THURSDAY, OCTOBER 5, 1876

THE WOUNDED IN SHOOTING

SOME time since a well-known public writer excited the surprise and anger of a large portion of the community by vehemently protesting against the amount of animal suffering caused by field-sports, and a long and rather bitter controversy ensued. Mr. Freeman's remarks were, if we recollect right, limited to "hunting," in the conventional sense of the word—that is, the chase of the fox or the hare with hounds, and many estimable persons were not a little shocked to find themselves accused of having, nearly all their life-time, been committing the grossest cruelty. Whether the principles and practice of humanity sustained any benefit by this fierce attack, whether the attack was made in the best possible taste, and whether in making it Mr. Freeman did not overlook a very important consideration (of which, by the way, we are not aware that any of his opponents took advantage), are questions we do not here propose to discuss. We are now led to make a few calculations based on the returns contained in the Eighteenth and last Report of the Board of Inland Revenue of the number of persons who take out licences to kill what the law calls "game" and to carry a gun. This Report (which we may observe is one presented to both Houses of Parliament, and can be obtained by anybody at her Majesty's Stationery Office for the small sum of sixpence) is undated, but refers to the financial years 1873-4, and 1874-5. That for the past year (1875-6) is not, we believe, published, or we would gladly avail ourselves of it. However, in the Report before us it stands that, in the year 1873-4, there were, 132,036 holders of gun licences and 65,846 holders of licences to kill game. In the year 1874-5 the corresponding numbers were 144,278 and 68,079. It would not be easy to estimate the number of "head" slain by these persons, but there is no reason why, for our present purpose, we should attempt to do so. The beast or bird killed by the gun generally dies as speedy a death as can possibly be inflicted, and the tenderest and most sentimental of hearts cannot complain on the score of humanity *quoad* the victim. But how about the wounded—which everyone knows to be many? Is it possible to estimate their number? We think it is; but let us premise that in making the computation we have no desire to harrow the feelings of our readers by a sensational description of the miseries which an animal may suffer from the lodging of one or many pellets of shot in any part of its body. In some cases they may be frightful, in others productive only of a slight degree of pain, hardly amounting to more than personal inconvenience; but in striking the balance we may, on the whole, assume that acute pain, enduring for some hours or days, is suffered by every beast or bird which the shot strikes, and the shooter does not "bag." Now as to the number of these wounded.

Recalling our own shooting days, we should say that a man must be an uncommonly good and careful shot who does not on an average wound without "bagging" more than three head of game each day that he takes the field. Many men will "lose" that number every day, and by "losing" a bird, a hare, or a rabbit, we mean that it has fallen to the gun or been hit hard enough to insure its capture, had not the retriever, the scent, or the marking been bad. But such cases bear no proportion to the numbers (of grouse or partridges especially) that are hit but not hard enough to be counted "lost." They are seen to flinch as they are struck, but that is all; away they go, whether to the next hill-side, into the next field, or much further, no one asks, and no one thinks more about them. *À la guerre comme à la guerre.* Now supposing that all who shoot game are good and careful shots, we should have on our estimate each shooter wounding his three head per diem irrespective of what he brings to bag. But all shots are neither good nor careful, therefore we think our estimate cannot be too great, and we have also to take in cases of what may be called extravagant shooting, where the numbers of wounded must transcend any ordinary computation.[1]

We have now to reckon the number of days that each holder of a game licence may be supposed to shoot. The shooting season begins for grouse on August 12, for partridges on September 1, and for pheasants on October 1. As we do not wish to be guilty of any exaggeration, but only to strike a fair average, let us take the partridge-shooting season, *i.e.*, from September 1 to February 1, inclusive.[2] Herein we have twenty-one weeks. It does not seem an immoderate assumption to suppose that each holder of a licence to kill game goes out on an average two days a week during that time. There are, no doubt, many men who get no more than two days' shooting throughout the whole season and yet take out a licence; but there must be at least as many, if not more, who are not so conscientious and run the risk of shooting for the whole season without paying the duty. The Commissioners in this very Report say (p. 18) of the Game Licence, that "while it is used by game preservers as a means of punishing poachers, there can be no doubt that among persons of a higher station in life it is very largely evaded." Then there is a very considerable number of inveterate sportsmen who go out day after day throughout the whole season—to say nothing of the grouse shooters who, as most of them pay highly for their moors, unquestionably shoot every day they can for a month or six weeks. Therefore taking the partridge season as a basis, we think that our assumption of an average of two days a week for those twenty-one weeks is not excessive This will give an average of forty-two days of shooting for each of the 65,846 holders of licences to kill game in 1873-4, and of the 68,079 in 1874-5. Now we have already shown the likelihood that each of them wounds on an average three head of game *per diem*, we therefore multiply both of these numbers by 126 ($= 42 \times 3$) and we find that in the former of these two years there must

[1] One such very recent case we may cite from the columns of a contemporary (*The Field*, Sept. 23, 1876). In nine days, between the 1st and 15th of September, inclusive, of this year, the Maharajah Duleep Singh, on his estate at and near Elveden, killed to his own gun 2669 head of game, of which 2530 were partridges. This is vouched for by his Highness's head-gamekeeper. It is true that there is only one Elveden and one Maharajah in this country, and that the fact of its being communicated to a newspaper shows that both master and man thought the slaughter rather remarkable; but instances which approach it are not altogether unknown.

[2] The Report on which we base our calculations is in one respect defective, since it does not separate the respective numbers of holders of licences for the entire year or for the half-year. Judging, however, from the amounts of duty charged, the latter are about one-fifth of the whole. The majority of them are supposed to be chiefly schoolboys, and, as they are learning the art, they may be justly considered clumsy performers with the gun, wounding more than the average of adult shots.

have been 8,296,496, and in the latter 8,577,954 animals left wounded.

Then with regard to the holders of gun licences. It does not seem an excessive estimate to suppose that each wounds on an average two animals (birds, almost exclusively, in this case) a week throughout the year of fifty-two weeks. A great proportion of holders of these licences no doubt do not exercise their privilege every week. Many of them do so only with the object of protecting their crops; but the season for fruit and garden vegetables goes on all the summer, say from May to September, and the harvest lasts six weeks, while for some three weeks before that begins the corn is ripening, and is then most attractive to sparrows. A single shot into a flock of sparrows will wound many more than it kills, and such shots, as our ears tell us, are frequent during the day. It does not seem possible to place the average number of birds wounded by each holder of a gun licence lower than we have done. We have therefore to multiply the number of holders by 104 (= 52 × 2), and then we find that in 1873-4 there must have been 13,731,744, and in 1874-5, 15,004,912 animals left wounded by this class of persons.

Adding the two sets of numbers, we have a grand total for the former of these years, 22,028,240, and for the latter, 23,582,866 wounded; while this increase of over 1,500,000 in one twelvemonth forbids our supposing that the next Report would show much, if any, diminution.

Just as before we purposely abstained from distressing our readers by dwelling on the effects of all this wounding, so now we purposely abstain from using any strong language, or calling those who shoot by bad names. This is not meant to be a sensational article. We are sure in our own mind that sportsmen are not by nature cruel—very far from it. Yet, if we may trust our figures, here are the plain facts that acute pain of uncertain duration was, in the year ending March 31, 1874, inflicted upon *over twenty-two millions* of animals, and in the following year upon *over twenty-three millions and a half* in the British Islands. We are not aware that we possess any bias that would make us exaggerate our estimates to produce these results. Our only object is to attempt as near an approximation to the truth as we can. The figures stand for themselves, and if anyone thinks he can furnish fairer averages let him give his *data* for them. We are, as it is, willing to guard against any unconscious exaggeration and to knock off more than 10 per cent. of our grand totals, so as to say roundly that only twenty millions have suffered in each year. But we would invite our readers to reflect on the proportion which even that number bears to the number of animals which during the same time have been subjected to experiment by the physiologists of this country. The latter have been by many excellent persons held up to obloquy as monsters of cruelty. If this has been done justly what must they think of those who use the gun?

BLASERNA ON MUSICAL SOUND

The Theory of Sound in its Relation to Music. By Prof. Pietro Blaserna, of the Royal University of Rome. With Numerous Woodcuts. International Scientific Series. (London: Henry S. King & Co., 1876.)

OF the many valuable works which have appeared in the International Scientific Series, none deal with a better subject than that of Prof. Blaserna. "The student of physics," he says truly in his Preface, "does not go much into the study of musical arguments, and our artists do not sufficiently understand the very important bearing that the laws of sound have upon many musical questions."

The first three chapters of the book hardly call for detailed notice. They reproduce the familiar facts of acoustics lucidly and succinctly. Vibration, its transmission and velocity, echo, noise as contrasted with musical sound reinforcement by sympathy, sounding-boards and resonators, complete the first division of the su bject. The second begins with measurements of vibration, graphically or by means of the siren. The limits of audible sounds are thus determined to lie between 16 and 38,000 per second; of the human voice between the 61 vibrations of double B is the bass, and the 1,305 of the soprano F in alt.

