouble to write to you merely stating whether they wandered to the right or the left, it is possible that a sufficient body of facts might be collected either to confirm or disprove this curious belief.

GEORGE DARWIN

Down, Beckenham, April 29

Perception in Dogs

PERHAPS you will think that the following story of a Mentone dog, Pietrino, is worth adding to the similar stories which have appeared in your columns:—

The Archduchess Marie Régnier passed the winter of 1871–2 at the Hotel Victoria in Mentone. While there she became much attached to a spaniel belonging to M. Milandri, the landlord, and on her return to Vienna in the spring she took the dog there. Not long after, the dog reappeared at the hotel in Mentone, having returned on foot a distance of nearly one thousand miles over a country totally unknown, excepting having once traversed it by rail. The fatigue caused the poor fellow to die a few days afterwards, and Pietrino is honoured with a grave and a monument in the hotel gardens.

I send you a French paper containing the same facts.

JAMES B. ANDREWS

Villa d'Adhemar, Mentone, April 17

PERHAPS the following anecdote on the instinct of dogs, which has lately come to my knowledge, may prove of interest to some of your readers.

A family residing in Yorkshire possessed two dogs, one a mastiff, and the other a small dog. The owner, visiting Hastings, took the little dog with him, and at the house where he stayed there was a larger animal, who, disregarding the laws of hospitality, woefully maltreated his youthful visitor. The little dog, upon this, disappeared, and in a few days returned, bringing with him the mastiff from Yorkshire, which set upon the Hastings dog and thrashed him to within an inch of his life. Having performed this piece of retributive justice he returned to his home in the north, while the little dog stayed to rejoice over his fallen antagonist.

A. PERCY SMITH

Rugby, April 18

Prehistoric Art

MR. SEARLE V. WOOD'S inquiry (NATURE, vol. vii. p. 443) whether any existing race of savages is capable of depicting animals with the spirit and fidelity of the supposed contemporary representations of the mammoth is a most pertinent one, but must be answered in the affirmative. In the Atlas to Gustav Fritsch's great work on the Aborigines of South Africa, just published at Berlin, will be found reproductions of delineations of animals, executed in caves by the Bushmen, which are certainly equal to the carvings and tracings of the prehistoric period. The originals are usually painted, but sometimes carved or scratched in sandstone or some other soft material. Five different colours are employed; the objects represented are usually the animals indigenous to the country, but the human figure is occasionally introduced, and since the arrival of the European colonists, horses and even ships have been added. It is most remarkable to find the Bushmen in this respect so far in advance of the comparatively civilised negro, who has never of his own impulse produced anything approaching to the merit of these designs. Perhaps some of your contributors will be able to state whether any corresponding difference exists in the cerebral organisation of the respective races.

R. G.

London, April 19

April Meteors

IN continuation of my report sent you yesterday in reference to the April meteors of this year, I desire to add the following. The evening of April 21 being clear, a watch was sustained from 9^h to 12^h, during which time 14 shooting-stars were seen. These, with the 20 observed on the two previous evenings, make the total number seen 34 in $7\frac{1}{2}$ hours of observation. The details of the meteors noticed on April 21 are as under:—

Ref. No.	Date.	Time.		Beginning. R.A.	Beginning. D.	Ending. R.A.	Ending. D.
21	April 21	9.8	$1\frac{1}{2}$ mag. *	266°	54°+	236°	32°+
22	,,	9.10	2nd mag. *	299	$38\frac{1}{2}$+	309	38 +
23	,,	9.29	3rd mag. *	310	59 +	319	58 +
24	,,	9.41	3rd mag. *	289	61 +	270	68 +
25	,,	9.57	2nd mag. *	263	50 +	238	47 +
26	,,	10.22	3rd mag. *	273	51 +	273	61 +
27	,,	10.30	4th mag. *	325	68 +	328	60 +
28	,,	10.32	4th mag. *	$264\frac{1}{2}$	61 +	255	55 +
29	,,	10.50	4th mag. *	319	$69\frac{1}{2}$+	339	66 +
30	,,	11.7	α Lyræ	$295\frac{1}{2}$	45 +	309	49 +
31	,,	11.16	3rd mag. *	278	49 +	270	$59\frac{1}{2}$+
32	,,	11.32	4th mag. *	275	14 +	283	12 +
33	,,	11.40	3rd mag. *	284	59 +	270	47 +
34	,,	11.45	4th mag. *	334	47 +	341	41 +

Nos. 22, 25, 26, 30, and 31 were from the radiant near α Lyræ. On April 19 and 20 the largest proportion of meteors were Lyraïds, but on April 21 they were in a minority. Nos. 21, 23, 24, 33, and 34 were conformable to a radiant at ο Draconis, R.A. 283°, D. 59°+, and it is worthy of note that on the two preceding nights there were no indications of this radiant point. To sum up my recent observations, it would seem that from the various meteoric tracks noted, the April shooting-stars of this year had three well-marked centres of radiation, viz., (1) near α Lyræ, (2) near Arcturus, and (3) at ο Draconis (R.A. 283°, D. 59+). There were also evidences of at least two other radiant points that, owing to the paucity of meteors, could only be approximately ascertained, viz., (1) near ζ Draconis, and (2) near α Cygni. The brightest meteor seen on April 21 was a Lyraïd; time, $11^h\ 7^m$. Its path was accurately fixed. The meteor first appeared at 1° N. of δ Cygni, and travelling to N., disappeared in a small triangle of stars 5° N. of α Cygni. Several of the meteors emitted sparks in traversing their courses, but the majority were small objects of very brief duration.

The foregoing particulars (taken in conjunction with my previous letter) may be useful in determinating the radiant point of the April meteors, especially with regard to those diverging from Lyra, which, I believe, are considered identical with Comet I. 1861. I fixed this point at R.A. 274°, D. 37+, which is nearly of accord with the result of Karlinski (1867), R.A. 278°·2 D. 34°·5+, and of Prof. A. Herschel (1864), R.A. 277°·5, D. 34°·6+.

Bristol, April 22

WILLIAM F. DENNING

A proposed new Barometer

IN the number of the *Philosophical Magazine* for May 1871 is an article by Prof. Heller, of Ofen, rendered (carelessly enough) from Poggendorff's *Annalen*, describing a balance fitted with nearly equal weights of very different volumes, which he proposes as a barometer. He says that the principle on which it is founded "has not hitherto been used in barometric measurements." This is not quite correct; a balance, absolutely identical in principle, is described by Boyle in vol. i. p. 231, of the Philosophical Transactions, under the title of "A new Statical Baroscope." It would seem that the practical difficulty of keeping it in accurate adjustment has been and still will be a bar to its use in the way the two inventors have proposed; otherwise, it might perhaps be advantageously employed in mountain surveys; it would, at any rate, be free from many of the objections to the aneroid.

Considered, however, as an exact barometer, I would main-

tain that the principle is altogether erroneous, depending as it does on the assumption that the pressure of the atmosphere is purely a function of its specific gravity or density. This is not true, for pressure may vary within wide limits, whilst the density remains unchanged. Experimentally this might be shown by putting, say, an aneroid and a balance, such as I have been speaking of, in a large glass vessel, which can be made air-tight when closed. Under normal conditions the two will at first register the same pressure ; but if the temperature is sufficiently increased or diminished, the increase or diminution of elastic force will manifest itself by the aneroid ; but as the density remains unaltered, the balance will show no change. Does such an experiment at all correspond with any natural observations? I think so, in, of course, a limited degree. If the lower part of a column of air is heated, its expansive force will push the adjacent air outwards and upwards ; but as it does so, it has to overcome a certain amount of inertia ; to do this requires time, during which, as the volume of the heated air does not increase in proportion to the temperature, the elastic force does. This ought to be shown by the barometer ; I think it often is, but the barometer is a sluggish instrument at best, and its indications are undoubtedly wanting in quickness, and therefore in exactness. Still its principle is correct ; so is the principle of the aneroid, or of Bourdon's barometer (on which there is an interesting paper in the *Quarterly Journal* of the Meteorological Society for April 1872), though practical difficulties stand in the way of their use becoming general. But the tangent balance is not capable of measuring atmospheric tension, except when that tension depends on density alone ; and this is frequently not the case—perhaps never.

J. K. LAUGHTON

April 23

Acquired Habits in Plants

AT p. 446 of NATURE, J. G. records a "dog violet" which he thinks has assumed an unusual form. As there are several plants called "dog violet," and as one of them does in favourable situations attain a very considerable height, it would be interesting to know what was the species observed by the river Aled. The *Viola canina* (*V. riviniana* Reich.), in one of its forms which is probably a distinct species, has flowering shoots which sometimes attain a foot in length, and if supported by the surrounding vegetation do sometimes stand nearly upright, If this was the plant observed, J. G. only found a more than usually strong form.

C. C. BABINGTON

The Zodiacal Light

MR. BACKHOUSE asks if the observations given in vol. iii. p. 203, afford any proof that the Zodiacal Light is not a lens-shaped disc of light enveloping the Sun ; if this theory were correct, and the sun enveloped in a continuous mass of light-reflecting matter, whenever the light is seen in the evening after sunset, it ought to be also seen in the morning before sunrise, of the same brilliancy at the same angular distances from the sun, especially when those distances are small, for then the effect of an elliptical form in the section of the envelope by the plane of the ecliptic would be almost entirely eliminated.

The results of observation given in most of our hand-books of astronomy are therefore directly at variance with this theory, and I did not consider it necessary to allude to it before.

Jamaica, April 6

MAXWELL HALL

ON VENOMOUS CATERPILLARS *

POISON and venom are often used as convertible terms. I do not understand them to be so. Poison properly means something which injures the system by introduction through the stomach. Venom, something which injures by introduction into the vascular system through lesion of the tissues. Most poisons are also venoms ; whatever injures, if introduced into the stomach, will most probably also injure if introduced directly into the blood. But the converse is not true : most venoms are not poisons, that is, it is not by digestion and assimilation that they work, but by entering the vascular system from without. It is said that you may swallow the venom of the rattlesnake with impunity ; and I imagine you may, if it does get absorbed through the mucous membrane ; but Dr. Fayrer's experience, lately published, of the effects of the semi-swallowing, which occurs in extracting the venom from a poisoned wound by sucking, would rather seem to show that such extremely virulent venom would penetrate the mucous membrane, and act as if actually introduced by a wound, his throat having become dangerously ulcerated from sucking the poison from the wound of a man bitten by a cobra. There is yet another way than swallowing or being wounded, by which venom may injure, and that is through the nervous system, by application to the skin. This is the way in which the nettle must sting. In that case there is not the smallest lesion in the skin, and if a nettle were artistically made to touch the open surface of a gaping wound, it would not sting at all ; neither is it by mechanical irritation that the pain is caused. The nettle has a venom gland, as well as the rattlesnake, and it is the application of this venom to the delicate termination of the nerves in the skin which produced the pain felt.

The subject to which I invite the consideration of the Society this evening is whether any insects possess similar power of injury to that of the nettle. In ordinary cases the venom of insects is applied by a puncture in the skin, into which the venom is introduced by an apparatus provided for the purpose. But for a long time it has been said that certain caterpillars sting like the nettle, although the authorities have for the most part been too vague to allow us to be very sure as to the fact ; and supposing the fact to be true, it has been argued that the pain or annoyance was merely the result of mechanical irritation of a similar nature to that which medical men sometimes meet with in hairdressers, or rather hair-cutters, where minute portions of the cut hair of their customers work their way into the skin below the shirt-sleeve and give rise to a painful and irritating sore on the wrist. Two passages which I shall take leave to quote, will bring the question, as it at present stands, pretty fairly before the meeting. The first is from a paper by myself on the geographical relations of the chief Coleopterous Faunas, which was published in the Linnæan Society's Journal for 1870 (p. 55) :—

"A very remarkable African affinity in the Lepidoptera has been mentioned to me by Dr. Welwitsch. It is plain that an affinity to any genus endowed with peculiar properties is rendered doubly certain if the supposed allied species possesses the same properties. There is a Lepidopterous insect in Australia, the larva of which possesses remarkable poisonous powers. It has been named *Doratophora vulnerans*. Such insects also occur in South Africa. Livingstone speaks of a caterpillar called *Rigura* as producing fearful agony if a sore is touched with its entrails. Mr. Baynes, in his "Explorations in South-west Africa," speaks of another, or perhaps the same, which he calls the *Kaa*, and which is used as a poison for their arrows by the Bushmen ; and Dr. Welwitsch had a personal experience of the severe swelling and pain in every part of his body which he touched with his hand after collecting specimens of a caterpillar against which he had been warned as poisonous. He had in consequence of the warning carefully avoided touching them, shoving them into a phial with a straw ; but whether he had inadvertently touched them or fingered the leaves on which they had been feeding (which he collected for examination), he and his servant were both laid up helpless for two or three days. His specimens of the caterpillar were lost ; but among his Lepidoptera Dr. Fendler of Vienna, who has undertaken a description of them, finds no less than four species of *Doratophora*, and these, doubtless, are the perfect insects of species of the caterpillar, from one of which he suffered."

