THURSDAY, AUGUST 30, 1877

THE ZOOLOGICAL RECORD

The Zoological Record for 1875; *being Volume Twelfth of the Record of Zoological Literature.* Edited by Edward Caldwell Rye, F.Z.S., M.E.S., &c. (London: John Van Voorst, Paternoster Row, 1877.)

ZOOLOGISTS, it must be said, are a somewhat ungrateful set of men. There can be no question of the extreme value to them of "The Zoological Record," and yet they allow, as is notorious, the Association which was formed to continue that useful publication to lead a precarious existence, dependent on the charity of various other scientific bodies. This is not creditable to the zoologists of our own country, nor, though in a less degree, to those of our colonies, past and present. Those of the United Kingdom are unquestionably wealthy as a class, but their wealth is very unequally divided. Many, and among them we are glad to say are some of the best, are amateurs who follow the study simply for their own pleasure, and are sufficiently blessed with this world's goods. Yet they see that many of their brethren have need, without taking any trouble to help them. The number of "literary and scientific" institutions, museums, reading-rooms, and the like, throughout the country, is very great, and there can be scarcely any of them that does not possess one or more members who take an interest in zoological pursuits. But how few of these institutions and so forth, are there on whose bookshelves "The Zoological Record" is to be found! Surely but a very slight amount of exertion is required on the part of such members to get this work taken in by the institution to which they belong? As a rule the library-committees of such bodies are not averse to books of reference, and here is one that is absolutely necessary to every student of or worker in zoology. It is no secret that the Zoological Record Association has the greatest difficulty in "making ends meet," and a very moderate amount of the support we have above indicated would go far to remove the difficulty, and to prevent the possibility of indelible disgrace accruing to the zoologists of this country, by the cessation of this useful annual.

The volume for 1875, which has just been issued, forms the twelfth of the series, and maintains the high character of its predecessors. It must be very satisfactory to Mr. Rye, as editor, to find himself supported by so strong a band of Recorders. Yet the *personnel* is, with one exception, entirely changed from that which was first enlisted by Dr. Günther. The exception is Dr. Eduard von Martens, who, with truly Teutonic tenacity, continues his labours on Molluscs and Molluscoids—nay more, since he first began, he has added the Crustaceans to his cares. The Mammals are in charge of Mr. Alston; the Birds have fallen to the lot of Mr. Salvin. Reptiles and Fishes are taken by Mr. O'Shaughnessy; Arachnids and Myriopods by Mr. Pickard-Cambridge. The editor himself bears the brunt of the battle; not only does he (as becomes one of the staff of the *Entomologists' Monthly Magazine*) look after the Insects as a general subject, but he also takes specially the orders, *Coleoptera*, *Hymenoptera*, *Diptera*, and *Rhynchota*—leaving the *Lepidoptera* to Mr. Kirby and the *Neuroptera* and *Orthoptera* to Mr. McLachlan. Dr. Lütken sweeps all the remaining groups into his net. The services of each of these gentlemen deserve the most conspicuous acknowledgment. Breaking stones on a road is the common expression for employment which combines the dullest and hardest handiwork with the lowest wages. Where mental labour is concerned it may be paralleled by the vocation of a Zoological Recorder. His task is certainly not more easy or exhilarating and he is not requited at a higher rate. There is scarcely one of the whole of these gentlemen, we are convinced, who does not enter upon or continue his occupation simply because he conceives it to be his duty—and his chief reward must be the satisfaction he receives from discharging it to the best of his ability—for it were absurd to call the miserable pittance, which is all that the Association can afford to dole out to him, any remuneration for the hours of weariness which the due execution of the Records requires.

So strongly do we feel the self-denying nature of the work done by the Recorders that we cannot find it in our heart to criticise any portion of it. There is, we think, and it is only to be expected that such should be the case, a marked difference in the execution of the several Records, and one that is not to be accounted for by experience or want of it on the part of their authors. The worst will bear favourable comparison with anything of the kind published elsewhere, and the accuracy of the references is quite beyond praise—for we could name at least one work of similar nature to consult which is often to follow a guide who either did not know or had forgotten the path. More than this—despite the difference of treatment of which we have spoken—there is a wholeness about the work that bespeaks an eminently able editor.[1]

The index to the genera and sub-genera recorded as new in this volume includes nearly *one thousand* names, and the excellent plan (first introduced, we believe, by the late Mr. Crotch) of indicating those names which have been already preoccupied in zoology is still continued. Taking a most merciful view of what constitutes a synonym, the editor has yet to mark fifty-nine of these names (thereby implicating thirty-seven authors) as used before—a far greater proportion than there of course ought to be. Some zoologists in conferring new names evidently pay very little attention to their predecessors' labours, and hence scientific nomenclature is encumbered by these unnecessary terms. One gentleman, indeed, seems oblivious of his own success in genus-making, and apparently has bestowed the same name on what he considers to be two distinct genera within a dozen pages of the same work! This is M. Mulsant, and he stands out as the greatest sinner in this respect. By himself he is guilty of making *three* synonyms, and in conjunction with M. Rey of *three* more. Messrs. Chambers, Schneider and Signoret are each responsible for *four*, Messrs. Chapuis and Reuter, for *three*, and Messrs. Boisduval, Chaudoir, Harvey and C. G. Thomson for *two*. The twenty-five who have committed this crime only once we need not name, and of course it is possible that in some cases their position is defensible, though in reality little is really

[1] Mr. Rye is so uncommon an editor that we believe he will be grateful to us for having a misprint detected—and it is the only one of importance that, after some study, we are able to point out. *Cyrrhophthalmus* (p. 259) should surely be *Cyphophthalmus*.

to be urged on behalf of so confusing a practice. When a man has a new genus to describe it should be his first duty to take care that he does not apply to it a name that has been proposed before, and it is not generally difficult to find this out. Of course the punishment ultimately falls on the offender's own head, for in these days somebody is sure to discover the blunder, and generally before long, but meanwhile the inconvenience may be and often is not inconsiderable.

In conclusion, we have but to wish the Zoological Record Association an increasing sale for their useful annual, and to express our thanks to Mr. Rye and his assistants.

ARCTIC METEOROLOGY

Scientific Results of the United States Arctic Expedition Steamer "Polaris," C. F. Hall commanding. Vol. I. Physical Observations. By Emil Bessels, Chief of the Scientific Department, U.S. Arctic Expedition.

THE United States Government has, with its accustomed liberality to science, published in a bulky volume of about 1,000 pages, under the auspices of the National Academy of Sciences, the results of the various observations of meteorology, astronomy, and magnetism, made by the scientific staff of the *Polaris* during the expedition to the Arctic regions in 1871-73. In the present notice we shall refer only to the barometric observations, and the discussion of them, which occupy altogether forty-three pages of the volume before us.

The barometric observations were made hourly at Polaris Bay, 81° 36′ lat. N., 62° 15′ long. W., from November, 1871, to August, 1872, and at Polaris House from November, 1872, to May, 1873, and they are published *in extenso* in this volume. These observations we have examined, and it is evident that they have been made with great care, and that, taken as a whole, they form one of the most valuable repositories of facts which we possess illustrative of the meteorology of the Arctic regions. The errors which do occur are of that class which may be regarded as "inevitable" in such a record of observations, viz., typographical errors, transposed or changed figures, and personal errors of observation which are well known to meteorologists, and admit of easy detection and correction.

On turning to the table of the mean hourly values for the different months (p. 18) calculated from the data just mentioned, we are at once struck with the extraordinary character of the hourly curves as disclosed by these figures, inasmuch as they show a repeated abruptness of change and a capriciousness of form which certainly could not be accepted unless on the clearest proof that they represent well-ascertained facts.

In examining the mean hourly values for December, 1871, the first month for which complete observations were made, it is seen that the calculations made from the individual observations are all correct. If we, however, take the trouble to critically examine the observations themselves from hour to hour, it is seen that there occur two uncorrected readings of 29·371 and 29·777 inches, instead of 29·571 and 29·577 inches, and twelve uncorrected readings in which the observers, as occasionally takes place with the best observers, have read the instrument 0·050, 0·100, or 0·150 inch either too high or too low. Correcting, then, these observations, and calculating afresh the hourly values, we obtain the result given in the following table (columns A.), to which are added the hourly values as printed in the volume (columns B.) :—

	A.	B.		A.	B.		A.	B.
hour.	inches.	inches.	hour.	inches.	inches.	hour.	inches.	inches
midnt.	29·759	29·759	8 A.M.	29·754	29·749	4 P.M.	29·749	29·749
1 A.M	·760	·760	9 ,,	·752	·749	5 ,,	·750	·748
2 ,,	·765	·765	10 ,,	·751	·752	6 ,,	·750	·750
3 ,,	·764	·764	11 ,,	·749	·756	7 ,,	·750	·750
4 ,,	·761	·761	noon.	·743	·740	8 ,,	·745	·741
5 ,,	·760	·756	1 P.M.	·742	·740	9 ,,	·738	·743
6 ,,	·760	·757	2 ,,	·744	·744	10 ,,	·735	·735
7 ,,	·759	·756	3 ,,	·748	·750	11 ,,	·734	·734

Thus, from not submitting the observations to a preliminary critical examination before calculating the averages, half of the resulting averages are faulty, and a monthly curve is obtained which completely fails to represent the physical datum for the ascertaining of which this elaborate set of observations were carried on in all the rigours of an arctic winter.

We are the more desirous of urging this matter on the attention of meteorologists, because the same method of hasty and ill-advised discussion of barometrical observations is widely practised ; and, it need scarcely be added, results in the publication of generally accepted averages, which more than anything else are seriously obstructive to any real progress in this intricate but vitally important branch of physical inquiry.

The observations for June, 1872, are free from these errors of observation, but notwithstanding this the hourly monthly values which have been deduced from them do not appear to be satisfactory. On calculating, then, the monthly values from the observations of this month, it turns out that only one of the twenty-four means is correct, the other twenty-three being more or less seriously in error. It is to be regretted that the hourly means for the other months of the period also are so much and so frequently in error, those for December, 1872, for instance, giving a curve which in its essential points is the reverse of the correct one, that the whole of the elaborate discussion of the barometric observations made by the scientific staff of the *Polaris* Arctic Expedition must be rejected.

The averages for the different months have been deduced in two ways, viz., from the twenty-four hourly means, and from the thirty or thirty-one daily means of the month. These two sets of averages would of course agree if the calculations were correct. In the printed tables they are made to agree even to the thousandth part of an inch, by simply placing the calculated average of one column under both columns. Thus the monthly average of June, 1872, is, as deduced from the twenty-four printed hourly means 29·888 inches, and as deduced from the thirty printed daily means 29·860 inches, but in the tables 29·888 inches is printed as the mean of both columns. It is thus evident that the reduction of this very important series of barometric observations requires yet to be made—a work which we hope will be yet undertaken, particularly since the summer and the winter means we have computed seem to suggest important connections between these arctic barometric curves and the curves of lower latitudes.

OUR BOOK SHELF

La Théorie Hugodécimale; ou, La Base scientifique et définitive de l'Arithmologistique universelle. Par le Cte. Léopold Hugo. (Paris, 1877.)

M. HUGO continues to pour forth his pamphlets with their polyglot inscriptions. On this we have "Urbi et orbi. Hic tandem triumphaliter fulget REGULARITAS!" "La pan-imaginarité Hugomathique: CONTINUITAS! CONTINUITAS! TRICONTINUITAS!" We have, in a former notice, glanced at the "Géométrie Hugomoïdale." The object of the present pamphlet is "à vulgariser et à répandre dans les diverses régions civilisées de l'ancien et du nouveau monde, Tou-Kieou, Tchong-Kouo, Fou-Song, &c., &c., cette haute doctrine philosophique, qui, dans sa concision, mérite assurément une place aux premiers rangs de la Philosophie Scientifique. Mais, dans mon isolement de simple philosophe, force me sera d'employer les combinaisons les plus étranges, et de frapper l'attention du lecteur par la singularité même de mon exposition."

One or two extracts must suffice to show how our author proceeds:—

"Évocation Chino-Tibétaine. Nous, suprême Grand Lama, voulons reproduire pour tous l'opération magique hugodécimale.

"Salut! Salut!

"En notre Divan sacré de Hlassa-Potala, parfumé de nuages d'encens, nous étendons la main gauche en désignant et déterminant un point dans l'espace ambiant.

"Salut! Salut!

"De notre main droite étendons le sceptre, pan-scientifique et sacré, sur ce point de l'espace. Salut! salut!

"Apparaît une figure enveloppant le point considéré: figure offrant quatre faces pareilles.

"O Saints Lamas, placez pieusement sur notre tapis précieux, le premier solide que l'espace régulier vient d'enfanter.

"SSÉ—MIÉ (with figure of tetrahedron).

"Salut! Salut!"

And so on through the ten solids, of which we gave an account in our earlier notice.

The third chapter is taken up with the "Géometrie Pan-imaginaire" and the "Arithmétique Pan-imaginaire," communications made to the Société Mathématique de France, and which we have previously described.

Sufficient notice has been taken of this *brochure* of thirty-two pages, with many figures.

To some of our readers our remarks will serve as a beacon; those who like to secure oddities may perhaps be induced to add this to their stock. Our principal reason for yet noticing another effusion of our author is that we have at last got a notice of him from one of his own countrymen, who calls him "Sans contredit, dans le domaine des sciences, l'un des plus actifs *novateurs* de l'époque" (M. Gérono, *Nouvelles Annales de Mathématiques*, Juin, 1877, pp. 278-280). Like ourselves, M. Gérono confines himself to *extracts*. In his *avertissement* M. Hugo bursts forth with "Écrasons les pan-routiniers! qu'ils tremblent, blottis dans leur petite science, devant l'ouragon hugomatique!" Upon this the French reviewer well remarks:—"Mon avis est qu'il ne faut écraser personne, et que les philosophes réformateurs doivent se garder de prendre l'exaltation des idées pour le sublime des idées. Ce n'est pas sans danger qu'on se lance dans la voie des réformes avec un enthousiasme qui, dans sa marche ascendante, pourrait s'élever jusqu'au délire." The writings of such a visionary perhaps hardly merit a notice; we are disposed henceforth to let him go his own way, trusting that time will clear up many, if not all, of his crotchets.

Mechanik der Bewegungen der Insektenfressenden Pflanzen. Von A. Batalin.

WE have here a record, reprinted from the pages of *Flora*, of a very careful series of experiments on the cause of the "spontaneous" movements of the glands of *Drosera* and other similar organs when irritated say by contact with a fly. Comparing the well-known explanation given by De Vries and others of the movements of tendrils—that contact causes an acceleration of growth in the organ, not on the side touched, but the opposite side, and consequently a concave curving round the touching object—Batalin offers the same explanation of the curvature of the tentacles of *Drosera* when irritated by a fly, viz., an acceleration of growth on the side opposite to the one touched, and in consequence a concave curvature. While admitting the care with which Batalin has performed his experiments, we fail to see how his explanation accounts for some of the well-known phenomena of these singular plants; as, for instance, the fact vouched for by several observers, that glands which are not themselves irritated exhibit the same concave curvature as those that are, and especially those so circumstantially described by Darwin as to the extreme sensitiveness of the tentacles of *Drosera* to the most dilute ammoniacal solutions, while they are quite insensitive to pure water. The "spontaneous" curvature Batalin believes to be a function of growth, and to be displayed in proportion to the faculty of growth possessed by the organ.

LETTERS TO THE EDITOR

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

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Relations between Sun and Earth

PERMIT me to correct a slight misapprehension in Mr. Archibald's very interesting article on the Indian rainfall in NATURE, vol. xvi. p. 340. Mr. Archibald speaks as if my discovery regarding the coincidence of the increase and decrease of the Madras rainfall with the cycle of sun-spots applied to "the whole of Southern India." Now, on the contrary, I guarded against such a generalisation by a sentence expressly inserted for that purpose. "I merely record," I said at p. 9 of my paper, "the statistical evidence collected at a point on the globe's surface, at which, from its tropical situation and physical conditions, such a factor would exercise an influence in a well-marked manner." I insisted on this, as the local influences at work on the rainfall suffice in several parts of Southern India, to disguise the operation of any general law. Mr. Archibald may, however, have been led into this misapprehension from an ambiguous expression in the first sheets of my paper, which were hastily struck off as I was leaving India, with a view to placing the Government in possession of the facts before my departure. In these sheets I find the words "Southern India" used once or twice as a periphrasis to avoid the too frequent repetition of the word Madras. This ambiguity was removed from the paper as finally printed. I need hardly add that the words "the whole of Southern India" nowhere occurred. I hope shortly to show in a more carefully elaborated work, the limitations under which the results arrived at in my former paper can be safely generalised. Meanwhile Mr. Archibald's interesting communications both in NATURE, and in the Calcutta *Englishman* are worthy of careful study. WM. HUNTER

Lanarkshire, August 27

The Telephone

IN the present agitation concerning speaking or telephonic telegraphs, the following extract from M. Le Comte du Moncel's "Exposé des Applications de l'Electricité," edition of the year 1857, vol. iii. p. 110, may be interesting as pointing out how nearly the idea has been forestalled.

"*The Electric Transmission of Speech.*"

"I did not wish to bring forward in the chapter of the electric telegraph a fantastic conception of a certain M. Ch. B——, who

believes that it will be possible to transmit speech electrically, because it might have been asked why I had classed among so many remarkable inventions an idea that, presented by the author as it is, is not more than a dream. However, to be faithful to the *rôle* that I have imposed upon myself of speaking of all the applications of electricity that have become known to me, I wish to quote here the information which the author has published on this subject.

"After the marvellous telegraphs which are able to reproduce at a distance writing of this or that individual, and designs more or less complicated, it seemed impossible, said M. B——, to advance further in the regions of the marvellous. Nevertheless, essaying to do something more, I asked, for example, if speech itself would not be capable of transmission by electricity; in a word, if one would not be able to speak at Vienna and be heard at Paris. The thing is practicable. This is how: Sounds, it is known, are formed by vibrations and carried to the ear by these same vibrations, which are reproduced by the intermediate media.

"But the intensity of these vibrations diminishes very rapidly with the distance, from which it follows, even in the employment of speaking trumpets, tubes, and of acoustical horns, the limits which cannot be surpassed are very restricted. *Imagine that one speaks near a mobile plate, flexible enough not to lose any of the vibrations produced by the voice, that this plate establishes and interrupts successively the communication with a battery. You would be able to have at a distance another plate which would execute at the same time the same vibrations.*

"*It is true that the intensity of the sounds produced would be variable at the point of departure where the plate is vibrated by the voice, and constant at the point of arrival where it is vibrated by electricity.* But it is demonstrable that this would not alter the sounds.

"It is evident from the first that the sounds would reproduce themselves with the same pitch in the scale. The actual condition of acoustical science does not permit of saying, *à priori*, whether the same conditions would hold good for all syllables articulated by the human voice. The manner in which these syllables are produced is not yet sufficiently well known.

. . . . . .

"In any case it is impossible to demonstrate, in the present state of science, that the electric transmission of sounds is impossible. Every probability, on the contrary, is for the possibility. An electric battery, two vibrating plates, and a metallic wire will suffice.

. . . . . .

"It is certain that, at a time more or less distant, speech will be transmitted to a distance by electricity. I have commenced some experiments to that effect, they are delicate and require time and patience. But the approximations obtained point towards a favourable result." PAGET HIGGS

Museums

THE following suggestions may possibly prove useful to directors of museums, and especially of provincial museums. Most of the plans recommended have been tried with success.

It is very desirable that in all collections intended for public instruction manuscript labels should be abolished. The advantages of perfect legibility, uniform style, and an occasional change of cards far outweigh the cost of letter-press. A convenient hand-press costs about 3*l*.; several founts of type in quantity sufficient for museum purposes, may be had for 5*l*. An assistant can be taught printing in a few days; I have at times engaged a printer's apprentice, paying sevenpence an hour for his services.

The proper display of dissected preparations put up in spirit has long been a serious trouble. Most dissections of small size can be pinned out on wax. Young's Paraffin Light and Mineral Oil Company, of West Calder, have lately prepared, at my request, smooth paraffin slabs, coloured deep blue, and cut to 12 in. × 6 in. These can be had at a shilling a pound. Cylindrical glass vessels are objectionable, not only on account of distortion, but because they render it difficult to demonstrate details of structure. Rectangular trays with movable plate-glass lids are far more convenient. These may be made of ebonite for the smaller sizes, and of wood lined with gutta-percha where the cost of ebonite becomes important. I hope before long to get a useful tray cast in glass. The edges must be accurately ground, and the cover secured by light brass clamps. In the bottom of the tray the wax tablet can be securely fixed. It is useless to cement the lid to the tray. Hardly any cement will stand prolonged exposure to dilute spirit, and it is necessary to readjust or clear the dissection from time to time.

Fossils are usually kept loose; in the larger collections they are mounted on tablets of wood or glass covered with paper. The first method is untidy and often causes loss of labels; wooden tablets are costly, difficult to cut of quite uniform size, and liable to warp; glass is also difficult to cut true, and wastes much time in covering with paper. Ten years ago I procured a supply of pasteboard tablets one-tenth of an inch thick from a pattern-card maker and have used them exclusively since. They are cheap (ninepence to a shilling a pound), can be cut perfectly true by machinery, do not warp, and may be had of any colour. Fossils glued to pasteboard with coaguline are perfectly fast; we range them in wall-cases upon shelves sloped to forty-five degrees, and never meet with accidents.

In our geological wall-cases I have introduced above the level of the eye a range of boards, nearly upright, but sloping slightly forwards at the top, upon which maps, sections, photographs, and descriptive notices can be pinned. In a palæontological collection this space is useful for drawings of restored animals.

It is much to be desired that the dealers would procure a better choice of zoological models in glass and porcelain. Reuss' foraminifera are still useful, though antiquated; Blaschka, of Dresden, keeps no stock, though he has supplied many of our museums with useful models in glass made from drawings. We want artistic and accurate coloured models of mollusca, hydrozoa, &c., far beyond the present supply.

Stuffed animals, especially stuffed mammalia, are the plague of a curator. I do not refer especially to their liability to moths (insects of all kinds can be kept down by placing saucers of carbolic acid in the cases) but to their grotesque deformity, their unnatural attitudes, and their proneness to contract in unexpected places. A model in plaster or clay, strengthened internally by wires would last for ever, and the skin would stretch over it readily enough when moist. Real skill in modelling is required here, and we have not yet been able to command it. The Schools of Art may in time help us over the difficulty. A well-modelled animal can never be very cheap, but if increased costliness should render set-up quadrupeds comparatively scarce, zoology need not suffer on that account.

Public museums should contain far more than they now do the elementary explanations necessary for the right understanding of the objects exhibited. A text-book illustrated by specimens instead of wood-cuts should be our aim, at least where the wants of the public are more concerned than the wants of special students. I should propose to relegate nine-tenths of our existing collections to cabinets were it not that things out of sight in cabinets are so liable to suffer from neglect. At present we aim at too much, introduce too many departments into a small museum, show too many obscure and uninstructive objects, and spoil everything by over-crowding.

Personally, I do not hold that local collections should be everything in a provincial museum. We have to consider the wants of residents as well as of passing strangers, and what the residents interested in natural history require is a general collection of typical specimens which will teach them something of the elements of their science. It is very easy to make imposing collections of land and fresh-water shells, butterflies, and so forth, which a naturalist passing that way praises because they contain here and there a choice thing, but which either teaches nothing to the uneducated visitor, or else teaches him the very undesirable lesson that the best thing he can do is to make a similar collection for himself. We have had more than enough of unintelligent collecting and unintelligent records of occurrence. Our provincial museums should tell the public that to know something of the structure of animals and plants is better than to know many species. L. C. MIALL

Leeds, August 17

THE great difficulty, as it seems to me, in promoting and maintaining the efficiency of our local museums lies in providing them with suitable curators; and in this connection an idea which occurred to me last year may prove not unserviceable. I have seen a large number of our provincial museums, and in many of them have found really extensive and valuable collections of natural objects which only require to be rightly named

and properly arranged to become admirable educational aids. In few, however, is there enough material to engage the whole time and attention of an able man in taking care of it; indeed a single month devoted to each of the departments of zoology, botany, geology, and so forth, would suffice, and, in many cases, more than suffice, to put each into working order to begin with, and after the first arrangement it would be easy enough to maintain the efficiency of each collection and to add what fresh acquisitions might be made in the course of a week's visit once a year.

Let, then, an association of the younger workers in the various branches of science be formed in London, under the direction of a committee of well-known names, and let it offer to send out every year for short intervals, to such museums as should be ready to pay for them, botanists, zoologists, geologists, and the rest, to name and arrange their several collections; each member so dispatched would then visit several museums in succession, confining his attention in each to the collection made in his own subject, and each museum would be visited by several members, one member for each of its essentially different collections. Thus for a slight expense (payment on the piece-work system) a large number of our Local Museums would be put under the curatorship of a group of specialists, and so be brought into efficient and permanent working order. The idea is simply that of visiting curatorships supplied on the principle of co-operation, and made possible by the facilities for travelling afforded by our modern railway system.

It can scarcely be doubted that in the summer, when lectures and lecturing are over, many scientific men might be found willing and able to undertake the task. W. J. S.

Rainbow Reflected from Water

MR. CROOKES' interesting observation of the reflection of a rainbow—described in his letter in NATURE, August 16—is easily reproduced, on a small scale, experimentally.

I fixed a "spreader" to the nozzle of a garden-engine so as to cause a shower of fine drops of water to spread in the sunshine. The segments of a bright primary rainbow and of a rather subdued secondary one stood out well-defined against the dark foliage of some trees, the remainders of the bows being lost against bright objects and sky behind.

At whatever point the bows were visible, I found that by placing a mirror or blackened glass wetted so as to form a surface of water, in place of the eye, and then observing from a fresh point, the reflections of both bows could be very distinctly seen at the same time that real bows were also visible.

The reflected bows were always apparently smaller in diameter than the real bows which were visible at the same time from the same position. The reason of this is, I presume, that the bows seen in the mirror are not the reflections of the bows visible, at the same time to the eye, but of bows which the eye would see if it occupied the place of the mirror, or rather of that portion of it which is observed. When, for instance, the mirror is one yard below the level of the eye, the drops by which the bows are formed that are reflected by the mirror, are necessarily about one yard below the corresponding drops by which the direct bows seen by the eye are formed; in other words the direct bows are one yard above the bows which are actually reflected. Therefore, when both are cut by a common horizontal line formed by the surface of the mirror, a reflected bow must be the more shortened of the two and its diameter apparently reduced.

I would suggest that this may be the explanation of the displacement of the colours where the real and reflected bows met, which Mr. Crookes observed. ROBERT SABINE

Hampton Wick, August 20

The Greenland Foehn

DANS le dernier numero (406) de votre journal je vois que vous m'avez fait l'honneur de donner un abstract d'un petit travail sur le foehn du Groenland. Malheureusement le rapporteur n'a pas bien compris le danois (ou le norwegien) en quelques endroits, et je me permettrai de vous indiquer les méprises suivantes comme les plus dangereuses.

2ième alinéa.—"Dr. Pfaff has carried on . . . . and these show that the average temperature of *February*, 1872, was − 8°·7 C., and of *February*, 1863 − 31°·6," etc. Les deux mots, "February," sont omis, ce qui fait croire que je parle de la température moyenne de l'année au lieu d'un mois.

5ième alinéa.—"These explanations go a great . . . . when at Jacobshavn shortly before *July*, 9° C. of heat are recorded." Au lieu de "July" j'ai dit "Christmas"; une température de 9° C. est normale en juillet.

Août 21 W. HOFFMEYER

On the Supposed Action of Light on Combustion

IN answer to Mr. Watson's inquiry contained in your last number, I may state that at the meeting of the British Association at Exeter, in 1869, I read a paper under the above title (See *Phil. Mag.* for September, 1869), in which some comparative experiments were made on candles burning in full sunshine and also in a darkened closet. This mode of experiment was adopted because it allowed the results to be tested by weighing. Candles of the same make were used and hard sperm candles preferred as being less affected by variations of temperature than composite. The candles were allowed to burn during four hours. I give one result:—

In the dark (temp. 81° F.) each candle lost 544 grains, or 136 grains per hour.

In the light (temp. 84°) each candle lost 567 grains, or 142 grains per hour nearly.

It is evident that in this case the increase of temperature caused by the bright sunshine led to an increased consumption of material, but the general result was that light has no retarding influence on combustion. C. TOMLINSON

Highgate, August 25

Evolution by Leaps

WITH reference to an article entitled "Evolution by Leaps," in your "Biological Notes" (NATURE, vol. xvi. p. 208), I would call attention to a fact which is not unknown to horticulturists, that a hybrid sometimes proclaims its origin by producing—even on the same rachis—flowers and fruits, some of which resemble one parent and some the other.

Many a time I have plucked a branch of two or three feet in length from a pear-tree growing in a village in Kent, which bore at the proximal end pears of a certain size and description, and on the terminal twigs pears smaller in size, of a different flavour, and later in blooming and ripening.

As this "sport" prevailed throughout the tree, which was large and flourishing, there was no possibility of its being the result of a direct graft. PAUL HENRY STOKOE

Beddington Park

Zygœna Filipendulæ

IN July last I was breeding some *Zygœna filipendulæ* (six-spot Burnet moth) from pupæ taken in a chalk-pit near Cambridge, one of which was developed into a moth with five wings; four of these correspond to the normal wings in this species and are perfect in every respect, as also are five of the legs. The sixth leg (a hind leg) is absent, its place being filled up by the extra wing, which springs from the exact point at which the missing leg would naturally join the body. In appearance the extra wing resembles the ordinary hind wing of the species, but is only about half its usual size. It is of a yellowish-red tinge, and not so thickly covered with scales as the other wings of the insect. Of the sixth leg there is no external trace whatever, as far as I can see; in fact it would seem at first sight as if the leg had, by some means or other, been transformed into a wing.

This moth is subject to a good deal of variation as regards the size of the spots on the fore-wings, two of which are occasionally united; also, in this particular locality, the red colour is replaced by yellow in about 1 per cent. of the specimens. The chalk-pit to which I have alluded is scarcely an acre in extent, and as the species does not seem to occur elsewhere in the immediate neighbourhood, continuous interbreeding must have been going on for a long time.

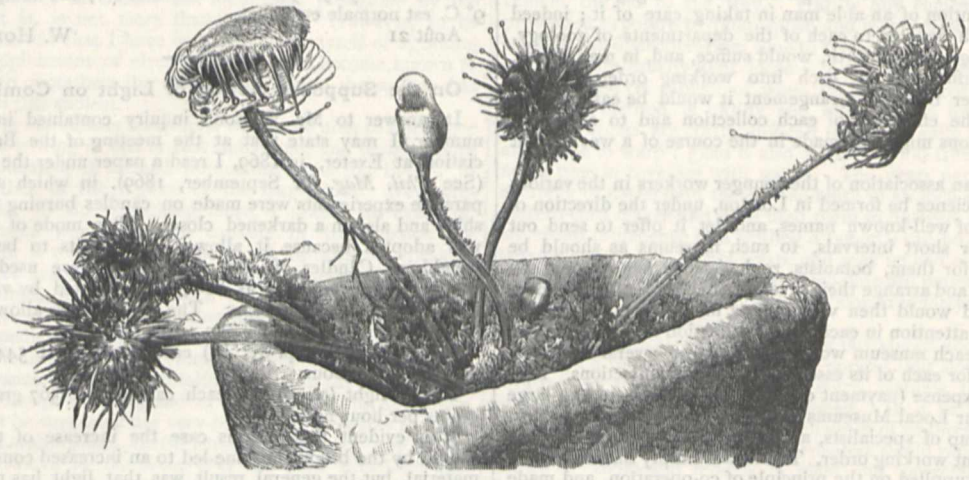
I have never met with or heard of such a curiosity of morphology either in this or any other lepidopterous species before, but some of your readers will doubtless be able to adduce other instances of a similar nature. N. M. RICHARDSON

Clare College, Cambridge, August 21

Drosera

I BEG to enclose a photograph of a specimen of *Drosera rotundifolia* found by me at the Lickey Hills on July 1 this year.