The importance of uniform pitch is adverted to. Its invariable rise, in the course of years, is explained by the "tendency of manufacturers of musical instruments, especially those made of brass, to raise the pitch continually, in order to give a greater brilliancy of tone to their instruments;" an indictment in which the players might justly have been included as well as the manufacturers.

The harmonic series, and its demonstration by means of the sonometer, conclude the fourth chapter. The laws of ratios, of interference, and of beats, with their resultant notes, occupy the fifth. From these the ancient Greek scale, attributed to Pythagoras, is built up, and compared with our modern scale, the youngest member of which, the minor third, "was only adopted in the seventeenth century, with many reservations, together with the harmony of the sixth, from which it can be easily derived."

Of the harmonic seventh (rather awkwardly termed throughout "the seventh harmonic") it is judiciously observed that "to an ear accustomed to our music, it may appear unpleasant; but an unprejudiced examination, according to the opinion of some—an opinion with which I entirely agree—shows that it is rather strange than unpleasant; that in certain special cases it affords very good discords and passing chords, and that the strangeness arises rather from our want of familiarity with it than from its inherent nature. Without wishing to push too far forward, and to prophecy what will happen in the future, it may be observed that the systematic introduction of the harmonic seventh into music would produce in it a very deep and almost incalculable revolution, a revolution which does not seem justifiable, because, for our magnificent musical system, another would be substituted, perhaps as magnificent, but certainly not better, and probably worse, at any rate more artificial."

Helmholtz's double siren is described at some length, and illustrated by numerical examples, carrying the student on to chords of three or more notes; the marked difference in character between the major and minor common chords being attributed to the disturbing effect of the resultant notes in the latter, which is absent in the former. Even Mozart shows "a certain reluctance to use the minor as a closing chord. It may be that the most highly gifted musical natures have, as it were, felt beforehand that which theory has since been able to explain in a simple and conclusive way." Discords and their contrast with concordant intervals lead to a comparison of music with the other fine arts, and to a sketch of its history, which is less satisfactory than other portions of the work. The following account of Hebrew music is quaint in the extreme:—"David and Solomon were very musical. They composed psalms full of inspiration, and evidently intended to be sung. To the latter is due the magnificent organisation of the singing in the Temple at Jerusalem. He founded a school for singers, and a considerable band, which at last reached the number of 4,000 trumpeters." The "Lyre of Orpheus," and the ratios derived from its traditional four strings, are far more fully explained. The Ambrosian and Gregorian scales follow, as well as the first attempts at polyphonic music in the tenth and eleventh centuries. Guy d'Arezzo is still credited with the invention of modern notation, though he really only used "neumas" and two clef lines, or staves, one yellow and one red. Luther, who doubtless was a musician, is accepted as the reformer of music as well as of the church. The modern and Pythagorean scales are numerically compared, and then transposition and modulation lead to a description of temperament. "The temperate scale," as it is here termed, "starts with the principle of making no distinction between the major and minor tone, of confounding the major semitone with the minor, and of considering the sharp of a note as equal to the flat of the succeeding note; so that all the notes of an octave are reduced to twelve only, which are considered equidistant from each other."

The difficulties in the way of true intonation, especially in the case of keyed instruments, are fairly stated, and the writer concludes with a remark in which we cordially sympathise:—"It does not, therefore, appear impossible, or even really difficult, for the full orchestra and chorus to perform a piece of music in the exact scale."

The subject of the eighth chapter is quality or "Timbre," in which Helmholtz's views are expounded and illustrated by good diagrams of optical and graphical methods, and of Koenig's ingenious apparatus. The last section draws distinctions between music as a science and as an art, and between Italian and German music; giving a remarkably fair estimate of Rossini's position as a melodist, rather than as a scientific musician, and on the other hand a deserved tribute of praise to the lofty character and deep dramatic feeling which, "notwithstanding some too realistic exaggerations, and some trivialities," mark the compositions of Richard Wagner.

On the whole, this volume is easily and clearly written, although, as already noted, it is rather sketchy and hurried in the historical part. There are other minor typographical, or probably translator's, oversights, such as Terpandro for Terpander, Cornue for Cornu, Orlando Tasso for Orlando Lasso, and harmonicon for harmonium. But it affords a readable *résumé* of a subject which is daily rising in scientific, as well as in purely artistic interest.

W. H. STONE

TWO BOOKS ON LANGUAGE

The Existence of Mixed Languages. By J. C. Clough. (London: Longmans, Green, and Co., 1870.)

On the Comparative Method of Learning Foreign Languages. By L. J. V. Gerard. (Leicester: 1876.)

THE existence of mixed languages is one of the vexed questions of Comparative Philology. By a mixed language is meant a language in which the grammars of two or more different languages have been fused together, not one in which the vocabulary is of a heterogeneous character. Mixed languages in the latter sense are, of course, plentiful enough; in fact there are languages like the Basque or the Telugu, in which the proportion of borrowed words is larger than that of native words. But though words may be borrowed, it is a grave question whether the expression of grammatical relations can be, and modern philology has been inclined to deny the possibility of such an occurrence. The grammar of one speech may be influenced by that of another, existing machinery being adapted to express grammatical conceptions introduced from abroad, or foreign modes of forming the sentence being imitated, and the idioms of one language may even be adopted by another, but anything beyond this is extremely unlikely. It is in grammar and structure that languages differ from one another; the expression of the relations of grammar embodies the mode in which a particular community thinks, and a change in their expression is equivalent to a change in the mode of thinking. And this mode of thinking is the result of a long succession of past experiences and stereotyped habits of thought.

Mr. Clough boldly challenges the orthodox view of the impossibility of mixed languages. He endeavours to support his heresy by an appeal to contrary instances. Thus he points to jargons like the Chinook, or Pigeon-English, to languages like Maltese or Hindustani, which have grown out of jargons, and finally to independent forms of speech like Turkish or Persian, in which he believes he finds examples of mixed languages. But he does not always distinguish between mixture in the grammar and in the vocabulary, or between the borrowing of idioms and of grammatical conceptions. Hence a large part of his book, that which deals with languages like the Keltic, the Romanic, and the Teutonic, is quite beside the point. On the other hand, he has omitted to notice some very important cases of an apparently mixed grammar, such as the Pahlavi of ancient Persia, the Assamese and kindred dialects of Northern India, and the Sub-Semitic languages of Africa. A full discussion of the phenomena presented by these might lead to a modification of the orthodox doctrine, at all events so far as the flexion of the noun is concerned. As it is, Mr. Clough has brought forward a good deal of pertinent matter, though a larger amount of what has nothing to do with the question in dispute. The whole of the second part of his book, for example, which relates to English, might easily have been spared. The book, however, is full of information, and the facts collected are usually accurate.

M. Gerard has reprinted a lecture delivered by him at the Leicester Museum, on the scientific, and therefore the natural, way of learning foreign languages. The lecture is an excellent one, at once original, clear, and practical. M. Gèrard is no friend to existing systems of teaching French and German, and he is undoubtedly right in his belief that their failure is due to a neglect of the way in which children learn their own or a foreign tongue. Instead of beginning by studying the rules of grammar and loading the memory with lists of isolated words, the child speaks in sentences, and only gradually learns to distinguish the several words of a sentence and the parts of speech to which they belong. To learn to speak a foreign language by reading a grammar and writing exercises is an impossibility. We must imitate the procedure of the child, and be content to follow the same method in learning a new language that we followed when learning our own. The essence of a language is its idioms; no amount of grammatical study will teach us these. The study of grammar should come after our acquisition of a language, not before it.

M. Gerard defines his method as follows:—"We must accustom ourselves to the expression of ideas in the language we wish to learn by comparing it with their expression in our own, until we are able, through imitation and analogy, to express them in our own. In other words, we must understand the language and think in it before we use it." Understanding a language means reading and hearing it; using a language means speaking and writing it. Hence the course of study recommended by M. Gerard comprises the four distinct processes of reading, hearing, speaking, and writing, reading coming first and writing last. If reading is the primary object in learning a new language, M. Gerard's course is undoubtedly the right one, but if speaking is rather aimed at, we think it a mistake to make reading precede. What is heard will then have to be translated into the language of the eye before it is understood, and this will be a serious impediment to the learner. Moreover, a language consists in the phonetic sounds by which it is conveyed, not in the symbols whereby these sounds are expressed on paper. Learning to read should follow learning to speak, as it does in the case of children. With this single exception, we can heartily endorse all M. Gerard's recommendations; they are founded upon nature and reason, and their practical efficiency has already been proved. Especially noticeable are his remarks on the use of translations; a dictionary is desirable only when we have acquired a fair elementary knowledge of a language and its forms of expression. Language starts with the sentence, not with the isolated word. A. H. SAYCE

OUR BOOK SHELF

The School Manual of Geology. By J. Beete Jukes, M.A., F.R.S., late Director of the Geological Survey of Ireland. Third Edition, revised and enlarged, edited by A. J. Jukes-Browne, B.A., F.G.S. (Edinburgh: A. and C. Black, 1876.)