The second passage which I wish to quote is from a paper by Mr. Roland Trimen, Notes on the above paper, and also published in the Linnean Society's journal. It is as follows :—

"At p. 55 Mr. Murray notes what he considers 'a very

* A paper read at the opening of the Kensington Entomological Society.

remarkable African affinity' in the Lepidoptera of Australia, in reference to the case of the larva of *Doratophora vulnerans* Lewin. The instances which he cites as analogous, however, are very different in character, for he quotes the mention by Livingstone 'of a caterpillar called *Rigura*, producing fearful agony if a sore is touched *with its entrails*'; and the statement made by Baynes and other travellers, that a caterpillar is used by the Bushmen to poison their arrows. It is evident that, if a caterpillar be used at all for poisoning arrows (concerning which report my inquiries have hitherto been attended by no satisfactory result) it must be the intestines or juices of the animal which are so employed. But the case of *Doratifera vulnerans* is the common one of (what appears to be mechanical) irritation, by means of clusters of spines, a defence possessed by many caterpillars, not only in Australia and South Africa, but throughout the globe, and of which the larva of the European *Cnethocampa processionea* presents a familiar example. Duncan (Nat. Libr. Ent. vol. vii. Exotic Moths, pp. 181-2. pl. xxii. f. 5) represents the larva of *D. vulnerans* as possessing four fascicles of rufous spines, exsertile at will on both the anterior and posterior portions of the body, and quotes Lewin to the effect that the wound inflicted by the fascicles is very painful. According to Mr. Murray's account it would appear that the African larvæ, from the handling of which Dr. Welwitsch experienced such suffering, were near allies (if not actually species of *Doratifera*); and the conclusion is obvious that it was by fascicles of spines that the pain was occasioned—not an uncommon case in the warmer parts of the world, and one by no means indicative of any special relation between the Lepidopterous faunas of South Africa and Australia."

Mr. Trimen is obviously right as to the absence of analogy between the venomous properties of the caterpillars spoken of by Livingstone and Baynes, and those met with by Dr. Welwitsch, and it was a slip on my part to collocate them together; but I am not satisfied that he is equally right in referring the pain caused by the species of *Doratophora* to mechanical irritation. He gives no facts in support of his assumption to that effect, and the facts communicated to me by Dr. Welwitsch regarding the insect from which he suffered seem to me wholly inconsistent with that supposition. It may be supposed from his and my silence that we acquiesed in Mr. Trimen's views. But it is not so. When Mr. Trimen's paper appeared Dr. Welwitsch spoke to me upon the point, and I urged him to communicate to the scientific world fuller details of the incident than I had given, and I understood that he intended to do so in any account of the insects collected by him. I therefore did not feel warranted in speaking, which I now regret, for as with much else that he had on hand to do, his life has been too short for him to do it himself. Now that he has passed away from us I should not like an erroneous impression to exist as to the facts; and although I have little to add to what I formerly stated as communicated by him to me, I should wish to repeat it more precisely, and to say that Dr. Welwitsch himself was firmly convinced that it was not a case of mechanical irritation but of a special virus of unusual potency.

In the first place, then, Dr. Welwitsch had heard of this noxious caterpillar before he met with it—the natives knew it well and dreaded it. In the next place when he did meet with it his native attendant warned him of it—and they took every precaution against touching it; they plucked leaves on which the caterpillars were feeding and guided them from the leaf into the wide-mouthed bottle or vessel he had to carry such specimens home in. They also took specimens of the plant on which they were feeding. I suggested to him that the sting might have been in the plant, but this he was positive was not the case. The virulence of the venom was such that by the time they reached home in an hour or so after, every tender part of their body which they had touched with their fingers had become swollen and inflamed; their eyes were closed up, their lips and cheeks swollen as if they had been assisting (as principals) at a prize fight, and the consequent fever was so great that they were laid up, unable to move for two or three days; and when they did get up he found that their attendants had bundled out of the house both the caterpillars and the plants on which they fed. Now it seems to me that mechanical irritation is a wholly inadequate cause for such extreme inflammatory action. Mechanical irritation may go a certain length, but there are bounds beyond which we must look for some other explanation.

But first we want more facts and more examples. I exhibit two caterpillars, apparently different species, which I have received from Old Calabar, given to me with a notandum as reckoned injurious if not venomous, but my information as to them is too vague to allow me to cite them as positive examples of venomous caterpillars. And I also show one from Brazil which I have received from my friend, Mr. Fry, which he informs me bears a very bad character in Brazil. Both of these, indeed, all to which this property has been ascribed, are hairy caterpillars; but then it is only hairy caterpillars that seem to have the necessary apparatus for stinging—all stinging plants, so far as I know, are hairy. If the caterpillars have a special venom, then, as in the nettle, there should be a gland at the base of each hair, which should be hollow, and the spines in most, if not all, our caterpillars are hollow. I know of no physiological reason against their being so made. In the skin of the newt there are pores which exude an acrid irritating fluid. If a hollow hair were placed over the pore with proper muscles, we should then have a parallel to the supposed case.

But, as I said before, we want information as to the existence and amount of this venomous property, and the chief object of this paper to-night is, after eliciting the views of the meeting, to suggest to those who may have the opportunity, the desirableness of making observations on the point. A. MURRAY

ON SPACE OF FOUR DIMENSIONS

WE may define *space* as that which indicates and measures the extension of the Universe. We may determine the form and position of any material object by assuming three infinite planes, fixed in infinite space, and at right angles to each other. Space then is the room occupied by matter, or included between distant masses of matter; and, as such, we know of it only as possessing three dimensions:—length, breadth, thickness.

Descartes (*Principia* pars. 2, "*Quid sit spatium, sive locus internus*") remarks, "For, in truth, the same extension in length, breadth, and depth, which constitutes space, constituted body; and the difference between them consists only in this: that in body we consider extension as particular, and conceive it to change with the body; whereas in space we attribute to extension a generic unity (*genericam unitatem*), thus after taking from a certain space the body which occupied it, we do not suppose that we have at the same time removed the extension of the space, because it appears to us that the same extension remains there so long as it is of the same magnitude and figure, and preserves the same situation in respect to certain bodies around it, by means of which we determine the space."

Gauss used to say that one of the happinesses of his future life would be the amplification of his conceptions of space; the realisation of that which he had once known as space of three dimensions, as space of four dimensions. For just as we can conceive of beings "like infinitely attenuated book-worms in an infinitely thin

sheet of paper," which can realise space of only *two* dimensions, so also we may conceive of beings capable of realising space of *four* dimensions. Prof. Sylvester, Dr. Salmon, Prof. Clifford, and others, have indicated in some of their profoundest mathematical demonstrations that they possess "an inner assurance of the reality of transcendental space." We desire now to bring forward, with great apology to the mathematicians for our temerity, some ideas, which we believe may enable even the least mathematical amongst us, to realise,—faintly, indeed, and very dimly—the possibility of existence of space, other than that which we now occupy. This we propose to do, (α) by attempting to realise a condition of life in space of two dimensions, and (β) by adding the element of diverse motions, to our already known space.

Our knowledge of the Universe involves the conception of *space*, *time*, and *number*. These are intuitive notions: we cannot strictly define them; in the abstract our notion of them is merely relative; apart from material existence we cannot realise them. Extension is an essential property of matter, and our conception of space is linked with our conception of extension. Robert Hooke, in a series of lectures *De Potentia Restitutiva*, written nearly two hundred years ago, and too little known, defines a sensible body as "a determinate space, or extension, defended from being penetrated by another, by a power from within." Now this power may be most readily conceived to be a vibratory motion of the particles across a position of rest. Let us imagine an infinitely thin plane vibrating between two fixed points with such velocity that no other matter can penetrate into the space limiting the vibration, then a solid bounded in one direction by the two fixed points would be the result. For example, let an infinitely thin sheet of iron a metre square vibrate with extreme velocity in a span of one metre, and a cubic metre of iron would be the result. The rapid vibration of the plate would defend the range of vibration from being penetrated, and impenetrable material substance would result. An infinitely thin line vibrating between two fixed points would furnish a plane. An infinitely thin plane vibrating between two fixed points would furnish a solid. Thus by the addition of motion we can convert a determinate space, approximately of one dimension, into space of two dimensions; and by the addition of motion we can convert space of two dimensions into space of three dimensions. Can we conceive of any motion which given to space of three dimensions shall generate space of *four* dimensions? We do not know of such motion, but we can surely conceive the possibility of its existence. Space of four dimensions is transcendental space: it is beyond the limit of our experience, but not beyond the limit of our imagination.

Let us now endeavour to realise the condition of a being living in space of two dimensions. If man possessed the eyes and the power of flight of an eagle, superadded to his ordinary intellectual qualities, he would, no doubt, have very enlarged views of space. As it is, man is distinguished from the brute animals by his erect bearing, and the range of space which his vision enables him to scan. Our eyes are easily movable in various directions, so also is our head; by a slight movement of the head and eyes, we may take in either space bounded by the horizon, or by a surface a foot square. If we throw our head back we enlarge our view of space; if we bend our head forward we narrow our view of space. Now, imagine that a man thus endowed, and with our own notions of space of three dimensions, begins to stoop forward and to grow so: his eyes survey less space; he stoops more forward; his body forms angles of 80°, 70°, 60°, 50° in succession, with a horizontal plane. Then he is obliged to go on all-fours, his limbs shorten and are gradually absorbed into the mass of his body; he crawls, he creeps; at length his limbs disappear altogether, and he trails himself along and glides like a serpent, moving in a horizontal plane. During these successive shrinkings in the direction of his thickness his head has become fixed, his eyes motionless, in the plane in which he moves, and his vision has hence become more and more limited. Now his body begins to diminish in thickness; he becomes thinner, and thinner, and thinner, and when he has become very thin indeed, let his thickness be expressed as the numerator of a fraction, while the denominator is an infinitely great number—say, if you will, as many figures as, written on paper, would reach ten billion miles, with ten figures to an inch. Now he is a mere plane, an infinitely thin surface; he occupies space approximately of two dimensions; his eyes are on a line. Try to imagine what the ideas of space of such a being would be; compared with our own ideas of space, compared with his own ideas before and during his process of flattening. He would now contemplate only a plane surface; he would see length and breadth without thickness. Compare also his ideas of space at each and every position between verticality and horizontality as his ken gets less and less, and at last the whole world is shut out from him.

Again, to come nearer home, and back again to the world of real existences, let us compare our own ideas of space after concentrating our vision for awhile on a book a foot square, with our ideas of space acquired while we ascend a lofty mountain, or lie upon our back on the deck of a vessel in mid-ocean. Compare the views of space possessed by a prisoner immured for forty years in a dungeon eight feet square, of La Sachette in the *Trou aux Rats*, of a being bed-ridden for half a century, with those of a hunter in the prairies of the West, a sailor of the Atlantic, even of a dweller in a flat tame country. The conceptions of space possessed by these different people will vary enormously. Contract the limits of space of possible contemplation; remove the possibility of contemplating space of great dimensions, and the *faculty* of such contemplation will itself die out; and thus, by a gradual process of diminution, we may arrive at our ideal being, living in space of two dimensions. Finally, let us imagine the being of two dimensions—length and breadth—to become narrower and narrower, and when he has become extremely narrow let us divide his breadth by an infinitely large number, and he becomes approximately of one dimension; he has now only length; he lives in a line; his one motionless eye is a point.

So much for space of less dimensions than our own. Let us now try to conceive an extension of our ordinary space; and let us attempt this by the superaddition of motion to known space. And let us clearly realise the fact that one and the same thing may easily possess various motions at the same time. For instance, when I walk across the room, talking the while; my vocal chords possess *five* distinct motions: (α) their own proper motion of vibration; *plus* (β) the motion of translation caused by walking forward; *plus* (γ) the motion of rotation of the earth about its axis; *plus* (δ) the motion of revolution of the earth about the sun; *plus* (ϵ) the motion of translation of the whole solar system through space. Let us suppose now that our bodies, instead of being at apparent rest, were to vibrate in arcs, with an amplitude of 10,000 miles, and with an infinite velocity; and let the plane of the direction of vibration itself vibrate between limits 10,000 miles apart; and let the whole vibrating system move with infinite velocity in a circle 1,000,000 miles diameter; and let the circle rotate upon its diameter; and let the sphere of revolution thus formed revolve in an infinitely great ellipse; and let the ellipse rotate upon one of its axes; and—— but hold! we have surely arrived at a somewhat enlarged view of our own relations to space. Conceptions of this nature sufficiently pursued may, perchance, lead us to the very threshold of transcendental space; and, once on the threshold, we may look wonderingly beyond.

G. F. RODWELL.

ON THE SPECTROSCOPE AND ITS APPLICATIONS

VIII.