If anything could demonstrate the propensity for fly-catching known to exist in this class of plants, surely this specimen does in the most marked degree. You will see that a moth has been entangled by the hairs of one of the leaves, which leaf has curved



itself right over the moth in the most determined fashion. There is every appearance of a struggle having taken place which ended in the defeat and destruction of the moth.

This specimen is, I should imagine, a very typical one, and as such I have sent a copy to Mr. Darwin. WRIGHT WILSON

Birmingham

The Radiant Centre of the Perseids

FROM twenty meteors, mostly with streaks, I deduced the radiant point at R.A. 40°, Dec. 56° N., August 3-7. On August 10 I saw a large number (fifty-seven per hour) of *Perseïds*, many of them with short tracks near the focus, and almost invariably with streaks, from 43° + 58°. On August 12 I observed quite an outburst of precisely similar meteors from a sharply-defined centre at 50° + 55°, and registered fourteen of them, but many others were noted between 12h. and 14h. On the 16th, between the same hours, I saw five paths close to a radiant at 60° + 59°. These had streaks and apparently exhibited the same features of motion, colour, &c., as those recorded on the few preceding nights. Can these four positions represent one and the same system of *Perseïds* with an apparent displacement of the radiant centre on the several nights of observation? The places may be regarded as accurate for the dates, and though quite possibly they are separate showers, it is at least singular they became so well marked one on each night. If the positions include the same system then the focus of divergence appears to have shifted from 40° + 58° on the 3rd-7th to 60° + 59° on the 16th, so that while the declination remained nearly the same the R.A. had advanced twenty degrees, which in D. 59° N. is equivalent to ten linear degrees of space.

It is a capital plan while observing and mapping meteor tracks to hold a perfectly straight rod in the hand, and directly a meteor is seen, to project the rod upon its apparent path, carrying the eye back in the same line of motion and noting the exact point with reference to stars upon which it converges. In the case of slow meteors or meteors with streaks, this is a very accurate method and especially to be recommended in regard to paths presumably a long way from the radiant. Eye-estimates are necessarily less exact, for while the *position* of the track is being noted the more important feature of *direction* is inaccurately remembered. W. F. DENNING

August 17

Fish Commensals of Medusæ

IN the numbers of NATURE for July 19 and 26 (pp. 227, 248) are communications respecting fish-sheltering Medusæ. The *Trochurus* in Europe appears to be a commensal of the Acaleph as well as the *Pollochius*. In the eastern waters of the United States, however, so far as I am aware, the Stromatoid fish *Poronotus similis* (*Stromateus similis* of some authors) seems to be the most common, if not the only associate, of several acalephs, viz., *Dactylometra quinquecirra*, *Zygodactylon grœnlandica*, and *Cyarea arctica*. Under the umbrellas of these species small *Poronoti* are to be found in the late summer swimming, sometimes even to the number of twenty or more, but generally much fewer. Mr. Alexander Agassiz, in his "Sea-side Studies," mentions the occurrence of an undetermined "Clupeoid" fish, but no other, under the umbrella of *Dactylometra quinquecirra*; the identification is probably erroneous. At least my own observations were made in the same region and at the same time of the year as Mr. Agassiz's, and only the *Poronotus* was seen. More detailed information respecting this association may be found recorded by Prof. Verrill in the "United States Commission of Fish and Fisheries" reports, Part I., pp. 449-450, 1873.

THEO. GILL

Smithsonian Institution, Washington, August 6

Science in Spain

I THINK it may interest the readers of your journal to have some slight idea of the state of natural sciences in Spain. Science is universal, and the efforts made by a nation which has been separated by centuries of intolerance and indifference from the movement and scientific life of other countries, cannot fail to be looked upon with indulgent eyes by those who cultivate science.

Of the three great branches into which we may divide natural science—physics, chemistry, and natural history, the first is in a most backward state in Spain. In almost all the professorships where this science is taught, the instruction given is so out of date, that no mention is made of the modern theory of the correlation of forces or thermo-dynamics, and the text-books used are French works, now quite obsolete. In every one of our upper schools—Institutos de 2da Ensiñanza—there is a professor who teaches physics and chemistry conjointly, who is instructed to go through a course of these sciences, which are reduced by this means to their lowest possible expression. In our universities, there exist classes in which an amplification of physics is taught; this study is part of those required for the preparatory exercises for the faculty of medicine. This course, if we take into consideration the knowledge brought by the pupils who attend it, is more an explanation of what they ought to have learnt than anything else. At the Madrid University alone, there is a class of "imponderable fluids;" the name in itself suggests an idea quite out of date at the present day. At the same university there is also a class of mathematical physics, but it does not form part of the studies required to receive a doctor's degree in the physico-chemical sciences, and is only included in the mathematical sciences. This is unfortunately all the official instruction on the subject which is given in Spain. Almost all the professors follow the theories which were generally admitted before the discoveries of Grove, Mayer, Rankine, Clausius, Tyndall, and Helmholtz.

During the Republican Government in Spain, it was decreed to reorganise these studies in a manner more in accordance with modern ideas, but the short rule of this reforming government prevented this plan from being carried out, or conquering the

tenacious resistance of the great majority of the Spanish professors.

Some champions of modern ideas are happily not wanting in Spain. Among them is one of the most distinguished members of the Madrid Observatory, Sr. Jimenez, who has written an interesting volume on the theory of numbers, which obtained a prize from the Spanish Academy of Science. Sr. Jimenez began to publish a few years ago a theory of light in compliance with the most authorised physico-mathematical doctrines. A man of immense and varied intellect, as a dramatic poet, as an engineer, as a mathematician and economist, and one of the principal men of the revolution, Sr. Echegaray has done much to popularise the modern theories of physics, by a volume dedicated to the General Public, and also by his elementary treatise on thermo-dynamics. He is now publishing some studies on light in a scientific review, which are chiefly intended to extend these studies in our scientific circles. Dr. Vicuña, Professor of Mathematical Physics at the Madrid University, endeavours to do the same by his teaching, and by means of the articles and memoirs which he publishes from time to time. Of these may be mentioned his theory and calculation of steam-engines in accordance with thermo-dynamics.

The scientific instruction which is given to the young men who attended the upper school at the Observatory of Marino, at San Fernando, near Cadiz, is much commended. Every day foreign books are more universally read, translated, and understood, the most popular being those by Tyndall. Prof. Barreda, Felin, Ramos, v. Chamorro are great advocates of modern science. Sr. Escrig y Mieg, the professor at the Institute at Guadalajara, has set up some interesting scientific apparatus there, and has introduced in the pneumatic machine an improvement which reduces the injurious space. The barometer constructed by Sr. Torres, the inventor of probably the most accurate barometer known in European meteorology, merits special mention. It is much to be regretted that owing to special circumstances, his instrument could not figure at the interesting exhibition at South Kensington.

At the Free Institution, lately established for teaching at Madrid, by private enterprise, which the readers of NATURE have already seen referred to in your columns, there is a class of experimental physics, according to the latest development of this science. On the evening of January 28, a series of public lectures were begun, with the object of popularising science in Spain. Dr. Simarro, a young professor at this institution, gave the first lecture on light, and repeated some of Tyndall's most remarkable experiments.

Most of these efforts are, however, still limited to the attempt to spread in Spain a knowledge of the actual state of physical science from other countries which are in a more advanced condition, rather than to contribute to general culture works of original investigation. The interesting studies of Prof. Serrano Faligate, on general and biological physics, some of which have been noticed by English reviewers, are almost the only works on the subject which can be mentioned of importance. It is indeed to be hoped this will no longer be the case when these studies are more generally developed, and act as a stimulant to the genius of the Spanish people.

Madrid FRANCISCO GINEZ DE LOS RIOS

OUR ASTRONOMICAL COLUMN

THE ROTATION of SATURN.—In NATURE (vol. xv. p. 243), reference was made to the discovery by Prof. Asaph Hall of a small, well-defined, very white spot upon the disc of Saturn just below the ring, and to observations which were in progress to ascertain, by means of it, the period of the rotation of the planet upon its axis. Prof. Hall succeeded in following up this spot which was from 2″ to 3″ in diameter until January 2, when the weather having become unfavourable, the planet low, and the spot faint and indistinct, observations were discontinued. From a thorough discussion of the observations at Washington and elsewhere in the United States, Prof. Hall finds for the mean time of the rotation of Saturn—

10h. 14m. 23s·8 ± 2s·30.

It has been necessary to assume that the spot had no proper motion upon the surface of the planet, which is a point on which the observations throw no light.

On the first detection of this spot on December 7, with the view to secure assistance from other observers in noting its central passages on the disc, an ephemeris was circulated from Washington, in preparing which the time of rotation was taken at 10h. 29m. 16·8s., given, as Prof. Hall remarks, "in nearly all the modern text-books as Sir W. Herschel's last and most accurate determination;" notwithstanding this it appears certain that Sir W. Herschel never assigned this period, and its adoption in the Washington ephemeris was so far unfortunate as it may have rather hindered than assisted observations; indeed "through this mistake several observers failed to see the spot."

It is very probable that Prof. Hall has suggested the real cause of the introduction of this erroneous value for the time of Saturn's rotation into so many of the so-called "text-books," the compilers of which rarely concern themselves with references to original authorities, and yet in this case the erroneous value has been given by writers, whom it might well be supposed it was safe to follow. In the *Exposition du Système du Monde*, the first edition of which appeared in An. IV. of the French republican era, Laplace says that Saturn rotates in 0·428, and the ring in 0·437, these figures being decimals of a day; they correspond to 10h. 16m. 19·2s. and 10h. 29m. 16·8s., the former expresses therefore the Herschelian period of rotation (10h. 16m. 0·4s.) to the nearest decimal in the third place, and the latter is the value for rotation of Saturn given in so many astronomical works. Hence Prof. Hall thinks that some one early in the century copied and converted the wrong number from Laplace and "the book-makers have faithfully copied this mistake."

Hansen in his "Allgemeine Uebersicht des Sonnensystems" gives 10h. 29m. 17s. for time of rotation both of Saturn and his ring; Mädler, "Ueber die Weltstellung der Körper unsers Sonnensystems," has 10h. 16m. for the globe and 10h. 29m. 17s. for the ring, but in the early editions of his treatise on Astronomy (as in that of 1849, pp. 251 and 254) he assigns 10h. 29m. 17s. for the globe, and 10h. 32m., after Herschel, for the ring, adding "wahrscheinlich ist sie der des Saturn selbst gleich und beide sind etwa 10h. 30m. in runder Zahl." Sir John Herschel, in the first edition of his Treatise on astronomy in Lardner's "Cabinet Cyclopædia" published in 1833, gives 10h. 29m. 17s. both for Saturn and the ring, and he probably followed Baily's "Astronomical Tables and Formulæ" which appeared in 1827, and where we find at pp. 39 and 59 the same period 10h. 29m. 16·8s. assigned for both rotations, and Baily expressly states that "the elements of the system are taken for the most part from the *Système du Monde* of M. Laplace (fifth edition, 1824), so that it is possibly to this work, which was one of general reference for many years, that the original oversight suggested by Prof. Hall is to be traced. Sir W. Herschel in the *Philosophical Transactions*, 1790, p. 480, states that his observations of lucid spots upon the ring, supposing them to adhere to it, would be explained by "admitting a revolution of the ring itself in 10h. 32m. 15·4s., and in the volume for 1794, p. 28, he finds for the rotation of the globe of Saturn, 10h. 16m. 0·44s., which are the only values that bear his authority.

Prof. Asaph Hall's value must now be taken as undoubtedly a very close approximation to the true period in which Saturn rotates. According to it, the planet's year consists of 25.217 Saturnian days. To the rarity of spots upon the disc of so small and well-defined a character as that which has been recently observed to such useful purpose at Washington, is perhaps to be mainly attributed the want of an earlier reliable determination of the rotation period in confirmation of Sir W. Herschel's, made upwards of eighty years previously.

THE COMET OF 1812.—In anticipation of the return of this comet to perihelion within the next few years, Prof. Winnecke has published ephemerides to facilitate its

rediscovery, which have been prepared by Herr Mahn on his suggestion. They appear in the *Vierteljahrsschrift der astronomischen Gesellschaft*, 12 Jahrgang, 2 Heft. Encke's period, 70·7 years, would bring the comet to perihelion again in 1883, but Mr. W. E. Plummer, now of the University Observatory at Oxford, some years since stated that a period of 69·2 years would better agree with normal places which he had very carefully prepared. The comet may therefore visit us in 1881, or possibly much earlier with the unknown effect of perturbation. The sweeping-ephemerides are arranged upon a plan conveniently indicating the line in which the comet should be sought at a particular date. It is a case where the "orbit-sweeper," suggested by Sir George Airy, and advocated by Prof. Winnecke, would, if provided with an object-glass of sufficient optical capacity, render much assistance.

THE COMPANION OF SIRIUS.—In the *Comptes Rendus* of the French Academy of Sciences, August 13, M. Flammarion has a graphical representation of the orbit assigned by Dr. Auwers, to the perturbing companion of Sirius and of the observed course of the small star discovered by Mr. Alvan Clark, with the view to illustrate the increasing differences between theory and observation. Allusion was made to this subject in NATURE (vol. xiii. p. 428), where the differences of Dr. Auwer's ephemeris, 1872-75, were given. The latest measures of the Clark-companion at Washington, show for 1877·21, position $(c - o)$, $+6°·9$, distance $-0''·88$.

Prof. Asaph Hall found no other star in the vicinity of Sirius nearer than one of the thirteenth magnitude, which was measured on February 28, 1877; position 114°·9, distance 72″·09; probably the star seen by Mr. Marth at Malta in January, 1865. An examination of the vicinity with the great refractor was made at the request of M. Tempel, of Florence, who had suspected the existence of several small stars near Sirius.

SATELLITE OF MARS.—One of the newly-discovered satellites of Mars was observed by M. M. Henry at the Observatory of Paris, on August 27.

At 12h. 9m. mean time, position 249° 56′, distance 85″·2, the satellite was very faint, and only observable when the planet was screened from view.

BIOLOGICAL NOTES

THE DEVELOPMENT OF THE NERVES IN VERTEBRATES.—Mr. Balfour's discovery that the spinal nerves of sharks and rays are developed as outgrowths from the central nervous system has been followed by a similar revelation with regard to birds. Mr. (now Dr.) A. M. Marshall (of Cambridge) has given an account of investigations respecting the origin of nerves in the fowl (*Journ. Anat.*, April, 1877), describing a longitudinal ridge arising on the summit of the neural canal, and giving off paired processes, the rudiments of the posterior roots of the spinal nerves. Hensen has made analogous observations on the spinal nerves of the rabbit. The anterior roots arise later, distinct from one another, as processes from the spinal cord. Mr. Balfour has endeavoured to solve the difficult question of the relations of the cranial to spinal nerves. He finds as yet no traces in the brain of anything comparable to anterior roots of nerves; all the nerves are posterior roots. The fifth, or trigeminal, arises from the dorsal summit of the hind-brain very early, just like a dorsal root of a spinal nerve. This nerve also, instead of being a compound one, is at any rate in its origin perfectly simple. The auditory nerve and the facial arise by one common root. The glossopharyngeal and vagus have a series of distinct roots. In an adult Scyllium twelve separate strands have been counted in the vagus nerve. This number, and their origin like so many separate spinal nerves, opens up interesting questions in regard to the primitive segmentation of the head and the loss or condensation of segments in the evolution of the vertebrates. Dr. Marshall's observations on the cranial nerves of the chick, so far as they go, correspond to Mr. Balfour's. It appears that there is no definite indication of a limit between head and trunk afforded by the central nervous cord, by the outgrowths from it, or by the mode of development of the nerves. It is open for consideration whether the absence of anterior roots to the cranial nerves may not furnish such a limit; this would be very convenient for morphology.

INSECT AID IN FERTILISATION OF FLOWERS.—Mr. Thomas Meehan, of Philadelphia, continues to bring forward cases to show that many flowers are not so dependent on insect fertilisation as has been imagined. Recently (*Proc.* Acad. Nat. Sciences, Philadelphia, 1877, p. 128) he has instanced the common mignonette, which usually does not seed when forced in greenhouses in winter. It has been asserted that this is due to the absence of suitable insects to produce fertilisation. But last winter Mr. Meehan's specimens took to producing seed in abundance, two to six perfect seeds in every capsule. This showed that some other circumstance had come into play which affected the reproductive organs, insect aid having been as much absent as in other cases.

INSECTIVOROUS PLANTS.—Dr. C. Cramer, of Zürich, publishes, under the title "Ueber die Insectenfressenden Pflanzen," a useful epitome of all that has at present been recorded respecting the singular phenomenon of "Insectivorous Plants." In a series of papers in *Flora*, on the Mechanics of the Movements of these plants, A. Batalin calls attention to a hitherto neglected paper of Oudemans, published (in Dutch) in 1859, in which he describes the greater part of the phenomena of irritation in Venus's fly-trap (*Dionæa muscipula*), agreeing in almost every point with the description subsequently given by Darwin and others.

SPONTANEOUS MOVEMENTS IN PLANTS.—M. E. Rodier, of Bordeaux, has described a singular series of automatic or spontaneous movements in a well-known water-plant, *Ceratophyllum demersum*. They consist of a rhythmical motion caused by a curvature of the axis extending over six hours, which is neutralised in the course of the next twelve hours, and followed by a curvature in the opposite direction extending over four hours, which is again neutralised in four hours, the whole cycle thus extending over a period of twenty-six hours. The movement appears to be entirely unaffected by light.

DISCOVERY OF OXYGEN IN THE SUN BY PHOTOGRAPHY, AND A NEW THEORY OF THE SOLAR SPECTRUM[1]

I PROPOSE in this preliminary paper to indicate the means by which I have discovered oxygen and probably nitrogen in the sun, and also to present a new view of the constitution of the solar spectrum.

Oxygen discloses itself by bright lines or bands in the solar spectrum and does not give dark absorption lines like the metals. We must therefore change our theory of the solar spectrum, and no longer regard it merely as a continuous spectrum with certain rays absorbed by a layer of ignited metallic vapours, but as having also bright lines and bands superposed on the background of continuous spectrum. Such a conception not only opens the way to the discovery of others of the non-metals, sulphur, phosphorus, selenium, chlorine, bromine, iodine, fluorine, carbon, &c., but also may account for some of the so-called dark lines, by regarding them as intervals between bright lines.

It must be distinctly understood that in speaking of the solar spectrum here, I do not mean the spectrum of any

[1] Paper by Prof. Henry Draper, M.D. Read before the American Philosophical Society, July 20, 1877. We are indebted to Dr. Draper's kindness for the plate and illustrations which accompany this paper.

limited area upon the disc or margin of the sun, but the spectrum of light from the whole disc. I have not used an image of the sun upon the slit of the spectroscope, but have employed the beam reflected from the flat mirror of the heliostat without any condenser.

In support of the above assertions the accompanying photograph of the solar spectrum with a comparison spectrum of air, and also with some of the lines of iron and aluminium, is introduced. The photograph itself is absolutely free from handwork or retouching. It is difficult to bring out in a single photograph the best points of these various substances, and I have therefore selected from the collection of original negatives that one which shows the oxygen coincidences most plainly. There are so many variables among the conditions which conspire for the production of a spectrum that many photographs must be taken to exhaust the best combinations. The pressure of the gas, the strength of the original current, the number of Leyden jars, the separation and nature of the terminals, the number of sparks per minute, and the duration of the interruption in each spark, are examples of these variables.

In the photograph the upper spectrum is that of the sun, and above it are the wave-lengths of some of the lines to serve as reference numbers. The wave-lengths used in this paper have been taken partly from Angström and partly from my photograph of the diffraction-spectrum published in 1782. The lower spectrum is that of the open air Leyden spark, the terminals being one of iron and the other of aluminium. I have photographed oxygen, nitrogen, hydrogen, and carbonic acid, as well as other gases in Plücker's tubes and also in an apparatus in which the pressure could be varied, but for the present illustration, the open air spark was, all things considered, best. By other arrangements the nitrogen lines can readily be made as sharp as the oxygen are here, and the iron lines may be increased in number and distinctness. For the metals the electric arc gives the best photographic results, as Lockyer has so well shown, but as my object was only to prove by the iron lines that the spectra had not shifted laterally past one another, those that are here shown at 4325, 4307, 4271 .4063, 4045, suffice. In the original collodion negative many more can be seen. Below the lower spectrum are the symbols for oxygen, nitrogen, iron, and aluminium.

No close observation is needed to demonstrate to even the most casual observer that the oxygen lines are found in the sun as bright lines, while the iron lines have dark representatives. The bright iron line at G (4307), on account of the intentional overlapping of the two spectra, can be seen passing up into the dark absorption line in the sun. At the same time the quadruple oxygen line between 4345 and 4350 coincides exactly with the bright group in the solar spectrum above. This oxygen group alone is almost sufficient to prove the presence of oxygen in the sun, for not only does each of the four components have a representative in the solar spectrum, but the relative strength and the general aspect of the lines in each case is similar. I do not think that in comparisons of the spectra of the elements and sun, enough stress has been laid on the general appearance of lines apart from their mere position; in photographic representations this point is very prominent. The fine double line at 4319, 4317, is plainly represented in the sun. Again there is a remarkable coincidence in the double line at 4190, 4184. The line at 4133 is very distinctly marked. The strongest oxygen line is the triple one at 4076, 4072, 4069, and here again a fine coincidence is seen, though the air spectrum seems proportionately stronger than the solar. But it must be remembered that the solar spectrum has suffered from the transmission through our atmosphere, and this effect is plainest in the absorption at the ultra-violet and violet regions of the spectrum. From some experiments I made in the summer of 1873 it appeared that this local absorption is so great, when a maximum thickness of air intervenes, that the exposure necessary to obtain the ultra-violet spectrum at sunset was two hundred times as long as at mid-day. I was at that time seeking for atmospheric lines above H like those at the red end of the spectrum, but it turned out that the absorptive action at the more refrangible end is a progressive enfeebling, as if a wedge of neutral tinted glass were being drawn lengthwise along the spectrum towards the less refrangible end.

I shall not attempt at this time to give a complete list of the oxygen lines with their wave-lengths accurately determined, and it will be noticed that some lines in the air spectrum which have bright analogues in the sun are not marked with the symbol of oxygen. This is because there has not yet been an opportunity to make the necessary detailed comparisons. In order to be certain that a line belongs to oxygen, I have compared, under various pressures, the spectra of air, oxygen, nitrogen, carbonic acid, carburetted hydrogen, hydrogen, and cyanogen. Where these gases were in Plücker's tubes a double series of photographs has been needed, one set taken with and the other without Leyden jars.

As to the spectrum of nitrogen and the existence of this element in the sun there is not yet certainty. Nevertheless, even by comparing the diffused nitrogen lines of this particular photograph, in which nitrogen has been sacrificed to get the best effect for oxygen, the character of the evidence appears. The triple band between 4240, 4227, if traced upward into the sun, has approximate representatives. Again at 4041 the same thing is seen, the solar bright line being especially marked. In another photograph the heavy line at 3995, which in this picture is opposite an insufficiently exposed part of the solar spectrum, shows a comparison band in the sun.

The reason I did not use air in an exhausted Plücker's tube for the production of a photograph to illustrate this paper and thus get both oxygen and nitrogen lines well defined at the same time, was partly because a brighter light can be obtained with the open air spark on account of the stronger current that can be used. This permits the slit to be more closed and of course gives a sharper picture. Besides the open air spark enabled me to employ an iron terminal and thus avoid any error arising from accidental displacement of the reference spectrum. In Plücker's tubes with a Leyden spark the nitrogen lines are as plain as those of oxygen here. As far as I have seen, oxygen does not exhibit the change in the character of its lines that is so remarkable in hydrogen under the influence of pressure as shown by Frankland and Lockyer.

The bright lines of oxygen in the spectrum of the solar disc have not been hitherto perceived, probably from the fact that in eye observation bright lines on a less bright background do not make the impression on the mind that dark lines do. When attention is called to their presence they are readily enough seen, even without the aid of a reference spectrum. The photograph, however, brings them into a greater prominence. From purely theoretical considerations derived from terrestrial chemistry and the nebular hypothesis, the presence of oxygen in the sun might have been strongly suspected, for this element is currently stated to form eight-ninths of the water of the globe, one-third of the crust of the earth, and one-fifth of the air, and should therefore probably be a large constituent of every member of the solar system. On the other hand the discovery of oxygen and probably other non-metals in the sun gives increased strength to the nebular hypothesis, because to many persons the absence of this important group has presented a considerable difficulty.

At first sight it seems rather difficult to believe that an ignited gas in the solar envelope should not be indicated by dark lines in the solar spectrum, and should appear

not to act under the law, "a gas when ignited absorbs rays of the same refrangibility as those it emits." But in fact the substances hitherto investigated in the sun are really metallic vapours, hydrogen probably coming under that rule. The non-metals obviously may behave differently. It is easy to speculate on the causes of such behaviour, and it may be suggested that the reason of the non-appearance of a dark line may be that the intensity of the light from a great thickness of ignited oxygen overpowers the effect of the photosphere just as if a person were to look at a candle flame through a yard thickness of ignited sodium vapour, he would only see bright sodium lines, and no dark absorption lines. Of course, such an explanation would necessitate the hypothesis that ignited gases such as oxygen give forth a relatively large proportion of the solar light. In the outburst of *T Coronæ* Huggins showed that hydrogen could give bright lines on a background of spectrum analogous to that of the sun.

However all that may be, I have no doubt of the existence of substances other than oxygen in the sun which are only indicated by bright lines. Attention may be called to the bright bands near G, from wave-lengths 4307 to 4337, which are only partly accounted for by oxygen. Farther investigation in the direction I have thus far pursued will lead to the discovery of other elements in the sun, but it is not proper to conceal the principle on which such researches are to be conducted for the sake of personal advantage. It is also probable that this research may furnish the key to the enigma of the D_3 or Helium line, and the 1474 K or Corona line. The case of the D_3 line strengthens the argument in favour of the apparent exemption of certain substances from the common law of the relation of emission and absorption, for while there can be no doubt of the existence of an ignited gas in the chromosphere giving this line, there is no corresponding dark line in the spectrum of the solar disc.

In thus extending the number of elements found in the sun we also increase the field of inquiry as to the phenomena of dissociation and recomposition. Oxygen, especially from its relation to the metals, may readily form compounds in the upper regions of the solar atmosphere which can give banded or channeled spectra. This subject requires careful investigation. The diffused and reflected light of the outer corona could be caused by such bodies cooled below the self-luminous point.

This research has proved to be more tedious and difficult than would be supposed because so many conditions must conspire to produce a good photograph. There must be a uniform prime moving engine of two-horse power, a dynamo-electric machine thoroughly adjusted, a large Ruhmkorff coil with its Foucault break in the best order, a battery of Leyden jars carefully proportioned to the Plücker's tube in use, a heliostat, which of course involves clear sunshine, an optical train of slit, prisms, lenses, and camera well focussed, and in addition to all this a photographic laboratory in such complete condition that wet sensitive plates can be prepared which will bear an exposure of fifteen minutes and a prolonged development. It has been difficult to keep the Plücker's tubes in order; often before the first exposure of a tube was over the tube was ruined by the strong Leyden sparks. Moreover, to procure tubes of known contents is troublesome. For example, my hydrogen tubes gave a spectrum photograph of fifteen lines of which only three belonged to hydrogen. In order to be sure that none of these were new hydrogen lines it was necessary to try tubes of various makers, to prepare pure hydrogen and employ that, to examine the spectrum of water, and finally to resort to comparison with the sun.

The object in view in 1873, at the commencement of this research, was to secure the means of interpreting the photographs of the spectra of stars and other heavenly bodies obtained with my 28-inch reflector. It soon appeared that the spectra of nitrogen and other gases in Plücker's tubes could be photographed, and at first some pictures of hydrogen, carbonic acid, and nitrogen were

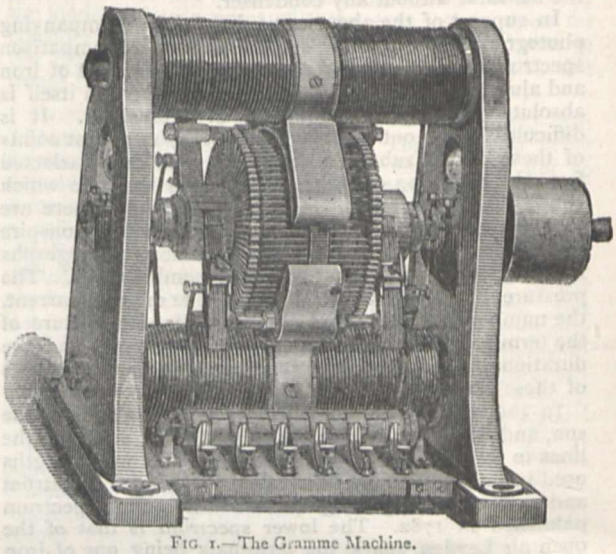


FIG. 1.—The Gramme Machine.

made, because these gases seemed to be of greatest astronomical importance on account of their relation to stars, nebulæ, and comets. Before the subject of comparison spectra of the sun was carefully examined there was some confusion in the results, but by using hydrogen the source of these errors was found out.

But in attempting to make a prolonged research in this direction, it soon appeared that it was essential to be able to control the electrical current with precision both as to quantity and intensity, and moreover to have currents which, when once adjusted, would remain constant for hours together. These conditions are almost impossible to attain with any form of battery, but on the contrary are readily satisfied by dynamo-electric machines. Accordingly, I sought for a suitable dynamo-electric machine and motor to drive it, and after many delays procured a combination which is entirely satisfactory. I must here acknowledge my obligations for the successful issue of

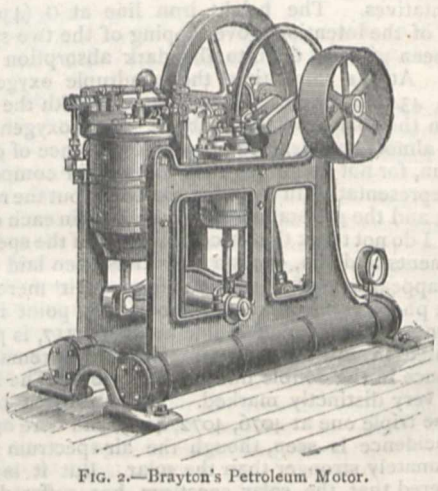


FIG. 2.—Brayton's Petroleum Motor.

this search to Prof. George F. Barker, who was the first person in America to procure a Gramme machine. He was also the first to use a Brayton engine to drive a Gramme.

The dynamo-electric machine selected is one of

Gramme's patent, made in Paris, and is a double light machine, that is, it has two sets of brushes, and is wound with wire of such a size as to give a current of sufficient intensity for my purposes. It is nominally a 350 candle-light machine, but the current varies in proportion to the rate of rotation, and I have also modified it by changing the interior connections. The machine can produce as a maximum a light equal to 500 standard candles, or by slowing the rotation of the bobbin the current may be made as feeble as that of the weakest battery. In practical use it is sometimes doing the work of more than fifty large Grove nitric acid cells, and sometimes the work of a single Smee.