THE late Prof. Jukes's admirable "School Manual of Geology" is already so favourably known to teachers of the science, for the clearness of its style, the accuracy of its information, and the abundance and excellence of its illustrations, that, in welcoming the appearance of a third edition of the work, we shall confine ourselves to a few remarks upon the changes which the editor has found necessary to make in it. In doing so, we have again to commend Mr. Jukes-Browne's skill in so well maintaining the distinctive characters of his uncle's work, while not hesitating to introduce such new matter as is demanded by the progress of the science.

In revising the chapter on igneous rocks, the editor acknowledges the assistance he has received from the Rev. T. G. Bonney. The principle of classification which he adopts—that, namely, of grouping the rocks, not according to one set of characters only, but on the basis both of their mineralogical constitution and their minute structure—we consider unexceptionable. To some of the definitions adopted in this chapter we must however demur, as for example to those of andesite, porphyrite, and diorite, in all of which the essential felspar is stated to be *oligoclase*. As petrographers are not in possession of any ready means for determining the exact variety of felspar in a rock, in the absence of a complete chemical analysis of it, such a distinction becomes almost entirely useless in practice. Most continental writers avoid this difficulty by applying the same general terms to all such rocks as are shown, by microscopic examination or otherwise, to have any variety of the plagioclase felspars as their predominant constituent. We must also confess to grave doubts as to whether the revival of the obsolete term *leucilite* is warranted either by necessity or convenience.

In respect to that long-vexed question of geology, the limit between the Silurian and Cambrian systems, we think that Mr. Jukes-Browne has exercised a very wise discretion. He has in the present edition adopted the judicious compromise between the claims of Murchison and Sedgwick, which was long ago suggested by Lyell and Phillips, and has received such able support from the researches of Salter and Hicks. If convenience and scientific truth are not to be wholly sacrificed to the desire to do homage to the memory of an individual, it is quite time that the aggrandised empire of Siluria should be resolved into its proper elements, and that these should resume their due place in the brotherhood of formations.

In introducing some necessary changes into the chapter on the Glacial period, the editor has wisely avoided too hastily adopting any of the crude speculations which have recently been advanced on the subject. The statement, however, that the till of Scotland is of *older* date than the boulder clay of the English Midland Counties surely stands in need of some modification.

We heartily congratulate the editor and publishers of this very useful little manual on the well-merited success which it has attained.

Geology: its Influence on Modern Beliefs. Being a Popular Sketch of its Scientific Teachings and Economic Bearings. By David Page, LL.D., F.G.S. (Edinburgh and London: William Blackwood and Sons, 1876.)

UNDER the above title Dr. Page has published two essays which are devoted to an exposition of the chief scientific results, and a vindication of the economic value and importance, of geological research. The somewhat rhetorical style of these essays is sufficiently accounted for by the fact that they were originally prepared by their author as popular lectures for an Edinburgh audience—a disposition of them which was frustrated by his ill-health. Dr. Page has very effectively grouped, and eloquently sustained his several theses, while many of the chief points of his discourses are rendered more telling by admirably chosen illustrations from the immediate neighbourhood of the city in which the lectures were to have been delivered. In one or two instances, however, we notice that the author has not succeeded in avoiding the danger of making his generalisations of too sweeping a character—as for example when he informs us, without any qualification, that "men need not search for the veined marbles of the metamorphic rocks in tertiary beds, for metalliferous veins in secondary strata, nor for workable coal-seams in the Old Red Sandstone and Silurian systems."

The Law of Storms Considered Practically. By W. H. Rosser. (London: Chas. Wilson, 1876.)

WE have read this little book with very great pleasure, and can strongly recommend it to the navigator as giving briefly, but pleasantly and intelligently, an account of the history of the law of storms, down to the present time, inclusive of the various theories which have been propounded. The book is also to be commended as evincing throughout a remarkable justness of criticism, of which the criticism on Prof. Blasius' recent book on storms may be cited as an illustration, and a close adherence to its text, viz., storms practically considered.

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.*]

Force

IN his valuable lecture on force at Glasgow, reported in NATURE, vol. xiv., p. 459, Prof. Tait did great service by insisting on the duty of precision and consistency in the use of this as of other scientific terms, and showed clearly how the word "force" may be used precisely and consistently. My reason for troubling you with this communication is that I am unable to identify this use of the word with Newton's, on the assumption that the English equivalent for Newton's *vis* is "force."

As the same difficulty has probably occurred to other readers of NATURE, I should be glad if Prof. Tait would kindly tell us through your columns what are the equivalents in English for the phrases (1) *vis*, (2) *vis insita*, (3) *vis impressa*, each of which is used in Newton's "Principia."

In the phrase *vis insita*—if *force* is the English for *vis*—is not a meaning of the word "force" implied which is wider than and inclusive of the meaning of *vis impressa?* P. T. MAIN

An Intra-Mercurial Planet

THE discussion as to the existence of a planet within the orbit of Mercury leads me to communicate an observation made many years ago, which I believe nothing but the existence of an unknown planet between us and the sun can explain. On Sunday, January 29, 1860, the sun rose in a fog in London, so that he could be steadily looked at as if through a dark glass. Soon after eight o'clock a perfectly round black object was seen by four persons, including myself, clearly defined upon the lower half, according to my recollection, of the sun's disc. It passed slowly across his face and made its egress at about half-past nine A.M. In apparent size it was equal to the representations I have seen of Mercury in transit. F. A. R. RUSSELL

Pembroke Lodge, Richmond Park, September 30

Brilliant Meteor

THE brilliant meteor of September 24 was well seen in the neighbourhood of Ipswich, and as the observation of it was difficult in the absence of stars, the following notes may be useful. It was first seen at 6h. 31m. 15s. L.M.T., and the train was visible as a luminous cloud until 6h. 47m. 3s. L.M.T. The course had a length of about 25°, which was described in three seconds, and made an angle of 80° with the horizon. By means of the train which it left behind, it was possible to fix the point of disappearance with considerable accuracy, namely: altitude, 14° 6′; azimuth reckoned from south towards east, 54° 16′. At this time Saturn was visible, having an altitude of 10° 56′, azimuth 53° 15′.

For purposes of description the course may be divided into three portions, roughly equal. In the first portion the meteor had a uniform brightness somewhat greater than a first magnitude star, but during the second portion it rapidly increased to many times the brightness of Venus, and almost suddenly diminished to its former magnitude. In the third portion it again increased in brilliancy, considerably exceeding its former maximum, and was suddenly extinguished without bursting. This third portion only was marked by the train estimated about 6° long, with a scarcely perceptible breadth. During the sixteen minutes that the train was visible it drifted about 12° northwards, losing gradually its definite outline. Direction of wind, south-south-west.

The diameter of the disc was certainly not greater than 2′, and the form was pear-shaped, though not very prolonged, leaving the observer with the idea that the peculiarity of form was merely due to the persistence of the impression on the retina. It is very difficult to estimate its maximum brightness accurately, as the heavens afford us no object with which to compare it. I have recently shown that Venus has only $\frac{1}{800}$th part of the light of the full moon, and there is no other standard of light with which to bridge over this gap. If the moon had only a diameter of 2′, its intrinsic lustre would be 240 times greater than it is, and the intensity would probably be such as would cause the observer involuntarily to avert his eyes when seen suddenly, even in full twilight; still, I do not think the meteor had much less light than such an object would have. The glare was of the colour, and closely resembled, a very vivid flash of lightning, for which it was mistaken by many persons.

JOHN I. PLUMMER

Orwell Park Observatory, September 27

The Age of Palæolithic Man

IN the extremely interesting communication on this subject which Mr. Skertchley has made to NATURE, vol. xiv. p. 448, there are one or two points on which I should like to say a few words.

First, in approaching this subject and endeavouring to find out the whole truth let us in starting have nothing but the truth. A human bone, a fibula, was certainly found beneath glacial clay in the Victoria Cave at Settle, but so far *no implements* have turned up from that ancient horizon. This is a simple inadvertence which does not in any way affect the strength of Mr. Skertchley's position, but I am anxious to correct it and as it were strangle it at the birth lest cuckoo-like it should shoulder kindred but legitimate statements out into the cold.

Mr. Skertchley's remarkable discovery consists in the finding of palæolithic implements beneath the great chalky boulder clay of Mr. Searles V. Wood, jun., which is the so-called East Anglian upper boulder clay, and this, as Mr Skertchley says, and as I believe Mr. Searles Wood holds, and with which I certainly agree, is probably as old as the Lancashire lower boulder clay or till. And this Lancashire till is undoubtedly of the same age as the till of Scotland, as all authorities admit. Moreover this till is generally admitted to be the product of the great ice-sheet of Scotland and the North of England. We are therefore landed at the conclusion that implements have been found in beds which are probably of earlier age than the Scottish ice-sheet, a conclusion in which I cannot but heartily concur. Mr. Skertchley does not state this directly, but I presume this is the legitimate inference to be drawn from his statements, and one which he would himself admit.