I TOLD you I had something more to say about the spectrum of blood, and this is not only an instance of the way in which the spectrum helps us in several important questions that, at first sight, do not seem at all connected with each other, but it shows the enormous power of research that is open to us. The colouring matter of blood, for instance, is found, like that of indigo, to exist in two perfectly different states, which give two perfectly different spectra. The colouring matter of blood is indeed capable of existing in two states of oxidation, which are distinguishable by a difference in colour, and also in their action on the spectrum. They may be made to pass one into the other by suitable oxidising and reducing agents; they have been named by Professor Stokes, their discoverer, red and purple cruorine. Previous to the introduction of spectrum analysis, red and purple cruorine were perfectly unknown. Further, if by means of a spectrum microscope, such as I have already described, a blood-stain is examined, Mr. Sorby asserts that the thousandth part of a grain of blood, —that is to say, a blood-spot so small that it only contains $\frac{1}{1000}$ of a grain, is perfectly easy of detection by means of this new method, and he has shown that its presence may be easily proved in stains that have been kept for a long time, and recognised even after a period of fifty years.

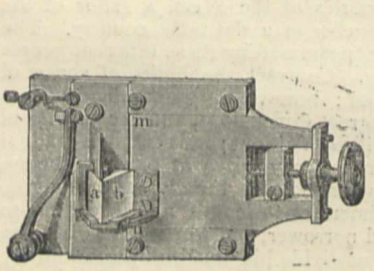

FIG. 46.

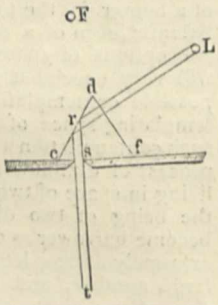

FIG. 47.

Fig. 46.—Steinheil's slit, showing reflecting prism. Fig. 47.—Path of light through reflecting prism and into the slit.

He has also shown how it may be detected under the most unfavourable conditions, provided that a trace of hæmatin has escaped decomposition or removal; he has, in fact, successfully applied this method in several important criminal cases.

Another very interesting fact is, that when blood contains very small quantities of carbonic oxide gas in solution, it exhibits a very curious series of absorption bands. This fact is of considerable value in toxicological research, for in cases of poisoning by the so-called charcoal fumes, where, as is well known, the poisonous action is due to the formation of carbonic oxide, it can be readily detected by the peculiar bands which the blood under these circumstances exhibits.

Mr. Sorby has also applied the spectrum microscope to the study of blow-pipe beads, and has shown that in some cases as small a quantity as $\frac{1}{10000}$th of a grain of some substances can be thus recognised, even when mixed with other coloured bodies, which would interfere with the usual reactions dependent on colour alone.

In the case of radiation, as you know, we are able to determine the existence of new elements altogether. This is produced to a certain extent, as in the above case, in the absorption spectrum. Let me give you another practical application of this principle. Dr. Thudichum, as a result of researches made for the Medical Department of the Privy Council, has communicated to the Royal Society a paper in which he narrates the result of his inquiries on the yellow organic substances contained in animals and plants; and at the present moment it is impossible to say what important practical results may be expected as we come to know more about these substances, especially in the matter of dyes, which I am sure is a thing that will commend itself to you.

Again, Mr. Sorby, in a communication to the Microscopical Society, brings the matter still nearer home. He shows us that, in the case of wines, he can, by means of the absorption bands, determine the very year even of vintage, and this, you will see at once, is a matter of very great importance. Let me read you an extract from one of Mr. Sorby's reports. He says:—"The difference for each year is at first so considerable that wines of different vintages could easily be distinguished; but after about six years, the difference is so small that it would be difficult or impossible to determine the age to within a single year. After twenty years, a difference of even ten years

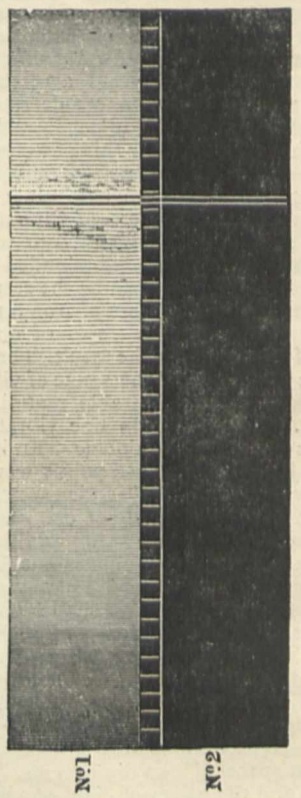

FIG. 48.—Coincidence between the bright line given out by sodium vapour and the dark line produced by the absorption of sodium vapour.

does not show any striking contrast, and the age could not, therefore, be determined to nearer than ten years by this process. However, up to six years I think it quite possible to determine the age to within a single year. I took specimens of various ports from the casks, of different ages up to six or seven years, and labelled them in such a manner that I did not know the age of any, but could ascertain it afterwards by reference. I then made the experiments with great care, and found that, by proper attention to the details described above, I could correctly determine the year of vintage of each particular specimen." (*Chemical News*, December 17, 1869, p. 295.)

We have, in fact, a definite method of analysis of animal and vegetable colouring matter, and also of the colouring matter of decayed wood. Nor is this all, for, in another communication—for these things are now beginning to crowd upon us, and they will continue to do so much more by-and-by—Dr. Phipson asserts that this new method is perfectly competent to indicate any ar i-

ficial coloration of wine. Mr. Sorby, on the other hand, has given his attention to beer; so that you see, if I have been taking you occasionally to the stars, I sometimes have the opportunity of travelling a great deal nearer home.

Mr. Sorby has also made some extremely delicate and interesting researches on the colouring matters existing in leaves. He has been able to identify numerous colouring principles, which he has arranged in five distinct groups: these groups rejoice in the names of chlorophyll, xantophyll, erythrophyll, chrysophyll, and phaiophyll, the absorption spectra of which are perfectly distinct and well marked. It is found generally that leaves contain colours belonging to several groups, and frequently more than one of the same group. Mr. Sorby also finds that the change of colour which takes place in autumn consists chiefly in the disappearance of the chlorophyll, which renders the remaining colours visible, and these most frequently are of a yellowish tint. Some leaves, however, turn red in the autumn: this appears to be due to a falling off of the vital power of the plant, for by artificially diminishing the vital power, the intensity of this red colour is increased.

One great value of this method of research is that it enables us to recognise special colouring-matters, even when mixed with several others, and to determine the particular conditions in which they occur in plants or animals—whether in a solid state or in solution—and whether those dissolved out by reagents exist as such in the living organisms, or are the products of decompositions.

So that you see, on the whole, at the present moment, I think we may be full of hope that the new process may gradually lead to many more practical applications; but really we cannot say much about them at present, because the introduction of spectrum analysis is so recent. We are, however, already furnished with another instance of the close connection there always must be between any great advance in physical inquiry and the application of the skill of our opticians to aid us in the inquiry. We have the Sorby-Browning spectrum microscope, and then a large number of people can study the beautiful phenomena which this new method of research has opened up to us, where formerly it was almost impossible to imagine that science, or even the practical affairs of earth, should in any way benefit.

Having thus dealt very briefly with some of the more practical applications of the subject, I must now take you a somewhat distant journey to the sun and to the stars; and I must, in the first instance, attempt to connect the two perfectly distinct classes of phenomena which I have brought to your notice,—the phenomena, namely, of radiation, and the phenomena of absorption; and this con

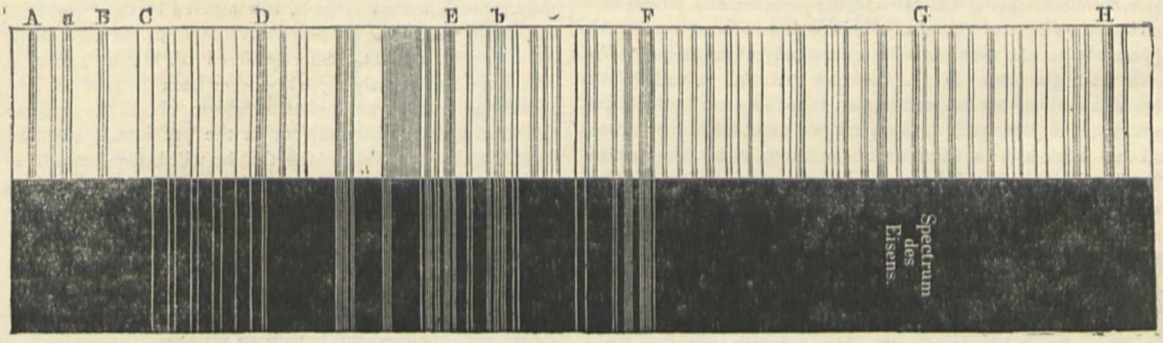

FIG. 49.—Correspondence of some of the lines given out by iron vapour (below), and of some of the Fraunhofer lines in the solar spectrum.

nection between radiation and absorption is an instance of the slow growth of science. I remarked to you in the former lecture, that Fraunhofer, at the beginning of this century, had a very shrewd suspicion of the perfect coincidence of place in the spectrum between certain dark lines which he saw in the spectrum of the sun, which I promised to explain to you on this occasion, and the bright lines in the spectrum of sodium. You know how very simple the spectrum of sodium is: you will, perhaps, think it very strange indeed that such a simple thing was not explained very long ago. But Fraunhofer at the first suspected, and after him many of our greatest minds suspected, that there was some hidden, wondrously strange, connection between the double yellow line which you will remember is characteristic of sodium, and a certain double line which exists among the strange black lines of the solar spectrum, which I begged you to banish from your minds on the last occasion, when we were merely dealing with radiation. But now I must ask you to bear with me while I attempt to make clear to you all the strange facts concerning these black lines. I have been favoured by Dr. Gladstone with an extract from Dr. Brewster's notebook, dated St. Andrews, October 28, 1841. In it Brewster says:—"I have this evening discovered the remarkable fact that, in the combustion of nitre upon charcoal, there are definite bright rays corresponding to the double lines of A and B, and the group of lines *a* in the space A B. The coincidence of two yellow rays with the two deficient ones at D, with the existence of definite bright rays in the nitre flame, not only at D but at A, *a* and B, is so extraordinary, that it indicates some regular connection between the two classes of phenomena." The double lines A and B refer to some of these dark Fraunhofer lines in the solar spectrum, which for convenience of reference were at first called after the letters of the alphabet; we now find that their number is so enormous that it is absolutely impossible to attempt to grapple with them in any such method, but these names are still retained.

The explanation of the coincidence between the two bright lines of burning sodium vapour and the two dark lines D in the solar spectrum was first given by Prof. Stokes about 1852.

It is this. The light emitted by an incandescent vapour is due to the vibrations of its molecules, as a sound note emitted by a piano wire is due to the vibration of the wire. You have only to go into a room where there is a piano, and sing a note, to find that the wire which corresponds to your note will respond to your voice. Now, in the same way, when light is passing through a vapour, the molecules of which vibrate at any particular rate, they will be urged into their own special rate of vibrations by the vibrations of the light which correspond to that particular rate which is passing through them. Hence the light will, so to speak, be sifted, and the force it has exercised in impelling the particles in the interrupting vapour to vibrate will tell upon it; and in this way those particular vibrations which have had the work to do will be enfeebled.

It is clear that the parts of the spectrum thus reduced in brilliancy will depend upon the vapour through which

the light has passed. If sodium vapour be traversed, then the light corresponding to the bright lines of sodium will be enfeebled.

This great law, to which the researches of Stokes and Stewart and Angström have led, and which has been established by the experiments of Foucault, Kirchhoff, and Bunsen, may be summed up as follows :—*Gases and vapours, when relatively cool, absorb those rays which they themselves emit when incandescent;* the absorption is continuous or selective as the radiation is continuous or selective.

J. NORMAN LOCKYER

(*To be continued.*)

NOTES

THE Emperor of Brazil has conferred upon Dr. Warren De La Rue the distinction of Knight of the Imperial Order of the Rose.

THE subject of Professor Tait's Rede Lecture, to be delivered on the 23rd inst., will be "Thermo-Electricity."

A PARAGRAPH has recently appeared in several scientific papers quoted from the *Zeitschrift für Parasitenkunde*, stating that Prof. Hallier of Jena has described a new potato-disease, which made its appearance last autumn in the neighbourhood of that town, the disease being indicated by the presence of a purple web and the appearance of a number of black spots on the skin, referable apparently to the perithecia of a pyrenomycetous fungus. We learn from the Rev. M. J. Berkeley that this so-called new disease is nothing but the well-known "copper-web" which is in some years very destructive to asparagus, mint, and other crops, and has been known in some instances to attack the potato. The description in the *Zeitschrift* is identical with this familiar parasite. Figures will be found in Tulasne's "Fungi Hypogæi," under Rhizoctonia, showing that the so-called perithecia are spurious. Mr. Broome has detected the form of fructification known as conidia.