The Gramme machine could not be used to work an induction coil when it first reached me, because when the whole current was sent through the Foucault interruptor of the Ruhmkorff coil, making 1,000 breaks per minute, the electro-magnets of the Gramme did not become sufficiently magnetised to give an appreciable current. But by dividing the current so that one pair of the metallic brushes, which collect from the revolving bobbin, supplied the electro-magnets, the other pair could be used for exterior work, no matter whether interrupted or constant. The current obtained in this way from one pair of brushes when the Gramme bobbin is making 1,200 revolutions per minute is equal to 100 candles, and is greater in quantity and intensity than one would like to send through a valuable induction coil. I usually run the bobbin at 622 revolutions per minute, and this rate will readily give 1,000 10-inch sparks per minute with the 18-inch coil. Of course a Plücker's tube lights up very vividly and generally; in order to get the maximum effect I arrange the current so that the aluminium terminals are on the point of melting. The glass, particularly in the capillary part, often gets so hot as to char paper. The general appearance of the machine is shown in Fig. 1.

As long as the Gramme bobbin is driven at a steady rate the current seems to be perfectly constant, but variations of speed make marked differences in the current, and this is especially to be avoided when one is so near the limit of endurance of Plücker's tubes. A reliable and constant motor is therefore of prime importance for these purposes. A difference of one per cent. in the speed in the engine sometimes cannot be tolerated, and yet at another time one must have the power of increasing and diminishing the rate through wide limits. The only motor, among many I have examined and tried, that is perfectly satisfactory, is Brayton's Petroleum Ready Motor.

This remarkable and admirable engine acts like an instrument of precision. It can be started with a match, and comes to its regular speed in less than a minute; it preserves its rate entirely unchanged for hours together. Moreover, it is economical, cleanly, and not more noisy than a steam engine. The one of two-horse power I have, ran for six months, day and night, supplying water and air to the aquaria in the Centennial Exhibition at Philadelphia. At any time on going into the laboratory it can be started in a few seconds, even though it has not been running for days.

Henry Draper's Observatory, Hastings-on-Hudson, New York

THE NATURAL HISTORY OF THE JENISSEI

AN account of the Swedish Overland Expedition to the Jenissei in the summer of 1876, the cost of which was defrayed by Mr. Oscar Dickson of Gothenburg, has appeared in the *Göteborgs Handels Tidning*. The expedition was under the leadership of Dr. Hjalmar Théel of Upsala, who was accompanied by Botany-Docent W. Arnell, Philosophy-Candidate F. Trybom, Zoologist, and Rector M. Brenner, Botanist, from Finland. Docent Sahlberg, Entomologist, from Helsingfors, also went with the expedition to the Jenissei with the intention of prosecuting independent researches there. The party travelled by Nischni-Novgorod, Perm, Tjumen, Tomsk, and Krasnojarsk on the Jenissei, arriving at the last place on June 8.

We regret that our space permits of our giving only the following account of the natural history of the Jenissei by Dr. Théel:—

The Jenissei has a length of about 1,660 English miles below Krasnojarsk. The banks are sometimes pretty high and bold, sometimes low, alternating in this respect with each other, so that, when the left is high, the right is the opposite. Where the bank is low and exposed to inundations, willows thrive beyond everything. The high banks are clothed with *Pinus obovata* and *cembra*, and larch. At Jeniseisk the river is about 1½ versts broad, gradually widening northward, till at Kurejka it is five versts broad. Between Tolstonos and Goltschika the river widens and assumes the appearance of a lake more than sixty versts wide. Here the tides are quite observable. At Dudinskoj a depth reaching twelve fathoms was found.

The Russian population of the Jenissei Valley is very sparse and uncivilised, and inferior, as far as the fine arts are concerned, to some of the Asiatic races. Cattle rearing is in its infancy, though there are perhaps few regions more suited for it than the valley of the Jenissei. Cows are met with as far as Dudinskoj, but their proper management did not appear to be understood. At villages on the upper Jenissei, with as many as forty or fifty cows, a glass of milk could scarcely be obtained. The making of cheese is completely unknown, the making of butter nearly so. There are horses as far north as Dudinskoj, sheep only to Vorogova, and no goats north of Jeniseisk. Cultivation is at a still lower standpoint, rye not being at present grown below Antsiferova, sixty-seven versts north of Jeniseisk, and oats to Zotina, 60° 55′ N. lat. Potatoes are grown to Turuchausk, but are there very small. For some years Skoptzi settled on the Chantajka river, 68° 20′ N. lat., have successfully grown potatoes.

Fish forms the principal food of the people, and during summer nearly every one is a fisher. Fishing is carried on with various kinds of nets, with lines and hooks, and even with leister and torch. There are found in the Jenissei pike, ruffe, perch, burbot, *Cyprinus curassius*, tench, *Thymallus vulgaris*, several species of the family *Leuciscus*, among them one which strongly resembles our common roach, a kind of *Petromyzon*, *Gasterosteus pungitius*, a kind of bullhead (*Cottus*), &c. All these are of inferior importance for domestic use, and mostly serve as food for dogs. The more valuable are the sturgeon, salmon, and coregonus. There are two varieties of sturgeon, the common sturgeon or "Ossetrina," *Accipiter sturio*, and the sterlet, *Ac. ruthenus*. The *Ossetrina* is caught along the whole Jenissei, and sometimes reaches a weight of 225 lbs. The sterlet is not found north of Dudinskoj, and commonly weighs 3 or 4 lbs., but sometimes reaches 18 lbs. There is another called the prickly sturgeon, "Kosterska," believed to be the young of the *Ossetrina*. There are many varieties and transition forms of sturgeon, rendering their proper classification difficult. The salmon is most numerous in the upper course of the river at Minousinsk, where a profitable fishery is carried on. Two types are distinguished, "Tajmen" and "Kunschja." The former is caught in greatest numbers in the upper course of the river, and weighs 40 to 60 lbs.; the latter is found in lakes on the *tundra*, and very seldom in the Jenissei below Dudinskoj. At the Nichandrovska Islands a salmon, probably a Tajmen, was caught, which was nearly five feet long and weighed between 80 and 100 lbs. Of the Coregonus the following species were found in the Jenissei:—Njelma (*C. leucichthys*), Tschir

(*C. nasutus*), Muksun (*C. muksun*), Peljedka (*C. pelet*), Omul (*C. omul*), Common Siklöja or Seldj (*C. albula?*).

The common Coregonus is said to be found in the Jenissei the whole year round. The Tschir, Njelma, and Muksun are seen almost simultaneously in early spring, the Tschir first beginning to ascend, and then the other two almost simultaneously, or the Njelma rather earlier. Finally masses of the Siklöja, and last of the Omul, make their appearance. These seldom go above the rapids between Podkamennoje Tunguska, and Asinova. There is no accurate information about the *Pelet*, but it does not appear to go far from the mouth of the river.

The bird world was sparingly represented on the Jenissei. In the south the *Passeres* were most numerous. In the neighbourhood of the limit of trees on the *tundra* and at the Briochovska and Nichandrovska Islands the swimming birds and waders first became more numerous. *Colymbus septentrionalis*, *Harelda glacialis*, *Oidemia fusca* and *nigra*, *Fuligula marila*, *Anas pœnelope* and *acuta*, and *Cygnus bewickii* occurred here in great numbers, but with a few others were the only species of the order *Natatores* that could be found in those northern regions. A number of birds, for instance geese, *Anser segetum* and *albifrons*, and swans, occur first at the period of migration in autumn, when the uncommon red-necked goose, *Anser ruficollis*, is also met with not unfrequently. Altogether 140 to 150 species, of which only fifteen to twenty were extra-Scandinavian, have been observed during the summer, among them about twenty-five *Natatores* and twenty *Raptores*. It is singular that, for instance, at Tolstonos, 69° 55′ N. lat., accordingly beyond the limit of trees, many small birds belonging to the order *Passeres* occur. Schmidt there found ten species, to which number we are able to add four more, viz., *Fringilla linaria*, *Emberiza pusilla*, *Saxicola œnanthe*, and *Phyllopneuste trochilus*. A number of birds in Siberia are found drawing more and more to the west. It is stated, for instance, that the species, *Alauda alpestris*, *Emberiza rustica*, and *pusilla*, &c., which formerly could only be met with in Siberia and Eastern Russia, are now found in Finland and Western Russia, and indeed even within Scandinavia. In the time of Pallas the Ural formed the western limit of the *Emberiza aureola*, which is now common in the whole north of Russia. It is therefore not impossible that part of the birds at present peculiar to North Russia and Siberia may in the future belong to the fauna of Sweden. Trybom states that at Krasnojarsk, the insect fauna was abundant and very unlike the Scandinavian. As the party descended the river the insects diminished in number more speedily than could have been expected, those strangest to the Swedes generally disappearing first. Where the wood had been burned lately, and vegetation had not been able to regain its ordinary condition, the insect fauna was also poor. Compared with the phanerogamous plants occurring within the same area the Scandinavian insects taken overhead are immeasurably more numerous than those of the Jenissei River Valley. It is on the *tundra* that the most which are common to Scandinavia are found. In the collections made the *Coleoptera* are most numerously represented, then the *Hymenoptera*, *Diptera*, *Lepidoptera*, *Neuroptera*, and *Orthoptera*. The number of species collected is believed to exceed 1,000, among them about fifty kinds of diurnal *Lepidoptera*. Of these two-thirds are Scandinavian. Of the insects collected about Krasnojarsk only the half are Swedish. The four species (*Colias palæno*, L., and *Boothii*, Ross, *Pieris napi*, L., and *Argynnis pales*, W. V.) found at the Nikandrovska Islands are all Swedish. The distribution to the north or south was for many species different from that in Scandinavia. Thus *Pararga hiera*, Hübn., ceased there at least three degrees farther south than in Sweden. *Lycœna acis*, Ochs., was not found farther north than at Nikulina, 60° 25′ N. lat. *Pieris daplidice*, L., was, on the other hand, found as far as Fatianova and *Lycœna argiolus*, L., at Turucharsk (65° 55′ N. lat.), *Heteropterus sylvius*, Knock., which was very common as far as Krasnojarsk, was also found there. *Argynnis aphirape*, Hübn., is found in Sweden six degrees farther south than it was seen on the Jenissei, but *Arg. freja*, Thbg., on the contrary, two degrees more to the south in the latter place. *Polyommatus helle*, W. V., is pretty common on the Jenissei, two degrees farther south than in Sweden.

Arnell states that the moss flora of the Lower Jenissei, like that of the whole of Siberia, generally may be said to be almost completely unknown to science, only eighteen species of mosses being previously known. The number collected during the expedition may, perhaps, as far as may be judged before the material is thoroughly worked out, be reckoned at about 300, many being foreign to Scandinavia and many even new to science. The most peculiar localities on the Lower Jenissei are the tree stems on the banks, which are periodically overflowed. The stems receive a coating of earth often to a height of many feet above the ground, and form an excellent locality for mosses. Here are found not only some Scandinavian mosses as *Leskea polycarpa*, *Myrinia*, *Amblystegium riparium*, *Fontinalis hypnoides*, *Neckera undulata*, *Homalia trichomanoides*, *Pylaisea* (in an unending variety of forms), &c., but also and especially by two non-Scandinavian mosses, namely, the uncommon genuine *Timmia negapolitana* and an exceedingly pretty *Eurhynchium concinnum*, formerly referred to *Mynrella* or a peculiar family of *Achrolepis*, but undoubtedly belonging to *Eurhynchium*.

The masses of decayed stems found in the forests in incomparably larger numbers than in Scandinavia form another peculiar locality. They are characterised especially by *Dicrana fragilifolium* and *fuscescens*, which here exhibit all possible transition forms to each other, and a number of *Hepaticæ*, part of them foreign to Sweden. Mountain localities, especially with primitive rocks, are seldom met with on the Jenissei. The mosses peculiar to primitive rocks were found very sparingly. *Grimmia* and *Rhacomitrium* were seldom met with. Of these two families *Grimmia apocarpa*, which is not particular as to what it grows on, is the only species which in some degree is distributed over the region. Only once was a *Rhacomitrium* found in the whole distance from Krasnojarsk to the limit of trees, about 1,660 miles; first north of the limit of trees the family began to take to some extent the place it has in Sweden. The moss flora of the Lower Jenissei may be said to be specially characterised by its richness in *Mnia* and *Marchantiaceæ*. The following were also richly represented :—*Splachnaceæ* (with eight species), *Polytrichum*, *Bryum* (particularly towards the north, in very beautiful forms, partly new), *Webera*, *Dicranum*, *Encalypta* and *Sphagnum*, &c. Some of the greatest Scandinavian rarities were found, as *Orthothecium intricatum*, *Mynrella julacea* and *apiculata*, *Hylocomium oakesii*, *Pogonatum capillare*, *Oligotrichum lærigatum*, *Cinclidium subrotundum*, *all with fruit*. Enormous masses, in which two species of *Riccia* occurred, were found close to the water's edge on the clay banks inundated during summer the whole way from the Nikandrovska Islands to Jeniseisk. In Scandinavia the northernmost representative of this family does not go farther north than about the sixty-second degree of latitude. Extensive collections of fresh-water algæ were also made, but no detailed account of them can yet be given.

Arnell states that somewhat over 700 herbaceous plants were collected during the summer at about sixty different points on the Jenissei; of these about 200 are foreign to Sweden. Several families and races, as *Gymnospermæ*, *Androsace*, *Pedicularis*, and *Anemone* are richer in species on the Jenissei than in Scandinavia; the following races numerously represented in Sweden are sparingly met with on the Jenissei :—*Hieracium*, *Campanula*, *Veronica*, *Tri-*

folium, *Geranium*, *Sedum*, &c. The forests which clothe the banks of the Jenissei consist to a great extent of non-Scandinavian trees, namely, of the larch, *Pinus cembra*, *Abies sibirica*, and the *Abies obovata*, which scarcely differs from *Pinus abies*, and of *Populus nigra*. Of the trees common to Scandinavia the most important are the birch (*Betula verrucosa* and *glutinosa*), pine, aspen, bird's cherry, and mountain ash. Besides, the *Salices* play a very important part on the Jenissei, inasmuch as they form extensive woods on the low banks periodically overflowed; these *Salices* often grow to uncommonly large sizes, and consist in part of non-Scandinavian species, one of which, *Salix vitellina*, is the most common of all, and spreads over the whole of the region examined by the botanists of the expedition.

The bush vegetation too in Siberia exhibits differences from that of Scandinavia. On the Jenissei *Alnaster fruticosus* is important beyond others, because it forms thickets, and especially towards the north increases in mass, going in that direction beyond the limit of trees. Among other bushes foreign to our flora there occur on the Jenissei the Siberian pea tree (*Robinia*), *Spiræa confusa*, *sorbifolia* and *salicifolia*, *Sambucus racemosa*, *Cratægus sanguinea*, *Cassandra calyculata*, peculiar types of roses, &c. Among the bushes common to Scandinavia the most important are the black and red currant, dwarf birch, *Lonicera cærulea*, which is far more widely distributed than in Sweden, juniper, *Myrica gale*, raspberry, *Empetrum nigrum*, *Vaccinium vitis idæa*, and *myrtillus*, &c. Towards the north the bushy *Salices* play an important part, as in our northern regions. On the Jenissei there has been found only one species of *Alnus*, which is specially interesting as not being either of the Swedish species, but perhaps the genuine *Alnus pubescens*. On the other hand there are absent on the Jenissei many of our trees and bushes, as the nobler deciduous trees and fruit trees, and, what may be said to be distinctive of the Jenissei flora, heather, which is so extensively distributed in Sweden, is wanting.

TEMPERATURE AND HUMIDITY OF THE AIR AT DIFFERENT HEIGHTS

A MEMOIR on the temperature and humidity of the air at different hours, by Dr. H. E. Hamberg, based on observations made by him during the summer of 1875, at heights varying from 2 inches to 22 feet above the ground, was published recently in the *Transactions* of the Royal Society of Sciences at Upsal. The memoir is a valuable one, and is of interest to more than the mere meteorologist, it being evident that the inquiry is so handled as to bring it into close connection with such difficult questions as convection currents in the free atmosphere and the diffusion of vapour through the air.

In clear weather the temperature of the air nearest the surface was lower than that above it, from two to three hours before sunset to at least two to three hours after sunrise. At all the six heights the temperature fell to the minimum at the same hour, viz., about 3 A.M.; but while it continued from this time to rise steadily at all the heights, the lowest temperatures continued to be observed in the strata nearest the ground till several hours after sunrise. From this remarkable result Dr. Hamberg concludes that the increase of temperature in the lower strata of the air in the early part of the forenoon is not an immediate and direct consequence of the heating of the ground, but is rather to be attributed to the absorption by the air, or more strictly by its aqueous vapour, of the heat received from the sun's rays or reflected from the ground.

Over uneven ground covered with vegetation the temperature near the surface is generally higher over those parts of the field which rise above the general level. Thus even slight elevations of only one or two feet have the air immediately resting on them often 2° higher or more, whilst on the other hand, a trench or depression one or two feet below the general level has the air resting on it often 2°, or more, lower than the air over the level portions of the field, a result of considerable practical importance in agriculture and horticulture.

The latent heat set free on the formation of dew appears from the observations clearly to retard the lowering of the temperature, but not to the extent which might have been expected. When, on the deposition of dew, the temperature of the air near the surface has fallen below 32°, as soon as the dew is congealed into hoar-frost the temperature of the lowest stratum of air in contact with the ground instantly rises to 32°; but at the same time the temperature of the air higher up steadily remains lower than 32°.

The absolute humidity of the air on clear nights on which no dew is deposited decreases from the ground upwards, just as happens during the day; but on the other hand, with dew, the humidity is least nearest the ground, and increases with the height, and this influence of dew, in diminishing the humidity, extends upwards to at least twenty-two feet, the height to which the observations were carried. Since his observations clearly show that the absolute humidity begins in the evening to diminish near the ground before any dew is observed to be deposited, and also diminishes at all heights on those nights during which no dew whatever is formed, Dr. Hamberg is of opinion that the diminution of the humidity of the air during night is to be sought for in other physical causes than the deposition of dew.

Several of the points discussed will doubtless be made subjects of further investigation by others. In all cases it is most desirable, indeed absolutely necessary, to a critical valuation of the observations, that the authors give woodcuts and descriptions of the exact position and mode of protection adopted in the case of each thermometer employed in the observations. For such refined inquiries the method of observation must necessarily be a refined one; in other words, such as will certainly secure the necessary comparability among all the instruments.

THE CHRONOMETERS OF SWITZERLAND

WE find in a recent number of the *Bulletin* of the Society of Natural Sciences at Neuchâtel an interesting report of the Neuchâtel Observatory on the annual competition of chronometers for prizes awarded yearly by the Observatory. The report gives some idea of the degree of perfection reached in Switzerland in the construction of chronometers. The 231 chronometers (four box and 227 pocket chronometers) admitted to the competition out of 270 sent in were submitted to a severe test, including changes of temperature and of position during periods of from two weeks to two months, and the results of the trial appear as follows. The average diurnal variations in the rates of the box-chronometers proved 0·32 sec. (against 0·20 in 1874), and of the pocket ones 0·46 sec. (against 0·53 in 1874), and there was but two per cent. of these last, the average diurnal variation of which reached 1 sec. The various systems of escapements appeared, as was observed in former years, to have but little if any influence on the degree of precision of watches, provided they remain constantly in the same position, vertical or horizontal. The compensation for changes of temperature proved to be altogether satisfactory, the average variation of 167 chronometers submitted to variations of temperature from 15 to 25 Cent. degrees being but 0·13 sec. for each Centigrade degree. It must, however, be noticed that only 51 per cent. of them showed variations below one-tenth of a second for each degree, and that 10 per cent. showed variations above 0·3 sec. Finally, the differences between the rates during the first and the last weeks were: for box-chronometers, 2·11 sec.

after a period of two months; and for pocket-chronometers, 1·57 sec. after a trial of six weeks; and the average differences between the maximum and minimum rates proved to be, for box-chronometers, 3·23 sec., after a two months' trial; and for pocket-chronometers, 6·22 sec. and 5·75 after six weeks and one month's trials. These figures show certainly that there is enough to do yet in raising the industry to the high degree of perfection which is desirable, but the steady progress during the last ten years is remarkably seen in a table showing the increase of precision of the Swiss chronometers in every direction. Thus the average diurnal variation, which was as high as 1·27 sec. at the competition of 1864, regularly decreases to 0·46 in 1875; the average variations of rate produced by changes of position, being 8·21 sec. ten years ago, is now but 1·97; and the defective compensation for temperature rapidly decreases from 0·48 sec. for each degree to 0·16, and now it is but 0·13. Besides, the report states, some of the best chronometers reach as high a degree of perfection as to make them comparable with astronomical clocks. Thus the box-chronometer which received the first prize is a true phenomenon of its kind. Its mean diurnal variation is as low as 0·08 sec., *i.e.*, that of good astronomical clocks; its mean weekly rate changed after a two months' trial only by 0·57 sec.; the difference between the maximum and minimum rates is but 0·94 sec., and the imperfect compensation for temperature is 0·04 sec. for each degree; finally, its characteristic number, calculated by the Greenwich method, reaches but 8·90 sec. The two best pocket-chronometers realise perhaps a yet greater success, their average diurnal variations being respectively but 0·13 and 0·17 sec.

THE BRITISH ASSOCIATION

THE two *soirées* that were held in the Guildhall, the first on the evening of Thursday, the 16th instant, and the second on Tuesday, the 21st, were very fully attended.

At the second *conversazione* several objects of scientific interest were exhibited. At the centre table Prof. Herbert McLeod showed his beautiful cycloscope, an instrument which formed the subject of a paper read by Prof. McLeod before Section G on Wednesday week. Mr. Silvanus P. Thompson, of University College, Bristol, showed his apparatus for exhibiting certain optical illusions, upon which a paper was read by him in Section A. Prof. Osborne Reynolds showed the apparatus by which his paper upon the rate of progression of groups of waves was illustrated; and Mr. J. W. Swan exhibited a modification of the Sprengel pump.

In the picture gallery Dr. Graham Bell had his articulating telephones at work.

There was great competition for the tickets for the excursions for both Saturday and Thursday. The excursion to Lee Moor under the guidance of Mr. Spence Bate, F.R.S., was originally limited to 100, but there were more than 300 applications for tickets, and extra waggonettes had to be put on. The party, after having visited the China Clay Works of Messrs. Martin, the largest establishment of its kind in the world, divided into three parties: the first walked across the Moor to Sheepston, to examine some prehistoric remains recently discovered by Mr. Spence Bate. Another party under the charge of Mr. Martin took a walk to Shell top and Pen Beacon, from which fine views may be had; and a third detachment remained in the grounds of Mr. Martin, which are unique in their way, from the intricacy of their laying out.

The popular excursion of the day was, however, that up the Hamoaze and Tamar, to H.M.S. *Cambridge*, under Great Albert Bridge at Saltash, into the Sound, and visiting the Breakwater and Eddystone Lighthouse. The Admiral of the Port placed three Government steamers at the disposal of the Association, and there was tremendous crowding to get on to the boats. Upon reaching H.M.'s gunnery ship *Cambridge*, the gunnery and torpedo practice began, and some splendid feats of firing at long ranges were exhibited.

On the same day there was a dredging excursion under the superintendence of Mr. Gwyn Jeffreys and Mr. Hearder.

While these excursions were going on a select party was, at the invitation of the Mayor and Corporation of Exeter, visiting that ancient city. At the luncheon, the toast of "The British Association," was proposed by Sir Stafford Northcote, Chancellor of the Exchequer, and responded to by Mr. Spottiswoode, F.R.S., the President-elect.

The excursions on Thursday last were first to Liskeard, the Cheesewring, and the Caradons, at the invitation of the Mayor of Liskeard. The second excursion was by way of the Tamar to Morwellham to the celebrated Devon Consols Copper Mines, taking on its way the fine old mediæval mansion of Cotehele, which was thrown open to the members by the Earl of Mount Edgcumbe, to whom it belongs. The last of Thursday's excursions was to Totnes, Torquay, and Brixham, and like the Exeter excursion, was only by special invitation. It was divided into four sub-excursions (*a*), Archæological, visiting Totnes and Berry Pomeroy Castles; (*b*), Mechanical, visiting the Experimental Works of Mr. Froude, F.R.S.; and (*c* and *d*), Antiquarian and Geological, the first to Kent's Cavern, under the guidance of Mr. Vivian, and the second to Brixham, with Mr. Pengelly, F.R.S.

The Plymouth meeting of the British Association for 1877 has been decidedly a quiet one; its attendance as a whole has been below the average, and its funds are proportionately low; but it has done good work, and it has been marked by several papers of great scientific interest. The discovery by Prof. J. C. Adams of the original papers of Newton respecting the rotation of the apse of the moon, the exhibition of the articulating telephone of Dr. Graham Bell and the very valuable suggestions contained in the address of Prof. Carey Foster, must all help to mark the Plymouth meeting in the annals of the Association as a valuable one, notwithstanding its failure in points of attendance and pecuniary position.

The following are some of the figures connected with the recent meeting:—

Number of tickets issued to			Old Life Members ...	161
,,	,,	,,	New ,, ,, ...	19
,,	,,	,,	Old Annual Subscribers	238
,,	,,	,,	New ,, ,, ...	58
,,	,,	,,	Associates	447
,,	,,	,,	Ladies	283
There were also present, of Foreign Members				11
Making a total of				1,217

The total receipts from the sale of tickets amounted to 1,267*l.*

REPORTS.

Prof. O. Reynolds presented the *Report of the Committee appointed to consider what Effect Reversing the Screw had on the Steering of a Steamer under Full Way.*—Since the last meeting of the Association the Committee had carried out further experiments, and the results now obtained show that the larger the ship the more important the effect of reversing the screw became. In answer to the request of the Committee, the Admiralty had made a trial with H.M.S. *Speedy*, but the conditions under which it was conducted precluded the possibility of more light being thrown on the subject. The greatest speed was five knots, and the effect of the rudder with the screw reversed was so small that the vessel in most instances turned her forward end into the wind. The Admiralty had been urged to have experiments made with larger and more powerful ships, but as yet had not assented.

The Committee forwarded copies of their last year's report to the Admiralty, the Board of Trade, the Trinity House, and other corporations, but no intimation had been received as to any action being taken upon it. The report was discussed at the conference of the Association for the Reform and Codification of the Law of Nations last year at Bremen, where a resolution was agreed to declaring that the existing international rules for preventing collisions at sea were not satisfactory, and it was desirable the governments of maritime states should take counsel together with a view to amend the rules and adapt them more carefully to the novel exigencies of steam navigation. This showed that the subject had already attracted considerable attention, and it was important to notice that the conclusions of the Committee had not yet in the smallest degree been controverted. Numerous collisions had happened during the year, which, to judge from the law reports, might in many instances have been avoided had the effect of reversing the screw been known and acted upon; but it did not appear as if a consideration of this had influenced any of the judgments given. The collisions had for the most part been with small ships, and so had not come much into notice. The loss of the *Dakota*, however, was a disaster of the first magnitude, and would unquestionably cause the subject to be considered by the authorities.

Report of the Committee for commencing Secular Experiments on the Elasticity of Wires.—The Committee have been chiefly occupied with preliminary arrangements and preliminary experiments.

A room has been fixed upon in the tower of the University buildings in Glasgow for suspending wires for the secular experiments. In this room there is an available height of sixty feet. A tube of cast-iron, within which the wires are to be hung, is at present being erected, and will be ready in two or three weeks. The tube is to be 60 feet high and 9 × 4½ inches in cross section.

Wires of gold, platinum, and palladium have been supplied by Messrs. Johnson and Mathey, and with these it is proposed to commence the secular experiments. These wires have been specially drawn for the Committee. Each of them weighs one grain per foot.

A cathetometer suitable for making observations on the wires after they are hung up in their place has been designed and is being constructed by Mr. James White, instrument-maker, Glasgow. Preliminary experiments have been undertaken for the purpose of determining Young's modulus, and the breaking weight of the gold, platinum, and palladium wires.

Some experiments have also been undertaken in connection with the subject under investigation as to the effect of continued application of force on the breaking-weight of steel wire and soft iron wire, and results of importance have been obtained. These experiments are still being carried on, and numerical results will be given in a future report. It is found that when a weight nearly as great as the breaking-weight is kept for a long time—several days, for instance—and applied to pull out a soft iron wire, the effect is to increase largely the strength of the wire. It is often increased by as much as 6 or 7 per cent.

Report of the Committee on Luminous Meteors, by J. Glaisher.—The Committee have to record a year of very active research and of diligent and successful observations of shooting stars, fire-balls, and aërolites since the last report. The toilsome work of mapping and projecting star showers, and comparing and arranging the radiant point in lists, has occupied so much attention that they have been obliged to postpone till next year the work of furnishing observers with a *résumé* of the known star showers. The autumn and winter months were marked by numerous large fire-balls observed in England and abroad, some of which are of very special interest. Two, if not more, aërolites have fallen in America, and one at Constantine, in Algeria. Besides the magnificent meteor seen in the United States on December 21 last, from which one of these aërolites was projected, an equally splendid aërolite passed over Cape Colony on March 16 last with loud explosions, but no aërolites are known to have fallen from it in its flight. Much of the attention of the Committee has been engaged in the continued examination and comparison of star showers, and valuable work has been performed by Mr. W. F. Denning. There have been no marked star showers for one or two years, but some examples of frequency on certain nights have occurred. The August shower of 1876 and of the present month have both been below the average. The work of the Committee has, as in former years, been chiefly performed by Prof. A. S. Herschel.

The Report of the Committee appointed to consider the Ordnance Datum Level.—After detailing the various causes which they found had led to the uncertainties referred to in the communications made in 1875, the Committee came to the following conclusions:—1st, That of the two tide gauges at Liverpool, now purporting to refer to the old dock sill, the zero of that fixed at the south-east corner of the Canning dock was about 5·64 inches above that on the river face of the Canning Island, Liverpool. 2nd. That in order to reconcile the statement in the ordnance book of levelling, "that the datum level for Great Britain is 8-10ths of an inch above the mean tidal level obtained from the records of the self-recording tide-gauge on the St. George's Pier, Liverpool," with the usual facts which the Committee have collected, it is necessary to bear in mind that the records of the self-acting gauge referred to were the observations of one month only of the year 1859, and that the mean tide of that period was 7·8 inches below the mean decade from 1864 to 1873. 3rd. That the difference of levels between the old dock sill and the ordnance datum, given in the ordnance book of levelling as 4·67 feet, is correct on the assumption that the zero of the gauge on the face of the Canning Island, and not that of the gauge in the Canning dock, be taken as the correct level of the old dock sill, and that, as stated in the ordnance book of levelling, the ordnance datum be taken at 8·10ths of an inch above the mean tide level of the month of March, 1844, as ascertained by the ordnance department. 4th. That it is thus apparent that the ordnance is an entirely arbitrary level, and could not be again obtained from tidal observations. The committee had thought it advisable to take advantage of the present inquiry in order to obtain information as to some of the various local datum marks in use in the British Isles, and to endeavour to ascertain the difference of each relatively to the ordnance datum, which would thus be the means of comparison between them. In order to enable the Committee to carry out this work they begged to be re-appointed.