There can be no doubt that this is very strong and corroborative evidence of the general views so ably urged by my friend, Mr. James Geikie, that all palæolithic implements and the fauna associated with them are of inter-glacial age. It may seem captious after having been led to the battle by so able a general, and having driven the enemy so far already, to grumble at his stopping short in the pursuit, yet such is the object of my present remarks. And I would wish to point out that there are heights, or rather depths, which may yet be advantageously scaled to the further discomfiture of the foe.

Mr. J. Geikie has not ventured to carry the age of the bulk of the palæolithic beds further back than the time immediately *succeeding* the great Scottish ice-sheet. He appears to regard the "great submergence" which followed this as the chief cause for the removal from certain areas of the remains of men and animals which peopled them in inter-glacial times. "The palæolithic gravels of the south-east of England . . . are contemporaneous with those ancient valley-gravels of Scotland which overlie the till and boulder-clay, and which are themselves partially rearranged and covered with marine deposits belonging to the time of the great submergence."[1] He certainly once "puts his hand to the (ice-) plough." "No doubt, however, portions . . . especially in the districts south of the Thames, may date back to the earlier warm periods of the glacial epoch, and thus be contemporaneous with the fresh-water beds in the Scottish till; while some may go back even to pre-glacial ages;" but he immediately "looks back" to the sea of the great submergence as the great destroyer of palæolithic records. "After the great ice-sheet shrank back and the till and boulder clay had been deposited, a land-surface existed, rivers flowed down the valleys, and plants and animals clothed and peopled the country. In Scotland the fluviatile deposits belonging to that period have been subjected to great denudation, but in one place at least they have yielded animal remains, frogs and water-rats. But if the country had never been submerged after the withdrawal of the ice from the low grounds, there is good reason to believe that the presence of the relics of palæolithic man and remains of the animals with

[1] "The Great Ice Age," pp. 482-3.

which he was associated would have occurred in the valley-gravels of Scotland, Ireland, and the northern and midland counties of England, just as in those of the south-east." Mr. Geikie makes a similar statement in his preface :—"A wide land-surface existed in the British area after the disappearance of the ice-sheet and before the period of great submergence ;" and he cites the discovery of the human fibula under glacial clay in the Victoria Cave in confirmation.

It has always seemed to me that in discarding the power of the ice-sheet for that of the "great submergence" as an agent for the removal of all traces of an earlier fauna, Mr. Geikie, when attacking the tree of prejudice, has cast down his axe and taken up a whittle. Apart from the very doubtful extent and depth of the submergence, its destructive powers cannot for completeness be compared to that of the grinding of an ice-sheet. In a submergence, even if the beating of the surf destroyed all superficial deposits—a supposition which, if applied, a coast so abounding in land-locked and sheltered firths as Scotland partly submerged would present, is in the highest degree improbable—the rivers at least would carry down carcases into secure resting-places and entomb them in estuary mud, and it would be most unlikely that no such relics should be preserved when the land rose again. But, on the other hand, it is difficult to believe that any organic remains could escape the grinding of an ice-sheet if continued through a long period.

In the Victoria Cave, at any rate, the surroundings are such that nothing but an ice-sheet could have sealed up with glacial clay the remains discovered by the Committee. The valley lies close by, but is 900 feet deeper, and no advance of a mere valley glacier in the supposed later increase of glacial conditions could have brought the boulders to that height. The form and situation of the hill near the top of which the cave lies is such, that no small ice-field could have formed on it and brought this glacial *débris*. The origin of the boulders, their position, the ice-scratches on the rocks hard by, all point to the time of greatest glaciation when the whole district probably was covered in with ice and snow of great thickness. And the agent which closed the cavern and concealed the animals within it must have been the same which swept the country clean of their remains all around further than the eye can reach.

To sum up, the direct evidences as yet found to support, by actual infraposition, the inter-glacial age of palæolithic man and of the fauna with which he is associated, are as follows :—

1. Victoria Cave, Settle :—A *human fibula* under glacial till, and associated with *Elephas antiquus*, *Rhinoceros leptorhinus*, Hyæna, Hippopotamus, &c.[1]

2. At Wetzikon, Canton Zurich, a piece of lignite containing *basket-work* lying beneath glacial deposits, and associated with *Elephas antiquus* and *Rhinoceros leptorhinus*.[2]

3. Near Brandon, Suffolk, *implements*, with bones not yet determined, in brick-earth beneath the great chalky boulder-clay of East Anglia.

There is nothing in any of these instances to support the notion that this particular fauna lived subsequently to the age of the Scottish ice-sheet and immediately prior to a great submergence.

The Settle till is undoubtedly of the age of the ice-sheet. The Wetzikon lignite lies upon a glacial till beneath a river gravel, and upon that are huge angular erratic blocks, "clearly indicating the presence of a great glacier posterior in date to the organic remains."[3]

The Brandon implements are beneath the chalky boulder clay which Mr. Searles Wood, jun., believes to be the product of an ice-sheet, though partly deposited beneath the sea, a condition which is incompatible with the co-existence of a great submergence.

After, and in sole opposition to, such evidence, we can hardly contentedly take the existence of frog and water-rat as upholding the presence of palæolithic man and his congeners in times later than the great ice-sheet of Scotland. The Arctic mammals are, of course, out of court and cannot be taken as evidence, for it is highly probable that they returned with the retreat of the ice; but, so far, we have no evidence that this was the case with the more tropical animals.

My friend Mr. James Geikie will, I am sure, take these suggestions in the friendly spirit in which they are offered. My chief reason for bringing them forward is that we hear that a new edition of his valuable work is in preparation, and it will be a loss to geology if this matter be not fully discussed by one who is so well able to handle the subject in all its bearings. Meanwhile, we are deeply indebted to him for progress already made, and also to my friend Mr. Skertchley for this important addition to the evidence and the perspicuous manner in which he has brought it before us. R. H. TIDDEMAN

[1] "The Relation of Man to the Ice-sheet in the North of England," NATURE, vol. ix., p. 14, 1873; also "Settle Caves Exploration," Brit. Assoc. Reports for 1874 and 1875.

[2] Rütimeyer; *Archiv für Anthropologie*, 1875; also NATURE, vol. xiii. p. 130.

[3] Lyell; "Antiquity of Man," p. 368.

The Flame of Chloride of Sodium in a Common Coal Fire

SOME time ago a correspondent of NATURE (vol. xiii. p. 287) inquired for an explanation of the fact that while common salt (chloride of sodium) colours the flame of an ordinary spirit-lamp yellow, the same substance thrown upon a common coal fire gives rise to a blue flame. In the next number (p. 306) Dr. Schuster stated that the origin of the blue flame was still involved in mystery, and (if my memory is correct, for I have not the number at hand) that he and Prof. Schorlemmer had been engaged in an investigation of the same.

Dr. Schuster's letter shows that the question is not an unimportant one; and as I have lately made a few experiments which seem to confirm an explanation which occurred to me at the time, I send a short description of them.

The theory I put forward is that the blue flame noticed when salt is thrown upon a coal fire (of bituminous coal) is possibly due to the presence of *carbonic oxide* (CO), produced by a series of reactions, through which the common salt is converted into, first, sulphate, and then sulphide of sodium, as in the manufacture of crude carbonate of sodium (*black ash*), all the reactions being simply carried out in one furnace instead of two.

Leblanc's process consists in—1. Converting common salt into sulphate of sodium. 2. The "salt cake" is then mixed with coal and limestone, placed in a furnace and heated strongly, during which process *a blue flame of carbonic oxide is observed to play upon the surface*.

Now in the case we have under consideration, the only difference is that the salt is first converted into sulphate by the oxidation of the iron pyrites, from which no coal is free (and, in fact, it has been proposed to use such a process commercially, viz., by roasting common salt with iron pyrites).

At this stage, then, the reaction going on in the fire will be expressed by the equation—

$$4NaCl + 2FeS + O_{11} = 2Na_2SO_4 + Fe_2O_3 + Cl_4.$$

Almost simultaneously with this, the carbon of the coal comes into play, reducing the sulphate of sodium to sulphide, thus—

$$Na_2SO_4 + C_4 = Na_2S + 4CO \text{ (carbonic oxide).}$$

Of course were any substance present answering to the limestone used in practice, as may occur in the ash, we should have the full conversion to "black ash," viz. :—

$$6Na_2S + 8CaCO_3 + C_2 = 6Na_2CO_3 + 6CaS + 2CaO + 4CO,$$

with a further evolution of carbonic oxide.

I need not say that carbonic oxide burns with a violet blue flame perfectly indistinguishable from that produced by throwing salt into a *bituminous* coal fire. This may be proved at once by experimenting with a fire of *anthracite*, which itself only gives the slight lambent blue flame of carbonic oxide. The presence of salt makes no difference whatever in the colour of this flame, and it is difficult indeed to determine whether the salt is ignited at all. The difference in the two cases is just this :—A common coal fire has usually a large, bright, or smoky flame. Salt thrown on it diminishes its size and brightness by robbing it of free carbon or hydrocarbon—which gave it those qualities, and which is derived from the volatile matter—as in the reactions above set forth, the result being the production of carbonic oxide. In the case of anthracite, however, the free carbon is absent; but the carbonic oxide exists, and is equally apparent before and after the addition of salt. It is possible that the heat, instead of volatilising the sodium compounds and so giving the yellow flame, is expended in effecting the new chemical transformations.