LADY LYELL, wife of Sir Charles Lyell, Bart, F.R.S., died last Thursday, in her 65th year. Her ladyship was the eldest daughter of the late Mr. Leonard Horner, F.R.S.

DURING the Easter term the following lectures in natural sciences will be given at Cambridge :—On Heat (1) Advanced (for the Natural Sciences Tripos), by Mr. Trotter, Trinity College, in Lecture-room No. 11, on Mondays, Wednesdays, and Fridays at 10, commencing Wednesday, April 30 (2) Elementary (for Special Examination and 1st Part of Natural Sciences Tripos), on Tuesdays, Thursdays, and Saturdays at 11, commencing Tuesday, April 29. On Chemistry, by Mr. Main, St. John's College, on Tuesdays, Thursdays, and Saturdays at 12, in St. John's College Laboratory, commencing Thursday, April 24. Instruction in Practical Chemistry will also be given. On Palæontology—the Mollusca, &c., by Mr. Bonney, St. John's College, on Tuesdays and Thursdays, at 9, commencing Thursday, April 24. On Geology—(for the Natural Sciences Tripos, Stratigraphical Geology), by Mr. Bonney, St. John's College, on Mondays, Wednesdays, and Fridays, at 10, commencing Wednesday, April 23. Elementary Geology (for the First part of the Tripos and the special examination), on Tuesdays and Thursdays, at 11, commencing Thursday, April 24; there will be excursions, of which notice will be given from time to time. On Botany (for the Natural Sciences Tripos), by Mr. Hicks, Sidney College, on Tuesdays, Thursdays, and Saturdays, at 11, in Lecture-room No. 1, beginning on Tuesday, April 29; the lectures during this term will be chiefly on Cryptogamic Botany and on Classification. Biology: the Trinity Prælector will give a course of Practical Lectures on Elementary Biology, on Mondays, Tuesdays, and Wednesdays, at 11 A.M., commencing Wednesday, April 30. This course is intended as an introduction to the study of both anatomy and physiology. A short lecture of about half-an-hour will be given at each meeting, followed by practical work for about 1½ or 2 hours.

THE annual *soirée* of the Royal Society last Saturday at Burlington House was a great success. The number of visitors was exceedingly large, and the objects exhibited were numerous and varied. In the Mathematical Room, Mr. Latimer Clark showed his remarkable experiment of the influence of light on the conductivity of selenium, recently described in NATURE.

THE office of "Lord Rector" of a Scotch University is generally regarded as merely honorary, a testimony of the estimation in which the students hold the gentleman whom they elect. As a rule the Lord Rector acquiesces in this opinion, and seldom does more in return for the supposed honour conferred than mark the commencement or close of his three years' tenure of office by making a speech to the students. As might be surmised, Prof. Huxley, who was recently elected to the Lord Rectorship of Aberdeen University, which counts Prof. Bain among its staff of teachers, does not regard the office as merely honorary: he intends to take advantage of the position conferrred upon him by doing some actual work for the good of the University. Naturally one of the first grievances he has attacked is the medical curriculum, which at Aberdeen, as at most other medical schools, is hampered by the "traditions of the elders" as to the supposed advantages of the dead languages to a medical student. Shortly after Prof. Huxley's election, he received a numerously signed petition from the medical students requesting him to use his influence to obtain the omisssion of Greek as a compulsory subject in the preliminary examination. Prof. Huxley has given notice that he will bring forward at the next meeting of the University Court a resolution to reform the medical curriculum at Aberdeen, as he considers it at present rather overweighted with classics, and believes that some new arrangement would probably be exceedingly advantageous, especially in the matters of natural history and botany.

WE hear from Mr. Lloyd that living specimens of the Lancelet (*Amphioxus lanceolatus*) have been very recently received at the Crystal Palace Aquarium, from Naples, and are now alive. We hope that Dr. Dohrn will be successful in sending other living specimens of this most interesting fish to other Aquaria in this country, so that its affinities and development may be more thoroughly worked out and generally understood.

MR. THOMAS WILLIAM BRIDGE was on Friday elected to a Natural Science Scholarship at Trinity College, Cambridge. Mr. Bridge has for some two years worked under Mr. J. W. Clark, the Superintendent of the University Museums of Zoology and Comparative Anatomy, and about a month since was appointed, by the Professor of Zoology, to the newly-founded post of Demonstrator in Comparative Anatomy in the University.

DR. DIVERS, of the Middlesex Hospital, has been appointed to the Professorship of Chemistry in the new Engineering College at Jeddo.

PROF. AGASSIZ has not been behindhand in employing the advantages placed at his disposal by Mr. Anderson's munificent bequest. A programme is already published of a summer course of Natural History at Penekese Island, designed chiefly for teachers, and for students preparing to become teachers. Among those that Prof. Agassiz is able to include on his staff we find the names of Profs. Shaler, Wilder, Packard, and Putnam, and every attempt is being made to obtain a sufficient endowment, through the liberality of others, to offer the course free of charge to deserving students. The Superintendent of the United States Coast Survey and the United States Commissioner of Fisheries have also promised all the assistance in their power to this excellent undertaking.

DR. CHARLES C. ABBOTT has discovered in the river drift at Trenton, New Jersey, in gravel at great depth, and beneath undisturbed layers of fine sand, three chipped implements, of unquestionably human manufacture, lying close to each other. One has a knife-like form, 9 in. long, made of a reddish-brown stone, compact, laminated, and susceptible of a high polish. The other two bear a considerable resemblance to common European forms: one is of opaque yellowish quartz, 5¼ in. long, and 1½ in. in greatest width; the other is a flake of sand-stone rock, 6½ in. long, 3½ in. wide. From the occurrence of such specimens so near each other, Dr. Abbott thinks that we must admit that the antiquity of American man is greater than the advent of the so-called "Indian."

THE Royal Geographical Society have awarded the following medals for the present year:—In Physical Geography: Gold medal to W. C. Hudson, age 18, of Liverpool College; bronze medal to W. A. Forbes, age 17, of Winchester College. In Political Geography: Gold medal to S. E. Spring Rice, age 16, of Eton College; bronze medal to A. T. Nutt, age —, of University College School.

AT the meeting of the Royal Geographical Society on Monday, Sir Henry Rawlinson said despatches with reference to the East Coast Livingstone Expedition had been received from Sir Bartle Frere, dated March 27. The English portion of the expedition had been recently materially augmented, for, instead of consisting as previously of Lieut. Cameron and Dr. Dillan, it had received the valuable services of Lieut. Murphy, an officer of Engineers, who had obtained permission from the Indian Government to join it. Mr. Moffatt, a nephew of Dr. Livingstone, had also joined the expedition, and there was every reason to expect that his assistance would be of the greatest use in time of need. Bergamoyo had been already reached, and by the latest accounts the march into the interior had been commenced. From the first camp, at a distance of twenty miles from Bergamoyo, communications had been received from Dr. Dillan, in which he intimated his expectation of being speedily joined by Lieut. Cameron, Lieut. Murphy, and Dr. Moffatt. They would, notwithstanding the fact that the rainy season was not yet over, at once proceed on their journey.

PROF. THISELTON DYER announces a course of six lectures on the "Aspects of Vegetation" at the Royal Horticultural Society's Gardens; and Mr. Thomas Moore a course of six demonstrations on "Medical Botany" in the Chelsea Botanic Garden.

A TWICE-MONTHLY scientific periodical, in Turkish, is to be brought out in Constantinople called the *Dolab*, the *Repository*.

ON Jan. 31 there was a slight shock of earthquake at Rangoon in English Burmah. On Feb. 12 an earthquake was felt at Peshawur and Lahore in India. Slight earthquake shocks were felt on March 14, at 8 P.M., at Yanina (Janina) in Albania, Turkey.

THERE is a report from Doncaster to the effect that shortly after two o'clock on Tuesday afternoon the town was visited by a smart shock of earthquake, which shook several houses to their foundations. In our correspondence this week will be found an account of an earthquake which occurred recently in the south of Scotland.

THE French Association for the Advancement of Science, commences its second annual session at Lyons on August 21. We believe that there is every hope of a most numerous and interesting meeting.

THE *New York Journal of Applied Chemistry* for February contains a very excellent article on "The Promotion of Scientific Research," by Prof. C. A. Joy, in which he animadverts severely on those so-called "practical men" who test the value of all scientific investigation by the "What is the use?" standard. "Original research," the writer says, "is the nervous fluid that furnishes strength to the muscle. The brawny arm is but dead meat unless the body is fed with nourishing food. Theodore Parker, in one of his discourses, alludes to the figure of a Chinaman in a shop window turning vigorously a crank; upon investigation he found that it was the crank that turned the man, and not the man the crank. It is the same with practical applications. The practical man applies the principle, and with great pomp and arrogance claims to turn the crank; it is not true—a power higher than his is behind it all; the original investigation, the discovery of the principle upon which the movement rests, is really the engine that drives the man and makes him do its bidding." Prof. Joy in speaking of the recent article in NATURE, in which Sir Benjamin Brodie calls attention to the enormous expenditure of money of the University of Oxford, in the way of subsidies to students and annuities to fellows, without any adequate results, counsels the Americans to forbear copying the English University system. He proposes the following plan of promoting scientific research:—Let there be incorporated a society for the promotion of scientific research, to consist of a small number of strictly scientific trustees, who shall hold the property and appropriate the income to such objects as they deem worthy of aid. It would not be, strictly speaking, a society, but a foundation for the purposes specified. The head-quarters of the corporation should be in New York City. If the wealthy citizens of New York, who owe all they possess to the progress of science, would give money into the hands of such a board of trustees, they would be doing a most important work. Wherever and whenever any person was known to be engaged in the prosecution of some scientific research, the trustees could make him an allowance for conducting the inquiry, or to enable him to publish his results. Such assistance would often secure important discoveries. There are numerous professors scattered over the country whose salary is so small that they are obliged to add to it by outside work, or whose services at the college are so pressing that they have no leisure for anything like voluntary labour. A little assistance and encouragement to such persons would go a great way. Any college would be flattered by having their officers thus singled out by the best judges of the country as worthy of a subsidy from a society founded to encourage research. This course is preferable to giving a fund to a college for educational purposes, or to found a professorship, as the means for education are very great in this country, and there is far less need of mere educational facilities than there is of men engaged in purely scientific study. It has often happened that money has been raised to found a professorship for a particularly able man; after his death a person of inferior ability takes his place, and thus the object of the donor is defeated. It is therefore better to put the money into the hands of trustees selected for the purpose, and let them pay the income to those who are known to be worthy to receive it. The demands upon the fortunes of our wealthy men are constant and numerous, and they naturally give to such objects as are within their comprehension. If they could be made to understand that the source of our prosperity is science, and that the springs of discovery whence flow all the improvements of the day must be kept perennial, they would freely give of their substance, and we should soon see the watch-fires of original research kindled over the whole country.

THE New York Nautical School-ship *Mercury* has spent the past winter in deep-sea research, as in a previous season, and,

as before, has utilised the opportunities presented in the interest of science. Captain Giraud surveyed a large portion of the so-called "volcanic region" of the Atlantic Ocean, finding the water very deep in that vicinity. Specimens brought up from the bottom appeared to be of undoubted volcanic origin. The Casella-Miller deep-sea thermometer was used on one occasion at a depth of 2,040 fathoms, two miles north of the equator, in longitude 22° 16′ west, and indicated a temperature of 35° F., at 1,000 fathoms 38°, and at the surface 81°, the air being 80°. During the voyage from the Canary Islands to Rio the temperature at uniform depths was found to vary only about two degrees.

THE Iron-Steel Institute conclude their meeting at Willis's Rooms to-day.

PRIZES for papers on the "Elvan Courses" of Cornwall, are offered by Mr. J. A. Phillips, F.C.S., to the present and former pupils of the Miners' Association of Cornwall and Devon. The papers and illustrative specimens are to be deposited with Mr. J. H. Collins, F.G.S., Hon. Assistant Secretary of the Miners' Association, Polytechnic Hall, Falmouth, on or before Sept. 1, 1873. The author of the best paper will be entitled to a prize (in books, selected by himself) of the value of 5*l*. A second prize, also in books, of the value of 3*l*., will be given to the author of the paper next in order of merit.

WE have received the first number of a new American journal, started last month, *The Sanitarian*, edited by Dr. A. N. Bell, of New York. It aims at presenting the results of the various inquiries which have been, and which hereafter may be made, for the preservation of health and the expectations of human life, so as to make them most advantageous to the public and to the medical profession. Among the most important articles is one by the editor, on "The New York Quarantine Establishment," which is illustrated with two maps. This is preceded by one on "Infant Mortality, with suggestions for improving the condition of Foundlings;" and followed by another on "The necessity of Re-Vaccination." We strongly recommend this excellently conducted journal to those interested in sanitary science.