Report on the Conditions under which Liquid Carbonic Acid exists in Rocks and Minerals, by W. N. Hartley, F.R.S.E.—In a paper read at the Glasgow meeting of the Association, Mr. Hartley described the method of determining the exact temperature at which the carbonic acid sometimes found inclosed in minerals becomes gaseous. This temperature is called by Prof. Andrews the critical point, and has been determined by him in the case of pure carbonic acid prepared artificially to be 30°·92 C. Mr. Hartley gives a table showing the critical point of carbonic acid inclosed in various minerals in which certain variations from Dr. Andrews' number are apparent; these, however, may be accounted for when the critical point is below the normal point by the carbonic acid being mixed with some incondensible gas like nitrogen.

It seemed desirable to ascertain whether the presence of liquid carbonic acid in rocks was not of frequent occurrence, and whether the immense number of cavities dispersed through various minerals which are usually considered to contain water may not often contain liquid carbonic acid, or whether the occurrence of this body is characteristic of certain formations. A considerable number of minerals was examined, including sapphires, zircons, garnets, topazes, and sections of fluor spar. Incidentally the inquiry led to some very interesting results concerning the motion of the bubbles in fluid cavities when influenced by some source of heat, of which the following is a summary:—

1. The bubbles in certain fluid cavities approach a source of heat brought near them.

2. The bubbles in certain cavities recede from the source of heat.

3. That 5° C. rise of temperature suffices to cause the apparent attraction.

4. That a rise of ½° C. will in some cases cause the apparent repulsion.

5. That in certain cases a bubble which receded from the source of heat at ordinary temperatures approached it when raised to 60° C.; the source of heat always being from ½° C. to 5° warmer than the specimen.

6. That this could occur in cavities containing liquid carbonic acid as well as water, but that it made no difference whether the carbonic acid was raised above its critical point or not.

Mr. Hartley has also examined a remarkable vibration of minute bubbles in fluid cavities first noticed by Mr. Sorby. It was found that these bubbles approached a warm body

brought near them, and that they ceased moving, and clung for some time to the warmer side of a cavity. The conclusion arrived at for these phenomena is as follows:—It is impossible to imagine a body which is not gaining or losing heat, or at the same time gaining and losing heat; it is therefore impossible to imagine it as entirely throughout of a uniform temperature. It is evident, then, that an easily movable particle, which can be set in motion by exceedingly slight differences in temperature, will make the transference of heat from one point to another plainly visible. The minute bubbles in the cavities are such particles, and these vibratory motions afford ocular demonstration of the continual passage of heat through solid substances. A further continuation of the research was extended to the conditions under which solid particles exhibit the Brownian movement.

Concerning the presence of liquid carbonic acid in minerals, Mr. Hartley finds that it is not of common occurrence, but only occasionally met with. He also describes in his report the means of demonstrating in certain cavities the continuity of the gaseous and liquid states of matter as shown by Dr. Andrews in his well-known experiments. Regarding the proportion of gaseous and liquid carbonic acid to water in the cavities, some important generalisations have been arrived at.

Mr. Hartley gives reasons in the report which cause him to fix the temperature of formation of the mineral in the case of topaz somewhere above 342° C., the critical point of water. In certain other cases in which the cavities differ in the nature of their contents, the water, he thinks, must at the time of their formation have been in the liquid state. It is possible to determine within certain limits the temperature which a rock or mineral has endured if liquefied carbonic acid is found inclosed in it.

Report on some Double Compounds of Nickel and Cobalt, by J. M. Thomson.—On attempting to prepare the so-called conjugated sulphate of nickel, cobalt, and potassium mentioned by Vohl (*Ann. Chem. Pharm.* lxv.), who assigns to it the formula $NiCoK_4(SO_4)_4 . 12H_2O$, it was found that the several fractions deposited consecutively form a solution containing molecular quantities of the simple potassio-sulphates of the two metals, possessed different colours, and showed also the property of dichroism to a remarkable degree. The operation having been repeated several times with a like result, it was determined to examine whether any regular replacement of the two isomorphous metals took place. Quantities of the two salts were dissolved in a sufficient quantity of water, and the resulting solution evaporated gently over a water bath at a temperature of 80°, the crystals being allowed to deposit in successive fractions.

The crystals of the conjugated salts are oblique prisms, having a tendency to modification when allowed to grow to any great size. The first fractions have a greenish grey colour when seen in the mass, showing the preponderance in them of the nickel potassic sulphate over the corresponding cobalt salt; the latter fractions, however, gradually become more crimson in colour as the cobalt potassic sulphate preponderates over the nickel salt. Details of analyses are given in the report, showing the different quantities of nickel and cobalt contained in the several fractions.

It is shown that Vohl's formula may be correct for isomorphous metals having a considerable difference in their atomic weights, but fails when two metals, such as nickel and cobalt, having the same atomic weights, occur in the conjugated salts, as they give rise to replacements requiring a very high molecular formula to express their constitution.

The examination of the optical properties of the several fractions possesses some interest. It was observed that the colours shown through the different axes passed in a direct order down the spectrum. In the first fractions the more highly refractive rays of the cobalt spectrum mingle with the green of the nickel, whilst in the latter, the two rays are those adjacent to each other in the cobalt spectrum.

That these salts or fractions are not merely isomorphous mixtures is shown by the fact that large crystals taken for analysis exhibit throughout the same dichroism. If, then, the phenomenon of dichroism is dependent on molecular constitution, as seems probable, it follows that all bodies exhibiting dichroism must be definite chemical compounds, and therefore the molecular formulæ of some of these must be far more complicated in their structure than is at present imagined.

Abstract of the Thirteenth Report of the Committee for exploring Kent's Cavern, Devonshire.—The Committee, in their Twelfth Report, read at Glasgow last year, brought up the history of their researches to the end of August, 1876. They have now the pleasure of continuing that history to the end of July, 1877. During the intervening eleven months the work has been continued without interruption, on the same method and under the same daily superintendence as heretofore. The workmen named in the Twelfth Report are still employed on the exploration, and continue to give unqualified satisfaction.

On November 2, 1876, Mr. Busk, a member of the Committee, visited the cavern, accompanied by one of the superintendents, when he inspected that portion of the work which was then in progress, as well as the principal parts where the exploration has been completed.

The researches continue to attract large numbers of visitors, most of whom are admitted by the authorised guide, who, under well-defined and strictly-observed regulations, conducts them through such branches of the cavern as are of general and popular interest, but not to those in which the work is in actual progress, or has not been begun. The superintendents have also had the pleasure of accompanying a large number of visitors, including men of all professions and of various countries.

The Bear's Den.—The chamber termed the Bear's Den measures about sixty-seven feet in length, from north to south nearly, from eight to thirty-eight feet in width, and from eight to fifteen feet in height, the last dimension being measured from the bottom of the excavation. The limestone roof is extremely rugged, fretted, and water-worn.

Adjacent to its western wall is a vast boss of stalagmite, which the superintendents have preserved intact on account of the inscriptions which crowd it. One of these, "William Petre, 1571," is of considerable interest on two accounts: 1, the date is, so far as is at present known, the earliest in the cavern, and the only one belonging to the sixteenth century; 2. Its genuineness can scarcely be doubted, as it is known that at the period in question there was a William Petre, a native of South Devon, quite a young man, and a nephew of Thomas Ridgway, who then resided on the estate in which the cavern is situate, and of which he was the proprietor. Moreover, in a lately discovered lease, dated 1659, and conveying "closes, fields, or pieces of ground," mention is made of "one close called Kent's Hole," thus showing that the cavern was so well known about the middle of the seventeenth century as to render it probable that it was known also, at least, as early as towards the close of the sixteenth.

As the Rev. Mr. MacEnery broke ground in every part of the Bear's Den fifty years ago, its original condition can only be learned from the description of it which he has left, and which may be given in the following very condensed form:—

"The floor of the Bear's Den was studded with conical mounds of stalagmite supporting corresponding pendants from the roof. Fallen masses of limestone were strewed about, and some of them were incorporated in the crust. An irregular sheet of stalagmite, about a foot thick, overspread the floor, and was based on a shallow bed of indurated rubble containing tubes of stalactite collected in heaps in particular places, a great abundance of *album græcum*, an unusual proportion of bear's teeth, and an iron blade much corroded. Points of stalagmitic cones were observed to protrude upwards into the rubbly bed, and were found to rise from a lower sheet of stalagmite. The cones of this lower sheet were precisely under those of the upper, denoting that they were successively deposited from the same tubes above, but the lowermost set exceeded by double the thickness of the uppermost, and the depth of the stalagmite sheet was in the same proportion. The lower sheet extended over the entire area of the den, but the superincumbent bed of rubble, and its overlying thin sheet of stalagmite, 'thinned out' towards the sides. The removal of these partial beds displayed the entire surface of the lower sheet, which exhibited a most singular appearance. Over the whole area it was cracked into large slabs, resembling flags in a pavement. The upper sheet was not in the least fractured. The average thickness of the cracked sheet was about two feet. It possessed the hardness of rock, and but for its division into insulated flags it would have been almost impossible to pierce it.

"The first flag we turned over displayed a curious spectacle. Skulls and bones of bear, crowded together, adhered to its under surface. Flag after flag disclosed the same phenomenon; but in one place numerous skeletons lay heaped on each other; the entire vertebral column and its various other bones, even to the phalanges and claws, were discovered lying in their natural relation, in a state of preservation as if belonging to the same individual. The remains of bear prevailed here to the exclusion of all other animals. Some of the teeth were of the most dazzling

enamel, and the bones of their natural fresh colour. Others, on the contrary, were of a darkish brown; even the enamel was of a greenish tinge. Owing to the induration of their earthy envelope, or their incrustation by stalagmite, few were extracted entire. Two skulls were buried in the stalagmite as in a mould, and were brought away in that state. In no case were the remains broken or gnawed by the jaws of carnivores. The long bones were generally found entire; and when observed broken, it was only mechanically from pressure. The bones were highly mineralised, heavy, brittle, and easy of fracture; and, when struck, rang like metallic substances."

The portions of the stalagmitic floor which Mr. MacEnery had failed to break up, chiefly adjacent to the walls and other confines of the Bear's Den, furnished the Committee with two good examples of the remarkable cracks of which he speaks. One of these was in the north-east corner, where a crack, about half-an-inch wide, extended from wall to wall, a distance of about twelve feet, passing quite through the stalagmite, which was nowhere less than two feet thick, but without faulting it in the slightest degree, or, so far as could be observed, in any way affecting the underlying deposit. Mr. MacEnery, however, states, though somewhat obscurely, that in some instances a derangement had taken place in the materials covered by the broken stalagmite. The second existing crack varies from ·25 to 2·5 inches wide, and passes completely through the boss of stalagmite already mentioned, but without faulting it. No such cracks appear to be mentioned by Mr. MacEnery as occurring elsewhere, nor have the Committee met with anything of the kind in any other branch of the cavern.

The ground broken by Mr. MacEnery extended to a depth of from eight to twenty inches over almost the entire area of the Bear's Den. As was his wont, he left the excavated materials almost where he found them, and there were amongst them a large number of specimens which had been overlooked or neglected, including 1 tooth of horse, 1 of fox, 2 teeth of deer, 4 of hyena, 4 of mammoth, upwards of 200 of bear, very numerous bones, especially of the vertebral column and feet, a crowd of fragments of bone, numerous balls of coprolite, and a few bits of coarse pottery.

It cannot be doubted that such cracks as Mr. MacEnery describes must be a probable source of uncertainty respecting the position and relative chronology of some of the objects found in the underlying deposit, especially where this deposit shared in the disturbance.

In accordance with Mr. MacEnery's description and the foregoing considerations, the deposit the Committee had to excavate was the breccia, with a small amount of cave-earth lying on it here and there.

The excavation in the Bear's Den was limited, as in other branches of the cavern, to a depth of four feet below the bottom of the stalagmite, and the limestone floor was nowhere reached.

The "finds" in the Den were 216 in number, of which 12 were in the stalagmite; 101 in the first or uppermost foot-level, 47 in the second, 32 in the third, 23 in the fourth, or lowest, and 1 in a small recess. Omitting those found in the stalagmite and the recess, 32 of the "finds" were in cave-earth, 65 in a mixture of cave-earth and breccia, and 96 in the breccia; whilst the matrix of the remaining 10 must be regarded as uncertain. The colour and other characters of the specimens, however, indicate with tolerable certainty to what beds and eras they belong.

Besides a considerable number of bones and pieces of bone representing every part of the skeleton, the specimens included upwards of 620 teeth of bear, 24 of hyæna, 10 of horse, 7 of fox, 5 of mammoth, 4 of lion, and 1 of wolf(!), or of dog(?). There were also 20 "finds" of coprolite and 11 flints.

Amongst the bones the skull of a bear may be mentioned, which, to re-quote the language of Mr. MacEnery, was "buried in the stalagmite as in a mould, and was brought away in that state." Many of the specimens are of considerable interest, but perhaps none of them differ so much from those mentioned in previous Reports as to require detailed description.

None of the flints found in the Bear's Den are of so much interest as many of those exhumed in other branches of the cavern, and described in previous Reports.

A pillar of stalagmite was met with, in November, 1876, under the following peculiar circumstances:—It measured about fifty-one inches in basal circumference, and three feet in height. The base was of nondescript outline, but everywhere above the pillar was rudely elliptical in horizontal section, and it measured thirty inches in girth at the height of one foot, where it was least. When found, however, it was in two parts, having been divided along an almost horizontal plane, where it was thinnest. Each segment stood perfectly erect, but not one on the other; for though the bottom of the upper segment was on precisely the same level as the top of the lower, the upper portion had been moved westward to the extent of fifteen inches horizontally, and stood there on the breccia. It cannot be doubted that when the dislocation occurred the pillar had reached its full height, and the breccia had accumulated round it to the height of one foot; that is, it had reached the level of the plane of fracture. It is difficult to see how, by any possibility, the deposit could at that time have reached a greater height; and difficult also to understand how anything other than human hands could have shifted the upper segment and placed it so as to have preserved its erect position. On the other hand, it is just as difficult to see what motive man could have had for such a work. The whole, when found, was completely buried in the breccia, and the top of the upper segment was about a foot below the bottom of a thick remnant of the stalagmitic floor, which was intact and not cracked.

Rats, undoubtedly attracted by the candle grease dropped by the workmen, continue to present themselves wherever the work is in progress, irrespective of the distance from daylight.

The Tortuous Gallery.—As soon as the work in the Bear's Den was completed, the exploration of a narrow passage opening out of its southern end, and termed "The Tortuous Gallery," was begun. Its height varies from 15 to 6 feet, and its width from 1·5 to 4·5 feet. It proceeds in a southerly direction for about 23 feet, and then turns sharply towards the east. Ground had been broken, here and there, by the earlier explorers up to 11 feet from the Bear's Den. Everywhere farther in there was a continuous unbroken floor of stalagmite from 1·5 to 3·5 feet below the limestone roof. The underlying deposit was exclusively the breccia, or, so far as is known, the oldest the cavern contains. Its upper surface formed a continuous declivity, at a mean gradient of 1 in 2·5.

The "finds" met with in the Tortuous Gallery up to the end of August, 1877, were but fourteen in number, and the objects they contained were of but little importance. Six of them were in the first or uppermost foot-level—all near the entrance; two in the third; and six in the fourth—all at some distance from the entrance. They included, besides bones and bone chips, fourteen teeth of bear—some of them being in portions of jaws—and one tooth of horse. The latter was found on the surface, near the Bear's Den, with three bits of coarse, friable, black pottery.

On reviewing the work of the last eleven months, the superintendents cannot but express disappointment at not having found the very large number of choice specimens which Mr. MacEnery's glowing description had led them to expect in the Bear's Den. Nevertheless, the discoveries they have made not only justify his description, but show that in that branch of the cavern the osseous remains were almost entirely confined to the uppermost foot of the breccia, and mainly to its actual surface. So long as the lower levels remained untouched the belief that they were equally rich would naturally have prevailed; and it cannot be doubted that in disposing of this belief satisfactory work has been done.

No trace of *Machairodes latidens* has been met with since the Glasgow meeting.

Fifth Report of the Committee for Assisting in the Exploration of the Victoria Cave, drawn up by R. H. Tiddeman, secretary.—The work has been carried on almost continuously throughout the year until July 14, when the low state of the exploration fund rendered it advisable to give up working for the present. Prof. Busk has reported on the bones submitted to him. Out of 181 determined bones and teeth he reports of ox 46, deer 14, sheep or goat 16, hare 3-4, fox 5, bear 41, wolf 4, hyæna 30, rhinoceros 11, elephant 3, badger 7.

Of the ox one is *Bos primigenius*, the other probably *Bos longifrons*. Of the bears some are not unlike *Ursus spelæus*; others are undoubtedly grisly bear. The hyænas are, as usual, individuals of various ages. Rhinoceros is represented by at least eleven well-marked specimens, all of which are clearly referable to *R. leptorhinus*.

Three or four fragments of elephants' teeth occur. Fourteen specimens of deer belong to red deer, but there is no clear indication of reindeer.

A small ruminant, probably goat, occurs; some of the bones appear to be rather recent. Badger, fox, a small wolf, hare,

rabbit, several birds, and water-vole, complete the list of those which have been determined from the bones obtained in the year.

A great part of the work this year has been expended in lowering the levels in chambers A and D. An adit has also been cut from the further end of Chamber A to the end of Chamber D. This part was completely filled up to the roof with several beds of clay and stalagmite. These were all of earlier age than the hyæna bed, which was the great deposit of early pleistocene age. They were almost entirely free from animal life of any kind. The only specimens found were near the bottom of them, and in one spot, consisting of teeth of a small wolf. This, then, is by far the oldest inhabitant of the cave. The presence of wolf of course implies the presence of other animals.

The Committee is now working with a view to disclosing the old bed of the river which first formed the cave.

Third Report of the Committee for Investigating the Circulation of Underground Waters in the New Red Sandstone and Permian Formations of England, and the Quantity and Character of the Water supplied to various Towns and Districts from those Formations, drawn up by C. E. De Rance (secretary), with supplemental report by T. M. Reade.—No less than 10,000 square miles of England and Wales are occupied by the new red sandstone and permian formations, which absorb not less than ten inches of rainfall annually, and probably more where the overlying drift is pervious or absent, and the sandstone open and permeable.

The Rivers Pollution Commissioners classify waters in the order of their excellence, for general fitness for drinking and cooking, as follows :—

A. Wholesome.	1. Spring water.	Very palatable.
	2. Deep well water.	
	3. Upland surface water.	Moderately palatable.
B. Suspicious.	4. Stored rain water.	
	5. Surface water from cultivated land.	
C. Dangerous.	6. River water to which sewerage gets access.	Palatable.
	7. Shallow well water.	

The average amount of hardness of the water of the deep wells of the new red sandstone tabulated by the Rivers Pollution Commission being 17°·9, and that of the springs no less than 18°·8, the relation of hardness of water to the rate of mortality of the persons drinking it becomes a matter of great importance.

The Commissioners give three tables of statistics that bear directly upon this point :—

From Table I. it appears that in twenty-six towns, inhabited by 1,933,524 persons supplied with water, not exceeding 5° of hardness, the average death-rate was 29°·1 per 1,000 per annum.

From Table II. we learn that in twenty-five towns inhabited by 2,041,383 persons drinking water of more than 5°, but not exceeding 10°, the average death-rate was 28°·3 per 1,000.

Table III. gives sixty towns, with an aggregate population of 2,687,846, drinking water of more than 10° of hardness ; the average death-rate was only 24°·3.

Of the towns in Table I. none are supplied from the new red or permian formations.

In Table II. three are so supplied.

In Table III. ten are so supplied, from which it will be observed that the largest number of towns supplied with new red water are found in the table with the lowest death-rate and the hardest water.

The same result is obtained if we compare towns of corresponding populations and occupations supplied with soft waters from surface areas and those supplied with deep well water in the new red sandstone. Thus :—

	Per 1,000.
Manchester, 351,189 inhabitants, average death-rate ...	32·0
Birmingham, 343,787 ,, ,, ,, ...	24·4
And again—	
Stirling, 14,279 ,, ,, ,, ...	26·1
Tranmere, 16,143 ,, ,, ,, ...	18·8

The averages are, of course, also dependent on many external causes. Thus, Greenock and Plymouth, both supplied with soft water, with an equal number of inhabitants have a death-rate respectively of 32·6 and 23·3 per 1,000, due to difference of density of population, Greenock only having one house for every twenty-eight people. And again, Liverpool and Birkenhead, both supplied with moderately hard water in the one, an old and densely-populated town with a site saturated with what is injurious to health, the death-rate is 31 per 1,000, while Birkenhead, a new town on an open site with wide streets, has a death-rate of only 24 per thousand, though mainly inhabited by a poor and struggling class of persons.

Still it is worthy of note that the five inland manufacturing towns with the lowest death-rate are all supplied with hard water, and all from the new red sandstone.

	Population.	Mortality per 1,000 per annum.
Birmingham	343,787	24·4
Leicester	95,220	27·0
Nottingham	86,621	24·2
Stoke-on-Trent	130,985	27·9
Wolverhampton	68,291	25·9
Average	144,981	25·5

And again the average death-rate of twelve inland non-manufacturing towns supplied with soft water was 26·0 per 1,000, while that of twenty similar towns supplied with hard water was only 23·2.

When, however, the mortality of the districts, including the principal English watering places, is compared, there appears to be little variation in the death-rate, whether the population be supplied with soft, moderate, or hard water, so that it may be safely concluded that where sanitary conditions prevail with equal uniformity, the rate of mortality is practically uninfluenced by the degree of hardness of the water drunk, and the Rivers Pollution Commission are of opinion that soft and hard waters, if equally free from deleterious organic substances, are equally wholesome.

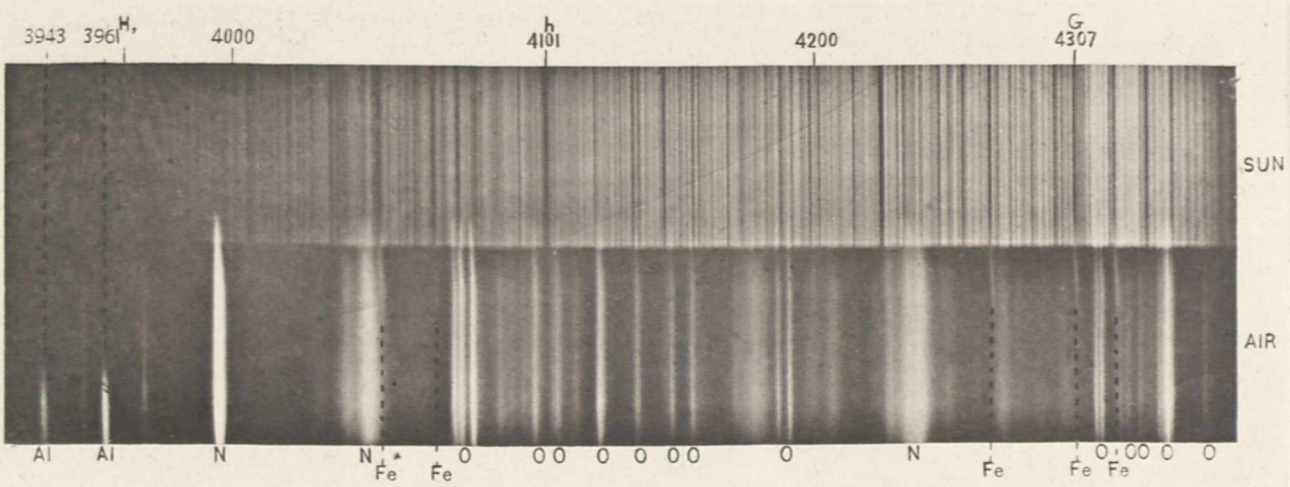
The Committee are of opinion that it is desirable that they should continue to inquire into areas where new red and permian waters might be obtained by means of deep wells. Looking to the national importance of utilising the underground waters of England, it is desirable that the sphere of this inquiry should be extended so as to include the oolites, which are often not made available for the supply of the population living upon them until the water is hopelessly polluted with sewage. The result of their labours, since the formation of the Committee, has been to prove that there is an available supply of water from the new red sandstone and permian of England of not less than a billion and a-half of gallons of water, the quality of which is remarkably free from organic impurity, and the hardness of which does not in the least appear to affect the health of the population at present taking their supply from it. The death-rate of this area compares well with the best soft-water districts.

Mr. J. Mellard Reade, C.E., F.G.S., added a special report *On the South-West Lancashire Wells*, in which he analysed the information he had obtained for the Committee through the printed forms of inquiry, supplemented by further inquiries which had suggested themselves to him. For the purposes of comparison Mr. Reade selected three nuclei or centres, about which the most important systems of wells are grouped, viz., Liverpool, Birkenhead, and Widnes, and illustrated them by maps and vertical sections showing the relative water-levels reduced to a common datum.

The President thought it important to note the influence of heavy and long-continued rain in relation to absorption by rocks. When rain lasts only a short time, even if it were very heavy, only a little was absorbed ; but if the rainfall were spread over a longer time, a larger proportion would sink into the rocks. M. Lebour described the method adopted by the French engineers for representing the underground water-contours on maps, there being also lines showing the strike of the rocks ; he commended this method to the consideration of the Committee.

SECTION A.—Mathematical and Physical.

On the Relative Apparent Brightness of Objects in Binocular and Monocular Vision, by Silvanus P. Thompson, B.Sc.—It is a common idea that objects appear brighter when seen with the two eyes than with one. There appear, however, to be exceptions to this statement. The following is a method of submitting the question to photometric measurement :—The comparison



DISCOVERY OF OXYGEN IN THE SUN BY PHOTOGRAPHY, BY PROFESSOR HENRY DRAPER. M. D. 1876.

The upper part of the photograph is the spectrum of the Sun, the lower part is the spectrum of the Oxygen and Nitrogen of Air. The letters and figures on the margin are printed with type on the negative; with this exception the photograph is absolutely free from hand work or retouching. O. indicates Oxygen, N. Nitrogen, Fe. Iron, Al. Aluminium. The figures above the Sun's spectrum are wave-lengths; G. h. H., are prominent Solar lines at the violet end of the spectrum. The principal point to examine is the coincidence of the bright Oxygen lines with bright lines in the Solar spectrum. The picture is printed from Draper's original negative by Bierstadt's Albertype process.

NATURE, *August* 30, 1877.

photometer employed consists of a cardboard screen, having an aperture divided into two equal portions. One half is covered with tissue paper and illuminated directly from behind. Behind the other half is set, at the polarising angle, a mirror of black glass. Light from a second lamp falls upon a screen of tissue paper, whose light is then reflected in the mirror. Thus the two halves of the aperture may be illuminated equally, but with light in one case wholly unpolarised; in the other, wholly polarised. Let two Nicol prisms be now taken, having their principal sections placed parallel and perpendicular, respectively to the plane of polarisation of the mirror, and let one Nicol be placed in front of each eye. One eye only will receive the whole of the polarised light, while the unpolarised will be equally distributed, half to each eye. The total amount of light received upon the retinal surface will be the same from each half of the aperture; but their apparent illuminations will be unequal, that of the polarised light appearing the greater. By comparing the distances at which the lamps must be placed, it appears that light is more powerful in producing an effect when concentrated upon one eye than when equally distributed to the two, though according to what law experiments are not yet sufficiently numerous or exact to determine; but, on the other hand, the light so concentrated on one eye does not produce the sensation of twice as much illumination as the half of the light viewed by both eyes at once.

A paper by Mr. C. Meldrum was read *On the Diurnal Variations of the Barometer and Wind in Mauritius*. Mr. Meldrum remarked that in 1875, 1876, and 1877, the number of cyclones had been much below the average, and that there had not been any one great storm such as that which occurred in the periods 1860-63, and 1870-73. This, so far, confirms the hypothesis of a connection between the frequency of sunspots and the frequency of cyclones.

With regard to the rainfall the evidence in favour of a cycle corresponding with the sunspot cycle has much increased. Dr. Hunter, of Calcutta, has lately found for Madras a rainfall cycle identical with that which the author had previously found both for India and various other parts of the world. Mr. Meldrum has recently discussed the rainfalls of thirteen stations in the French colonies for various periods from 1832 to 1872, and obtained results nearly the same as those that had been found for 144 stations scattered over both hemispheres. Dr. Fritz, of Zurich, has shown that the severest hailstorms and the highest levels of the rivers occur on the years of maximum sunspot. In short there can, he thinks, be little doubt of an eleven-year rainfall cycle, and when its laws are known they will probably be of much practical use.

Account of a Meteor which passed over Bhawnepoor, in India, in October, 1873, by Major G. Noel Money.—In the beginning of October, 1873, I was staying for a few days at Bhawnepoor, capital of the independent state of the same name, which is situated along the left bank of the River Sutley, and north of the great sandy desert of Bikaneer.

Early one morning I was roused from my sleep by a sound exactly resembling that which would be produced by half-a-dozen express trains passing close to the house at the same moment. The room was as light as the brightest noonday. Before I had time to collect my thoughts, two violent explosions in rapid succession shook the whole house; the doors and windows rattled for fully ten or fifteen seconds. Earthquakes being of not unusual occurrence in the north of Indía, particularly at that time of the year, I naturally concluded this was something of the kind, and hurried out of the house. As I did so the light faded, and I was surprised to find, as I reached the verandah, that it was still night, although the first streaks of dawn were visible in the east. The native servants were running out of their houses in the greatest alarm; I asked what was the matter. "God knows! the sky has fallen," was the reply.

After breakfast we heard that a shower of stones had fallen eighteen miles off to the north-east of Bhawnepoor, and later in the day some pieces were brought in. The largest was an irregular mass, as far as I can recollect about three feet long, and a foot thick; still hot, blackened outside as if by the action of fire, of which it smelt strongly, of a dark grey colour inside, and very heavy. I have now a piece which I broke off this large mass; although no bigger than a man's fist, it weighs nearly two pounds. The natives who brought these in said there were many more; one they declared, was as large as a bullock-cart, and so hot that they could not touch it.

It was afterwards ascertained that a second shower of pieces, apparently the result of the second explosion, fell about thirty miles beyond the first. It is satisfactory to know that there was scarcely a possibility of deception as regarded these pieces; there not being such a thing as a stone, rock, or pebble the size of a pea, within the radius of a hundred miles from Bhawnepoor, the soil being either pure alluvial deposit or the finest sand.

The accounts given by native eye-witnesses of this meteor were varied and unreliable, and one could only arrive at a satisfactory result by an exhaustive process of comparison, but I was fortunate enough to meet, the same day, a thoroughly trustworthy eye witness in the person of an European overseer who was superintending the works at a new palace, which was in course of erection for the Nawab at Bhawnepoor. This man had gone down to the works before daybreak to look after a brick-kiln, and being in an open space had an uninterrupted view of the meteor. He described it as a large ball of fire, as big as twenty moons, which passed, with a roaring sound, directly over his head in a north-easterly direction. It lit up the whole sky, the light being perfectly dazzling, and left behind it a flaming track of red, green, and yellow. Before passing out of sight two explosions in quick succession took place, at each of which a shower of sparks seemed to fall, but no alteration appeared in the size and shape of the meteor itself.

It has always been a subject of surprise to me that no attempt was made by Government to collect any information regarding this meteor. Had reports been called for from the various districts it would have been easy to ascertain where it was first and where last seen. Some estimate might then have been made as to its size and distance from the earth's surface.

To give some idea of its magnitude, I may mention that at Dera Ghazi Khan, seventy miles north of Bhawnepoor, it was seen and heard nearly as plainly as it was by us. At a place 200 miles north and a little west of Bhawnepoor, it was so brilliant that a native gentleman was, as he informed me, startled from his sleep by the sudden light, and ran out of his house thinking the next house must be on fire. He did not, however, hear any explosion.