In the case of a spirit-lamp or of a Bunsen burner there is no supply of carbon, nor is there any iron pyrites to be converted into sulphuric acid, consequently the above complicated process cannot take place, and the flame only shows the sodium coloration.

The following laboratory experiments were made with a view to test the accuracy of these speculations :—

1. A little common salt was placed in a crucible, inclosed in a jacket, and exposed to the Bunsen flame. The fringe of flame appearing above the crucible was of course coloured most intensely yellow.

2. A similar arrangement was made, only that the crucible contained a mixture of common salt and powdered charcoal. Although the crucible was heated to a redness, the flame had lost most notably its intense yellow colour and occasionally a slight blue tinge appeared around the edge. This last I do not lay much stress on, as it might be merely due to the Bunsen flame; but the diminution of the sodium colour could not be overlooked.

3. The crucible was now filled with a mixture of salt and powdered charcoal, together with a very little of sulphide of iron (in fact, the substance used for the preparation of sulphuretted hydrogen), and exposed over the Bunsen burner as before. In this case the sodium coloration almost completely disappeared, while the blue flame became very distinct indeed.

No difference could be observed, whether the air was turned on or off the burner, in these experiments.

When the above mixtures were exposed on platinum wire in the naked flame, they only gave the sodium colour. This is doubtless to be ascribed to the stronger heat volatilising some of the sodium salt before it had time to enter into the necessary changes. This is the more likely, because mixtures made with just the slightest trace of salt gave the yellow colour in the naked flame, while the mixtures used in the crucible as described, and which gave the blue colour, contained fully 50 per cent. of salt.

Dr. Schuster, in the note already mentioned, refers to a paper by Dr. Gladstone (*Phil. Mag.*, 1862, vol. xxiv., p. 417), on the similar behaviour of certain metallic chlorides in imparting a blue or violet colour to flames of various kinds. I find that in this paper the violet colour given by the chlorides of potassium, sodium, and barium, in the flame of red-hot coals is noticed, Dr. Gladstone remarks, however, that "a doubt must rest on such observations made with a common coal fire, as it is quite conceivable that these chlorides may give up their chlorine to the alkalies or earths of the ash.

It struck me that it would have some bearing on the matter, to ascertain if other salts of sodium exhibit the same phenomenon. On trial I find that there is no difference.

A little pure sulphate or carbonate of sodium thrown on a coal fire produces exactly the same blue flame as common salt, both with ordinary coal and with anthracite. These salts, in the flame of the Bunsen or the spirit-lamp, give the strong yellow flame of sodium at once. It is clear that their behaviour on hot coals is explainable in exactly the same way as that of common salt, viz., by the production of carbonic oxide. It is inferable, therefore, that the blue flame of common salt is not to be ascribed solely to some property inherent in chlorides alone; and the solution I have proposed seems the more plausible.

A correspondent in NATURE suggested the probable formation by a reaction between common salt and *copper pyrites* in the coal, of chloride of copper, and that the last would give the blue flame. However, it is iron pyrites, and not copper pyrites, that occurs in coal; and, moreover, the flame of copper chloride is bluish green, and not blue. EDWARD T. HARDMAN,

Kilkenny Her Majesty's Geological Survey

OUR ASTRONOMICAL COLUMN

THE INTRA-MERCURIAL PLANET QUESTION.—Notwithstanding the suspicious aspect of the spot remarked upon the sun's disk by Weber at Peckeloh, on the afternoon of April 4, 1876, as it is described by him in his letters to Profs. Heis and Wolf, it would appear that it must be relegated to that class of ordinary solar spots which are better defined than in the majority of cases, and continue visible but a short time. A letter has been addressed to the Abbé Moigno by Señor Ventosa, of the Observatory at Madrid, containing a very definite observation of a spot on that day which was evidently the one noticed at Peckeloh. A similar letter to Prof. Peters is published in *Ast. Nach.*, No. 2106.

It is not, perhaps, generally known in the astronomical world that the systematic observation of the sun's disk forms one of the routine subjects to which attention is directed at the Madrid Observatory. The observations are made daily with the large Merz-Equatoreal, projecting the image of the sun upon a screen so as to present one of considerable diameter. The heliographic positions of the spots are determined on the method adopted by the late Mr. Carrington on the image projected by the finder, which is provided with a suitable reticule, and, whenever possible, their distances from the limb are measured directly with the large telescope. The drawings are made by hand.

After noon on April 3 the sun was without spot, a group of *facula* only being visible very near the S.W. limb. But on the morning of April 4 there was a small spot, a simple nucleus without penumbra, of an apparently elliptical figure, with a small *facula* on the N.W. side (puro nucleo sin penumbra, de figura eliptica aparentemente, y con une fácula pequena por el lado N.O.); this was very well observed. Cirrus was scattered over parts of the sky, but the images were well defined. The observations gave the following results:—

April 3 at 22h. 9m. 54s. M.T., at Madrid, angle of position of the spot, 76° 43′, distance from the centre of the disc 818″·9, the sun's semi-diameter being taken at 960″·9. At 22h. 24m. direct measure of the distance of the spot from the sun's limb gave 147″, consequently 814″ for the distance from the centre. The dimensions of the spot were 4″ × 2″.

April 5, after noon, the sun was again without spot; the most remarkable object was a bright *facula* very near the N.E. limb. It will be seen that the first Madrid observation was made 5h. 7m. previous to that at Peckeloh.

The opinion expressed by M. Leverrier before receiving the Madrid observation, that certain problematical solar-spot observations upon record might accord with a revolution of an intra-mercurial planet in about twenty-eight days, in which case an inferior conjunction might fall on the 2nd or 3rd of the present month, has been construed into a definite prediction of a transit of the so-called *Vulcan*, on one of those days, a prediction which M. Leverrier distinctly repudiates, though it has been widely circulated by the daily press in and out of France. The rejection of the observation of April 4 in the present year leaves us in doubt again as to what period will correspond to the most reliable data, assuming the existence of an inter-mercurial planet.

Mr. Wray's observations about midsummer, 1847, and others of hardly less authority, require explanation. It is impossible to repudiate them, but whether referable to the passage of planetary or cometary bodies, must remain for future decision.

THE VARIABLE STAR, ALGOL.—The following are Greenwich times of visible geocentric minima of Algol to the end of the year, calculated from the elements in Prof. Schönfeld's latest catalogue of variable stars:—

	h.	m.		h.	m.
Oct. 20 ...	16	42	Dec. 2 ...	16	55
23 ...	13	21	5 ...	13	44
26 ...	10	20	8 ...	10	33
29 ...	7	8	11 ...	7	22
Nov. 12 ...	15	13	22 ...	18	38
15 ...	12	2	25 ...	15	26
18 ...	8	51	28 ...	12	15
21 ...	5	40			

THE MINOR PLANETS.—It appears by a telegram from Vienna in the Paris *Bulletin International*, of September 23, that Herr Palisa, of the Observatory at Pola, has recovered No. 66 of the group of small planets—Maia—detected by Mr. Tuttle, at Cambridge, U.S., though at some distance from the position given in the *Berliner Jahrbuch* for 1878.

The following names are proposed for recent discoveries:—No. 165, discovered August 9, 1876, Loreley; No. 166, August 15, Rhodope; No. 167, August 28, Urda. Nos. 168 and 169 are announced; the former was detected by Prof. Watson on September 27, and the latter by M. Prosper Henry on the following night near the same position. Both are eleventh magnitudes.

THE RADIOMETER IN A BALLOON

THE Count Elemer Bathyani made a private ascent in the *Tricolore* balloon on Monday, August 28, with Duruof as an aëronaut. The balloon started from La Villette Gasworks at 11.50 in the morning, and descended at Chevru, near Coulomiers, about forty miles from Paris, at 2 o'clock, after having run little short of a hundred miles. The aerial craft had been overtaken by a series of winds in different directions. The culmination of the ascent was 2,500 metres.

The objects of Count Bathyani were to rotate the radiometer at different altitudes, so as to illustrate the augmentation of the luminosity of the sun, and to condense the vapour of clouds with an ether evaporator, in order to collect moleculæ suspended in the air, and ascertain whether vapour was mixed with a certain quantity of ammoniac, nitrous or nitric compounds, or ozone. The last operation could not be executed, because the balloon did not meet a true cloud, having passed in the superior zone through lacunæ, between the several cumuli. But the radiometer experiments were successful, and we are enabled to give a correct table of the results obtained. The radiometer was blue-red, constructed by Gaiffe.

In the Shade.—On the ground (at La Villette), 35 revolutions per minute, with a pressure of 750 mm., sky half covered by disconnected cumuli, temperature, 26° C., at an altitude of 1,750 meters.

In the *Tricolore* floating between cumuli at a distance of 1,500 metres from the earth, sixty-four rotations per minute—temperature, 15°.