AMONG the rarer and more interesting remains found in the mounds of the west of America, are plates of mica cut into different shapes, and evidently preserved as objects of great rarity and value; and, in the absence of this mineral in the Mississippi Valley, the question has frequently arisen whence the material could have been derived. A recent communication from Prof. W. C. Kerr, the State Geologist of North Carolina, tends to throw some light on this subject, and to open an interesting chapter in regard to the American prehistoric man. The work of collecting mica is at present carried on upon the largest scale in the high and rugged region between the Black Mountain, the Roanoke, and the head waters of the Nolachuchy, principally in Mitchell County, North Carolina. The region in question has long been known for the existence of numerous open works and tunnels, which, at first sight, were supposed to have been made in the search for silver or some other valuable metal. Prof. Kerr, in his capacity of State Geologist, was led to investigate this question, and very soon found, in every instance, that the excavations referred to were much older than the earliest discovery of the country by the Spaniards, and that in all cases they were found in ledges of coarse granite, which contained nothing but large patches of mica. Prof. Kerr has been satisfied for some time that in these mines we have the work of the contemporaries of the mound-builders, and the localities whence they derived the mica. What use they made of it we cannot say; but it is suggested that it may have served the purpose of mirrors, or possibly have been used as windows, as well as for ornament. The number and size of these mines is remarkable, some of the open cuts being more than 100 ft. in diameter, and 20 ft. or 30 ft. in depth, even after the caving in and filling up of centuries of weathering. The tunnels often extend inwards several yards, but are said to be too small for a man of ordinary size to work in. These show distinct marks of the tool in the granitic wall, as if made by a chisel-shaped instrument about an inch broad. Numerous plates of mica are found in these tunnels and excavations, some of them trimmed to particular shapes. These facts open up a new chapter in the history of the American aborigines, illustrating the character of the commerce carried on at a very remote period, and showing the magnitude of the operations, and the extended period of time over which they must have been prosecuted, to enable a people furnished with nothing better than wooden and stone tools to produce excavations of so great magnitude.

Sirius, a journal of popular astronomy published at Leipzig and Vienna, contains, in its fourth number for this year, a lecture by Prof. Oppolzer, on "The Importance of Astronomy in connection with Ancient History," the continuation of an article on "Copernicus and his Anniversary," one of a series of articles on the "Topography of the Heavens," the present treating of the constellation Gem ini, besides a few notes.

THE additions to the Zoological Society's Gardens during the last week include a Ring-necked Parakeet (*Palæornis torquata*) from India, presented by Mr. W. E. Johnson; a long-eared Owl (*Otus vulgaris*) from Europe, presented by Dr. Bree; a Wood Owl (*Syrnium aluco*), presented by Mr. H. W. L. Browne; a Chinese Harrier (*Circus spilonotus*); a grey Eagle Owl (*Bubo cinereus*) and a Bosman's Potto (*Perodicticus potto*) from W. Africa; a horned Tragopan (*Ceriornis satyra*) from the Himalayas; a black-tailed Hawfinch (*Coccothraustes melanurus*) from Japan; two crested Buntings (*Melophus melanicterus*); two red-eared Bulbuls (*Pycnonotus jocosus*), and a red-vented Bulbul (*P. hæmorrhous*) from India; a red-headed Bunting (*Emberiza rutila*), and a yellow-browed Bunting (*E. chrysophrys*) from Japan; a black Tanager (*Tachyphonus melaleucus*) from S. America, purchased; two Emus (*Dromæus novæ-hollandiæ*) from Australia, deposited; a great Kangaroo (*Macropus giganteus*), and a Derbian Wallaby (*Halmaturus derbianus*), born in the gardens.

ON THE HYPOTHESES WHICH LIE AT THE BASES OF GEOMETRY*

Plan of the Investigation

IT is known that geometry assumes, as things given, both the notion of space and the first principles of constructions in space. She gives definitions of them which are merely nominal, while the true determinations appear in the form of axioms. The relation of these assumptions remains consequently in darkness; we neither perceive whether and how far their connection is necessary, nor, *a priori*, whether it is possible.

From Euclid to Legendre (to name the most famous of modern reforming geometers) this darkness was cleared up neither by mathematicians nor by such philosophers as concerned themselves with it. The reason of this is doubtless that the general notion of multiply extended magnitudes (in which space-magnitudes are included) remained entirely unworked. I have in the first place, therefore, set myself the task of constructing the notion of a multiply extended magnitude out of general notions of magnitude. It will follow from this that a multiply extended magnitude is capable of different measure-relations, and consequently that space is only a particular case of a triply extended magnitude. But hence flows as a necessary consequence that the propositions of geometry cannot be derived from general notions of magnitude, but that the properties which distinguish space from other conceivable triply extended magnitudes are only to be

* By Bernhard Riemann. (Translated by Prof. W. K. Clifford, from vol. xiii. of the Göttingen Abhandlungen.)

deduced from experience. Thus arises the problem, to discover the simplest matters of fact from which the measure-relations of space may be determined; a problem which from the nature of the case is not completely determinate, since there may be several systems of matters of fact which suffice to determine the measure-relations of space—the most important system for our present purpose being that which Euclid has laid down as a foundation. These matters of fact are—like all matters of fact—not necessary, but only of empirical certainty; they are hypotheses. We may therefore investigate their probability, which within the limits of observation is of course very great, and inquire about the justice of their extension beyond the limits of observation, on the side both of the infinitely great and of the infinitely small.

I.—*Notion of an* n*-ply extended magnitude*

In proceeding to attempt the solution of the first of these problems, the development of the notion of a multiply extended magnitude, I think I may the more claim indulgent criticism in that I am not practised in such undertakings of a philosophical nature where the difficulty lies more in the notions themselves than in the construction; and that besides some very short hints on the matter given by Privy Councillor Gauss in his second memoir on Biquadratic Residues, in the "Göttingen Gelehrte Anzeige," and in his Jubilee-book, and some philosophical researches of Herbart, I could make use of no previous labours.

§ 1.—Magnitude-notions are only possible where there is an antecedent general notion which admits of different specialisations. According as there exists among these specialisations a continuous path from one to another or not, they form a *continuous* or *discrete* manifoldness: the individual specialisations are called in the first case points, in the second case elements, of the manifoldness. Notions whose specialisations form a *discrete* manifoldness are so common that at least in the cultivated languages any things being given it is always possible to find a notion in which they are included. (Hence mathematicians might unhesitatingly found the theory of discrete magnitudes upon the postulate that certain given things are to be regarded as equivalent.) On the other hand, so few and far between are the occasions for forming notions whose specialisations make up a *continuous* manifoldness, that the only simple notions whose specialisations form a multiply extended manifoldness are the positions of perceived objects and colours. More frequent occasions for the creation and development of these notions occur first in the higher mathematic.

Definite portions of a manifoldness, distinguished by a mark or by a boundary, are called Quanta. Their comparison with regard to quantity is accomplished in the case of discrete magnitudes by counting, in the case of continuous magnitudes by measuring. Measure consists in the superposition of the magnitudes to be compared; it therefore requires a means of using one magnitude as the standard for another. In the absence of this two magnitudes can only be compared when one is a part of the other; in which case also we can only determine the more or less and not the how much. The researches which can in this case be instituted about them form a general division of the science of magnitude in which magnitudes are regarded not as existing independently of position and not as expressible in terms of a unit, but as regions in a manifoldness. Such researches have become a necessity for many parts of mathematics, *e.g.*, for the treatment of many-valued analytical functions; and the want of them is no doubt a chief cause why the celebrated theorem of Abel and the achievements of Lagrange, Pfaff, Jacobi for the general theory of differential equations, have so long remained unfruitful. Out of this general part of the science of extended magnitude in which nothing is assumed but what is contained in the notion of it, it will suffice for the present purpose to bring into prominence two points; the first of which relates to the construction of the notion of a multiply extended manifoldness, the second relates to the reduction of determinations of place in a given manifoldness to determinations of quantity, and will make clear the true character of an n-fold extent.

§ 2.—If in the case of a notion whose specialisations form a continuous manifoldness, one passes from a certain specialisation in a definite way to another, the specialisations passed over form a simply extended manifoldness, whose true character is that in it a continuous progress from a point is possible only on two sides, forwards or backwards. If one now supposes that this manifoldness in its turn passes over into another entirely different, and again in a definite way, namely so that each point passes over into a definite point of the other, then all the specialisations so obtained form a doubly extended manifoldness. In a similar manner one obtains a triply extended manifoldness, if one imagines a doubly extended one passing over in a definite way to another entirely different; and it is easy to see how this construction may be continued. If one regards the variable object instead of the determinable notion of it, this construction may be described as a composition of a variability of $n+1$ dimensions out of a variability of n dimensions and a variability of one dimension.

§ 3.—I shall now show how conversely one may resolve a variability whose region is given into a variability of one dimension and a variability of fewer dimensions. To this end let us suppose a variable piece of a manifoldness of one dimension—reckoned from a fixed origin, that the values of it may be comparable with one another—which has for every point of the given manifoldness a definite value, varying continuously with the point; or, in other words, let us take a continuous function of position within the given manifoldness, which, moreover, is not constant throughout any part of that manifoldness. Every system of points where the function has a constant value, forms then a continuous manifoldness of fewer dimensions than the given one. These manifoldnesses pass over continuously into one another as the function changes; we may therefore assume that out of one of them the others proceed, and speaking generally this may occur in such a way that each point passes over into a definite point of the other; the cases of exception (the study of which is important) may here be left unconsidered. Hereby the determination of position in the given manifoldness is reduced to a determination of quantity and to a determination of position in a manifoldness of less dimensions. It is now easy to show that this manifoldness has $n-1$ dimensions when the given manifoldness is n-ply extended. By repeating then this operation n times, the determination of position in an n-ply extended manifoldness is reduced to n determinations of quantity, and therefore the determination of position in a given manifoldness is reduced to a finite number of determinations of quantity *when this is possible.* There are manifoldnesses in which the determination of position requires not a finite number, but either an endless series or a continuous manifoldness of determinations of quantity. Such manifoldnesses are, for example, the possible determinations of a function for a given region, the possible shapes of a solid figure, &c.

II.—*Measure-relations of which a manifoldness of* n *dimensions is capable on the assumption that lines have a length independent of position, and consequently that every line may be measured by every other.*

Having constructed the notion of a manifoldness of n dimensions, and found that its true character consists in the property that the determination of position in it may be reduced to n determinations of magnitude, we come to the second of the problems proposed above, viz., the study of the measure-relations of which such a manifoldness is capable, and of the conditions which suffice to determine them. These measure-relations can only be studied in abstract notions of quantity, and their dependence on one another can only be represented by formulæ. On certain assumptions, however, they are decomposable into relations which, taken separately, are capable of geometric representation; and thus it becomes possible to express geometrically the calculated results. In this way, to come to solid ground, we cannot, it is true, avoid abstract considerations in our formulæ, but at least the results of calculation may subsequently be presented in a geometric form. The foundations of these two parts of the question are established in the celebrated memoir of Gauss—"Disquisitiones generales circa superficies curvas."

§ 1.—Measure-determinations require that quantity should be independent of position, which may happen in various ways. The hypothesis which first presents itself, and which I shall here develop, is that according to which the length of lines is independent of their position, and consequently every line is measurable by means of every other. Position-fixing being reduced to quantity-fixings, and the position of a point in the n-dimensioned manifoldness being consequently expressed by means of n variables $x_1, x_2, x_3, \ldots x_n$, the determination of a line comes to the giving of these quantities as functions of one variable. The problem consists then in establishing a mathematical expression for the length of a line, and to this end we must consider the quantities x as expressible in terms of certain units. I

shall treat this problem only under certain restrictions, and I shall confine myself in the first place to lines in which the ratios of the increments dx of the respective variables vary continuously. We may then conceive these lines broken up into elements, within which the ratios of the quantities dx may be regarded as constant; and the problem is then reduced to establishing for each point a general expression for the linear element ds starting from that point, an expression which will thus contain the quantities x and the quantities dx. I shall suppose, secondly, that the length of the inear element, to the first order, is unaltered when all the points of this element undergo the same infinitesimal displacement, which implies at the same time that if all the quantities dx are increased in the same ratio, the linear element will vary also in the same ratio. On these suppositions, the linear element may be any homogeneous function of the first degree of the quantities dx, which is unchanged when we change the signs of all the dx, and in which the arbitrary constants are continuous functions of the quantities x. To find the simplest cases, I shall seek first an expression for manifoldnesses of $n-1$ dimensions which are everywhere equidistant from the origin of the linear element; that is, I shall seek a continuous function of position whose values distinguish them from one another. In going outwards from the origin, this must either increase in all directions or decrease in all directions; I assume that it increases in all directions, and therefore has a minimum at that point. If, then, the first and second differential coefficients of this function are finite, its first differential must vanish, and the second differential cannot become negative; I assume that it is always positive. This differential expression, then, of the second order remains constant when ds remains constant, and increases in the duplicate ratio when the dx, and therefore also ds, increase in the same ratio; it must therefore be ds^2 multiplied by a constant, and consequently ds is the square root of an always positive integral homogeneous function of the second order of the quantities dx, in which the coefficients are continuous functions of the quantities x. For Space, when the position of points is expressed by rectilinear co-ordinates, $ds=\sqrt{\Sigma(dx)^2}$; Space is therefore included in this simplest case. The next case in simplicity includes those manifoldnesses in which the line-element may be expressed as the fourth root of a quartic differential expression. The investigation of this more general kind would require no really different principles, but would take considerable time and throw little new light on the theory of space, especially as the results cannot be geometrically expressed; I restrict myself, therefore, to those manifoldnesses in which the line-element is expressed as the square root of a quadric differential expression. Such an expression we can transform into another similar one if we substitute for the n independent variables functions of n new independent variables. In this way, however, we cannot transform any expression into any other; since the expression contains $n\frac{n+1}{2}$ coefficients which are arbitrary functions of the independent variables; now by the introduction of new variables we can only satisfy n conditions, and therefore make no more than n of the coefficients equal to given quantities. The remaining $n\frac{n-1}{2}$ are then entirely determined by the nature of the continuum to be represented, and consequently $n\frac{n-1}{2}$ functions of positions are required for the determination of its measure-relations. Manifoldnesses in which, as in the Plane and in Space, the line-element may be reduced to the form $\sqrt{\Sigma dx^2}$, are therefore only a particular case of the manifoldnesses to be here investigated; they require a special name, and therefore these manifoldnesses in which the square of the line-element may be expressed as the sum of the squares of complete differentials I will call *flat*. In order now to review the true varieties of all the continua which may be represented in the assumed form, it is necessary to get rid of difficulties arising from the mode of representation, which is accompiished by choosing the variables in accordance with a certain principle.