Some soldiers of my regiment in Terar, in Afghanistan, 400 miles north of Bhawnepoor, told me that they had also seen it, and that it was so unusually large and brilliant that the moollahs (Mahomedan priests) were much exercised in mind about it, considering that it must forebode some calamity.

Very little notice was taken of the occurrence in the local papers, but this is to be accounted for by the fact that it passed over the most desert and thinly populated district in the whole of India. I believe, however, I am right in saying that it was also seen in Ajmere and Jypore, over 400 miles to the south-east of Bhawnepoor.

On the Determination of Temperature Coefficients for Insulating Envelopes, by T. T. P. Bruce Warren.—At the Exeter meeting of the British Association I read a paper on electrification, in which I endeavoured to show that the rate of variation in the insulation resistance of a core or cable under changes of temperature could be determined for any period of contact. A statement was made in that paper which has led to the belief that india-rubber has the same constant for correcting from one temperature to another, and for any period of contact.

Prof. Fleeming Jenkins, Mr. Latimer Clarke, and others have pointed out that this phenomenon is not met with in gutta percha, or any other insulator with which they are acquainted. This has led me to re-examine the matter, and to consider carefully the experimental data upon which the paper was founded.

The method of representing graphically the decrease of resistance due to increase of temperature corresponding to one minute's electrification, can be followed out for two, three, or any number of minutes. In this way a series of logarithmic curves are obtained for any required duration of contact; these curves are generated by a constant which must first be ascertained by experiment for changes of temperature at the end of one, two, three, &c., minutes.

This was omitted in the previous paper, or at least not dealt with as the importance of such a subject required.

The phenomenon of electrification, from what has just been pointed out, must appear to every electrician to have received additional importance, so as no longer to be regarded as an unintelligible or inapplicable fact. One very important consequence of its being reducible to an intelligible variation is that we can now calculate not only the changes in the resistance of an insulator due to variation of temperature, but we can ascertain with the same precision any required change due to prolonged contact,

at any required temperature. The resistances at different temperatures under different durations of contact will, when tabulated, represent a series of logarithms, the base of each system being the ratio between the resistances for the same differences of temperature, but corresponding to different periods of contact.

From these facts, electrification phenomena are capable of receiving a mathematical rendering, which must prove of great use to telegraph engineers.

If the temperature coefficient were constant for all and every period of contact, we should obviously obtain a series of curves with ordinates increasing in a constant ratio, which would mean that the resistances did not diminish as we reach the higher temperatures. Now as the temperature coefficients for increased duration of contact diminish, the curves more nearly approach each other as the temperatures are increased, which agrees with the fact that electrification ratios are reduced less and less as the resistance itself diminishes. A very curious result arises from this treatment of the subject, which I have not yet had sufficient time to examine, but which may be mentioned here as probably it may assist us to explain something of the nature of electrification. To determine approximately the electrification ratio and consequently the resistance at any required temperature and for any period of contact, calculate first the temperature coefficient for the required temperature, which is simply the expansion of the ratio for 1° F. to that power corresponding to the degrees of difference. Using this as the factor, extract the root of the ratio for any two given periods of contact, this will give very nearly the electrification ratio corresponding to the same period of contact at the required temperature.

It thus appears that electrification, which is an inseparable property of all insulators follows some law of variation in which the temperature coefficient of the insulator itself is a function.

I hope to communicate to a future meeting the mathematical development of the application of logarithmic functions to electrification and thermal charges in insulating media.

Notes on the Volumes of Solutions, by J. A. Ewing and J. G. MacGregor, D.Sc.—In a paper by the authors published in vol. xxvii. of the *Transactions* of the Royal Society of Edinburgh, containing an account of experiments on the density and electrical conductivity of certain saline solutions, notice is directed to the fact that the density of very weak solutions of sulphate of copper and sulphate of zinc is greater than it would be on the hypothesis that the anhydrous part of the salt dissolves without increase of volume in the whole of the water present, including the water of crystallisation. On the other hand the density of comparatively strong solutions is less than this hypothesis would make it. From this it follows that if a small quantity of one of these salts in the anhydrous state were added to water, it would cause contraction, while a larger quantity of the salt would produce expansion. The amount of such contraction, however, as indicated by observations of density, was so small, that the authors were unwilling to speak positively as to its existence until they had applied a direct volumetric test. They have now done so, with the result of confirming the deduction drawn from their earlier experiments.

The apparatus consisted of a large bottle, 2744 c.cm. in capacity, through the cork of which projected a vertical tube of 0·66 cm. in bore. The bottle, as well as a part of the tube, was filled with distilled water, and the salt was introduced in quantities of ten grammes at a time. The resulting change of volume was shown by the rise or fall of liquid in the tube. In order to eliminate the effect of variations of temperature, a second precisely similar bottle and tube were prepared and filled with water, and the two were placed together in a large tube full of water.

The second bottle acted as a thermometer, and the expansion or contraction due to the introduction of the salt into the first bottle was indicated by the difference between the changes of level in the two tubes. After the introduction of each dose of salt the bottle was rolled about for a time, so as to secure thorough diffusion and solution, and then an interval of at least six hours elapsed before readings were taken, in order that the heat given out by the hydration of the salt might be dissipated.

The following results have been obtained in the case of anhydrous sulphate of copper:—The maximum contraction occurs when the proportion of anhydrous salt to water is about one to fifty, and the amount of contraction is then 0·00043 of the original volume of water. As more salt is added the solution begins to expand, and with one part of salt to eighteen of water the volume is equal to that of the water originally present. After this any further addition of salt produces expansion beyond the original volume. The rate of expansion per unit quantity of salt appears to increase continually, but at first it is negative.

The above numbers are given subject to correction by more elaborate experiments that are now going on. The authors hope to extend the inquiry to other salts. They have already examined the behaviour of anhydrous sulphate of soda, but with that salt no contraction whatever has been observed; the solutions expand rapidly from the first.

On Magnetic Induction as affecting Observations of the Intensity of the Horizontal Component of the Earth's Magnetic Force, by Charles Chambers, F.R.S., Superintendent of the Colaba Observatory, Bombay.—The magnets used in observations of deflection and vibration, which observations are necessarily made in the field of the earth's magnetic force, are subject to the inducing action of that force; and it is the universal practice of magnetic observatories, sanctioned by the most eminent writers on terrestrial magnetism, to apply corrections on account of induction both to the deflection and vibration observations. The object of this communication is to advance theoretical reasons, supported by experimental evidence, against the propriety of the particular correction applied to the vibration observation. This correction is based on the assumption that the vibration magnet is susceptible of induction longitudinally but not transversely or not so sensibly; and the assumption probably rests on what the writer regards as a false analogy between a permanent magnet and an induced magnet. The former, when removed from the influence of a strong magnetising action, remains a magnet by virtue of its own internal forces, whilst the latter is a magnet by virtue of external forces alone; it does not therefore follow that because the power of a permanent magnet, measured by its magnetic moment, cannot be made by the same means nearly as great transversely as longitudinally, therefore the same may be said of an induced magnet. Indeed, in his treatment of the subject of the deviations of the compass, Sir George Airy gives to each elemental portion of a ship's iron as great a susceptibility to induction in one direction as in another; and in the more elaborate treatment of the same subject, in which Poisson's equations are taken as expressing the fundamental conceptions of the theory, terms representing transverse induction are still retained as of comparable magnitude in presence of others representing longitudinal induction.

Applying the Astronomer-Royal's theory to the particular case of the vibration magnet, its induced magnetism becomes an assemblage of elementary magnets, whose magnetic axes are all parallel to the magnetic meridian, and which, since they sensibly retain their parallelism to the meridian during the oscillation of the magnet, give rise to no moment of restitution, hence, according to this view, no correction would be required.

According to Poisson's theory, the amount of the correction is matter for experimental inquiry, and cannot be safely determined on *à priori* grounds. It may be objected, however, that the swinging of a ship being a slow motion compared with the oscillation of a magnet, the theory of the deviations of the compass must be modified in its application to the case in question; and this is, no doubt, a correct view, for the theory regards the inductive action as being, at every moment considered, sensibly carried to its limit of effectiveness; whilst it is not only conceivable, but doubtless the fact, that where, as with the oscillating magnet, the motion is reversed every few seconds, the transverse inductive action only partially approaches its limit. On this account we should be prepared to expect then, that even if the transverse induction were as great as the longitudinal when time for full development of the induction was allowed, it would be in defect in the case of the vibrating magnet.

In the years 1873 and 1874—long before these views of the subject of induction first occurred to the writer—he had had made in Bombay a careful comparison o two Kew unifilar magnetometers by means of practically contemporaneous observations. The result was to show a persistent difference in the values of the horizontal force yielded by the two instruments, far exceeding any probable errors of observation, and, after a careful examination of each single observational quantity and of each constant entering into the computations, the writer came to the conclusion that no error of the magnitude of that in question could have its source anywhere but in connection with the induction corrections. The values obtained for the horizontal force were, in British units of force—

With magnetometer No. 17.	With magnetometer No. 23.
8·0701	8·0841
8·0698	8·0823
8·0762	8·0916
8·0764	8·0945
8·0694	8·0965
8·0707	8·0904
8·0757	8·0844
8·0756	8·0821
	8·0902
Mean = 8·0730	8·0858
	8·0905
	8·0880
	Mean = 8·0884

No. 23 showing an excess over No. 17 of ·0154 British units of force, or of ·0019 of the whole horizontal force.

We observe that the greatest value given by No. 17 is less than the least value given by No. 23, and infer that the difference between the two means cannot be attributed to probable error of observation, the value of which for a single determination (about ·001 of the whole force) is, moreover, much smaller. If we now remove the corrections applied for induction to the vibration observations, the mean value yielded by No. 17 becomes ·0004 of the whole force greater than the mean yielded by No. 23. It thus appears that a small correction, such as we have already seen reason to expect, is required for the vibration observation, but—on an average for the two instruments employed—only of about one-sixth of the value of that which it is the custom of magneticians to apply; and as this small quantity scarcely exceeds the probable error of the mean determination of the horizontal force, it is yet premature to attribute it to any definite cause. Whilst, however, the experiments afford no sufficient reason for applying this small correction, they speak very distinctly in favour of no induction correction at all for the vibration observation as against the common practice.

To show that the error that we have been discussing is not of that minute order that is usually disregarded, we may mention that it would amount, in the case of the unifilar magnetometer used at the Observatory, to about eight times the probable error of an observation.

SECTION B.—Chemical Science.

On a New Mechanical Furnace used in the Alkali Manufacture, and for Calcining Purposes generally, by James Mactear, F.C.S.—The author exhibited and explained the construction of a working model of the furnace which he has introduced for the calcination or so called carbonating of soda, ash, or alkali, and which is also applicable to many other operations, notably that of calcining copper ores, especially as required in that branch of copper manufacture called the "wet process."

These furnaces are now being widely adopted by alkali manufacturers with great success, the saving in labour having been over 60 per cent., and of coal over 20 per cent., while the quality of the work done is much superior to hand work.

On an Improved System of Alkali Manufacture, by Mr. James Mactear.—The author described his improved system of manufacturing blend ash or crude alkali, and claims that it has the following advantages:—

1. By its use the output of the furnaces has been increased from 50 per cent. to 70 per cent.
2. There is a large saving during the lixiviation and in coal.
3. There is a much reduced quantity of waste.
4. There is a considerably increased yield of alkali from a given amount of sulphate of soda.
5. There is a considerable saving in wages.

The process is now widely adopted in Great Britain, and is also most successfully used in France.

On the Regeneration of the Sulphur employed in the Alkali Manufacture, by the "Mactear Process," as conducted at the works of Messrs. Charles Tennant and Co., St. Rollox, by James Mactear, F.C.S.—The author described his process as conducted at Messrs. Tennant's works, at St. Rollox, and showed how by its adoption the nuisance arising from alkali waste deposits and the drainage therefrom had been removed. He also gave details of the cost of manufacturing sulphur by this process, and a description of the plant employed.

The "Mactear Process" is specially applicable to those cases where the drainage of the waste deposits is allowed to flow into streams or rivers, as by collecting the drainage liquor and treating it in the manner described by the author, not only is a great source of nuisance removed, but a new outlet is obtained for hydrochloric acid, while the sulphur is produced at a cost which leaves an amply remunerative margin to the manufacturer.

Messrs. Tennant and Co. now recover weekly about thirty-five tons of refined sulphur by this process.

The Action of Various Fatty Oils upon Copper, by W. H. Watson.—This communication enumerates a number of experiments showing the extent to which different oils act upon copper, the conclusions arrived at being that paraffin and castor oils have the least action upon copper, whilst the action of sperm and seal oil is slight. The rest of the oils examined—linseed, olive, almond, colza, sesame, and neatsfoot, all act considerably upon copper, the action of linseed oil being especially great. The author concludes from experiments that the comparative action of different oils cannot in all cases be decided upon from the appearance of the oils after exposure to copper plates, though minute quantities of the metal may be easily detected in most oils from the colour produced.

On Changes in Candles produced by long Exposure to Sea-water, by Prof. Gladstone, F.R.S.—Mr. Latimer Clarke had sent the author some specimens of candles recovered from the wreck of a vessel sunk off the Spanish coast in 1702, which have remained submerged for a period of 173 years. The wick has rotted away, leaving scarcely any trace of its existence, while the fatty portion has become a friable heavy substance of a dull white colour. The candles bore evidence of having been formed by dipping. The fat may be easily separated from the rest by ether.

After exhaustion with ether there remained a strongly alkaline white ash, consisting of carbonate and chloride of calcium and sodium, with traces of potassium and magnesium. From analysis it appears that the fat has been converted in great measure into calcium and sodium salts, doubtless by the slow replacement of the triatomic group C_3H_5 in the stearine, by three atoms of the metal, with the simultaneous production of glycerine. Though the calcium in sea-water is far less abundant than the sodium, it appears to have had a much greater effect, and it is impossible to say whether the one salt may not have been made by double decomposition from the other. The author pointed out as an interesting point that whereas the fats have been in contact with a practically unlimited quantity of sea-water for 173 years, and a chemical change between them has been possible, the double decomposition has proceeded so slowly that the reaction is only about half completed at the present time.

Contribution to Chemical Dynamics, by C. R. Alder Wright and A. P. Luff.—Guided by certain theoretical speculations, the authors are endeavouring to trace out the connections between the chemical habitudes of certain substances and the temperatures at which their mutual inter-reactions are first noticeable, and notably the relations between the heat developed during their actions and these temperatures of initial action. Experimenting on oxides of copper and iron in different condition as to molecular structure, they find, that whilst the initial temperature of action varies within certain limits with the molecular state of the metallic oxide, when they are subjected to the ordinary action of carbon oxide, hydrogen, and carbon, a given form of either oxide is invariably acted on by carbon oxide at a lower temperature than by hydrogen, and by hydrogen than by carbon; whilst the heat evolution during the reduction of the metallic oxide by carbon oxide is always greater than that during reduction by hydrogen, which again is less than that during reduction by carbon. Similarly, so far as they can be compared, that metallic oxide is acted on at a lower temperature, in the production of which there is less heat evolution (*i.e.*, in the reduction of which there is most heat evolution). How far these generalisations are applicable to other metals is under examination, as are several other collateral points.

On the Coal brought Home by the late Arctic Expedition, by T. Wills.—The coal occurs on the side of a narrow mountain gorge about two miles from Discovery Bay, the winter quarters of H.M.S. *Discovery*. It appeared in the form of a slight saddleback thickest in the centre, becoming continually smaller at each end; the thickness of the seam at the deepest visible portion was 25 feet, and its visible length 250 yards; neither the bottom of the seam nor the underlying strata were visible at any place. Overlying the coal was very friable carbonaceous shale containing impressions of miocene plants, and above this shale a hard fossil red clay stone similar to the red miocene rock of the Disco coal beds, but sterile. The seam is almost uniform in character, and is very free from clayey veins. On obtaining the

sample of coal Mr. Wills expected to find it to be a lignite, as cretaceous or tertiary brown coal does occur in these high latitudes, and more especially as the impressions of miocene plants in the overlying strata seems to indicate a more recent period than the true carboniferous; but it turns out that this is not the case, for the coal in appearance and on analysis cannot be distinguished from a bituminous coal of exceedingly good quality belonging to the true carboniferous period. Mr. Wills, from recent information, understands that miocene plants have been found in the strata underlying the coal, in which case there can be little doubt that the coal is a miocene coal, although differing greatly from most specimens of such coals. The following is the result of several analyses:—

Specific gravity	1·29
Moisture	2·38
Ash	6·21
Sulphur	·96
Carbon	76·95
Hydrogen	5·43
Oxygen, Nitrogen } by difference	6·78
	100·00

On comparing these figures with the result of the analyses of a mixture of thirteen different seams from English coal-fields, Mr. Wills has found that the Arctic coal possesses very nearly the same composition.

On Hederic Acid and Resin of Scammony, by C. T. Kingzett.—In a paper *On some New Reactions in Organic Chemistry*, and their ultimate bearings the author in conjunction with Dr. Hake has described a number of instances in which bodies, for instance camphor, gives with strong sulphuric acid and sugar a violet-coloured product. Other bodies give this colour with sulphuric acid without the addition of sugar, and by means of these reactions the constitution of many substances may be in a measure predicted. Hederic acid, $C_{16}H_{26}O_4$ (Posset, also Davies), a constituent of ivy leaves, gives this colour best with sulphuric acid, and so also in a less degree does resin of scammony. In the present paper the author describes the process by which he has isolated glucose from these respective substances, thus confirming the hypothesis given in his original paper alluded to. Incidentally it is shown that the root of the convolvolus scammonia contains no alkaloid, and some information is given regarding a volatile oil obtained below 90° on distillation of scammony resin.

Albumen of Commerce, by C. T. Kingzett and M. Zingler.—In the patent process described by the authors, albumen solutions are bleached and preserved by passing a current of air through them in presence of oil of turpentine at a temperature of about 40° C. Under these conditions the turpentine oxidises, producing hydrogen-peroxide, camphoric acid, &c., the former of which bodies effects as it forms the bleaching of blood serum or other albuminous solutions, while the camphoric acid, &c., preserves them in the liquid condition entirely free from putrescible or other changes.

Alkaloids from Japanese Aconite, by Dr. Paul and C. T. Kingzett.—The authors have isolated from Japanese aconite an alkaloid of the formula $C_{29}H_{43}NO_9$ which is crystalline, but does not form crystallisable salts. They also show that when the alkaloidal principle is extracted by Duquesnel's process it is accompanied by the salt of an alkaloid, perhaps aconitate of aconitine; and from this it is suggested that the so-called aconitine obtained and analysed by Wright and others, has never been obtained absolutely pure, being probably a variable mixture of the alkaloid with the above salt.

Further Researches on Aconite Alkaloids, by Dr. C. R. Alder Wright and A. P. Luff.—Aconitine, $C_{33}H_{43}NO_{12}$, the active principle of *Aconitum napillus* is readily saponified by heating with water acids and alkalies into *benzoic acid*, and a new base termed by the authors *aconine* pseudaconitine, $C_{36}H_{49}NO_{11}$, the chief active alkaloid of *A. ferox*, similarly gives rise to *dimethyl-proto-catechuic* acid and *pseudaconine*, $C_{27}H_{41}NO_8$. These two decomposition products, aconine and pseudaconine, are comparatively inert physiologically. A number of their compounds and derivatives have been studied and a method for the approximate analysis of the impure alkaloids met with in commerce under the name "aconitine," has been devised, based on the quantitative estimation of the benzoic and dimethyl protocatechuic acids formed on saponification.

On Pyrocatechin as a Derivative of Certain Varieties of Tannic Acid, by John Watts, D.Sc.—From the known reactions of gallotannic acid and catechutannic acid, and of their derivatives, the author considered it probable that all the blue producing tannins would yield pyrogallol on distillation, while the green producing tannins, would yield pyrocatechin: on experiment such was found to be the case. The gallotannic acids distilled were,—valonea, oak-bark, divi, mysotolaves, sumach, and mimosa bark; and the mimotannic acids, rhatany, tormentil, and hemlock bark. The yield of pyrocatechin from rhatany was very considerable.

These results point to the conclusion that the blue- and green-producing tannins are related to each other in the same manner as pyrogallol and pyrocatechin. The author anticipates being able to bring forward shortly further experiments in support of this view.

On the Formation of the Black Oxide of Iron on Iron Surfaces for the Prevention of Corrosion, by Prof. Barff, M.A. (Cantab.)—The author pointed out the cause of his many failures in his first experiments and the failures which others had experienced in obtaining a perfectly adherent and coherent coating of black oxide, as arising from moisture in the steam with which the articles operated on were oxidised. When perfectly dry steam is used and no air admitted into the muffle, or oxidising chamber, then in all cases a perfect protecting film is formed. The process is exceedingly simple: a wrought-iron muffle containing the iron articles to be operated upon, is heated to a dull red heat, all the openings closed, and dry steam turned in, and the muffle kept filled with the steam during the whole operation, which lasts from three to five hours; the fire is then raked out, and the articles allowed to become black in an atmosphere of steam; after this the steam is turned off, and the muffle and its contents are allowed to cool slowly. The temperature to which the muffle is heated varies according to the nature of the articles operated on—from 350° to 700° C. More recent experiments seem to show that the process may be further simplified by using superheated steam of such a temperature that the external application of heat to the muffle is unnecessary. A considerable number of cast-iron, wrought-iron, and steel bodies which had been coated were exhibited. Many of these had been out of doors for months; others had been kept in fresh water or in sea-water for a similar length of time, but not the slightest indication of further oxidation was visible. Even strong nitric and sulphuric acids are without action on this coating of black oxide.

SECTION C.—GEOLOGY.

The Post-tertiary Fossils procured in the late Arctic Expedition; with Notes on some of the Recent or Living Mollusca from the same Expedition, by J. Gwyn Jeffreys, LL.D., F.R.S.—The fossils were collected by Capt. Feilden and Mr. Hart, the Naturalists of the Expedition, and by Lieut. Egerton and Dr. Moss, two of the officers of H.M.S. *Alert*, in very high latitudes, viz., between 82° and 83° N.L. The furthest point reached by the Expedition was 83° 20′ 26″. These fossils were found in mud-banks or raised sea-beds at heights ranging from the level of the sea to 600 feet above it. They consisted of eighteen species of mollusca, one of actinozoon, one of foraminifera, and one of marine plants, being altogether twenty-one species, all of which now live in the Arctic seas. The author gave a list of the species, and showed their distribution in a recent or living as well as fossil state; and he added some remarks as to the recent mollusca procured in the Expedition, and as to the apparent abundance of marine animals in the "Palæocrystic Sea" of Sir George Nares. Prof. Rupert Jones, Dr. Moss, Mr. Woodall, and Mr. De Rance took part in the discussion which ensued on the reading of this paper.

Sketch of the Geology of the Coast from the Rame Head to the Bolt Tail, by W. Pengelly, F.R.S.—Mr. Pengelly expressed his partial acceptance of Mr. Jukes' views. He believed the upper old red sandstone to be the equivalent of the lower Devonian, each containing *Phyllolepis concentricus*, which is not found at any other horizon. The author also called attention to the metamorphism which has taken place in the rocks at and near Prawle Point, for which no sufficient cause is now apparent. He supported the suggestion of Dr. Holl and Mr. Jukes that south of Prawle Point there may be a boss of granite now submerged, to which the change in character of the rocks is due. As evidence of this he spoke of a beach, in which many granitoid pebbles occur, but with this exception the pebbles are strictly local. He

thought that these pebbles were probably derived from the now submerged granite. The age of the metamorphism is clearly pre-triassic, for the triassic strata of the district contain pebbles of metamorphosed rock.

On the Drift of Plymouth Hoe, by J. H. Collins.—The author stated that excavations were nearly always going on in the neighbourhood of Plymouth Hoe, and that fresh sections of the so-called raised beaches and glacial deposits were continually being exposed.

He had lately visited the Hoe, Mt. Batten, and Deadman's Bay, in company with Mr. Whitley of Truro, and had found gravels, sands, and clays lying in the hollows of the limestone, and filling fissures and caverns. The gravels were sometimes cemented by stalagmite into a conglomerate. The pebbles were composed of quartz, limestone, tourmaline schist, greenstone, blue and red grit, hard clay-slate, schorl rock, granite, elvan, flint, chert, stalagmite, and one pebble of granite; all of which the author considered had been derived from the rocks of the neighbourhood within a few miles. None of the pebbles were in the least degree ice-scratched, and there were very few angular fragments of any kind.

The gravels had yielded bones of rhinoceros, elephant, and other animals of the so-called "Mammoth period." The author discussed the evidence of local denudation, and adopted or arrived at the following conclusions:—

1. The deposits are not raised beaches.
2. They are not glacial.
3. They were formed rapidly.
4. Gravels, fissure deposits, and cave deposits are of the same age.
5. That they belong to the Mammoth period.
6. There is no evidence in the immediate neighbourhood to carry back their formation more than a few thousand years.

Notes on the Devonian Rocks near Newton Abbot and Torquay, with Remarks on the Subject of their Classification, by H. B. Woodward, F.G.S.—After having alluded to the imperfect state of the information respecting the Devonian rocks, especially in regard to local details of structure, the writer pointed out that the succession of strata near Newton Abbott and Torquay was (in descending order) as follows:—3. Limestone; 2. Slates; 1. Red Sandstones. He noted the resemblances in lithological characters between these beds and the lower carboniferous rocks and old red sandstone, with which they were classed fifty years ago by De la Beche. He likewise drew attention to their relations with the Culm measures, observing that while there were indications of conformability to them, no positive proof to the contrary had been established; and the supposed instances of unconformability were all of them, as Jukes had considered, capable of explanation by faults and other disturbances. Attention was drawn to some striking cases of such phenomena. The impossibility of accepting fossil evidence alone was insisted upon, inasmuch as its value in classification could only be gained after the stratigraphical relations of the beds had been made out, and at present the exact horizons from which many of the species had been collected was not determined.

Further, the theory that the Devonian rocks were the equivalents in time to the old red sandstone required the existence at this period of a great barrier between the marine deposits of the former group and the freshwater accumulations of the latter, and there was no physical evidence in support of this. Taking all the facts into consideration, Mr. Woodward argued that they were in favour of the classification proposed by Jukes, which regarded the lowermost Devonian rocks as old red sandstone, and the slates and limestones as lower carboniferous, formed in an area which constituted a zoological province differing to some extent from that in which these rocks were deposited further north in the British area.

On the Devonian System in England and Belgium, by Prof. G. Dewalque.—Having surveyed, last year, the Devonian system of this country, I avail myself of the meeting of the British Association to offer a few remarks on the results of my survey. As my visit was short I cannot lay claim to a minute acquaintance with this great formation in England; but, as well acquainted with it in Belgium and the Rhenish provinces, I hope the following remarks may prove of some interest to the Association:—

I had not time to visit South Devon. As regards North Devon my conclusions are as follows:—1. The metamorphic character is more prevalent there than in Belgium, especially in the middle and the upper divisions. 2. All this series is perfectly continuous, from Barnstaple to Lynton. Nowhere is there a reappearance of such identical rocks as to prove a fault, by repetition of the series. 3. The sandstones of Baggy Point and Marwood (*Cucullæa zone*) perfectly agree, both lithologically and palæontologically, with certain portions of our "Psammites du Condros." The red sandstones of Pickwell Down correspond to the lower part of these Psammites. 4. The limestone of Ilfracombe represents, as has been previously stated, on palæontological evidence, the "stringocephalus limestone" (*Calcaire de Givet*) of Belgium and Germany; but the lithological appearance of the rock is very different. Hence it is easy to compare this Devonian series with that of the Continent. In this respect I differ but little from Mr. Etheridge. 5. The Devonian limestone is much more abundant on the Continent than on this side of the Channel. I think, moreover, that the same is to be said of the carboniferous formation, that is to say, the mountain limestone is replaced in North Devon (at least in part) by the beds of Barnstaple and Pilton. In the slates of Pilton I found beds and nodules of siliceous concretions, which represent, I think, the *chert* of the carboniferous limestone, or the so-called *phthanites* of our "calcaire carbonifère."

As to the old red sandstone I spent a week in Hereford, but saw very little of it. I could only hammer conveniently the "cornstones," of which I had from the descriptions a very imperfect notion. Such limestones occur identically in Belgium, with red shales, sandstones, and conglomerates in the northern trough, or "bassin de Namur." This fact seems to me of the highest value, for it leads me to this paradoxical conclusion: the old red sandstone of the United Kingdom is a marine formation, probably formed in the same ocean as the Devonian. The old red of Belgium lies regularly between limestones with *Stringocephalus Burtini* and others with *Spirifer disjunctus*. That is certainly a marine formation, and the same must be the case with the English old red sandstone.

On the Succession of the Palæozoic Deposits of South Devon, by A. Champernowne, M.A., F.G.S.—The Great Devon limestones, the author concludes, are, as Mr. H. B. Woodward has said, the highest rocks of South Devon, and the belief in a series of slates and red sandstones overlying them, is a fallacy. The beds which do succeed the limestones are the Culm measures (upper carboniferous), and from the field-work of Messrs. Woodward and Read there is reason to believe them perfectly conformable. In this case the difference between the Devonian and carboniferous limestones would be one of life distribution—a geographical, and not a chronological, difference. This would probably have been long ago recognised had the characteristic ichthyolytes of the old red occurred in the Staddon beds.

Note on the Carboniferous Coast-line of North Cornwall, by S. R. Pattison, F.G.S.—The portion of coast described extends from near Bude to Boscastle, and belongs to the formation first identified by Prof. Sedgwick in connection with the diagnosis made at Bideford by him and Sir R. Murchison as culm, or lower coal measures. Bude lies in or on the centre of the formation. The strata have a general northerly dip, and proceeding southwards down the coast of course lower beds become exposed. The Bude beds contain thin films of culm, with associated plant-remains in a very fragmentary condition. Prof. Morris many years ago in a note published in the *Proceedings* of the Geological Society of Cornwall, identified some of those remains as *Calamites*, *Sigillaria*, and *Asterophyllites*. Prof. Hull states the number of species in the North Devon beds, of which these are the continuation, at twenty-three, and Mr. Townshend Hall at twenty-six. The Bude beds are continued by foldings and succession downwards, but on arriving at St. Gennys a system of deep-blue schistose sandstones appear and form the base line of the cliff along the remarkable coast landslip which extends for two miles. From these dark-blue beds fragments or nodules containing *goniatites* appear on the beach. Then comatile-beds extend from Carne Beak to the cliffs in the parish of St. Juliott. They are most abundant at the St. Gennys end of the landslip. Here, at a sand-path descending to the beach, on the beach, are huge fragments of fallen rock containing very fine large impressions of plants, especially sigillaria. Proceeding towards Boscastle, at the gloomy gorge of Pentagion, the soft black shales, so characteristic of Boscastle, form the bulk of the cliffs, but below them rises a slaty rock once quarried, and in this I found the usual fragmentary plants of the Bude rocks. This, with the associated soft black beds, is the farewell rock of the carboniferous, for at the cliff, on the south side of Boscastle, slates arise under the black shales, which at the summit contain

traces of crinoids, and are the commencement of the Devonian slates, continued hence to Tentagel, and well known as Devonian.

These few facts seem to verify the general conclusion arrived at by former observers, and, when more fully investigated and the fossils identified, will help to correlate the carboniferous of North Cornwall with the divisions now established elsewhere. They seem at least to show that there are provinces in our local geology still holding out temptations of further conquest to the geological explorer.