In the Sun.—Time 11h. 50m. Temperature 18°, altitude 700 metres, sun shining through a layer of clouds fifty-four rotations per minute. Time 1h. 10m. Altitude 2,300 metres, temperature 13°. Sun shining; it is impossible to measure the number of revolutions, which are as great, if not greater, than with an ordinary white-black radiometer exposed to a radiant sun at the surface of the earth.

M. Gaiffe is constructing another differential radiometer to rotate under similar circumstances. One of the faces is to be white, and the other white with a black spot in the centre. The evaporator was working with ordinary vinic ether, but with methylic the condensation will be a great deal more powerful. The water in suspension will be precipitated under the form of ice; the refrigeration of condenser being then 20° C. below zero, all the dust floating in the air in the vicinity of condenser will be deposited with the ice. The ice is to be collected and ultimately analysed micrographically as well as chemically.

The difficulty is to prepare a vessel for holding the methylic ether, as the pressure is enormous even at ordinary temperature. But I was told at Auteuil frigorific works it can be obtained and filled ready for use very easily at a comparatively small expense.

W. DE FONVIELLE

THE RECENT TORNADO

IT is evident from a correspondence in the *Times* of Friday, Saturday, and Monday last that a tornado of almost unexampled intensity and destructiveness swept over the Isle of Wight and Hampshire on the morning of Thursday, September 28. The storm, which appears to have come from a southerly direction, struck West Cowes about seven in the morning, thence crossed the Solent in a north-easterly direction, and, striking the opposite coast, near the entrance of Southampton Water, passed up Hampshire between Titchfield and Portsmouth at least as far as Meonstoke, which is about sixteen miles to the north-east of Cowes.

Its appearance on approaching is described as that of an immense black cloud sweeping along the ground and giving out a low moaning sound which it was awful to hear. A gentleman in a small yacht, which fortunately was out of the course of the tornado, suddenly heard sounds very much resembling the noise caused by the escape of steam when at its highest pressure, and at the same time the whole sky became clouded with articles of all forms and sizes which were carried through the air to a height of about 300 feet and parallel with the shore. The Globe hotel was blown down, and several houses lost their roofs, fronts, or chimneys; a pier belonging to Dr. Kernock was wholly demolished, and many of the watermen's boats were sunk, being filled with bricks which had been blown through the air. It is stated that some bricks fell on board Lord Wilton's steam yacht, the *Palatine*, which was moored half a mile from the shore. At Cowes alone the damage done, the work of only one short minute or two is estimated at from 10,000*l*. to 12,000*l*. The destructive character of the tornado was maintained in its course through Hampshire, where turnips and other crops were literally dragged out of the ground, fine oak trees uprooted, farms and homesteads damaged, a barn being bodily lifted up, and instantly converted into a heap of ruins, and life lost. It made a clean sweep through a thick copse, clearing a path for itself 100 feet in width, along which the trees and underwood were all uprooted, as if men had grubbed up everything. In some cases it is said that the corners of ricks and cottages were cut off as if with a knife, and that iron pig-troughs were carried a distance of 300 to 400 yards, and gates lifted from their hinges and thrown into the adjacent fields.

Since the mode and suddenness of its approach, its brief continuance, and its terrible destructiveness, all show that in investigating this storm, it is a true tornado we are dealing with, we hope that, whilst the occurrences are fresh in the minds of those who witnessed them, some one will take the trouble to make a careful collection of the facts. As yet, little of the meteorology of this tempest is before us; what is required for its investigation is to know along different points of its track the time it began and ended, the changes in the direction of the wind, temperature, and state of the sky, and the aqueous precipitation accompanying it; the damage done, the objects whirled aloft, and the direction and course taken by them in their flight through the air. A careful investigation of the facts of this tornado would form a valuable contribution to meteorology at the present time, inasmuch as it would probably enable us to say whether tornadoes and other whirlwinds are to be regarded as typical, as is sometimes alleged of the cyclone of tropical regions and of the ordinary storms which sweep over these islands.

The services of a sufficient staff of observers are more urgently required to record non-instrumental observations of wind, rain, hail, cloud, &c., from which the broad features of wind-storms, hail-storms, and thunder-storms could be adequately described, and some knowledge arrived at as to the way in which the rainfall is propagated from parish to parish. If such organisations were set on foot over different portions of the British Isles, we should soon be in a position to attack several of the more important practical problems of meteorology, and to issue weather-warnings in the interests of agriculture and horticulture as began to be issued in France some months ago.

Storms seem to have been wandering widely recently. Ten days before the tornado above referred to, a storm of unusual violence visited the American coast, and the Paris *Temps* received on Saturday evening a telegram from the Puy-de-Dôme Observatory stating that a terrific hurricane had been blowing since the morning. It was impossible for the observers to walk outside the house without being blown down. The velocity of wind could not be registered by anemometer. The sky was clear, but clouds were covering the surface of the earth and clinging to the different mountains. On the following night and day the weather was boisterous and rainy at Paris.

THE PUY-DE-DÔME OBSERVATORY

We have already given some information concerning this important meteorological observatory, and to-day we present three illustrations showing its site and construction.

The site of this observatory is 1,465 metres above the level of the sea and about 1,000 metres above the level of Rabanesse, the meteorological station connected with it and situated in the gardens of the Clermont Faculty of Sciences. The Puy-de-Dôme was in ancient times supposed to have been the scene of so-called Druidical sacrifices, and was certainly the seat of a Roman temple, probably of Mercury. In excavating the mountain for the foundation of the observatory the extensive ruins of this temple were again brought to light. A number of medals, statues, and other objects have already been found and collected in a special museum. But it is intended to replace them in a repository which is to be built on the very top of the mountain.

It was on September 19, 1648, that Perrier, the then president of the Cour des Aides, verified on the top of the Puy-de-Dôme the great law of the diminution of pressure discovered by his brother-in-law, Pascal. Descartes says somewhere that he had suggested the experiment to Pascal. The illustrious philosopher was then an exile at Stockholm, where he died a few years afterwards. He was keeping up correspondence through Father Mersenne with a number of French *savants*, and especially with Perrier. Comparative observations for obtaining the height of the mercury were carried on during the years 1649, 1650, and 1651 at Clermont, at the Couvent des Minimes at Stockholm in the palace of the queen by Descartes, and after his demise by one of his friends, and at Paris by an observer whose name has not been preserved.

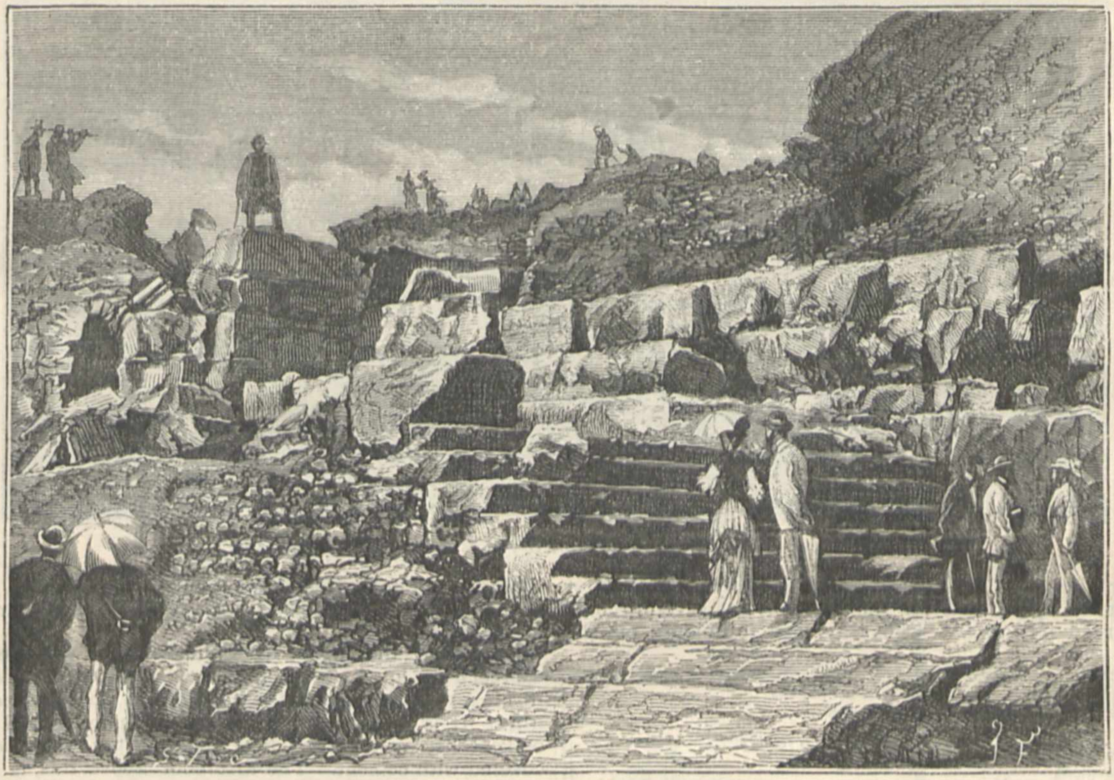

Fig. 1.—View of the Ruins of the Roman Temple beside the Puy-de-Dôme Observatory.