§. 2.—For this purpose let us imagine that from any given point the system of shortest lines going out from it is constructed; the position of an arbitrary point may then be determined by the initial direction of the geodesic in which it lies, and by its distance measured along that line from the origin. It can therefore be expressed in terms of the ratios dx_0 of the quantities dx in this geodesic, and of the length s of this line. Let us introduce now instead of the dx_0 linear functions dx of them, such that the initial value of the square of the line-element shall equal the sum of the squares of these expressions, so that the independent variables are now the length s and the ratios of the quantities dx. Lastly, take instead of the dx quantities $x_1 x_2 x_3 \ldots x_n$ proportional to them, but such that the sum of their squares $= s^2$. When we introduce these quantities, the square of the line-element is Σdx^2 for infinitesimal values of the x, but the term of next order in it is equal to a homogeneous function of the second order of the $n\frac{n-1}{2}$ quantities $(x_1 dx_2 - x_2 dx_1)$, $(x_1 dx_3 - x_3 dx_1)\ldots$ an infinitesimal, therefore, of the fourth order; so that we obtain a finite quantity on dividing this by the square of the infinitesimal triangle, whose vertices are $(0, 0, 0, \ldots)$, $(x_1 x_2 x_3 \ldots)$, $(dx_1, dx_2, dx_3, \ldots)$. This quantity retains the same value so long as the x and the dx are included in the same binary linear form, or so long as the two geodesics from 0 to x and from 0 to dx remain in the same surface-element; it depends therefore only on place and direction. It is obviously zero when the manifold represented is flat, *i.e.* when the squared line-element is reducible to Σdx^2, and may therefore be regarded as the measure of the deviation of the manifoldness from flatness at the given point in the given surface-direction. Multiplied by $-\frac{3}{4}$ it becomes equal to the quantity which Privy-councillor Gauss has called the total curvature of a surface. For the determination of the measure-relations of a manifoldness capable of representation in the assumed form we found that $n\frac{n-1}{2}$ place-functions were necessary; if, therefore, the curvature at each point in $n\frac{n-1}{2}$ surface-directions is given, the measure-relations of the continuum may be determined from them—provided there be no identical relations among these values, which in fact, to speak generally, is not the case. In this way the measure-relations of a manifoldness in which the line-element is the square root of a quadric differential may be expressed in a manner wholly independent of the choice of independent variables. A method entirely similar may for this purpose be applied also to the manifoldness in which the line element has a less simple expression, *e.g.*, the fourth root of a quartic differential. In this case the line-element, generally speaking, is no longer reducible to the form of the square root of a sum of squares, and therefore the deviation from flatness in the squared line-element is an infinitesimal of the second order, while in those manifoldnesses it was of the fourth order. This property of the last-named continua may thus be called flatness of the smallest parts. The most important property of these continua for our present purpose, for whose sake alone they are here investigated, is that the relations of the twofold ones may be geometrically represented by surfaces, and of the morefold ones may be reduced to those of the surfaces included in them; which now requires a short further discussion.

§ 3.—In the idea of surfaces, together with the intrinsic measure-relations in which only the length of lines on the surfaces is considered, there is always mixed up the position of points lying out of the surface. We may, however, abstract from external relations if we consider such deformations as leave unaltered the length of lines—*i.e.* if we regard the surface as bent in any way without stretching, and treat all surfaces so related to each other as equivalent. Thus, for example, any cylindric or conical surface counts as equivalent to a plane, since it may be made out of one by mere bending, in which the intrinsic measure-relations remain, and all theorems about a plane—therefore the whole of planimetry—retain their validity. On the other hand they count as essentially different from the sphere, which cannot be changed into a plane without stretching. According to our previous investigation the intrinsic measure-relations of a twofold extent in which the line-element may be expressed as the square root of a quadric differential, which is the case with surfaces, are characterised by the total curvature. Now this quantity in the case of surfaces is capable of a visible interpretation, viz., it is the product of the two curvatures of the surface, or multiplied by the area of a small geodesic triangle, it is equal to the spherical excess of the same. The first definition assumes the proposition that the product of the two radii of curvature is unaltered by mere bending; the second, that in the same place the area of a small triangle is proportional to its spherical excess. To give an intelligible meaning to the curvature of an n-fold extent at a given point and in a given surface-direction through it, we must start from the fact that a geodesic proceeding

from a point is entirely determined when its initial direction is given. According to this we obtain a determinate surface if we prolong all the geodesics proceeding from the given point and lying initially in the given surface-direction ; this surface has at the given point a definite curvature, which is also the curvature of the n-fold continuum at the given point in the given surface-direction.

§ 4.—Before we make the application to space, some considerations about flat manifoldnesses in general are necessary ; *i.e.* about those in which the square of the line-element is expressible as a sum of squares of complete differentials.

In a flat n-fold extent the total curvature is zero at all points in every direction ; it is sufficient, however (according to the preceding investigation), for the determination of measure-relations, to know that at each point the curvature is zero in $n\frac{n-1}{2}$ independent surface directions. Manifoldnesses whose curvature is constantly zero may be treated as a special case of those whose curvature is constant. The common character of these continua whose curvature is constant may be also expressed thus, that figures may be moved in them without stretching. For clearly figures could not be arbitrarily shifted and turned round in them if the curvature at each point were not the same in all directions. On the other hand, however, the measure-relations of the manifoldness are entirely determined by the curvature ; they are therefore exactly the same in all directions at one point as at another, and consequently the same constructions can be made from it : whence it follows that in aggregates with constant curvature figures may have any arbitrary position given them. The measure-relations of these manifoldnesses depend only on the value of the curvature, and in relation to the analytic expression it may be remarked that if this value is denoted by α, the expression for the line-element may be written

$$\frac{1}{1+\frac{\alpha}{4}\Sigma x^2}\sqrt{\Sigma dx^2}$$

§ 5.—The theory of *surfaces* of constant curvature will serve for a geometric illustration. It is easy to see that surfaces whose curvature is positive may always be rolled on a sphere whose radius is unity divided by the square root of the curvature ; but to review the entire manifoldness of these surfaces, let one of them have the form of a sphere and the rest the form of surfaces of revolution touching it at the equator. The surfaces with greater curvature than this sphere will then touch the sphere internally, and take a form like the outer portion (from the axis) of the surface of a ring ; they may be rolled upon zones of spheres having less radii, but will go round more than once. The surfaces with less positive curvature are obtained from spheres of larger radii, by cutting out the lune bounded by two great half-circles and bringing the section-lines together. The surface with curvature zero will be a cylinder standing on the equator ; the surfaces with negative curvature will touch the cylinder externally and be formed like the inner portion (towards the axis) of the surface of a ring. If we regard these surfaces as *locus in quo* for surface-regions moving in them, as Space is *locus in quo* for bodies, the surface regions can be moved in all these surfaces without stretching. The surfaces with positive curvature can always be so formed that surface regions may also be moved arbitrarily about upon them without *bending*, namely (they may be formed) into sphere-surfaces ; but not those with negative curvature. Besides this independence of surface regions from position there is in surfaces of zero curvature also an independence of *direction* from position, which in the former surfaces does not exist.

(*To be continued.*)

SCIENTIFIC SERIALS

Zeitschrift für Ethnologie, No. 6.—The present number gives a compendium of useful suggestions, which might advantageously be acted on in other countries besides Germany, addressed by the Anthropological Society of Berlin to all persons engaged in exploring, or other expeditions to distant regions. In those directions for observing and collecting whatever is most adapted to extend and rectify our actual knowledge, information is given in regard to the various races with whom travellers may come in contact, and the special geographical, linguistic, social and other conditions, which more particularly require further elucidation. —Prof. A. Bastian gives us in this number with his habitual completeness an exposition of the worship of the heavenly bodies among different nations, and the extent to which local conditions of climate and ethnological differences have influenced the character of the adoration offered to the sun and the moon and the stars. According to him a *true* worship of the sun—except in the polar regions—is only to be found on elevated plateaux, where the return of the orb of day was welcomed with gratitude after the colder night, while in low-lying tropical lands the aborigines looked with dread at the glowing ball of fire which each summer seemed to threaten their world with annihilation. We can strongly commend this paper as a most comprehensive, although not specially novel exposition of Aryan and other mythological systems.—The German engineer, Herr H. Keplin, has drawn attention to the mussel-hills (*Casqueiros sambaquis*) of Brazil in the district of the Rio do San Francisco do Sol. The position of these deposits appears to refute the idea of their being mere Kjokkenmödings, while the great respect shown by the natives for the dead, and their care to provide them proper sepulture, would seem to afford further evidence that these elevations, which often rise to a height of 50 feet, cannot be due to the hand of man. In reference to the above, it may interest our own archæologists to know that Herr Walter Kauffman draws attention in the same number to his discovery in the neighbourhood of Hull, at a spot known as Castle Hill, near Holderness, of a burial place belonging, as he conjectures, to the transition period between the Stone and Bronze ages. Herr Kauffman found on the western side of the hill, where the ground had been cut for building purposes, a fragment of some loam vessel, a compact mass of oyster shells, some flint flakes, and a human rib. After carefully removing the earth, Herr K. discovered at from 4 to 4½ feet below the surface the vertebræ of another skeleton, and finally collected nearly all the bones of two skeletons, completely enclosed in a mass of oyster shells.—Dr. A. B. Meyer, of Manilla, in the course of a short visit in the Philippines, found skulls which presented that peculiar appearance of sharpening or filing of the teeth, described by the old traveller, Thévenot, and the accuracy of which has often been called in question. The Negrito skulls from the Philippines, examined by Dr. Meyer, also exhibited the artificial flattening of the heads noticed by Thévenot.—Herr Virchow drew attention last summer to the fact that occasional deviations present themselves from the normal cranial configuration of a race, which ought to teach us extreme caution in regarding any single specimen as a typical form. He was led to make this remark by his observation in the Anatomical Museum of Copenhagen of the skull of Kay Lykke, a man of the noblest Danish descent, who had flourished two hundred years ago, and been celebrated in his day for his personal beauty, his effeminacy, and the sensual bias of his disposition. Yet the skull of this once elegant, accomplished, and self-indulgent courtier of the 17th century, belonging to an otherwise brachycephalic race, is more strikingly dolichocephalic and depressed than the Neanderthal head, and might readily be supposed to have belonged to an Australian savage. The cranial capacity which is given by Professor Panum, of Copenhagen, as 1,250 cubic centrm., is, moreover, below the amount that is conjecturally assumed for the Neanderthal skull.

The supplement to the vol. of the "Zeits. f. Ethnologie," for 1872, is exclusively occupied with the Linguistic Notes of Dr. G. Schweinfurth, drawn up as the result of his travel in Central Africa, and gives numerous vocabularies and specimens of the languages of the different tribes who occupy the district of the Bahr-el-Ghasal, among whom Dr. Schweinfurth lived more than two years.