Notes on the Palæontology of Plymouth, by R. N. Worth, F.G.S.—This paper did not enter into any controverted questions of stratigraphical geology, but simply noticed the main features of the palæontology of the limestone of Plymouth and its associated rocks. The Plymouth rocks were commonly classed as Middle Devonian, and consisted of slates, limestone, and slates and sandstones, in order from north to south. The northern slate rocks did not locally contain fossils; but in the vicinity of Saltash, &c., they did. The Plymouth limestone formed a band nearly half a mile in width and nearly six and a half miles in length. It originated clearly enough in a fringing coral reef, and in its origin and constitution was therefore essentially organic. The rocks on the south of the limestone were of a more complicated character than those on the north. Slates, limestones, shales, grits, ash-beds and sandstones, alternated with each other in remarkable fashion, while faults and contortions by no means solved the riddle. These rocks in part were largely fossiliferous. In the variety of its organic remains the Plymouth limestone was not so rich as most of the other chief limestone districts of South Devon—Wolborough and Barton, for example; but those that did occur were for the most part abundant. The leading peculiarity was that while at the western end of the limestone—that was to say, at the Dockyard, Mount Wise, and at Stonehouse, in the quarry behind St. George's Hall, molluscs of various kinds occurred, at times in great profusion; at the eastern end of the limestone—Cattedown, Oreston, &c., they were comparatively rare, and over considerable areas altogether absent. And in like manner, the branching corals were found chiefly at the western end of the limestone; and the genuine reef builders at the eastern. There did not appear to be any difficulty, however, in accounting for this. Molluscs could only find a habitat on the exterior portions of the reef, and it was evident that the eastern section of the limestone more particularly had been subjected to a considerable amount of denudation, and that the outer beds had to a large extent been removed. Bivalves and univalves were rarely associated, but kept to distinct areas, where they sometimes occurred in great abundance. The peculiar interest of the palæontology of Plymouth consisted in the products of the ossiferous caverns and fissures at Oreston, the Hoe, and Yealmpton, including the bones of the mammoth, hippopotamus (?), *Rhinoceros tichorhinus* and *leptorhinus*, cave lion, cave hyæna, cave bear, ancient bear, the lesser bison, long fronted ox, horse, ass, &c., and a vertebra of the whale.

On the Geological Significance of the Result of the Boring at Messrs. Meux's Brewery, Tottenham Court Road, by R. A. C. Godwin-Austen, F.R.S.—It is now very generally known that this undertaking, after passing through a great thickness of chalk, met with a very insignificant representative of the sands which underlie the chalk in the south-east of England, and thence passed at once into strata which, by characteristic fossils, were identified as of upper Devonian age. This is just as had been anticipated as to the absence of any portion of the oolitic series there,[1] and confirmed what many years since had been supposed to be the subterranean structure of the south of England; indeed, it may be fairly stated that geologists generally have been of opinion that a band of palæozoic rocks, extending from Westphalia westwards, passed somewhere beneath the secondary formations of the south-east of England.

The importance of determining the course of such palæozoic band was, that along the whole of the exposed part of its course, as from its extreme eastern place to near Valenciennes, it had dependent on it, on the north, the productive coal-measures of Westphalia, Belgium, and the north of France. From Valenciennes westwards the coal-measures are not exposed at the surface, but are reached beneath the chalk formation; but from the underground workings at Douay, Béthune, &c., the relation of the several members of the palæozoic series are known to correspond exactly with those where the series is exposed; as is the case also where they are again seen at the surface in the Boulonnais, and at sundry other valleys of elevation along the axis of Artois.

The whole of the coal-measures of Belgium and the north of France must be understood as occupying a trough formed out of the older members of the great palæozoic series, and the explanation given of the preservation of this extended and narrow band of coal-growth surface is that it has resulted from a contraction of the earth's crust in a south to north direction, at some time subsequent to the completion of the palæozoic series (coal-measures included), whereby along this line a series of east and west undulations were produced, in the deepest or most considerable of which, portions of the coal-growth surfaces became included so as to be preserved during the subsequent periods of denudation and removal.

From the consideration of the physical features of a line of country of elevation and disturbance, which crosses the European continental area for 300 leagues, it was inferred that like results were due to like causes here; the line of under-run of the palæozoic strata was conjecturally carried along by where it has just been met with; so it may reasonably be supposed that certain other phenomena which in like manner have resulted from the same disturbances should also correspond, and serve for guidance.

For the present it has not been ascertained in what *direction* the highly-inclined Devonian strata at Tottenham Court Road were dipping, a most important point in the considerations involved. It may safely be supposed that from their position any palæozoic rocks at such place must be trending east and west. The occurrence may seem to be an isolated fact, but there are other inferences which tend to give it importance.

The 653 feet of chalk strata were horizontal, or with only a very slight north dip. The Devonian strata gone through dipped uniformly at an angle of 30°. The section therefore corresponds exactly with those of the north of France.

In Belgium, and the north of France, it is on the *south side* of the palæozoic trough that the high inclines occur, as happens along the whole line from Liége to Trelon. On the north the beds are flatter and spread out wider. From this it may be supposed that it was the north side of the trough which was hit upon at Messrs. Meux's, and that it is a trough at this place follows necessarily from the circumstance that the beds so highly inclined were as low as the Devonian.

Bearing in mind that the whole of this part of Europe we are now considering formed part of the area over which the Devonian or lower carboniferous series preceded or was overlaid by the upper or true carboniferous formations, and that where one occurs the other follows everywhere, the fact of the inclination of the beds at Tottenham Court Road involves this, that the higher portions must soon follow—the mountain limestone on the Devonian, and the coal-measures on the mountain limestone.

This reasoning applies equally whether the Devonian strata at Tottenham Court Road may be dipping north or south, but thus much has been ascertained, that London just overlies the edge of a great coal-field, and the probability is that the coal-field lies to the north.

What seems to suggest that the coal in this direction may have considerable extension is derived partly from a study of the geological features of our own island, and partly from what is the case in Belgium. It is dependent on what was the original form and extent of the coal-growth surface, and on the places at which the greatest amount of contraction and subsequent denudation of the surface took place.

Mr. Whitaker described the deep borings around London, and gave an account of the strata traversed by them. He suggested that some of them should be continued deeper, and thought that in place of a "Sussex boring" or a "Kentish boring" they ought to have a general scheme for investigating the range of the palæozoic rocks. Mr. Lebour suggested that under London (as often occurs in Belgium) the rocks might possibly be inverted or reversed by oblique faults, so that Devonian rocks under certain circumstances might overlie the coal-measures. Mr. Topley, in reply, defended the past action of the Sub-Wealden Committee.

On a New Method for Studying the Optical Characters of Minerals, by H. C. Sorby, F.R.S.—The author first described the principles on which this method depended, and showed that the great difference between the appearance seen with the naked eye and the microscope is due to the object-glass being able to collect divergent rays. In looking with a low magnifying power at a small circular hole seen through a section of a crystal, very different phenomena present themselves, according to its optical

[1] See "Report of Coal Commission," vol. i., pp. 431-432.

characters. If it has no double refraction, only one well-defined circular hole can be seen. If the mineral possess double refraction and only one optic axis, like calcite, two images of the hole are seen. If the section be cut perpendicular to the axis, two circular holes are seen directly superimposed, but at two different foci. If the section be in the plane of cleavage, two widely-divided images are visible, the one due to the ordinary ray being circular, and the other, due to the extraordinary ray being distorted and drawn out in two opposite planes at two different foci. When the section is cut parallel to the axis, this image due to the extraordinary ray is still more elongated, but the images are directly superimposed. We thus at once learn that the mineral has double refraction, has an optic axis, and also what is the direction in which the section is cut. In the case of crystals like Arragonite, which have two optic axes, there is no ordinary ray, and at the focal points we see the circular hole drawn out in opposite planes into crosses. The character of these crosses depends upon the direction of the section, but the fact of the crosses being seen at once proves that the mineral has two optic axes. Some facts are better observed if, instead of a circular hole, we examine through the crystalline plate a grating with two systems of lines at right angles to one another. We then obtain what the author calls unifocal or bifocal images, according to the systems of crystallisation. Crystals without double refraction have only one unifocal image; crystals having one optic axis have one unifocal and one bifocal image; whereas crystals having two optic axes give two bifocal images. The definition of unifocal images is independent of the position of the lines, whereas in the case of bifocal images the lines are distinctly visible only when they are parallel or perpendicular to a particular axis of the crystal, and, spread out, become obscure and disappear when rotated to a different azimuth.

The above-named general characters differ so much in different minerals, that they furnish a most valuable means for their identification.

On the "Great Flat Lode" South of Redruth and Camborne, by C. Le Neve Foster, B.A., D.Sc.—In this paper the author described an important tin lode which is wrought in various places for a distance of three and a half miles. In some places it occurs, for instance at Wheal Uny, at the junction of the clayslate (killas) and granite, but in other mines it lies entirely in granite.

Its characteristics are :—

1. A *leader* of true fissure vein, generally only a few inches wide, and filled with clay, fragments of the inclosing rocks, and tin or copper ores, dipping 30° to 50° S., and striking from 20° to 45° N. or E. (true).

2. The *lode*, from four to fifteen feet wide, on one or both sides of the leader, consisting mainly of schorl-rock, containing grains and veins of tin ore. It yields from 1 to 3 per cent. tin ore.

3. A *capel*, or non-stanniferous or slightly stanniferous schorl-rock, separating the lode from the killas or granite.

4. Absence of any *wall* or plane of separation between the lode and capel, or between the capel and granite. The author said that all the appearances pointed to the fact that the lode and capel are merely altered granite. In confirmation of this vew he explained that he had found cavities in the lode resembling felspar crystals in shape, and probably left by its removal; furthermore the microscopic examination of the capel shows apparently pseudomorphs of quartz after felspar.

If it is admitted that the mass of the "Great Flat Lode," and its capels are altered rocks once containing felspar, we are driven to conclude that that rock must once have been granite, because of the gradual passage of the capel into granite. Supposing this view to be correct, we must adopt a similar explanation in the case of many of the important tin lodes in Cornwall.

The author ventured the opinion that half the tin ore obtained in Cornwall is now derived from altered granite.

On some Tin Mines in the Parish of Wendron, Cornwall, by C. Le Neve Foster, B.A., D.Sc.—The author described the tin deposits of the following mines :—Balmynheer, the Lovell, and South Wendron. The author supposes that the tinny rock is an altered granite, and he brings forward in support of his argument the fact that pseudomorphs of quartz and of gilbertite after orthoclase, are found in the stuff from the Lovell, and that there is a gradual passage from the tin rock into granite.

On some of the Stockworks of Cornwall, by C. Le Neve Foster, B.A., D.Sc.—The author divided the tin stockworks into three classes according as they occur in killas granite or elvan, and then described the mode of occurrence of tin ore at some of the most important

The Carboniferous Limestone and Millstone Grit in the Country around Llangollen, by G. H. Morton.—The author described the carboniferous limestone exposed in the Eglwyseg ridge near Llangollen, North Wales. He stated that the finest section is exposed at the Ty-nant ravine on the bed of Cefn-y Fedw, and that the country around must be considered as the typical area of the lower carboniferous series of North Wales. The millstone grit or Cefn-y-Fedw sandstone, which reposes on the limestone in the same district, was also described. The following tabulation explains the succession and thickness of the entire series :—

Tabular View of the Carboniferous Limestone and Cefn-y-Fedw Sandstone in the Country around Llangollen.

		feet.	
Cefn-y-Fedw sandstone.	Aqueduct grit or upper sandstone and conglomerate	70	Upper Cefn-y-Fedw, Dee Bridge, or millstone grit series.
	Upper shale	30	
	Dee Bridge sandstone ...	30	
	Lower shale with fire-clay and bands of limestone.	18	Middle and lower Cefn-y-Fedw or Yoredale series.
	Middle sandstone	200	
	Cherty shale	50	
	Lower sandstone and conglomerate	250	
	Sandy limestone	75	
Carboniferous limestone.	Upper grey limestone ...	300	Upper carboniferous limestone.
	,, white ,, ...	300	
	Lower ,, ,, ...	120	Lower do.
	,, brown ,, ...	480	
		1923	
	Upper old red sandstone	300	

The following table shows the gradual attenuation of the carboniferous limestone towards the south-east.

Attenuation of the Carboniferous Limestone.

Subdivision.	Ty-nant.	Tan-y-Castell.	Trevor Rocks.	Bron-henlog.	Fron.
Upper grey limestone,	300	300	250	66[1]	88[1]
,, white ,,	300	250	140	99	27[2]
Lower ,, ,,	120	115	117	104	,,
,, brown ,,	480	360	100[3]	26[3]	,,
	1200	1025	607	295	115

This section shows how the limestone diminishes in thickness with the rise of the Wenlock shale towards the south-east. Between the Ty-nant ravine and Tan-y-Castell it has thinned out 200 feet, and at Fron-y-Cysyllte, four miles from the former place, the attenuation is not less than 900 feet.

The list of fossils collected by the author contained seventy-seven species. Of these fifty-eight occur in the upper grey limestone and only eighteen in the lower brown limestone. If the carboniferous limestone is simply divided into upper and lower limestone, thirty-eight species are peculiar to the two upper subdivisions and nineteen to the two lower subdivisions—twenty species being common to both. However, the species are by no means confined to the subdivisions in which they are found near Llangollen, for they occur at different horizons in other districts.

On the Occurrence of Branchipus *or* Chirocephalus *in a Fossil State in the Upper Part of the Fluvio-Marine Series (Middle Eocene), at Gurnet and Thorness Bays, near Cowes, Isle of Wight*, by Henry Woodward, F.R.S.—Mr. Woodward referred to the great interest surrounding the geology of the Isle of Wight from the labours of Ibbetson, Forbes, Mantell, Prestwich, Bristow, and many others, and the rich fauna contained in its strata, much of which still remains to be described, although the stratigraphical geology has been well worked out by the officers of the Geological Survey. Mr. Woodward called attention to a thin band of freshwater limestone occurring at the base of the cliff, belonging to the Bembridge series, from two to twelve inches thick, which at places is full of remains of plants and insects. *Dytiscus*, *Curculio*, *Formica*, &c., and what is most remarkable, the diaphanous bodies of a small phyllopod crustacean, without a hard shelly covering. This little crustacean is closely related to the "Brine-shrimp" (*Artemia salina*), so

[1] Upper portions been denuded.
[2] Reposes on the Wenlock shale.
[3] Base not ascertained with certainty.

abundant in the brine-pans at Lymington at the present day. *Branchipus*, or *Chirocephalus*, is a freshwater crustacean found living in ponds in Devonshire and Kent. Its preservation is due to the admirable nature of the fine argillaceo-calcareous rock, in which it has been entombed in such numbers, the delicate outline of its gill-feet being stained with iron, so as to be as well shown as in a photograph.

SECTION G.—MECHANICAL SCIENCE.

On Compound Turbines, by Prof. Reynolds.—The combination of centrifugal pumps not having hitherto produced the anticipated results, the author had endeavoured to discover the cause of the apparent anomaly, being satisfied that theoretically the increase in the number of pumps should produce a proportionate increase in the quantity of water raised. Properly connecting his pumps, the result was as theory had justified him in expecting; and the reason why others had failed to attain the same end was that the supply of water had not been adequate, and air had got in instead of water.

On the Difference of the Steering of Steamers with the Screw reversed when under Full Way, and when Moving Slowly, by Prof. Osborne Reynolds.—Referring to the Report on this subject the author said the fact that the results which had been established by the Committee were so little known to pilots and seamen, besides being likely to excite surprise, would tend to cast a certain amount of discredit, if not on the truth of the results themselves, at least on their importance. It seemed as if nautical men must have formed their opinions from experience, and such was the faith of the English people in the practical that it was very difficult indeed for them to believe that a few landsmen, calling themselves scientific, could teach sailors how to steer ships. So strong was this feeling that it was to collisions they must look in the hope of preventing collisions. This sounded like a bull, but it was perfectly true, for nothing but disasters would awake our rulers to the idea that something was wrong. Fortunately, or unfortunately, such disasters were not wanting. There were the cases of the *Ville du Havre* and the *Loch Earn*, in which the collisions were undoubtedly due to the steamers having turned in the opposite direction to that intended. These and other disasters furnish evidence enough of the mistakes which had been perpetrated, and of the importance as well as the truth of the results the Committee had established. He fancied that the ignorance which existed was due to the fact that few seamen had turned a ship under full way with the screw reversed, and contented themselves by arguing as to what must happen in such a case from their experience in manœuvring their ships when moving slowly. Of such manœuvres they had had abundance, but as soon as they got beyond their experience, they adopted the seemingly obvious, but entirely erroneous opinion that the way of the ship would cause the rudder to act as if she was going ahead in spite of the screw being reversed. He felt strongly that in speaking thus in a town like Plymouth he ran the risk of being looked upon as impertinent. If he were wrong he was impertinent, and no one would feel it more than he should. It was not a pleasant task to point out imperfections, however accidental they might be. Even if one saw the wheel coming off an omnibus, all the thanks he was likely to get for pointing it out to the conductor was to be asked if he could not tell him something he didn't know. Of course they must learn as they went on, and all he, with deference, asked of seamen was to try the experiments for themselves, and then aid the Committee in bringing facts under the notice of the Legislature. Their own interests demanded this, for as things now were great injustice might be done to the captain who in a case of emergency adopted the very best course to save his ship.

Mr. William Froude thought the question which Prof. Reynolds had so ably dealt with of immense importance, and deserving minute consideration. Having himself had some experience of small steam launches, he had been surprised at the effect produced by the working of the screw, so that he concurred with the conclusion at which Prof. Reynolds individually, and the Committee collectively, had arrived. If sailors would occasionally listen to the advice of outsiders, it would do them no harm. Ignorance as to the effect of reversing the screw upon the way of a ship would often lead a captain into danger which might be avoided.

Sir William Thomson urged that the Committee should be reappointed, so that the Admiralty might have another opportunity of confirming or refuting the conclusions. This was undoubtedly nothing less than a national question, for the conflict now going on between Russia and Turkey proved that skill in manœuvring was of vital importance in torpedo warfare. In olden times the glory of England was maintained by the facility with which her ships were manœuvred, our navy being a match against the navies of all the world in this respect, and he hoped nothing would occur to destroy that pre-eminence.

On the Resistance of Ships, by Mr. William Froude, F.R.S.—The object of the paper was to show the effect produced on the resistance to a ship's motion by the lengthening or shortening of the flat middle body between the bow and stern. The results were based upon experiments made at Chelston Cross with models having the same ends, but different lengths of parallel body inserted amidships. By separating the effect of the frictional skin resistance, which was proportional to the wetted surface, he proved that the increase or diminution of the power required to propel a ship, in consequence of the alteration of the length of the parallel body, depended very largely on the coincidence, or want of coincidence, of the wave crests travelling alongside the ship with the points at which the reduction of breadth by the fine lines began. When this diminution coincided with a wave crest there was no loss, but rather a gain of speed; while when it coincided with a wave hollow the loss of speed, or increase of resistance, was considerable.

The Elevated Railway of New York, by Capt. Douglas Galton.—The first portion of this railroad was completed for steam-traction at the beginning of 1872, and was originally constructed for a rope railway, which did not prove successful. This section consisted of single "Phœnix" columns, nine inches in diameter, spaced from 26 to 30½ feet apart along the axis of the roadway, and carrying two pairs of rolled deck or "I" beams of shallow depth, one pair under each rail. This structure was originally deficient both in vertical and lateral stiffness. The deflections of the girders were too great, and the oscillations of the columns too large. In the next alteration the columns consisted of clusters of round solid wrought iron bears, four and a quarter inches diameter, grouped by two and by four, braced together so as to form a single support, and carrying rolled channel bearers, two under each rail. The bars were bent so as to branch like a Y at the top, the columns composed of two bars forming a bracketed support under the beams, and those composed of four bars giving longitudinal stability to the structure. Although imperfect and needlessly expensive, this style of column might be considered the parent of all subsequent improvements, and to have furnished a valuable hint for future designs. The line was single with sidings to allow trains to pass. Its length, including the sidings, was 7¾ miles, but it was now proposed to double the line throughout and extend it. The atmospheric brake, which was in use upon all trains on the line, placed them entirely under the control of the engineman, and was so effective that a train moving at a maximum speed could be brought to a full stop in a distance barely exceeding its length. The cost of this elevated railway for a double line was estimated at about 55,600*l*. It was simple in construction, and did not much interfere with street traffic in erection; it was very economical as compared with underground railways; it was pleasant to travel on; and it was comparatively free from risks of accident from collision; it was easy of access; the form of locomotive adopted was free from objection, as it was comparatively noiseless and did not appear to frighten horses when passing above them, and on the whole was more free from objection than any other form of road for rapid transit in towns.

Mr. G. Stephenson followed with a similar paper *On a New Safety Suspension Tramway or Light Railway*.

The Importance of giving a Distinctive Character to the Needles Light, by Sir Wm. Thomson, F.R.S.—He urged the necessity of giving a distinctive character to different classes of lighthouses, referring more particularly to the Needles light. He contended that the period of no revolving light ought to be more than half a minute, and stated that the three minutes revolving lights on the Irish coast had been done away with, and periods of a minute and half a minute substituted. To every fixed light a distinctive character should be given. Nine-tenths of our lighthouses had fixed lights, which had the advantage of being continuously visible, but lost the advantage of the great intensity of the revolving light. The distinctive character which he suggested should be given to the Needles and similar lighthouses was similar to the signals invented by Capt. Colomb, but instead of short and long flashes, he proposed to substitute short and long eclipses.

Sir Wm. Thomson read a paper *On an Improved Method of Recording the Depth in Flying Soundings, by substituting Chromate of Silver laid on by Albumen instead of Green Vitriol Solution.*

On the Eddystone Lighthouse, by J. N. Douglas.—He stated that the rock upon which this lighthouse was built had been so undermined by the sea that it had been determined to build another of larger dimensions at a distance of 120 feet from the present structure. He expressed a hope, however, that if Smeaton's wonderful handiwork were taken down, it would be considered worthy of another site on English soil.

On Recent Experiments in Telephones, by Prof. Graham Bell, of Boston.—He stated at the outset that after the lecture delivered by Mr. Preece it would be scarcely necessary for him to put before them a description of the construction and the operation of the telephone in its present form, but he thought it would be interesting if he took up the subject in another light, and showed them the evolution of the telephone, and described to them the process by which the instrument had been brought up to its present state. Having alluded to the fact that it was now some years since his attention was first directed to the form of the vibrations of the air during the production of speech, and having pointed out that he was not aware how the idea of using electricity as a means of conveying these vibrations from one place to another suggested itself to him, Mr. Bell gave an interesting account of the time and labour which he, assisted by Dr. Clarence, J. Blake, Prof. Pearce, and other friends on the other side of the Atlantic, had devoted in endeavouring to discover some means by which the sound of the human voice could be successfully conveyed to whatever place was desired. He gradually traced the progress of these researches, and enumerated the different forms of instruments which had been invented for the purpose of accomplishing the object desired, several of which instruments he exhibited, at the same time explaining that experiments were still being made in Boston with a view to further improvements in, and in the further development of, the telephone. He confessed that he did not yet know which was the best form of instrument that could be used, reminded his audience that he did not bring the invention before them as a perfected one, that it was still in embryo, but expressed a hope that at the next meeting of the British Association he might have the opportunity of producing before them still more perfect forms of the instrument. Prof. Bell then announced that he had brought with him his telephonic organ, and that he should presently attempt to produce a little "bad" music for the benefit of the Association. This organ, he explained, resembled a harmonium or parlour organ. The reeds were all connected with a battery, and in front of each reed there was a little screw with a platinum point. When the instrument was blown the reeds vibrated against the screws, which were all connected with a telegraph wire, which had been brought into that room, and contact being made, the music was thus conveyed. He also explained that the organ was in the Guildhall, and that telegraphic communication had been made between that building and the Post-office, and between the latter place and the room in which they were then assembled. Experiments with the instrument were then proceeded with, the telegraph wire being attached by Mr. Preece to a telephone with a powerful battery and with a somewhat capacious "mouth." Harris, Mr. Preece's assistant, who was stationed at the Post-office, was then communicated with by that gentleman, and told to request the organist to "strike up," and almost immediately the audience were astounded by hearing with perfect distinctness the well-known air, "God save the Queen." The organist was then ordered, through Harris, to play "something with chords," and again the sounds of music were clearly heard, although this time the tune could not be recognised. Another instrument without a battery, was then connected with the wire, but as Mr. Bell had prophesied, the sounds of music conveyed to the audience by means of this instrument were very faint, being audible only to those at the top of the room. The first instrument was now again used, Harris being requested by the professor to sing as loudly as possible. In a second or two the favourite song "Auld Lang Syne" was heard with remarkable clearness, although many of the notes were somewhat "shaky." Harris next read a newspaper paragraph, and although the sound of his voice was distinctly heard, no one was able to ascertain the subject of what he was reading. Prof. Bell explained the reason of this, and informed the audience that the louder the voice was at the transmitting end the more indistinctly it was heard at the other end.

THE FRENCH ASSOCIATION AT HAVRE

THE French Association commenced its Session this year at Havre on August 23. M. Broca, the well-known anthropologist, is president this year, and after a few remarks on the rapid and steady progress of the Association, he announced as the subject of his presidential address, "The Fossil Human Races of Western Europe."

M. Broca spoke of the antiquity of historical nations, showing that it has been very much exaggerated, mainly by the nations themselves, and that even in the case of Egypt the historical epoch cannot be pushed back beyond 6,000 or 7,000 years. M. Broca then showed that up to a very late period man's advent on the earth was universally accepted as very recent, long posterior to the last geological phenomena which have modified the conditions of life and produced changes in climate, and with these in the flora and fauna. The president then gave a brief sketch of the change of opinion which has taken place during the past thirty or forty years, on the question of the antiquity of man; pointed out with what incredulity the accounts of the first finds of human remains under conditions showing their antiquity were received, and that it was only after long years of labour, 1840 to 1858, that Boucher de Perthes at last managed to obtain a serious hearing for the argument in favour of the genuineness of his discoveries and of the antiquity of man. The English palæontologist, Falconer, went to Abbeville, in 1858, in order to examine at once the beds explored by Perthes, and the rich collection of cut-flints and bones which had been exhumed. M. Broca refers also to the early work in the same direction of Prestwich, Evans, Flower, and Lyell, stimulated by whose example, French men of science at last came forward in earnest to examine for themselves. The French Anthropological Society took the matter up, and the prudent and straightforward Isidore Geoffroy St. Hilaire at last declared that the last objections to the antiquity of man had vanished. Fossil man had proved his right to be received on the platform of positive science. The year 1859, which saw the doctrine of the antiquity of man make its way into science with irresistible force, was the beginning of one of the most fruitful of eras. New and boundless horizons were opened to the view of men of science; over all Europe geologists, archæologists, anthropologists, set themselves to work with astonishing activity. Only eighteen years have passed since then, and never, perhaps, in any past time, have we seen so rich a harvest.

Boucher de Perthes raised only a corner of the veil which conceals early humanity. He proved that man lived during all the quaternary epoch, that he was the contemporary of the reindeer and other animals which have since migrated, of the mammoth, and other extinct animals. But was this all? and is humanity not older still? This latter question, still more grave than the former, was soon asked; more grave, for the duration of each of the three periods of the tertiary epoch was incomparably longer than the quaternary epoch. But M. Broca did not intend to discuss the researches concerning tertiary man; the discoveries made by M. Desnoyers at St. Prest, near Chartres, and by Prof. Capellini in several tertiary beds of Tuscany, tend to establish the existence of man during the pliocene period; those of the Abbé Bourgeois in the commune of Thenay (Loir-et-Cher) carry back even to the miocene, *i.e.*, to the middle-tertiary, the existence of an intelligent being who knew how to cut flint, and who could be nothing else than man. But these facts, although collected by thoroughly competent observers, and although accepted after keen discussion by many eminent *savants*, are not yet sufficiently numerous nor incontestable to constitute a definitive proof. Tertiary man is not yet on the platform of science; he holds the place occupied by quaternary man twenty years ago. Will it be given to another Boucher de Perthes to demonstrate with irresistible evidence the existence of tertiary man? That is the secret of the future.

After referring to the vast amount of evidence for quaternary man obtained both in the Old and New World, M. Broca said that he is better known now than many peoples mentioned in history. We know enough to establish with certainty the multiplicity and the great diversity of quaternary races, and although the regions hitherto explored include only Western and a part of Central Europe, we can now, on this little corner of the globe, recognise and distinguish at least three fossil human races connected with two essentially different types. The two types are the dolichocephalic and the brachycephalic—the long-heads and the short or round-heads. Between these are the mesatocephalic.

By dividing the one diameter of the head by the other we obtain what is known as the cephalic index. The dolichocephalic are those whose cephalic index is less than $\frac{4}{5}$ or 77·7 to 100; the brachycephalic are those whose index is greater than the fraction $\frac{4}{5}$ or 80 to 100; the index of the mesatocephalic is between the two. But the variations of the cephalic index are so extended that it appears useful to distinguish two degrees in the dolichocephalic type; the dolichocephalic properly so called are those whose index descends below 75 to 100, the index of the subdolichocephalic being above that limit. So among the brachycephalic, we distinguish these properly so called from the subbrachycephalic, according as the index is above or below the fraction $\frac{5}{6}$ or 83·3 to 100. In consequence of many mixtures of races which have been produced before or during the historic period, these diverse cranial forms exist to-day with a varying degree of frequency among all the populations of Europe. We may conclude with certainty that the peoples of Europe are the issue of several races characterised by very different cranial forms.

After referring to the simple theory of Retzius, M. Broca said that the diversity of the races of Europe does not date from the almost recent era of the Asiatic invasions; it does not date from that long period of polished stone which preceded the introduction of metals, and which succeeded the age of the reindeer; it goes back to quaternary times. More, the dolichocephalic type, far from being the latest comer among us, is the most ancient of all; the migrations and the mixture of races, far from developing it, have only attenuated it; and these brachycephalics, who were formerly considered an autochthenous race, conquered and dispossessed by stronger and more civilised races, have been, on the contrary, foreign invaders, whose slow and progressive immigration modified in a manner as profound as durable the ethnology of Western Europe. They only appeared in the later times of the quaternary epoch. Before them two other races of dolichocephalic type had successively occupied the ground. M. Broca then proceeded to describe the chief distinctive characteristics of these three races, discovered by science after so many ages of oblivion. Names have been given to these three races after the places where their remains have been found, viz., Canstadt, Cromagnon, and Furfooz.