The idea of building an observatory on the Puy-de Dôme was originated by M. Alluard, the present director, about fifteen years ago. It was supported first by M. Duruy, the Minister of Public Instruction, under the Empire. M. Faye, then on a tour in the capacity of general inspector, approved it, and reported favourably. The astronomer paid more than one visit to the Puy-de-Dôme to ascertain the practicability of the proposal, which was supported also by M. Leverrier.

Up to the present moment the Government have paid only the expenses for the instruments, the whole of the costs of building having been supported by the Department and city of Clermont. The expenses have amounted to 10,000*l*.

The distance from Clermont to the Puy-de-Dôme is about ten kilometres, six of which can be done in a cart. A mountain road has been made at the expense of the Department, and with very little difficulty; the track of the old *via Romana* had only to be followed.

Commandant Perrier, Director of the French Ordnance Survey, has established a barracks close to the observatory for determining, by electricity, the latitude of the Puy-de-Dôme. He will continue his work as long as the state of weather permits. For such observations the Puy-de-Dôme is connected telegraphically with Mount Souris.

The observatory, as we have already intimated, was inaugurated on August 22, during the meeting of the French Association at Clermont. Eight hundred persons made a pilgrimage to the top of the Puy-de-Dôme, to be present at the opening, and in spite of the unfavourable state of the weather, the ceremony was successful. Under an enormous tent a collation was provided for the visitors, and after the repast, many pleasant congratulatory speeches were made. M. Bardoux, president of the General Council, in speaking eloquently of Pascal, whose name is intimately associated with the Puy-de-Dôme, announced that the Government intended to erect a bronze statue to the great philosopher, in Clermont. Dr.

Janssen spoke in the name of the Meteorological Society of France, described the celebrated experiment which Pascal made on the mountain and the barometer which he used, and showed what science owes to the observations made with this precious instrument. He at the same time announced that the Meteorological Society had awarded to M. Alluard a first silver medal. Many other eloquent speeches were made, in all of which reverential reference was made to the immortal Pascal.

The observatory consists of two distinct parts—the house of the keeper and the meteorological building. The former comprises, first, the telegraph office, from which messages are sent to the station on the plain, and alongside of which are apartments for the keeper, who has

FIG. 2.—Puy-de-Dôme Observatory on the Day of its Inauguration, August 22, 1876.

been chosen by M. Alluard from the navy. On the first floor are apartments for the director, and several rooms reserved for *savants* who may wish to sojourn on the

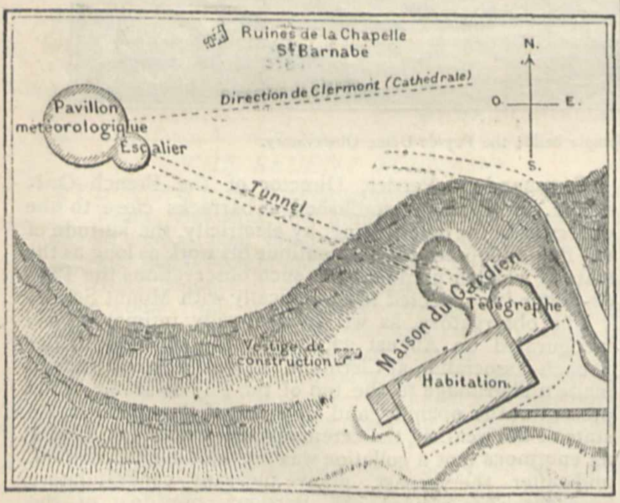

FIG. 3.—Plan of the Puy-de-Dôme Observatory.

summit of the peak to carry on observations. The body of this building communicates with the meteorological building by a subterranean tunnel. The latter building comprises an underground floor built above a vault, and another upper story which is on a level with the summit of the peak.

Traversing the tunnel from the house of the keeper, we reach the lower part of the meteorological building; this is a vault into which the light of day does not penetrate. It is intended for the magnetic chamber, and will be kept dry by a thorough ventilation, the walls being covered with cement. The first floor above this, is also underground, but is provided with two holes, by which the light enters. It constitutes a circular chamber, surrounded by a corridor, for the purpose of enveloping it in a layer of insulating air. Here will be placed the apparatus, the regular working of which requires a constant temperature, and among which we may mention Redier's registering barometer. The upper story, as we have said, is level with the ground, and forms a beautiful building, provided with four windows, adjusted to the four points of the compass. It communicates with a small external louvered cage, containing the various classes of thermometers. Inside are the following instruments:—(1) M. Hervé Mangon's anemograph, communicating by electric wires with the Robinson anemometer, placed on the top of the fixed mast on the upper part of the tower; (2) Mangon's register or pluviometer; (3) M. Hasler's thermohygrograph; (4) Fortin's and Tonnelet-Renou's barometers; (5) regulating clock; (6) astronomical telescope. This portion of the building is furnished with tables placed between each window.

Independently of the observations recorded by the registering apparatus, the keeper makes observations every three hours, transmitting them by telegraph to the station on the plain. These observations on the summit and those on the plain are compared conjointly with the message which arrives at midday from the Paris Observatory. On these are based the meteorological bulletin of the department.

The station on the plain at Rabanesse is installed in a house provided with a quadrangular tower of 15 metres in height. It is provided with a large shelter for the thermometers, and M. Alluard has had a fine photographic studio constructed, in which he intends to organise a regular service for photographing clouds. Other ingenious and beautiful arrangements have been made here, and the entire establishment, on mountain and plain, is one of the most complete in existence, and may be expected to furnish much valuable meteorological data.

For the illustrations we are indebted to our French contemporary, *La Nature.*

ON THE APPARATUS EMPLOYED BY THE LATE MR. GRAHAM, F.R.S., IN HIS RESEARCHES[1]

MR. GRAHAM will probably be best remembered as a chemist, although the most important of his researches where either purely physical, or were devoted to the elucidation of questions which occupy an intermediate position between physics and chemistry. It is specially interesting, therefore, to observe what was the nature of the apparatus he employed in obtaining results of such importance as those with which his name is associated.

FIG. 1.

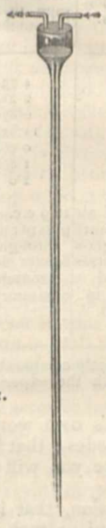

FIG. 2.

From the fact that the instruments on the table are those with which he arrived at all his more important conclusions, it will at once be evident that the appliances he used were both few and simple. Before I proceed to describe them, I should, as the time at my disposal is very limited, briefly state that Graham's labours were mainly devoted to ascertaining the nature of molecular movement in cases in which he was satisfied that no *mass* movement could take place, and, as Dr. Angus Smith has pointed out, while Dalton showed the relative weights of the combining quantities, Graham showed the relative magnitude of groups into which they resolve themselves. It is interesting to note that, as Prof. J. P. Cooke has observed, while Faraday was so successfully developing the principles of electrical action, Graham, with equal success, was investigating the laws of molecular motion. Each followed with wonderful constancy, as well as skill, a single line of study from first to last, and to this concentration of power their great discoveries are largely due.

The Royal Society's Catalogue of papers shows that his earliest paper was on the absorption of gases by liquids. It was published in 1826 in Thomson's "Annals of Philosophy"; in it he considers that gases owe their absorption in liquids to their capability of being liquefied, and therefore that solutions of gases in liquids are mixtures of a more volatile with a less volatile liquid. He concludes the paper by saying, that "All that is insisted on in the foregoing sketch is, that when gases appear to be absorbed by liquids they are simply reduced to that liquid inelastic form which otherwise, by cold or pressure, they might be made to assume, and their detention in the absorbing liquid is owing to that mutual affinity between liquids which is so common." It was a theoretical paper only, and no apparatus was even described; I have quoted it merely because, in his last paper in the *Phil. Trans.*, more than thirty years afterwards, he speaks of the liquefaction of gas in colloids in much the same terms.

In 1829, the *Quarterly Journal of Science*[2] contains his first paper on the diffusion of gases; he found that the lighter a gas is the more quickly it diffuses away from an open cylinder. The cylinders he employed were nine inches long, and 0·9 inches interior diameter; they were placed in a horizontal position, and the gas under examination was allowed to diffuse outwards through a narrow tube directed either upwards or downwards according as the gas was heavier or lighter than air. It was therefore

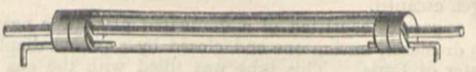

FIG. 3.

by the aid of a simple cylinder that he was led to believe, as he states in this his first paper, "that the diffusiveness of gases is inversely as some function of their density, apparently the square root of their density." He subsequently found that so great is the tendency of gases to diffuse into one another, that this mixture or inter-diffusion will take place through apertures of insen-

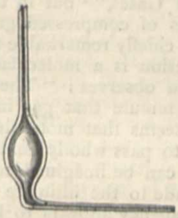

FIG. 4.