Nuovo Giornale Botanico Italiano, vol. iv. Nos. 1—4, Jan.—Dec., 1872. The volume for 1872 of this journal, edited by one of the most accomplished of Italian botanists, Prof. Caruel, contains evidence of considerable scientific activity in the Peninsula. A large space of these four numbers is devoted to cryptogamic botany ; we have papers on the mosses of Abyssinia, by De Venturi, and of Ceylon and Borneo, by Hampe ; on the fungi of Parma, by Passerini ; on Diatoms, by Ardissone, and on a new classification of cryptogams, proposed by Prof. Cohn. Besides several papers on systematic, descriptive, and geographical botany, one of the most interesting on physiological and histological subjects is by Saccardo, on the amyloid corpuscles contained within the fovilla of pollen, illustrated by a plate. Prof. Caruel contributes a very valuable biographical notice of the Italian botanist, Andrea Cesalpino, born at Arezzo in 1519, and a summary of the contents of his great

work, "De Plantis," published at Florence in 1583, which his biographer states to contain the essential features of the classification propounded by A. L. Jussieu two centuries later.

Annalen der Chemie und Pharmacie, February, 1873. The number commences with a paper on a new derivative of sulphocarbamic acid, by H. Hlasiwetz and J. Kachler. The new body is obtained by the action of carbonic disulphide on camphor in the presence of ammonia. Measurements of its crystals are given. The numbers obtained by an analysis agree well with the formula C_2, H_{10}, N_4, S_2; this is regarded as an ammonia salt; a copper compound C_2, H_8, N_2, S_2, Cu, has been obtained, but the acid cannot be isolated from it, as SH_2 refuses to precipitate the copper. Several other compounds of the body are described.—The next paper is a short note by M. Berthelot on the formation of Acetylen by the silent electric discharge. Messrs. R. Boettger and Theodor Petersen contribute a paper on the Nitro-compounds of Anthrachinon. The following bodies are described: α Mononitroanthrachinon, α Monamidoanthrachinon, and α Diazoanthrachinon Nitrate; the behaviour of these α bodies with concentrated sulphuric acid is then described.—On the Vanadates of Thallium, by Thomas Carnelly. The author describes the method of preparation and properties of the salts in question; this paper has already appeared in the April number of the Chemical Society's journal, as also has the next, on Ethyl-amyl, by Harry Grimshaw, and Schorlemmer's paper on the Heptanes from Petroleum.—Crystallographic Notices, I. by C. Klein, is a long paper on the measurement, &c. of crystals; a contribution to our knowledge of Neurin, by Julius Mauthner; "Remarks on my Water Air-pump," by N. Jagn; and a paper on Excretin from Human Excrement, by F. Hinterberger. The author has established the formula C_{20}, $H_{36}O$ for this body, and has obtained a Brominated derivative C_{20}, H_{34}, Br_2 O.

Bulletin de la Société de Géographie.—The first article in the March number is by the Abbé Durand, formerly a missionary in Brazil, on the Solimoes, the name given to the Amazon from its junction with the Rio Negro upwards, this being the name of the most powerful tribe on its banks. The Abbé gives an account of his journey up the river as far as Peru. His article contains many valuable facts as to towns, and people, and products of the district through which he passed. The next article is the last of Capt. Derrégagaix's papers on the South of the Province of Oran; the present one treating of the Geology and Meteorology of the district. This is followed by a translation of part of Col. Yule's essay on the geography of the Oxus prefixed to Wood's "Journey to the Source of the Oxus."—M. N. de Khanikoff contributes a paper on our knowledge of the Khanate of Khiva.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 24.—On the Durability and Preservation of Iron Ships, and on Riveted Joints, by Sir William Fairbairn, Bart., F.R.S.

On the employment of Meteorological Statistics in determining the best course for a Ship whose sailing qualities are known, by Francis Galton, F.R.S.

Zoological Society, April 29.—Anniversary Meeting.—Viscount Walden, F.R.S., president, in the chair.—After some preliminary business the report of the Council was read by the Secretary, Mr. P. L. Sclater, F.R.S. It stated that the number of ordinary members of the Society on January 1 last, was 3,050, of Foreign members, 25, and of Corresponding members, 197. The total income of the Society in 1872 was 26,728*l.*, being 2,017*l.* more than that of 1871, and exceeding the income of any previous year, except that of the year 1862, when the International Exhibition was held. The total expenditure of 1872 had been 26,900*l.*, and a balance of 1,956*l.* had been carried forward for the benefit of the current year. The assets of the Society on December 31, 1872, were calculated at 10,532*l.*, while the liabilities were reckoned at 5,490*l.* The Reserve-fund consisted of a sum of 8,000*l.* Reduced 3 per Cents. The Scientific publications of the Society for 1872 had consisted of the usual volume of "Proceedings," four parts of "Transactions," a Revised List of the Vertebrated Animals, now or lately living in the Society's Gardens, and a General Index to the ten years of the Society's "Proceedings," from 1861 to 1870. The most important work undertaken in the Society's Gardens in 1872 had been the bridge over the Regent's Park Canal, intended to connect the Society's new grounds on the north bank, with the present Gardens. This had been completed in October last at a total cost of 1,333*l.* The new Lodge and Entrance-gates in Primrose-hill Road had likewise been finished, and the new entrance opened to the public for the first time on Easter Monday. The total number of visitors to the Society's Gardens in 1872 had been 648,088, being 52,171 more than the corresponding number in 1871. The greatest number of admissions in any one day in 1872 had been 44,608, which took place on May 20 (Whit Monday). The number of animals in the Menagerie on Dec. 31, 1872, was 2,010. Many of the accessions during the year had consisted of specimens of rare or little known animals, of which full particulars are given. The Report concluded with a long list of donors, and their several donations to the Menagerie. The Meeting then proceeded to elect the new Members of Council and the Officers for the ensuing year, and a ballot having been taken it was found that Viscount Walden, F.R.S., had been elected President, Mr. Robert Drummond, Treasurer, and Mr. P. L. Sclater, F.R.S., Secretary of the Society. The new Members of Council elected were Francis Galton, F.R.S., John P. Gassiott, Jun., St. George Mivart, F.R.S., George Russell, and Richard H. S. Vyvyan.

Geological Society, April 9.—His Grace the Duke of Argyll, K.T., F.R.S., president, in the chair. The following communications were read:—"Lakes of the north-eastern Alps, and their bearing on the Glacier-erosion Theory," by the Rev. T. G. Bonney, F.G.S. The purpose of this paper was to test, by the lakes of the Salzkammergut and neighbourhood, the theory of the erosion of lake-basins by glaciers, which has been advanced by Prof. Ramsay. The author premised (1) that an extensive glacier could not exist without a considerable area to support it; (2) that under no circumstances could a glacier excavate a cliff of considerable height (say 1,000 ft.) approximately vertical; (3) that owing to the proximity of the regions, a theory of excavation which applied to the Western and Central Alps ought to be applicable also to the Eastern Alps. He then proceeded to examine a number of lakes in detail. The Königsee lies in a remarkably deep, steep-sided valley, terminated by a cirque, with cliffs full a thousand feet high, and has no large supply area behind. The Hallstadtersee is similarly situated, has a cirque at the head, and two lateral valleys nearly at right angles to the lake, up which arms of it have formerly extended. These are not likely to have furnished glaciers which could have excavated the lake; and above the cirque there is no large supply area. The Gasauthal consists of lake-basins separated by valleys of river-erosion. The Fuschelsee and Wolfgangersee, on the south side of the Schafberg, are separated by a narrow sharp ridge of hills, incapable of nourishing glaciers large enough to grind them out; there are no signs of glaciers from other directions having eroded them. The Mondsee and Attersee (once one lake) on the north lie under the steep cliffs of the Schafberg, which could not have nourished a large glacier; and the ridge of the Schafberg is too sharp to admit of the supposition that a great glacier, coming from the south, has passed over it to excavate the lake; yet the Attersee, in a position least favourable to glacial action, is the largest and deepest lake in the Salzkammergut. The head of the valley in which these lakes lie is really among low hills, in the direction of the Austro-Bavarian plain. The Traunsee was shown to give no evidence in favour of a theory of glacial erosion. Since then these lakes either had at their heads preglacial cirques (the very existence of which was incompatible with much erosive power on the part of a glacier), or were beneath sharp and not greatly elevated ridges of rock, the author concluded that they had not been excavated primarily by glaciers. He considered a far more probable explanation to be, that the greater lake-basins were parts of ordinary valleys, excavated by rain and rivers, the beds of which had undergone disturbances after the valley had assumed approximately its present contour. He showed that the lakes were in most cases maintained at their present level by drift; and that, while in a region so subject to slight disturbances as the Alps, positive evidence for his theory would be almost impossible to obtain, no lake offered any against it, and one, the Königsee, was very favourable to it.—"On the Effects of Glacier-erosion in Alpine Valleys," by Signor B. Gastaldi. The author described the occurrence in the valley of the Lanzo and other Alpine valleys, at heights between 2,000 and 3,000 metres (6,700 and 10,000 feet), of large cirques, in two of which, in the valley Sauze de Césanne, the bottom was occupied in the autumn

by glaciers reduced to their smallest dimensions. The author noticed the various rocks in which these cirques were cut, and expressed his opinion that they are the beds formerly occupied by glaciers, the power of which to excavate even comparatively hard rocks, such as felspathic, amphibolite, and chlorite-schists, he considered to be proved. The author then referred to the mouths of the Alpine valleys opening upon the plain, which he described as being generally very narrow in proportion to their length, width, and orographical importance; and he pointed out that in the case of the valley of the Stura, at any rate, the outlet of the valley has been cut out by the river. This peculiarity he accounts for by the fact that whilst the calcareous and felspathic rocks are easily disintegrated by atmospheric action, certain other rocks, such as the amphibolites, diorites, syenites, amphibolite-schists, euphotides, serpentines, &c., resist atmospheric denudation; and he indicated the peculiar distribution of these rocks in the region under consideration, by reason of which portions of them occupied the points which are now the mouths of the valleys.

Anthropological Institute, April 22.—Prof. Busk, F.R.S., president, in the chair.—The following papers were read:—The Religious Beliefs of the Ojibois or Santeux Indians resident in Manitoba and at Lake Winnepeg, by A. P. Reid, M.D.—The predominating Danish aspect of the local nomenclature of Cleveland, by Rev. J. C. Atkinson.—Rock Inscriptions in Brazil, by John Whitfield.—Remarks about the consecration of the Serpent as an Emblem but not an Object of Worship among the Intelligent Druids, by James Hutchings.

Entomological Society, April 7.—Prof. Westwood, president, in the chair.—Mr. Champion exhibited specimens of *Tribolium confusum* and *Ptinus testaceus*, which he had observed in British collections mistaken for *T. testaceum* and *P. fur*.—Mr. Verrall exhibited several new species of *Diptera* belonging to the families *Asilidæ* and *Syrphidæ*, taken in Britain.—Mr. McLachlan stated that he had been informed by Lord Walsingham that he had observed Dragon flies in California and Texas preyed upon by other large insects which seized them whilst flying through the air. The latter were, no doubt, some species of *Asilus*; but it was the first time he had heard of Dragon flies being preyed upon by other insects, as they had, hitherto, been supposed to be free from such attacks.—Mr. F. Smith made some remarks on a species of *Pentatoma* sent from Calcutta by Mr. Rothney, which was of the same colour as the bark of the tree on which it was observed in great numbers.—Major Parry communicated a paper on the characters of seven nondescript Lucanoid Coleoptera, with remarks on the genera *Lissotes*, *Nigidius*, and *Figulus*.—Mr. Frederick Bates communicated "Descriptions of new Genera and species of *Tenebrionidæ* from Australia, New Caledonia, and Norfolk Island."—Mr. Müller read some interesting remarks on the habits of the *Cynipidæ*, communicated to him in a letter from Mr. W. F. Bassett, of Waterburg, U.S.—Part I. of the Transactions for 1873 was on the table.

Meteorological Society, April 16.—Dr. Tripe, president, in the chair.—A discussion took place on the following questions which had been submitted to the consideration of the Meteorological Conference held at Leipzig in August last:—No. 2. Barometers for Stations of the second order. No. 4. Maximum and Minimum Thermometers. No. 5. Instruments for determining Solar Radiation. No. 18. Uniformity in Hours of Observation. No. 20. Division of the Year for the Calculation of Mean Results. On question No. 2, several spoke in favour of aneroids, and several that they were not to be trusted; the opinion of the meeting was that for hard rough work where the aneroid is exposed to low and high pressure it is not suited for taking correct observations, and that the Kew barometer is much to be preferred. On question No. 4 the testimony of the meeting was in favour of Phillips' and Negretti's maximum thermometer. On question 5, reference was made to a paper by Rev. F. W. Stow, M.A., on "Solar Radiation," which is printed in the Journal of the Society for April 1873. Time would not allow of questions 18 and 20 being fully discussed, so they will be brought up again at the meeting on May 21.