The race of Canstadt is the oldest. Its remains were exhumed so long ago as 1700 by Duke Eberhard, of Würtemberg, at Canstadt, near Stuttgard. These remains were found in the Würtemberg collections only in 1835 by Fred. Joeger, who recognised their importance. But the Canstadt cranium has not been universally accepted as genuine. Six or seven other incomplete crania, some fragments of jaws and long bones, are all that have hitherto been found of the Canstadt race. To these belong the Neanderthal skull and the lower jaw, found by M. Dupont in 1865 in the Naulette Cavern, in the valley of the Lesse, Belgium. The jaw has some very peculiar characteristics, and the Neanderthal skull recalls the form of that of the anthropoid apes. The Canstadt race seems to have been robust, of short stature, probably not exceeding from 1·68 m. to 1·70 m. The crania, though incomplete, show that the Canstadt race was "dolichoplatycephalic," *i.e.*, long-headed, but with the top of the head much flattened. The marked dolichocephaly of the Canstadt race is to be found now only among the Australian and the Esquimaux. The platycephaly was due greatly to the obliquity of the forehead, which rapidly retreated. Although the occipital region was also prominent, yet the cranial capacity was small, and appears to have been smaller than that of the Hottentots and Australians. Other characteristics of inferiority were the prominence of the incisors, the great size of the jaws, the total absence of chin, and the total absence of the alveolar arch. If the skull found in the Forbes Quarry at Gibraltar be of the Canstadt type, as M. Broca is inclined to think, it shows still more marked characteristics of inferiority. The Canstadt race, he concludes, was certainly very savage, more savage than any existing race; its instruments were of the rudest kind, and it had to carry on a painful struggle for existence with the powerful mammals that then disputed the ground with them. Nevertheless its geographical extension was very great; it is found at Brux, in Bohemia; at Canstadt, in Würtemberg; at Neanderthal, in the Rhine provinces; Naulette, in Belgium; Eguisheim, in Alsace, at Paris, Arcy-sur-Cure, in Yonne, Mount Denise, in Haute-Loire, Olmo near Arezzo, Tuscany, and probably at Gibraltar. In Central and Western Europe then it maintained its place from the beginning to the middle of the quaternary epoch, when appeared another stronger and more perfect race which took the place of the former only probably after having nearly exterminated it.

This second fossil race was that of Cromagnon. It takes its name from a cave discovered in 1868, near the village of Eyzies, in the valley of the Vézère, Dordogne. This race, now represented by a score of crania, some almost complete skeletons, and a large number of bones, is comparatively well known. Though dolichocephalic like the Canstadt race, it otherwise differs completely from it. Its mean height was 1·78 m., and one skeleton measures 1·85. Its crania was equal if not superior to that of modern Parisians; forehead straight and high; vertical diameter well developed, and the cranial arch elevated; chin pronounced, and lower incisors vertical. The type as a whole approaches the Caucasian, though the upper incisors project somewhat, and the cheek-bones are high. The Cromagnon race is also characterised by its peculiar bones, its elastic-like femur, its platycnemic tibia, its channelled fibula, its arched cubitus; these characteristics, found now only in scattered individuals and much subdued, are normal to the Cromagnon race, and distinguish it from all modern races. With regard to the great capacity of the Cromagnon skull it should be remembered that among them the weak in intellect as in body would not survive as they do with us; still it shows a highly intellectual race, as is evidenced besides by the highly finished remains of their work which have been found. This race did not extend so far east as that of Canstadt. It has been found in Italy and probably in Britain; but it occupied especially France and Belgium. Its chronology coincides almost with the second half of the quaternary epoch, the age of the reindeer being that of its greatest prosperity. Its decline came with the departure of that animal. Still the race survived in some parts, and mixed with new races, and they have left behind them a lasting anthropological characteristic; even now their peculiarities occasionally appear in obedience to the law of atavism.

The Cromagnon race takes us down to the neolithic period; the Furfooz race leads us back to the reindeer. The latter race was discovered in 1866 and 1867, by M. Dupont, in several caverns on the right bank of the Lesse, near the village of Furfooz, Belgium. Crania, bones, and cave-dwellings have furnished materials for its study. The height of the Furfooz race was only 1·53m. to 1·62m., and descends even to the level of the Lapps. The bones are exactly similar to our own. Its only peculiarity was the elbow-perforation of the humerus, which, however, cannot be regarded as any mark of inferiority. With this race appears for the first time a rounded cranial type, which is not yet true brachycephaly, but which announces the arrival of the brachycephalics. The cranium as a whole is small, especially in its anterior parts; the forehead is narrow, low, and retreating, the vault little elevated, thus placing the race below that of Cromagnon, and nearer that of Canstadt. The face is smaller than the Cromagnon one, cheek-bones less prominent, the orbits narrower and higher, the nasal opening less extended compared to its breadth, the lower jaws smaller and thinner. The Furfooz race arrived in Belgium only at the end of the reindeer age. They lived in caverns and by the chase, but were inferior to the Cromagnons, their art and their weapons and implements being of a much ruder type. But they manufactured pottery, which is not found among the remains of the Cromagnon race, and which would indicate a date a little before the epoch of polished stone. This race was mesatocephalic or subdolichocephalic, and while they lived in Belgium, the true brachycephalics, with indices of eighty-three, eighty-five, and beyond, entered France by the eastern frontier. Their remains have been found at Solutré, in the Mâconnais. The discovery made in the loess at Nagy-Safi, near Gran, in Hungary, proves that the true brachycephalics lived on the Danube at the height of the quaternary epoch. Their immigration, however, belongs to subsequent geological periods belonging to the present geological epoch, and therefore not entering into M. Broca's subject; they may possibly have been modifications of the Furfooz race, by crossing and otherwise.

It is the problem of anthropologists to unravel these different elements as they appear in modern European races; and altogether we have no reason to be ashamed of our remote ancestors.

The Mayor of Havre followed M. Broca with a few warm words of welcome, when M. Deherain, the general secretary, gave a sketch of the work of the Association in 1876. M. G. Masson, the treasurer, made a statement as to the funds of the Association. For the past year its income has been 48,764 francs, and its expenditure 44,181 francs, of which 6,361 francs were given as grants for research. The capital of the Association at the end of 1876 was 210,307 francs.

The bad weather, our correspondent writes, has told upon the

success of the various excursions organised. The uncertainty of public affairs, moreover, has caused the French papers to give the most meagre reports of the proceedings; indeed only the titles of a number of communications are given without any attempt at a report.

On Friday M. Fremy was elected president for 1878 by a full house, and almost unanimously. The place of the next meeting will be Paris in all probability. Consequently an opportunity will be afforded to influential members of the French Institute to give a new impulse to the organisation of the French Association, and to remodel it more fully according to the pattern of its English sister.

A number of members of the British Association arrived at Havre at the beginning of the session, including Dr. Huggins, Prof. Sylvester, Messrs. Glaisher, sen. and jun. It has been regretted that no formal delegation from France was sent to Plymouth, as contemplated, and that no direct request was sent to Mr. Bell to bring over his wonderful telephone.

A committee was appointed at Clermont-Ferrand to report on the position of French meteorology. A report was drawn up pointing out the necessity of memorialising the French Government to establish a special meteorological institute. The report was not adopted by the Meteorological Section, and a new report will be drawn up, and was to be proposed on Monday. But the discussion will offer little interest, owing to the absence of the leading French meteorologists.

The mathematical and astronomical section has been well attended under the presidency of Professors Catalon (Liége University) and Sylvester, the former being acting president and the second honorary.

The Geological Society of Normandy has organised an exhibition of local geology in the old Palais de Justice, which may be considered as a model of care, order, and completeness. A number of large oil pictures have been executed to show the different stages of the evolution of life before the appearance of man on earth, from the age of coal-measures.

M. Gabriel de Mortillet, general secretary to the section of anthropology of the International Exhibition, has delivered a lecture on the organisation of that section. The Trocadero Palace will be devoted entirely to "Histoire de l'Homme." One of the aisles will be devoted to the ethnography of living savage nations, and will be considered as affording a fair representation of primordial ages. The other aisle will be entirely devoted to the history of the arts, which are supposed to represent civilisation in its highest state of development. The central part of the building is devoted to anthropological science, viz., European anthropology, prehistoric anthropology, demography, comparative linguistic, &c. Exhibitors of all nations will be admitted, and all the expenses of the exhibition will be supported by the French administration. The space allotted to foreigners for this exceptional exhibition will not be reckoned as part of the total space granted to their own nation in the Champ de Mars. M. Gabriel de Mortillet, Chateau de Saint Germain, Seine-et-Oise, will answer any letters addressed to him, and give practical directions to intending exhibitors.

The scheme, of which we gave details some time since, has been conceived by M. Krantz himself, who was desirous to see the science of man utilised as an introduction to the exhibition of the works of man.

ENGLISH NAMES OF WILD FLOWERS AND PLANTS[1]

EIGHT years ago I was piloting a famous botanist from the east of England among the fields and lanes round Taunton, when he asked me the name of a plant which he did not at the moment recognise. I answered that it was the gipsy-wort, and received a prompt rebuke. "This is the third time," he said, "that I have inquired the name of a flower, and you have answered me in English. The Latin names are universal, the English at best are local. It is to be wished that all English names of plants could be forgotten, and their scientific names become popularised instead." Unquestionably a foolish utterance, it was of great service to myself, for it set me to consider the real value of these names which my pedantic guest despised, and from that time to this I have never encountered the popular name of any English wild flower without questioning it closely as to its etymological history and meaning, and noting the passages in our literature where it occurs. It would be a great pleasure to me to believe that the knowledge gained by these inquiries, put together to the best of my power, could interest you to-night as much as it has interested myself.

It is no new thing to infer from the terms in use at the beginning of a nation's history the arts and customs of the nation using them. Thus the fact that in all or nearly all the Aryan languages the words for the Supreme Being, for the king, for brother and sister, for ploughing, grinding, building, closely resemble one another, is admitted to show that our common forefathers in times when they were still one people, and had not yet scattered into India, Persia, Europe, had the beginnings of religion and government, possessed the family life, knew the simple arts which are most needed for the comfort of home life. Let us see what light will be thrown upon the habits of our Teutonic forefathers if we apply their method of investigation to the popular names of plants.

The following words are common to all the Teutonic languages; must have been known, that is, to the race from which we ourselves, with the Germans, Danes, Swedes, and Norwegians, are descended, on their first settlement in Europe, and before they broke up into sub-divided nations. The first I will take is *birch*, the rind of which must, we find, have been used for boat-building and for roofing houses; for boat-building, since the word *bark*, from the same root as *birch*, stands for ship in English, Dutch, Icelandic, Danish; for roofing houses, since the Old English *beorgan* and the German *bergen*, also from the same root, mean to cover, protect, or shelter. From this simple word, then, we gather that our ancestors possessed the arts of building boats and of roofing or thatching houses. Houses could not be built without timber; and we find the word *tree* in almost every Aryan language standing for three things—for a tree, for timber, and for an oak, extending the use of oak wood for building purposes back to the first formation in Asia of our mother language, and presenting us with the additional facts that our European ancestors built of oak timber the houses which they roofed with birch. In *hazel* a fresh fact lies buried. It is in all Germanic dialects the instrumental form of *hæs*, command or *behest*, a hazel stick having been used, as Jacob Grimm informs us, in the earliest times as a sceptre or baton to keep order among slaves and cattle. Without dwelling on the fact that the old word *hælsian*, to foretell, indicates the use of the hazel rod for purposes of divination, we have the additional probability revealed in a single word that our remote ancestors possessed slaves and cattle. In *hawthorn*, common to Swedish, German, and English, we have testimony to the use of a haw, *hæg*, *hedge*, or fence, "honouring the holy bounds of property," and consequently to the division and appropriation of land, in the earliest Teutonic time. My next word makes some demand upon your etymological credulity. Without tracing particulars, I will ask you to believe that the Sanskrit *Kshi*, to dwell, passes through various forms in one direction to the English *home*, in another to the word *heath*; now meaning the plant which grows wild on open land, standing originally for the land itself. "My foot," says Rob Roy, "is on my native heath;" and the same idea was enshrined in the same word to the first Teuton settlers. In the forest he fought his enemies, hunted his prey, hewed timber for his fences, and peeled bark for his roofs; his home was in the open land, or *heath*, from which, again, when ages had passed away and Christianity possessed the towns, he still worshipped his father's gods upon his father's heath, and gained, as Trench thinks, his ancient name of *heathen*. A sixth word lifts him higher than all the rest. The word *beech*, in Gothic, Old-High-German, modern German, Norse, Danish, Dutch, English, is identical with *book*, the Runic tablets of our ancestors having been carved upon this wood. In *sloe*, the wild plum, we have the root of *slay*, its tough wood having been used for bludgeons; *dog-wood* is *dagger*-wood, from *dag*, to strike; from *ash*, whose wood was therefore used for spear-shafts, came the Old English *æsc*, a spear; *sedge* is allied to *sæcg*, a sharp small iron sword. And let us observe that while all these plants, bearing purely Teutonic names, extend far into Northern Asia, trees which stop short at a more southern limit—the elm, chestnut, holly, sycamore, plum, pear, peach, cherry—all have Latin names, showing that the Teuton squatters came from a colder country than that in which they are supposed to have settled near the Roman Provincials on the Lower Rhine. The knowledge that wheat, barley, oats, corn, rye, are all Teutonic words, completes the historical picture given by the first list of names. They show us a race of men coming from a northern to a southern region,

[1] Lecture by Rev. W. Tuckwell before the Somersetshire Archæological and Natural History Society.

dwelling in timber houses, roofed and thatched, launching boats upon the rivers, possessing cattle and slaves, recognising the rights of property and the sacredness of home, fighting with cudgels, swords, and spears, familiar with cereal agriculture, in some way not ignorant of letters. All these facts, just hinted at here, but challenging minute investigation, we owe to a dozen common names of English plants, whose Latin equivalents teach and commemorate nothing of any national interest to ourselves.

These names, and a few more, are as old as the English language; but from the Conquest to the sixteenth century botanical inquiry ceased in England, and the rest of our popular names are little more than three hundred years old. Most of these come to us from the Greek and Latin; but some of them are so corrupted as not to be easily recognisable. Any scholar will detect in *acacia* the Greek word for *guilelessness*; in the *amaranth*, with which Milton's worshipping archangels wreathed their brows, the Greek for *unfading*; in the *periwinkle* the *pervinca* used to *bind about* the head; in *lettuce*, the meaning of *milky*; in *geranium*, the descriptive name *crane's bill*. In the *plane* he will see the *Platanus* of the poets; in the *rose*, the *Rhodon* of Homer and the *Rosa* of Virgil; in the *sycamore*, the wild fig of the Bible, transferred in mediæval miracle plays to the tree which now bears the name; in the *vine*, the *oinon* and *vinum*, whose Sanskrit root is still present in our words *twine* and *twist*. He will understand that the *basil* which poor simple Isabel planted in the pot which held her murdered lover's head was the *regal* plant, used perhaps of old in some royal bath or unguent; that the *angelica*, which now flavours our soups, and was once a specific against the plague, was given to mankind by angels; that the *belladonna* was applied as a cosmetic to make ladies beautiful for ever; that the *cyclamen*, which still grows wild in Devonshire, owes its name to its prominent circular tuber. He will not so readily discover that the *tansy* of our cottage gardens is the Greek *athanasia*, immortality, administered to Ganymede that he might become fit for his life in heaven; that the common milfoil *yarrow* is the *hiera*, or holy herb, pledged to heal all herbs with its fragrant leaves; that *nasturtium* means *nose-twister*, from its pungent smell; that our Quantock *whortle-berry* is a corruption of *myrtillus*, *myrtle-berry*; that *eglantine* is *aculenta*, the prickly rose, or sweet-briar; that the herb *Bennett* or *avens*, is the *benedicta*, *blessed* herb, kept in houses to prevent the entrance of the devil; that the *hip* of the dog-rose is a form of the Greek and Latin words which people afflicted with sore throats know as *jujubes*; that *liquorice* is an Anglicism of the Greek *Glycyrriza*, *sweet-root*; that the *larch* is from the Latin *lar*, a *house*, in consequence of its use in building; that *lavender*, from the Latin *lavare*, to wash, was in the twelfth century Scotch and northern English for *washerwoman*, because then as now its sweet spikes were laid amongst fresh linen; that the *service-tree* is the Latin *cerevisium*, *beer*, its leaves having been used to flavour ale before the virtues of the hop were known; that the little *saiinancy-wort* was the ancient remedy for the disease *Kynanché* or *dogchoker*, which we know in its modern sound as *quinsy*; that the *mushroom* is the *muscarius* or *fly-bane*, because a particular agaricus, pulverised and mixed with milk, was used in Southern Europe as we now use the poison called "Keating's Insect Powder." Least of all will our scholar be quick to admit that the *narcissus* owes nothing to the love-sick youth over whom Ovid sung and Bacon moralised, but is connected with the Greek *narkodes*, sluggish, a derivative from *narke*, the torpedo, itself sprung from the Sanskrit *nark*, *hell*; cited by Sophocles (Œd., Col., 682), as crowning the goddesses of Hades; gathered by Proserpine before her wedding tour into the same dark region, because its heavy odour (for by it the ancients meant the hyacinth) blunts the nerves and makes men sleepy and torpid. I can find comparatively few names which we have borrowed from the French. *Dandelion* is, of course, the lion's tooth; why, botanists are not agreed. *Mignonette* is applied by us to a very different plant from that which bears the name in France. *Woodruffe*, known to travellers in Germany as flavouring the pleasant drink called *Maitrank*, takes its last syllable from *roue*, a *wheel*, its verticillate leaves being set like a wheel or rowell on the stone. *Pansy* is *pensée*, thought, from its significance in the language of flowers: "There's pansy," says Ophelia, "that's for thoughts." *Gilliflower* is *giroflée*, from *caryophyllum*, a clove, a name originally given to the carnation, but now transferred to the wall-flower. *Tutsan* is *toute-saine*, the oil in its leaves having made it a remedy for wounds. Most curious of all is *Apricot*, from *abricot*, which at one time I contentedly referred to the Latin *apricus*, *sunny*, ripening as it does on sunny walls. It is, in fact, traceable to the Latin *præcoqua*, *early*, the fruit being supposed by the Romans to be an early peach. The Arabs took the Latin name and twisted it into *al burquq*; the Spaniards altered its Moorish name into *albaricoque*; the Italians reproduced it as *albicocco*, the French as *abricot*, and we get it next in England, curiously enough, as *apricock*, so spelt in Shakspeare's time, and finally as *apricot*.

Many curious bits of myth and history reveal themselves as we excavate down to these old meanings. The *pæony*, or healing-plant, commemorates the Homeric god Pæon, the first physician of the gods, who tended the bellowing Ares when smarting from the spear of Diomed. The *centaury* is the plant with which the centaur Chiron salved the wound inflicted by the poisoned arrow of Hercules. The *ambrose*, or wormwood, is the immortal food which Venus gave to Æneas, and Jupiter to Psyche; the Sanskrit *amṛita* which Kehama and Kailyal quaff in Southey's splendid poem. The *anemone*, or wind-flower, sprang from the tears wept by Venus over the body of Adonis, as the rose sprang from his blood—

αἷμα ῥοδὸν τίκτει, τὰ δὲ δακρυα τὰν ἀνεμώναν.

The *daphne*, *syringa*, and *andromeda* tell their own tales: the last, which you may find in the peat-bogs round Shapwick station, is due to the delicate fancy of Linnæus, who first discovered and named it, blooming lonely on a barren, rocky isle, like the daughter of Cepheus, chained to her sea-washed cliff. The *Juno rose*, or tall white lily, was blanched by milk which fell from the bosom of Juno, the tale being transferred in Roman Catholic mythology to the Virgin Mary and the milk-thistle. The yellow *carline thistle* is named after Carl the Great (in Mr. Freeman's county I must not call him Charlemagne), who, praying earnestly for the removal of a pestilence which had broken out in his army, saw in vision an angel pointing out this plant as a heaven-sent cure. The *herb Robert* healed a disease endured by Robert, Duke of Normandy, still known in Germany as *Ruprecht's-plage*. The *filbert*, though this is disputed, commemorates the horticultural skill of one king Philibert. The *treacle mustard*, a showy crucifer resembling wallflower, was an ingredient in the famous Venice treacle, compounded, as you will remember, by Wayland Smith to treat the poison sickness of the Duke of Sussex. The word *treacle* is corrupted from the Greek *theriacum*, connected with wild beasts, whose blood formed part of the antidote. It was at first made up by the physician to Mithridates, King of Pontus; and is still in many parts of England known as *mithridate mustard*. The *flower-de-luce*, or fleur-de-lys, is the flower of King Louis, having been assumed as a royal device by Louis VII. of France, though legend figures it on a shield brought down from heaven to Clovis, when fighting against the Saracens. It is probably a white iris.

Not a few strange superstitions and beliefs are embalmed in well-known names. The *celandine*, from *chelidon*, the swallow, exudes a yellow juice, which, applied by the old birds to the eyes of young swallows, who are born blind, or have lost their sight, at once restores it. The *hawk-weed* has the same virtue in the case of hawks. The *fumitory*, *fume terre*, was produced without seed by smoke or vapour rising from the ground. The *devil's-bit* is a common scabious, with a premorse or shortened root, which was used so successfully for all manner of diseases, that the devil spitefully bit it off, and for ever checked its growth. The *eyebright*, or *euphrasy*, was given to cure ophthalmia.

> "Michael from Adam's eyes the film removed,
> . . . Then purged with euphrasy and rue
> The visual nerve, for he had much to see."

The *Judas-tree*, with its thorns and pink blossoms, was the tree on which Judas hanged himself. The *mandrake* gathered round itself a host of wild credulities. It was the *atropa mandragora*, a plant nearly allied to the deadly nightshade, but with a large forked tuber resembling the human form. Hence it was held to remove sterility, a belief shared by Rachel in the Book of Genesis, and was sold for high prices in the middle ages with this idea. In fact, the demand being greater than the supply, the dealer used to cut the large roots of the white bryony into the figure of a man, and insert grains of wheat or millet in the head and face, which soon sprouted and grew, producing the semblance of hair and beard. These monstrosities fetched in Italy as much as thirty gold ducats, and were sold largely, as Sir T. Brown tells us, in our own country. It was thought that the plant would only grow beneath a murderer's gibbet, being nursed by the fat which fell from his decaying body: hence it formed an ingredient in the love-philtres and other hell-broths of witches; and, as it was believed that the root, when torn from the earth,

emitted a shriek which brought death to those who heard it, all manner of terrible devices were invented to obtain it. The readers of Thalaba will remember the fine scene in which the witch Khawla procures the plant to form part of the waxen figure of the Destroyer. I have seen the plant growing in the Cambridge Botanical Gardens; it is not uncommon in Crete and Southern Italy; its fruit is narcotic, and its name is probably derived from *mandra*, an inclosed, over-grown place, such as forms its usual home.

The medical beliefs revealed by many names are not less curious than their legendary associations. It was the opinion of the old herbalists or simplers that God had not only provided special plants as a cure for every disease, but had made their curative power evident by stamping them with some resemblance to the malady they were meant to heal; and this faith, known to students of our older botany as the "Doctrine of Signatures," lurks or reveals itself in many an English name. The *lung-wort*, spotted with tubercular scars, was a heal for consumption; the *liver-wort*, liver-shaped in its green fructification, was a specific for bilious maladies; the scaly pappus of the *scabious* for cutaneous eruptions; the throat-like corolla of the *throat-wort*, or Canterbury bell, caused it to be administered for bronchitis; the saxifrage, cleaving the hard stones with its penetrating fibres, was efficient against calculus; the *scorpion-grass*, now known as the forget-me-not, whose flower-spike dimly resembles a scorpion's tail, was an antidote to the sting of that or of other venomous creatures; the *moon-daisy* averted lunacy; the *birth-wort*, *kidney-vetch*, *nipple-wort*, *spleen-wort*, were all appropriated, as their names suggest, according to resemblances, real or fancied. The pretty toad-flax of our walls and hedges owes its name to a strange mistake. Believed to be the cure for a complaint called *buboes*, it received the Latin name *bubonium*. A confusion between *bubo* and *bufo*, which is Latin for a *toad*, gave birth to its present name; and stories were not long wanting that sick or wounded toads had been seen to eat of it and to recover health.

Similar distortions occur in non-medical names; and it is most curious to notice how soon a story springs up or a belief asserts itself in confirmation of the mistaken identity. The common *fumitory*, which we have already noticed, received its name of *fume-terre*, earth smoke, from its causing the eyes to smart and water when applied to them, as smoke does. The meaning was lost as time went on, and was supplied by the belief that it was produced without seed by smoke or vapour rising from the earth. *Buttercup* was said to give colour and flavour to butter, as being eaten by cows, when in blossom, the facts being that it is a corruption of *bouton-cop*, button-head, and that cows eat the grass all round it, but always, if possible, avoid it. *Meadow-sweet* is a corruption of *mead-wort*, *honey-wine plant*, a beverage being still extracted from it by cottagers. *Bullrush* is *pool-rush*, as growing in pools, not in mud; *snap-dragon* is *snout-dragon*, from its shape; *marigold* is *marsh-gold*; *sweet-william* is *œillet*, a little eye; *pink* is the low German *pinksten*, Pentecost, from its flowering at Whitsuntide, the name being transferred first to the colour of the flower, then to a method of working flowers on muslin, called pinking; and so to the sword-stab in a duel, piercing or pinking an adversary as the needle pierced the cambric. *Nightshade* is *night-scada*, soother, or anodyne; *samphire* is St. Pierre, from its love of rocks; *sanicle* is St. Nicholas, the restorer of the three murdered children, from its healing powers; *poplar* comes from the Indian *tepul*, whose leaves when varnished and painted closely resemble those of the large Spanish poplar; *primrose* was anciently the *daisy*, and is called by Chaucer *primerole*, from the old French *primeverole*, the first spring flower; *primerole* was changed to *primrolles*, that to *primrose*, the first rose of spring; and it was not till the sixteenth century that it attached itself to the familiar flower which now bears its name. *Cowslip* is more strange still. It was originally *hose-flap*, and belonged to the mullein, whose great flannelly leaf might well be likened to the flap or skirt of a woollen under-garment. Later on it was transferred to the wild primula of our meadows, and the mistake was stereotyped by the unlucky botanist, who in ignorance of its origin gave the name of *oxlip* to its pretty congener, the *Primula elatior*. The *Jerusalem artichoke* is a sun-flower, not an artichoke; but the tubers resemble the artichoke in flavour. From its Italian name *girasole*, turn to the sun, came Jerusalem; and by a further quibble the soup made of it is called Palestine soup. The *forget-me-not* was originally the *germander speedwell*, whose blossoms, falling off and flying away as soon as it is plucked, gave emblematic force to the name. It was known in the days of chivalry as the "flower of souvenance," and was embroidered into the collars of the knights, a fact still recalled by its German name *Ehrenpreis*, prize of honour. About 200 years ago we find the name given to the ground-pine, *Ajuga chamæpitys*, whose nauseous taste once realised can never be forgotten. Finally it was seized upon by the river-side Myosotis, and forthwith sprung up a charming legend, created obviously to suit its latest identification, how that while two lovers loitered by a lake, the maiden saw and longed for the bright blue flowers, the knight plunged in to get them, but, unable to regain the shore, had yet agility enough to fling them into his lady's lap, and then with a last devoted look and the words "forget me not," sank below the waves for ever.

Many names of plants contain the geography of their origin. The *Canterbury bell* is obvious, so is the *Guelder rose*. The *Alexanders*, a rare plant round Taunton, but growing in great quantities at Blue Anchor, comes from Alexandria; the *candy-tuft*, from Candia; the *elecampane*, from Campania; the *medick*, from Media; the *carraway*, from Caria; the *walnut* or *Welsh nut* from the north of Italy, called Wälsh by the Germans. *Peach* is *Persicus*; *shalot*, *Ascalonicus*; *spinach*, *Hispanicus*; the *damson*, rightly spelt as *Damascene*, tells its own tale, which is less clear in the case of the *Dame's* or *Damascene* violet, a corruption extended and perpetuated, as often happens, by its Latin equivalent, *matronalis*.

All first attempts at classification, etymological or other, leave a large margin of miscellaneous items refusing to be ticketed or systematised; and there remain a few names falling under none of the categories which I have cited, yet too interesting to be omitted. Such is *apple*, retaining its form in the Teutonic, Celtic, Sclavonic, and Lettish languages, and springing apparently from the Sanscrit *ap*, water, which reappears inverted in the Latin *pa* of *Padus*, *po* of *Poto* and *Pomum*, meaning therefore the water fruit or juice fruit. Such again is *daffodil*, the *daffadowndilly* of Spenser and other poets. It is a combination of *sapharoun*, or saffron lily, with *a phodelus*, the old English *affodilly*. With the taste for alliteration often shown in popular names the sapharoun lily blending with the affodilly became by a mutual compromise daffadowndilly, whence daffodilly and daffodil. *Foxglove* is the *fox's glew*, or tintinnabulum, a ring of bells hung on an arched support. *Bedstraw* was a plant much used for couches before mattresses were invented, and a species which when dry yields a pleasant scent is still called *lady's bedstraw*. *Carnation* is *coronation*, its flowers being used as crowns or chaplets, just as *campion* is *champion*, gathered to crown the champions in a tournament. *Cress* is possibly from *cross*, its petals being cruciate; possibly from *crescere*, to grow, in token of its rapid increase. It was used in Chaucer's time under the form of *kers* to express any insignificant quantity.

"Of paramours ne raught he not a *kers*,"

from which comes, perhaps, our vulgar phrase, "I do not care a curse," though a yet ruder parallelism has since been manufactured to confuse its spelling and its etymology. *Nettle* is from *ne*, to spin, indicating that its coarse fibres were used for thread in early times, an idea borne out by Hans Andersen's beautiful tale of the wild swans, in which you remember that the princess was permitted to redeem her brothers from their transformation by weaving them shirts of nettles. *Shamrock* is from an Erse word signifying the *little trefoil*. The story of its theological use by St. Patrick is of modern date, and it has been taken by various writers to represent the *water cress*, the *wood sorrel*, the Dutch *clover*, and the *black medick*. Irishmen are divided in the present day between the two last, which are sold on St. Patrick's day both in London and Dublin. The *snowdrop* is so-called from its resemblance to the large eardrops worn by ladies in the sixteenth century, and represented often by painters of that period. The *tobacco* was the Indian name for the pipe in which the weed was smoked, not of the weed itself; and *potato* belonged at first to a tropical convolvulus, and was transferred by mistake to the well-known esculent. The *gooseberry* was the *cross-berry*, from its triple spine, which frequently takes the form of a cross. The *hollihock* is the *cauli-hock*, *hock* being an old name for the mallow, to whose order it belongs, and *cauli*, meaning cabbage, either from its lofty cabbage-like stalk, or, as in cabbage-rose, with reference to its rich double bloom. The *laburnum* closes its petals at night-fall like a tired *labourer*, and the *ozier* is named from the *oozy* beds which suits its growth.

I bring my list to an end, not because it is exhausted, but for fear my hearers should become so. I have picked only the most suggestive and curious of our many floral names, leaving an

abundant gathering to many gleaners. One branch of the subject I have barely touched, the superstitious practices attaching to many of our wild plants, though not surviving in their names. I have left alone the interesting question of Bible plants, of the hyssop, the juniper, the mustard-seed, the lilies of the field, the burning bush, the shittah, the almug, the gopher, the curiously mistranslated cab of dove's dung, with the light thrown upon their identity by the names given to them in the commentaries in our older translations. Nor can I do more than hint at the rich store of literary allusion to our wild flowers which abounds in all English poets, and the beautiful thoughts suggested to many of them by some particular plant. I should have liked to read you Chaucer's lines upon the daisy, Herrick's on the daffodil, Burns's on the dog-rose, Shelley's on the sensitive plant, Southey's on the holly, Wordsworth's on the lesser celandine, Longfellow's on the compas-plant. I should like to open volume after volume of Elizabethan and of later days; to enumerate and discuss the flowers with which Ben Jonson bids us "Strew, strew the smiling ground;" the "pretty paunce and chevisaunce," of Spenser; the "quaint enamelled eyes" that decked the laureate hearse of Lycidas;" the silver globes of guelder rose" which won the heart of Cowper; the "hawthorn bush beneath the shade" of Goldsmith's lovers; the "slight hairbell" which raised its head, uncrushed by the airy tread of Ellen Douglas. I should like to remind you of the lessons in natural theology which Paley drew from the "little spiral body" of the dodder seed; of the star-shaped shadow of the daisy which Archer Butler showed to Wordsworth, or how Linnæus, when he first saw the wild broom in flower,

> "Knelt before it on the sod,
> For its beauty thanking God."

Above all I should love to turn with you the page of Shakespeare; to read of the grey discrowned head of Lear wreathed with "rank fumiters and furrow weeds;" of Perdita at the shearing feast disparaging the streaked gilliflowers as Nature's bastards; of poor distraught Ophelia distributing her rosemary and herb of grace; of Puck telling how love in idleness was purpled with love's wound; of Titania gently entwining the "female ivy and sweet honeysuckle" round the sleek smooth ass's head of Bottom; of Helena and Hermia, "a double cherry seeming parted, two lovely berries moulded on one stem." For I should lay on you a spell mightier than I can forge myself; I should invoke allies before whom we all bow as the source of our intellectual happiness and growth; I should remind you how the most creative minds have drawn nutriment from these tenants of our hedgerows and hill-sides, and how the knowledge of their lore helps us in its turn to interpret the sweet thoughts and apt illustrations of the poets they inspired and delighted: how, if the aspirations of my Cambridge botanist were fulfilled; if the daisy could become the *bellis*, the strawberry the *fragaria*, the honeysuckle the *caprifolium*, the heather the *calluna*, the parting genius of romance and myth and association and folk-lore would be sent sighing from the domain of botany; and the richest and most attractive of the natural sciences would become the dullest and the most neutral.

In conclusion, let me disclaim all merit of originality in the ideas which have been put before you to-night. I have but attempted to bring together, with the interest attaching to cumulative illustration, conjectures which have been started and discoveries which have been worked out by others. Scattered through the old-fashioned tomes of Coles, Lyte, Parkinson; through the pleasant pages of Loudon, Pratt, Johns; above all in that most valuable work on popular botany which we owe to our Somersetshire naturalist, Dr. Prior, you will find all or nearly all that I have advanced. The flowers were plucked by other hands; mine has been only the *pia dextera* to sort and wreathe them.

NOTES

We greatly regret to record the death of Mr. J. P. Gassiot, D.C.L., F.R.S., which took place on the 15th inst., the opening day of the Plymouth meeting of the British Association, at the age of upwards of eighty years. Sir Wm. Thomson referred to Mr. Gassiot at the concluding meeting of the Physical Section in terms of the highest appreciation. His experiments with the vacuum tubes, an account of which will be found in the Royal Society's publications, extended over many years, and he varied them in very many ways, in order to throw light on the theory of the stratified discharge. Mr. Justice Grove worked a great deal with Mr. Gassiot, who continuously for many years experimented with a battery of high potential, beginning with a battery of 500 water, and ending with 3,500 *Leclanché* cells. He spared no expense or trouble in his own researches, and in making known to Englishmen the researches of continental physicists by the purchase of similar apparatus to that they had employed. At his scientific gatherings one met the eminent men of all nations, and in the early days of the British Association they generally assembled after the meetings at Clapham Common. Before his death he distributed the greater part of his apparatus; much of it was given to the Cowper Street Middle Class School, and his vacuum tubes (in very great numbers) to Mr. Spottiswoode. He was a generous patron of science, and a helper of scientific men. He has munificiently endowed the Kew Observatory and the Cowper Street Middle Class School, and was the founder of the Royal Society Scientific Relief Fund. His untiring activity enabled him to take an active part in the administration of some of the largest public companies, and though in years he lived a very long life, by his activity he may be said to have lived twice as long. He was the intimate friend of Faraday, and most men of eminence in England and abroad; those living will recall, when they hear of his death, the many pleasant and profitable hours spent at Clapham Common.

We learn from a correspondent in Alexandria, under date August 12, that the obelisk is now nearly quite inclosed in its iron casing, and its launch may take place in another fortnight or so. "It is now receiving an outer skin of strong thick planks, to protect the casing from injury when it is rolled down the inclined plane into the sea. Two delicate engineering operations have to be got over before it is ready for the launch. The first is to let down the obelisk on to its bed in the cylinder, and, that accomplished, to complete the riveting of the lower plates, and then let the whole down on to the ground; for at present the obelisk and cylinders are supported above the ground independent of one another. There will be no ceremony at the launch as the state of the sea may prevent the operation at any fixed time; and a calm day will have to be selected. The *fête* will take place when it is ready for sea after being docked in the Great Harbour. It has yet to have a rudder and bilge keels fitted, besides the cabin, wooden deck, mast, sail, &c. It will be painted bright-red and bear the name of "Cleopatra." If met at sea, it may be taken for a torpedo boat, and avoided accordingly. One side, the part which remained undermost, is in beautiful preservation, but other sides are more or less eroded; still, when erected and seen at a distance the hieroglyphs will probably appear more sharply defined than when seen close and in a prostrate position."

Prof. E. S. Morse, of Salem, Mass., is now busy with dredge and microscope in Japan, having fixed his headquarters at Inoshima, seventeen miles south of Yokohama. Recently he ascended one of the highest of the Japanese mountains, about 100 miles from the coast, and found opportunity there for dredging Lake Chiusenji, a body of water 4,000 feet above sea level. Its fauna was ascertained to be quite peculiar. Prof. Morse will return to the United States in time for his usual courses of lectures during the coming autumn and winter; but afterwards, in 1878, he expects to go back to Japan, having accepted an engagement in the Imperial University of Tokio, as professor of biology. He has also projected a summer school of natural history, to be conducted on the coast near the university; his text-book for beginners in zoology is to be translated into the language of Japan, and animals native to that country are to be

substituted for the American ones referred to throughout the volume.

THE *New York Tribune* tells us of a practical application of the telephone. Mr. J. L. Haigh, the contractor for manufacturing the wire for the Brooklyn Bridge, put up a telephone a short time ago, connecting his establishment with the Bridge Superintendent's office. Mr. Cheever, the agent for the telephone in the United States, has lately placed in New York several telephone instruments and wires. One of these connects his office with the Champion Burglar Alarm Company's office at Thirteenth Street and Broadway, using one of their old telegraph-wires, between three and four miles in length, as the medium of communication. Mr. Cheever has another wire running to Broad Street, in communication with an establishment engaged in the construction of telegraph lines. Mr. Cheever is erecting a line for the Clyde Steamship Company from its office in Bowling Green to Pier No. 2, North River, from which its steamships sail. This is a circuitous line, about five miles in length. The piers of the Brooklyn Bridge are also being connected by telephones with the superintendent's office, so that all the movements of the "travellers" in carrying the wires across from pier to pier can be communicated and directed without the use of signal-flags as heretofore. The current of sound in these telephones is carried by a single wire in either direction. All that it is possible to do in ordinary conversation between two people sitting within two feet of each other in a room can be done at the distance of five or ten miles, or even a greater distance, by simply raising the voice and speaking a little slower than naturally. The telephone instruments themselves are very simple, consisting of two wooden tubes, one of which is placed at the mouth, the other at the ear. The extension of these telephones all over the city in place of the electric telegraph is probblay only a question of time.

FROM the *New York Tribune* we learn that the first act of the new College Administration at Amherst has been the purchase of all the Shepard Scientific Collections located in the college cabinets. These collections, the private property of Prof. C. U. Shepard, were removed from New Haven to Amherst in 1847, through the influence of Prof. Hitchcock, and have remained there ever since, receiving constant personal attention from the Professor, and from the College such enlarged accommodations as their growth required. The purchase has been made for 40,000 dollars, or less than half the appraised value of the minerals, the College thereby securing for itself not only all the material necessary for study in this department, but also, to use the Professor's own words, a collection "which, besides being the largest ever formed by one individual, is actually the best now possessed by any college or university in this country or in Europe." The collections are three in number: viz., a mineralogical, a geological, and a meteoric. Of these the first is the most important and perfect, containing specimens illustrative of almost all the species of the twenty-two orders, selected with the utmost skill and appreciation of scientific beauty. The meteoric collection is the fourth for size and value in the world, the three others which outrank it being those of the national museums at London, Vienna, and Paris.

PROF. PIAZZI SMYTH sends to the *Edinburgh Courant* a memorandum from the Edinburgh Royal Observatory, dated at 2 P.M. August 21, in which he states that the 24-hour period then closed had witnessed by far the heaviest rainfall ever recorded there within an equal interval of time, having amounted to no less than 1·940 inches. "This particular storm," the memorandum states," which has been marked throughout by a heavy rain-band in the prismatic spectrum of the daylight, though by no particular fall of the barometer, commenced on August 17 with a veering of the wind from the west towards the east by way of the north, in which easterly position it settled for the four following days, or up to this time, when it has now gone back by the north to the west, and the depths of rain found in the rain-gauge each day have been thus :—

	in.
August 18	0·177
August 19	1·349
August 20	0·794
August 21	1·940

making a total of 4·260 inches in four days; in a climatic position, too, viz., the roof of this observatory, where the mean *monthly* fall throughout the year is only 2·091 inches."

IT is worthy of note in connection with the present exceptionally wet weather in this country that the rainfall in Victoria this season has been below the average, and the weather cold.

A SEVERE shock of earthquake was felt in Melbourne on June 25, at 3.30 A.M.

AS already announced, the fiftieth meeting of German naturalists and physicians will take place at Munich on September 17–22. Among the visitors who have announced their intention to read papers, are Professors Waldeyer (Strassburg), Ernst Haeckel (Jena), Tschermak (Vienna), Klebs (Prague), Dr. G. Neumayer (Director of the German Observatory, Hamburg), Virchow (Berlin), Dr. Avé Lallemant (Lübeck), and Günther (Anspach).

THE British Archæological Association commenced its annual meeting at Llangollen on Monday, under the presidency of Sir Watkins Williams Wynn, M.P.

THE first annual meeting held in Scotland of the Institute of Naval Architects was opened at Glasgow on Tuesday morning, when the members were received in the Corporation Galleries by the Lord Provost. Lord Hampton, the president, spoke of the immense amount of shipbuilding carried on in Glasgow. Papers were read "On Transverse Strains in Ships," by Mr. W. John, and on "Abnormal Influences in the Direct Motion of Steam-Vessels," by Mr. Robert Mansel. The members in the afternoon visited several of the shipbuilding yards in the neighbourhood.

THERE have been just added to the South Kensington Museum six models illustrating the cliff houses, cave dwellings, and lowland settlements met with through the district where the States of Utah, Colorado, Arizona, and New Mexico join. A series of models of the same kind was shown at the Philadelphia Exhibition, and through Sir Herbert Sandford these six have been generously presented by the United States' Government to this country. They are reduced to different scales, the cave dwellings being of smaller scale than the lowland dwellings, since with the former the surroundings are given, while with the latter they are not.

THE Archæological Congress at Kazan was opened on August 12, and will continue its sittings during three weeks. The Congress is divided into seven sections, one of which deals with pre-historic man. The questions to be discussed are of great interest, as well as the very varied archæological exhibition opened in connection with the Congress. Several excursions will be made by the archæologists along the banks of the Volga, and during one of these a *koorgan* (mound) will be excavated

AS we have already announced the Sanitary Institute of Great Britain will hold its Autumn Congress at Leamington from October 3 to 6. The president will be Dr. B. W. Richardson, who will open the Congress with an address on the evening of the 3rd. Other addresses will be given on the 4th and 5th, and among other papers to be read will be one by Surgeon-Major de Chaumont on "The Effects of Climate upon Health," by Mr.

W. Eassie, C.E., on "The Influence of Vegetation on Human Health," and by Mr. A. Haviland on "Geography of Disease in Relation to Sanitary Science." There will be an exhibition of sanitary apparatus, appliances, and articles of domestic use and economy, in the Drill Hall, Leamington, from October 3 to 18, in connection with the Congress.

RUSSIAN papers announce the return to Kuldja of Col. Prshevalsky. He has brought with him very interesting zoological collections, the most important of them being the skins of three wild camels.

PROF. WAGNER is engaged now in the organisation of zoological stations on the White Sea. One of these will be organised on the shore of the Anzerski Strait, the other on Cape Orlovsky, and the third on the Sviatoi Nos.

MESSRS. W. AND A. K. JOHNSTON have published a small pamphlet from the pen of Dr. Andrew Wilson, on the Colorado beetle (*Doryphora decemlineata*), with an excellent and much magnified coloured representation of the insect, and another of *Doryphora juncta*, "the Bogus potato-bug" of the colonists. An account is given of the structure and habits of the species, together with the most successful methods that have been employed for its destruction. Why *D. juncta* is depicted on the outside of the paper with the heading "The Colorado Potato Beetle" just above it, we are at a loss to comprehend. It is misleading, to say the least. We have also received from Messrs. Routledge a reprint from one of the Reports of Mr. C. V. Riley, the State Entomologist of Missouri, on the Colorado beetle, and from Mr. Stollwerck, of Cannon Street, a very successful model of the beetle at its various stages in a neat little case. The model has been made by Stollwerck Brothers, of Cologne, by order of the German Government, and has been widely distributed all over the country, in schools, &c.

WE notice an interesting report, by M. Kamensky, on the cotton-tree culture in Turfan, read at the last meeting of the St. Petersburg Society for the Protection of Trade.

FROM the *Twenty-third Annual Report* of the Brighton and Sussex Natural History Society we are pleased to see that the society is in a state of continued prosperity. The report contains many papers read at the society's meeting, most of them scientific, and many of them interesting and valuable. An equally satisfactory account of progress is given in the *Ninth Annual Report* of the Eastbourne Natural History Society, which also contains a number of interesting papers read at the meetings.

WITH reference to Galileo's claim to be the inventor of the telescope, M. Wolf quotes (*Annalen der Physik und Chemie*) from a manuscript of Scheiner (1616) in a library in Zurich, a curious passage, of which the following is part: "It must be allowed first, considering what the telescope does, that Baptista Porta has better right to be thought the inventor, because he describes, after his own way, in obscure words and puzzling expressions, an instrument like the telescope. But secondly, if we speak of the telescope, as it is now used after general perfection, we must say that neither Porta nor Galileo is the first discoverer of it, but the telescope in this sense was discovered in Germany, among the Belgians, and that accidentally by one Krämer, who sold spectacles, and either for amusement, or experimentation, combined concave and convex glasses, so that with both glasses he could see a quite small and distant object large and near; at which success being rejoiced, he united several similar pairs of glasses in a tube, and offered the combination at a high price to wealthy people. Thereafter they (the telescopes) became gradually more common among the people, and spread to other countries. In this way two of them were brought for the first time by a Belgian merchant to Italy; of these, one remained long in the college at Rome; the other went first to Venice, later to Naples; and here the Italians, and especially Galileo, at that time Professor of Mathematics in Padua, took the opportunity of improving it, in order to apply it to astronomical purposes, and extend its use further. Thus the telescope, as we have it to-day, was discovered by Germany, and perfected by Italy; the whole world now rejoices in it."

EXPERIMENTS have recently been made at Dortmund, on the Cologne-Minden Railway, with a newly-invented steam-brake, and on the whole they were crowned with success. A railway train travelling at full speed was brought to a standstill in the remarkably short time of twenty seconds, and the inventor is confident to be able to reduce this time to eighteen seconds.

WE have received the programme of the St. Thomas Charterhouse School of Science for session 1877-8, which commences on September 29. It is as well arranged as before, and we notice that another series of Gilchrist Lectures will be given this winter, by Dr. B. W. Richardson, on physiology. One of the subjects to be taught this session is "advanced and elementary physiography."

THE *New York Tribune* of August 10 and 11 devotes about six columns, with illustrations, to a description of the contents of the Peabody Museum, Yale College. Why does not some enterprising English "daily" try, by a similar experiment, whether the English public is ripe for such reading?

THE property of certain salts of cobalt (such as the chloride) to assume a blue colour in dry air and to change to pink during moist weather, has lately been utilised for ladies' hats and bonnets. An enterprising *marchand de toilettes* at Paris has added to his "nouveautés" artificial flowers covered with the salts in question, and christened them "barometers." "Hygrometers" would perhaps be more correct, but then the barometer is the old established weather prophet of the enlightened millions.

THE law deduced by Baer from observation on Russian rivers, regarding influence of the earth's rotation on the form of river banks and beds, has received confirmation by various observers since. The attention has been almost exclusively directed, however, to rivers flowing in meridian direction. And a like remark applies to investigations of the pressure arising from the earth's rotation on one of the rails in railways. In a recent paper to the Vienna Academy, M. Finger enlarges the problem beyond this and other limitations, studying the influence of the earth's rotation on movements (especially of rivers and winds) in any paths parallel to the *spheroidal* (not *sperical* surface of the earth. One surprising result is, that even when the azimuth of the direction does not vary, the lateral pressure to the right is not (as the adherents of Baer's law suppose) greatest for a motion along the meridian, nor has it the value indicated by the law for all azimuths, but it depends on the value of the azimuth, and, with conditions otherwise equal, it is greatest for a motion towards the east, and least for a motion towards the west. With regard to vertical pressure of a body moving along the earth's surface, M. Finger finds that in consequence of the earth's rotation alone, even if the temperature and vapour conditions did not vary, there would be an influence of wind-direction on the state of the barometer, small, indeed, but in the case of strong winds by no means to be negleted, so that a higher barometer would correspond to the east winds, a lower to the west.

A REGISTERING "physiological balance" has recently been devised by M. Redier, at the instance of M. Grandeau, for an agronomic station, its object being to represent in curves the gains or losses of weight of any matter (soil, plant, animal, &c.) placed in one of its scales. With three of these instruments

(one carrying bare soil, another a plant in the same soil exposed to air, and the third a similar plant, but with its stem passing up through a covering obturator), and with a dry and a wet registering thermometer, M. Grandeau hopes to be able to settle some important questions relating to quantity of water required by a given species, transpiration, quantity of evaporation from ground under various conditions, &c.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss Gover; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. G. B. Southern; a Sœmmerring's Antelope (*Gazella sœmmerringi*) from Abyssinia an Arabian Gazelle (*Gazella arabica*) from Arabia, presented by Capt. F. Cotton; an Emu (*Dromœus novæ-hollandiæ*) from New South Wales, presented by Mr. F. Green; a Slender-billed Gockatoo (*Cacatua tenuirostris*) from South Australia, presented by Major M. Pasley, R.A.; Crested Ground Parrakeet (*Calopsitta novæ-hollandiæ*) from Australia, presented by Mr. Salisbury Baxendale; a Purple-faced Monkey (*Semnopithecus leucoprymnus*) from Ceylon, deposited.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale des Sciences de Belgique, No. 3. On the pension-fund of widows of officers of the Belgian army, by M. Liagre.—Some curious examples of discontinuity in analysis (continued), by M. Plateau.—Reply to M. Terby's criticism on the map of Mars, published in the *Terres du Ciel*, by M. Flammarion.—Theorem on the Arquesians, by M. Saltel.—Applications of the method of analytical correspondence and of the law of decompositions to certain left curves, by the same.—Observations at Rome on the magnetic needle and the solar spots during 1875, by Abbé Spée.—Microscopic researches on the anatomy of the cochlea of mammalia, by M. Nuel.

No. 4.—On the theory of continuous periodic fractions, by M. Le Paige.—Studies on the planet Mars (10th notice) by M. Terbe.—Continuation of theorems on regular polygons, by M. Reynemund.—Fragment of tourmaliniferous rock from pudding-stone of Bonsalle, by MM. Poussin and Renard.

No. 5.—Application of the rhe-electrometer to the lightning-conductors of telegraphs, by M. Melsens.—Some remarks on the winter of 1876-77; periodicity of mild winters and hot summers, by M. Lancaster.—On subnormal polars and radii of curvature of plane lines, by M. Ghysens.—Morphology of the dental system of human races, by M. Lambert.—Stratigraphic arrangement of fossil seals collected in the strata of Antwerp, by M. Mourlon.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, August 1.—Mr. J. W. Dunning, F.L.S., vice-president, in the chair.—Mr. Stevens exhibited specimens of *Teretrius picipes*, Fab., one of the *Histeridæ* taken on a fence at Norwood. He also remarked on the appearance of a second brood of *Colias Edusa*, of which he had observed several males.—Mr. F. Smith exhibited (on behalf of Dr. Bennett of Sydney, who was present at the meeting), a fine pair of the beautiful and rare *Eupholus Bennettii*, Gestro., from Yule Island, New Guinea. It had been described under that name in the *Annali di Mus. Civ. di Genova*, viii. 1876.—The secretary exhibited a specimen of an insect forwarded to him by Mr. Bewicke Blackburn, who stated that a large field of mangolds belonging to the Knight of Kerry, in the island of Valentia, had been totally destroyed by it. It was believed to be the larva of some Coleopterous insect, but in consequence of the imperfect condition of the specimen, it could not be determined.—Mr. R. A. Ogilvie forwarded (through Mr. Douglas), specimens of an insect found in great quantities in a jar of pickles (piccalilly), devouring the pieces of cauliflower in the jar. Prof. Westwood had pronounced them to be the dipterous *Drosophila cellaris*, an insect commonly found in cellars and cupboards, delighting in stale beer, wine, &c. In answer to a question asked by Mr. Ogilvie, he said that the eggs were laid in the pickle-jar, and not in the cauliflowers before they were pickled.—Mr. Douglas also forwarded a letter from Mr. A. H. Swinton, of Guildford, inclosing a specimen of *Myrmica ruginodis*, which, on being placed under a wine glass, stationed itself near the rim, head downwards, and rapidly vibrating the abdomen, continued "an intense noise," resembling the spiracular piping of the dipteron, *Syrilla pipiens*.—Mr. Enock remarked that a specimen of a spider taken by himself at Hampstead, and exhibited at a previous meeting by Sir Sydney Saunders as *Atypus sulzeri* had been since submitted to the Rev. O. Pickard, Cambridge, who stated that it was certainly not *A. sulzeri*, but probably *A. beckii*, Cambridge, which he believed to be the same as *A. piceus*, Thorell, though he was not certain as the only specimen he had examined of *A. beckii* was a female, and until he could obtain the other sex, he could not give a decided opinion. He added that he would be glad if collectors in the Hampstead locality would search for the males during the next autumn and winter, as it would help him to clear up the difficulty as to the species. A discussion then took place with reference to the exhibition by Mr. Jenner Weir, at the last meeting, of a specimen of *Cicada montana*, which was reported to have been distinctly heard to stridulate, notwithstanding that the insect was a female, and also that the species was one of which even the males were not known to stridulate. Mr. Weir stated that he had, since the last meeting, again visited the New Forest, and had seen in the possession of Mr. James Gulliver two specimens of *C. montana*, and he was assured by Mr. Gulliver that the fact of it stridulating was well known to him, and that he was guided by the sound so made, in effecting the capture. Mr. Champion said that he himself had captured the insect, and had distinctly heard a loud buzzing noise, but whether that sound was caused by the males or females he could not say. Mr. Dunning considered that farther evidence was wanting to prove stridulation in the females.—The following papers were communicated, viz.: Notes on the new and rare species of *Sphingidæ* in the Museum of the Royal Dublin Society, with remarks on Mr. Butler's recent revision of the family, by W. F. Kirby.—Descriptions of new genera and species of *Cryptocephalidæ*, by J. S. Baly.—Descriptions of new species of *Cleridæ*, by the Rev. H. S. Gorham.

GENEVA

Society of Physics and Natural History, May 3.—Prof. Plantamour gave the results of the determination of the difference of longitude between the observatory of Zurich and the geodetic stations of the Gäbris (Canton Appenzell), and of the Pfänder (Austrian Vorarlberg), at which he has worked with MM. R. Wolf and Oppolzer. The two last observers have had to guard against the influence of the electric register on the rate of their pendulum, which was sometimes affected to the extent of one-tenth of a second.—Prof. Plantamour also referred to a particular fact which has been manifested by the corresponding observations made by him at Geneva, and by Col. Orff at Munich, and where the instants marked are influenced by the inclination to right or left of the head of the observer, according to the position he must take to apply his eye to the telescope. There is here a physiological or psychological phenomenon which deserves attention.

VIENNA

Imperial Academy of Sciences, June 14.—Action of bromine on phloroglacin, by M. Benedikt.—On the means of acid formation in the animal system, and on some phenomena of blood-serum, by M. Maly.—A new proof of Pohlke's fundamental proposition, by M. Pelz.—On a proposition relating to the theory of the higher equations, and on development of the root expression of a quadratic equation, by M. Zimels.—Testing of a method for determination of the water in silicates, by M. Sipöcz.—On formation of pimelin acid in action of a mixture of hydroxide and cyanide of potassium on bromide of amylene, by M. Bauer. The Cœlenterata, Echinodermata, and Worms of the Austro-Hungarian North Polar Expedition, by M. Marenzell.—On the spots in the xylema of leafy and resinous trees, by M. Kreuz.

June 21.—Orthoptera of Senegal, by M. Krauss.—On the probable connection of the wind with the period of sun-spots, by M. Hornstein.—On the determination of the value of a circle by an immediate method, by M. Georgievicz.—Observations on the nerves of the cornea and their vessels, by M. Königstein.—On the influence of the earth's rotation on the movements of any kind parallel to the earth's spheroidal surface, especially the currents of rivers and winds, by M. Finger.

July 12.—On the fresh-water fishes of South-Eastern Brazil (4th part), by M. Steindachner.—On the recurrence of two different kinds of bundles of vessels in the kidneys, by M. Drasch.—On the compounds of the camphor group, by M. Kachler.—On the substances besides anthracene occurring in crude anthracene, on carbazol, and on the behaviour of camphor to hydrate of chloral, by M. Zeidler.—Theory of the functions $C_{\nu_{11}}(x)$, by M. Gegenbauer.—On intermediate cells in the large antheridium cell of the pollen grain of some Coniferæ, by M. Tomaschek.—On the properties of dialysed egg albumen, by M. Laptschinsky.—The volcano of Monteferru, in Sardinia, by M. Doelter.—On a relation corresponding to the linear differential equations of the second order, by M. Winckler.—On the light line in the prism-cells of some seed envelopes, by M. Junowicz.—The Salse of Sassuolo, the origin of aptychous lime, and the Mediterranean flora in its relation to the bottom deposits, by M. Fuchs.—The stand-aneroid barometer, by M. Schell.

July 19.—On the chemical reaction of the visual nerves and the retina, by M. Chodin.—The fossil flora of Parschlug in Steiermark, by M. v. Ettingshausen.—On the orbit of the Loreley (165), by M. Gruss.—The development of the embryo of *Asplenium Shepherdi*, Spr., by M. Vouk.—On idryl, by M. Goldschmidt.—On the behaviour of some resins and resinous acids in distillation over zinc powder, by M. Ciamician.—On derivatives of isatin, by M. v. Somaruga.—On cinchonin, by M. Skraup.—Action of water on haloid compounds of alcohol radicals, by M. Niederist.—Action of nitric acid on trimethyl carbinol, by M. Haitinger.—Action of weak affinities on aldehyde, by M. Lieben.—Researches on fluorescence, by M. Mach.—Tenacity and elasticity of vegetable textures and organs, by M. Wiesner.—Analysis of the sulphur springs at Baden, near Vienna, by M. Kretschy.—On the spectra of the chemical elements and their compounds, by M. Ciamician.—Contributions from chemical laboratory in Brunn.—Influence of temperature on galvanic conductivity of liquids, by MM. Exner and Goldschmiedt.—Behaviour of taurine in the system of birds, by M. Cech.—On peculiar products of mykotic keratitis with the reaction of amyloid, by M. Frisch.—On heat conductivity of cotton, wool, and silk, by M. Schuhmeister.—Anatomy of the optic thalami and neighbourhood, by M. Schnopfhagen.—On the laws of nerve-excitation, by M. Fleischl.

PARIS

Academy of Sciences, August 20.—M. Peligot in the chair.—The following papers were read:—Meridian observations of small planets at the Greenwich and Paris observatories, during the second three months of 1877, communicated by M. Leverrier.—Observations on a recent work of M. Hebert, relative to the exceptional winter of 1876-7, by M. Faye. The phenomena are attributed by M. Hebert to a succession of strokes of sirocco with descending whirling motion, which have communicated the heat and drought characteristic of them. Forty-one distinct gyrations were observed in December alone. The sirocco stroke, which caused the very mild dry weather in the beginning of the year, belonged to three great cyclones which came, like all the others, from the Atlantic.—Examination of documents relative to a scientific expedition to Peru in 1735 to 1743, by M. De la Gournerie. The documents contain what is perhaps the first reference to platina, also references to M. Bouguer's celebrated memoirs, on attraction of mountains, not known till ten years afterwards (1749).—On an example of reduction of Abelian integrals with elliptic functions, by Prof. Cayley.—Properties common to supply pipes, canals, and rivers, with uniform *régime* (continued), by M. Boileau. The influence of resistance of the walls on the decrease of velocity of the liquid sheets (starting with the principal liquid thread) is proportional to the square root of the intensity of this resistance.—The plague in 1877; third reappearance in Bagdad; two centres of origin in Persia; by Dr. Tholozan.—Results obtained by application of sulphide of carbon to vines attacked by phylloxera, by M. Allies.—Discovery of a new planet by Mr. Watson (telegram from Mr. Joseph Henry).—Discovery of two satellites of Mars by Mr. Hall, at Washington, by Mr. Henry.—On a stellar system in rapid proper motion, by M. Flammarion. The stars in question (which are considerably apart) are 7510 B.A.C. and 2810 Σ (the second is double). They move in the same direction and with nearly the same velocity, which exceeds much the ordinary average of proper motions. The direction of motion is nearly opposite to that of the sun's translation in space.—On the characters of flames charged with saline powder, by M. Gouy. The observations seem to show that there is at the base of the flame a very thin layer, where the temperature is much higher than in the flame itself.—Researches on the chromates, by M. Etard.—Cerebral anæmia and congestion produced mechanically in animals, by attitude or by a gyratory movement, by M. Salathé. Rabbits kept in a vertical position, with head up, showed, after some time, symptoms of syncope, also convulsions. Respiration and heart-beats finally ceased. Reversal of position quickly restored the animal. Centrifugal force (the animal being rotated on a board) gave much more rapid cerebral anæmia or congestion, according as the head or feet were towards the centre of the board's motion. While it took about ten minutes to produce death by cerebral anæmia thus, it generally took at least double to produce it by congestion.—On the coloration of the optic elements in the *Locusta viridissima*, by M. Chatin. There is a considerable similarity to the same parts in crustacea.—Phenomena which accompany metamorphosis in the *Libellula depressa*, by M. Jousset de Bellesme. It is by swallowing air and storing it in its alimentary canal that the Libellula obtains the force necessary to accomplish most of its transformations (displacement of the wing, &c.). The mechanism is probably general in this class of animals.—Observations on falling stars of the month of August, by M. Chapelas. The number observed is the smallest since 1837.—On the heat which may be liberated by movement of meteorites through the atmosphere, by M. Govi.—The upper Devonian limestones of the north of France, by M. Gosselet.—On the physiological balance and its applications, by M. Grandeau. This instrument is to represent by curves the gains or losses of weight of any matter (soil, plant, animal, &c.), placed in one of the scales. M. Gosselin submitted for inspection a new *densimeter*, consisting of a small wooden rule suspended by a wire connected to a non-central point in it. A certain weight is placed at the end of the longer arm, and a piece of the body to be examined is hung from the shorter arm so as to give horizontal equilibrium. Then this piece is immersed in water and the weight on the longer arm is displaced till equilibrium is restored. The weight then indicates the density by its position on the scale.

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