MANCHESTER

Literary and Philosophical Society, April 15.—R. Angus Smith, F.R.S., vice-president, in the chair.—Mr. Francis Nicholson exhibited two fine eggs of the golden eagle (*Falco chrysaëtos*) taken the previous week from a nest in the north of Scotland. Fortunately some of the large landed proprietors both in Scotland and Ireland are now preserving this noble bird from persecution during the breeding time.—A letter was read from Mr. William Boyd Dawkins, F.R.S., who, as Secretary of the Committee of the British Association for carrying on the exploration of the Victoria Cave, felt obliged to notice the "Notes on Victoria Cave," by Mr. W. Brockbank, published in the Proceedings, March 10, 1873. Mr. Dawkins submitted that until the work of the Committee, to which the cave has been handed over by the kindness of the owner, be finished, and the observations, to which Mr. Brockbank has had no access, be recorded, his notes must of necessity be imperfect and liable to error. Mr. Dawkins then calls attention to two matters of fact, in which he shows Mr. Brockbank's statement to be entirely unfounded.—"On some Improvements in Electro-Magnetic Induction Machines," by Mr. Henry Wilde.

PHILADELPHIA

Academy of Natural Sciences, October 15.—Prof. Leidy directed attention to the collection of fossils, from the vicinity of Fort Bridger, Wyoming, presented by Dr. J. Van A. Carter, Dr. Joseph K. Corson, U.S.A., and himself. Some of the fossils were referred to a huge pachyderm with the name of *Uintatherium robustum*. [This subject has already been several times referred to in NATURE. See Mr. A. H. Garrod's letter last week]. Prof. Leidy further called attention to a multitude of chipped stones, which he had collected about ten miles north-east of Fort Bridger. Many of the fragments are broken in such a manner that it is difficult to be convinced that they are not of artificial origin. The materials of the splintered stones consist of jaspers, quartzites, some of the softer rocks of the tertiary strata, and less frequently of black flint identical in appearance with that of the English chalk.

December 3, 1872.—The president, Dr. Ruschenberger, in the chair.—Joseph Wilcox made remarks about some glacial scorings lately observed by him in St. Lawrence County, N. Y.

December 10, 1872.—The president, Dr. Ruschenberger, in the chair.—Jos. Wilcox made the following remarks:—Having lately visited many mineral localities in Canada, I desire to place them on record, as many of them are not mentioned either in the "Geological Report of Canada," or in Dana's "Mineralogy." At the falls of Ottawa River at Grand Calumet Island, black mica (phlogopite), pyroxene, hornblende, serpentine, tremolite. The following localities are all in the Province of Ontario:—At Arnprior, Calcite (dog tooth spar); near Packenham, Hornblende; in Bathurst, pyroxene, scapolite, sphene, apatite, peristerite; two miles south-west of Perth, bronze mica (phlogopite), having beautiful hexagonal marks on the cleavage planes; near Otty Lake, in North Elmsley, Apatite, pyroxene, black mica (biotite), zircon, red spinel—chondrolite; in Burgess, apatite, black mica (biotite); near Bob Lake, twenty miles north-west of Perth, the best crystals of apatite are found; near the St. Lawrence River, six miles south-west of Brockville, large octahedral crystals of iron pyrites, some of them four inches in diameter. All of these minerals are well crystallized, except the peristerite and chondrolite.—Prof. Leidy directed attention to some fossils recently received from Dr. J. Van A. Carter, of Fort Bridger, Wyoming. They were—*Palæosyops junior*, *Uintacyon eaax*, *Uintacyon vorax*, and *Chameleo pristinus*.—Remarks on silver ore from Colorado, by George A. König.

December 17, 1872.—Dr. J. L. LeConte in the chair.—Prof. Cope made some remarks on the Geology of Wyoming, especially with reference to the age of the coal series of Bitter Creek. He said that discovery of the Dinosaur *Agathaumas sylvestris* had settled the question of age, concerning which there had been much difference of opinion, in favour of the view that they constitute an upper member of the Cretaceous series. It appeared to the speaker, that the explorations directed by Dr. Hayden during the past season had contributed largely to our knowledge, proving the existence of an interruption between the cretaceous and tertiary formations: less it is true than that which exists elsewhere, and similar to that insisted on by Clarence King's survey in the region of Bear River and the Wahsatch country.—Prof. Cope defined a genus of Saurodont Fishes from the Niobrara Cretaceous of Kansas, under the name of *Erisichthe*. He stated that it agreed with *Portheus* and *Ichthyodectes* in the absence of nutritious dental foramina on the inner face of the dentary bone, and especially with *Portheus* in the irregular sizes of the teeth.

January 7.—Dr. Ruschenberger, president, in the chair.—E. Goldsmith described what he considers a new mineral which he names *Trautwineite*, after its first observer, Mr. J. C. Trautwine. The mineral has a green colour; the hardness is between 1 and 2, and it is micro-crystalline. The regular forms, which he saw, were short hexagonal pyramids, the infinite pyramid (prism), and triangular slender prisms, which may be one-sixth sections of the hexagonal prism. Under ordinary circumstances the mineral is dull, but when observed under power it appears vitreous. The streak is light green. The qualitative chemical examination indicated the oxides of chromium, iron, and magnesium.—Prof. Cope remarked, that, through the kindness of Prof. B. F. Mudge, he had an opportunity of examining additional specimens of the turtle from the cretaceous of Kansas, described by him in the Proceedings of the Academy, 1872, p. 129. The phalanges indicated a large flipper of the type of marine turtles. They are more flattened than in the *Propluridæ* so far as the latter are known, and are proportionally larger. The genus and species were named *Toxochelys latiremis*.

PARIS

Academy of Sciences, April 21.—M. de Quatrefages president, in the chair.—The following papers were read.—A final answer to M. Secchi, by M. Faye. M. Faye called attention to the fact that Father Secchi has accused him of insinuating that his drawings of the spots are not authentic, which insinuation also applies to the drawings of Carrington and Father Tacchini. This he showed was not the case, his statement that photographs, and not drawings, were required, being perfectly obvious as regards its signification. He then proceeded to answer Secchi's statements as to eruptions projecting the erupted matter towards a common centre, and asked how it was that these masses cooled during a passage which lasted often but a day or two, or even a few hours, could produce spots which lasted for months. He then answered several other objections, and called attention to Respighi's observations of the chromosphere, the earliest, as they are the best yet executed, as fully bearing out his theory.—On the condensation of Carbonic Oxide and Hydrogen, and of Nitrogen and Hydrogen, by the silent electric discharge, by MM. P. and A. Thenard. The authors had noticed that the protocarbide of hydrogen and carbonic anhydride, which, under the silent discharge condensed to a liquid, were doubled in volume and converted into carbonic oxide and hydrogen by the spark, they therefore sought to recombine the two latter gases by the discharge; in this they succeeded, and the action was more rapid than with the first. They also succeeded in producing ammonia from three volumes of hydrogen and one of nitrogen when treated in the same way; the action was most rapid when an acid was present to absorb the NH_3 as fast as it was formed.—On the physical and political history of Chili, by M. Gay, was a sketch of a work by the author in Spanish consisting of thirty volumes.—On the qualities necessary to the springs required for the supply of water to Paris by M. Belgrand.—M. Leymerie was then elected correspondent of the Mineralogical section in place of the late M. Haidinger, and M. Didion correspondent of the Mechanical section in place of the late Canon Moseley.—On a spectral illuminator, by M. F. P. Le Roux, described a new method of obtaining monochromatic illumination.—On the action of electricity on flames by M. Neyreneuf.—On the application of the curves *des debits* to the study of the laws of rivers and to the effects produced by a multiple system of reservoirs by M. de Graeff.—Observations on *Phylloxera vastatrix*, by M. Maxime Cornu.—A decree from the President of the Republic was received authorising the Academy to receive a legacy of 40,000 francs, left to it by the late Marshal Vaillant.—On the interference fringes observed in the case of Sirius and several other stars when large telescopes are employed; a consequence of the relative angular diameter of the stars in question, by M. Stephan. The author hopes, by means of certain observations, to obtain an approximate measurement of the diameter of Sirius.—On the comparison of electrical machines, by M. Mascart.—Remarks on the resistance of galvanometers, by M. J. Reynaud.—On the condensed discharge of the induction spark, by M. Th. du Moncel.—Researches on the chloride bromide and iodide of trichloracetyl, by M. H. Gal.—On the action of sodic sulphide on glycerin, by M. F. Schlagdenhauffen.—On a volumetric method of estimating oxygen in hydric peroxide and other liquids, by M. F. Hamel; this is an application of the disengagement of oxygen from the above body, by means of potassic permanganate. The gas liberated and the permanganate used form the data necessary for the preparation of standard permanganate solution, where the oxygen liberated per c.c. of reagent used is known. On the properties and composition of a cellular tissue which extends throughout the organism of the vertebrata, by M. A. Müntz.—Discovery of a new human skeleton of the paleolithic period in the caverns of Baoussé Roussé, by M. E. Rivière.—On the influence of various coloured rays on the spectrum of chlorophyll, by M. J. Chautard.—A note on the habits of "Lombrics," by M. E. Robert.

DIARY

THURSDAY, MAY 1.

ROYAL SOCIETY, at 8.30.—On the Effect of Pressure on the Character of the Spectra of Gases: C. H. Stearn and G. H. Lee.—On the Condensation of a Mixture of Air and Steam upon Cold Surfaces: Prof. Osborne Reynolds.—Further Observations on the Temperature at which Bacteria Vibriones and their supposed Germs are killed when exposed to Heat, &c.—Dr. Bastian.

SOCIETY OF ANTIQUARIES, at 8.30.—Flint Implements from Japan: W. L. Lawrence.—On Religious Guilds, and particularly the Privileged Guild at Walsoken, Norfolk: J. G. Nichols.

LINNEAN SOCIETY, at 8.—On Cinchonas: J. E. Howard.

CHEMICAL SOCIETY, at 8.—On Zirconia: J. B. Hannay.—On a new class of Explosives: Dr. Sprengel.

ROYAL INSTITUTION, at 2.—Annual Meeting.

FRIDAY, MAY 2.

GEOLOGISTS' ASSOCIATION, at 8.—On the Valley of the Vézère (Dordogne), its Limestones, Caves, and Pre-historic Remains: T. Rupert Jones.

ROYAL INSTITUTION, at 9.—Alcohols from Flints: Prof. Reynolds.

ARCHÆOLOGICAL INSTITUTION, at 4.

HORTICULTURAL SOCIETY, at 3.—Lecture.

SATURDAY, MAY 3.

ROYAL INSTITUTION, at 3.—Ozone: Prof. Odling.

SUNDAY, MAY 4.

SUNDAY LECTURE SOCIETY, at 4.—The Relations between Science and some Modern Poetry: Prof. Clifford.

MONDAY, MAY 5.

ROYAL INSTITUTION, at 2.—General Monthly Meeting.

GEOLOGISTS' ASSOCIATION.—Excursion to Aylesbury, from Euston Square at 10.15 A.M.

ENTOMOLOGICAL SOCIETY, at 7.

ASIATIC SOCIETY, at 3.

LONDON INSTITUTION, at 4.—Elementary Botany: Prof. Bentley.

TUESDAY, MAY 6.

ANTHROPOLOGICAL INSTITUTE, at 8.—Eastern Coolie Labour: W. L. Distant. The Westerly Drifting of Nomades from the Fifth to the Nineteenth Century. Part X. The Alans or Lesghs: H. H. Howorth.

SOCIETY OF BIBLICAL ARCHÆOLOGY, at 8.30.—On the Signification and Etymology of the Hebrew Noun הִרְשָׁתָא Tirshatha: R. Cull.—On the Chronology of the Olympiads in Connection with the Golden Age of Greece: W. R. A. Boyle.—On the Sites of Ophir and Taprobane, from Greek and Hindu Authorities: A. M. Cameron.—On the Character of the Preposition in the Egyptian Language: P. Le Page Renouf.—Translation of an Egyptian Hymn to Ammon: C. W. Goodwin.

ZOOLOGICAL SOCIETY, at 8.30.—On some new Species of *Araneidea*: O. P. Cambridge.—On African Buffaloes: Sir Victor Brooke.

ROYAL INSTITUTION, at 3.—Music of the Drama: Mr. Dannreuther.

WEDNESDAY, MAY 7.

SOCIETY OF ARTS, at 8.—Improvements in the Manufacture of Gun Cotton. S. J. Mackie.

HORTICULTURAL SOCIETY.—Exhibition of Roses, Azaleas, &c.

MICROSCOPICAL SOCIETY, at 8.—On the Development of the Sturgeon's Facial Arches: W. K. Parker.

LONDON INSTITUTION, at 7.—Conversazione and Lecture by Prof. Clifford.

THURSDAY, MAY 8.

ROYAL INSTITUTION, at 3.—Light: Prof. Tyndall.

MATHEMATICAL SOCIETY, at 8.—On an application of the Theory of Unicursal Curves; Plan of a Curve-tracing Apparatus: M. Hermite.—On Bicursal Curves: Prof. Cayley.

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