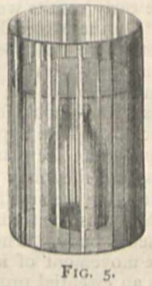

FIG. 5.

sible magnitude. And in his paper in 1834,[1] he treats in detail of diffusion through porous septa, his object being "to establish with numerical exactness the following law of diffusion of gases:—The diffusion or spontaneous intermixture of two gases in contact is effected by an interchange in position of indefinitely minute volumes of the gases, which volumes are not

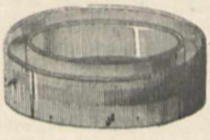

FIG. 6.

FIG. 7.

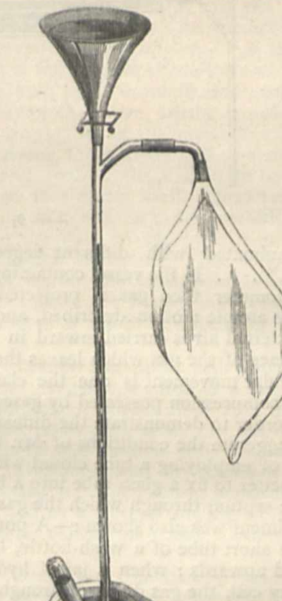

FIG 8.

necessarily of equal magnitude, being, in the case of each gas, inversely proportional to the square-root of the density of that gas." He started from the well-known experiment of Döbereiner, who found, in 1825, that hydrogen kept in a glass receiver standing over water, escaped by degrees through the fissure into the surrounding air, the water in the receiver rising

[1] Lecture by W. Chandler Roberts, F.R.S., Chemist of the Mint, at the Loan Collection, South Kensington.
[2] Quart. Journ. Sci., ii., 1829, p. 74.

[1] Edin. Roy. Soc. Trans., xii., 1834, p. 222.

to the height of about 2¾ inches above the outer level. In repeating Döbereiner's experiments and varying the circumstances, Mr. Graham discovered that hydrogen never escaped outwards by the fissure without a certain portion of air penetrating inwards, but with this essential difference, for every volume of air which penetrated into the vessel 3·8 volumes of hydrogen escaped.

The apparatus consisted of a graduated glass tube nearly an inch in diameter, having one end closed by a porous diaphragm of plaster of Paris. This tube was filled with the gas to be examined, and the rise of the mercury indicated the rate at which the interchange of gas and external air took place. He also interposed a bulb two or three inches in diameter between the diaphragm and the graduated tube with a view of increasing the capacity of the instrument, and of avoiding the interference of vapour. In this paper he traced the relation which diffusion bears to the mechanism of respiration, but time will not permit me to consider this question.

These early results were repeated and greatly extended in a paper "On the Molecular Mobility of Gases,"[1] but in the experiments there described, thin plates of compressed graphite were principally used. The paper is chiefly remarkable for the clear enunciation of the fact that diffusion is a molecular, and not a *mass* movement, for Mr. Graham observes: "The pores of artificial graphite appear to be so minute that gas in mass cannot penetrate the plate at all. It seems that molecules only can pass, and they may be supposed to pass wholly unimpeded by friction, for the smallest pores that can be imagined to exist in graphite must be tunnels in magnitude to the ultimate atoms of a gaseous body. The sole motive agency appears to be that intestine movement of molecules which is now generally recognised as an essential property of the gaseous condition of matter.

"According to the physical hypothesis now generally received, a gas is represented as consisting of solid and perfectly elastic spherical particles or atoms, which move in all directions and

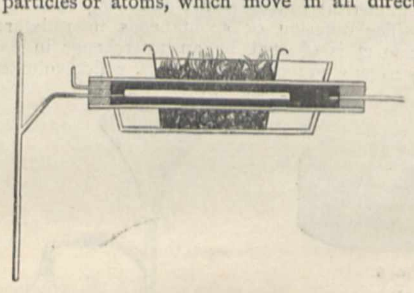

FIG. 9.

are animated with different degrees of velocity in different gases." . . . If the vessel containing the gas "be porous like a diffusiometer, then gas is projected through the open channels by the atomic motion described, and escapes. Simultaneously, the external air is carried inward in the same manner, and takes the place of the gas which leaves the vessel. To this atomic or molecular movement is due the elastic force, with the power to resist compression possessed by gases."

In order to demonstrate the diffusion of gases it is necessary to exaggerate the conditions of Mr. Graham's experiments. Instead of employing a tube closed with a disc of plaster of Paris, it is better to fix a glass tube into a battery cell and to employ it as the septum through which the gas is diffused. The following experiment was also shown:—A porous battery cell was attached to the short tube of a wash-bottle, both tubes being previously turned upwards; when a jar of hydrogen was placed over the battery cell, the gas diffused through the cell, and the change of pressure caused the water to issue like a fountain several feet in height. I believe this arrangement was devised by Prof. Bloxam.

Now I must ask you to follow me a step further. In 1846 Mr. Graham read a paper before the Royal Society "On the Motion of Gases." He showed that the *effusion* of gases through a minute hole in a platinum plug left no doubt of the truth of a general law that different gases pass through minute apertures in times which are as the square roots of their respective specific gravities, or with velocities which are inversely as the square roots of their specific gravities; or in other words, he experimentally verified the mechanical law that the velocity with which a gas rushes into a vacuum through such an aperture, is the same as that which a heavy body would acquire in falling from the height of an atmosphere, composed of the gas in question, of uniform density throughout. The relative rates of *effusion* and diffusion are alike, but Mr. Graham is careful to observe that the phenomena are essentially different in their nature. The former affects masses of gas, the latter (diffusion) only affects molecules.

[1] Phil. Trans., 1863.

The apparatus Mr. Graham employed consisted of two glass jars; the one containing the gas to be examined was placed in a pneumatic trough, and the other stood on the plate of an air-pump. They were in connection, a series of tubes containing the usual reagents for purifying and drying the gas being interposed between them. The jar on the air-pump was exhausted, and the gas entered it through a minute orifice in a platinum disc, the rate of passage being observed by the aid of a mercurial column.

Three years later Mr. Graham published a paper giving the results of an investigation on what he considered to be a fundamental property of the gaseous form of matter, which he termed transpiration. He employed capillary tubes, and found that effusion and transpiration differed widely;[1] "for if the length of the tube is progressively increased, and the passage for all gases becomes greatly slower, the velocities of the different gases are found to diverge rapidly from their effusion rates." The velocities at last, however, attain a particular ratio with a given length of tube and resistance, and preserve the same relation to each other for greater lengths and resistances, the most simple result probably being that of hydrogen, which has exactly double the transpiration rate of nitrogen, the relation of these gases as to density being as 1 : 14.

	Diffusion Velocities.	Effusion Velocities.	Transpiration Velocities.	Rates of Passage through Caoutchouc.
Hydrogen ...	3·83	3·613	2·066	4·73
Oxygen ...	0·9487	0·950	0·903	2·224
Nitrogen ...	1·0143	1·0164	1·030	0·870
Carbonic acid	0·812	0·821	1·237	11·819
Carbonic oxide	1·0149	1·0123	1·034	0·968
Marsh gas ...	1·344	1·322	1·639	1·869
Air	1·0	1·0	1·0	1·0
	About 9600 c.c. of air pass per minute through 1 sq. metre of stucco 2·5 mm. thick	78·3 c.c. of air pass per minute through a certain small aperture in a brass plate.	62·9 c.c. of air pass per minute through a glass tube 6·6 metres long and 0·55 mm in diameter.	16·9 c.c. of air pass per minute through one square metre of caoutchouc 0·02 mm. thick.

Note.—It is impossible to make the four columns strictly comparable on account of the difference of the conditions under which the experiments were made.

Thus, in what are very nearly Mr. Graham's own words, a gas may pass into a vacuum in three different modes; that is, by effusion, transpiration, or diffusion, and I hope you will bear with me while I recapitulate them.

1. The gas may enter the vacuum by effusion, that is, by passing through a minute aperture in a thin plate, such as a puncture in platinum-foil made by a fine steel point. The relative times of the effusion of gases *in mass* are similar to those of the *molecular* diffusion, but a gas is usually carried by the former kind of impulse with a velocity many thousand times as great as is demonstrable by the latter.

2. If the aperture of efflux becomes a tube, the effusion rates are disturbed. The rates of flow of different gases, however, assume again a constant ratio to each other when the capillary tube is so elongated that the length exceeds the diameter by at least 4,000 times. The transpiration rates appear to be independent of the material of the capillary; they are not governed by specific gravity, and are indeed singularly unlike the rates of effusion. The ratios appear to be in direct relation with no other known property of the same gases, and they form a class of phenomena remarkably isolated from all that is at present known of gases.

For instance it will be seen by the table already given that the rate of carbonic acid which is low for effusion and diffusion, becomes comparatively rapid when the gas passes by transpiration.

3. A plate of compressed graphite, although it appears

[1] Phil. Trans., 1849, p. 349.

to be practically impermeable to gas by either of the two modes of passage just described, is readily penetrated by the agency of the molecular or diffusive movement. The times of passage through a graphite plate into a vacuum have no relation to the capillary transpiration times of the gases, but they show a close relation to the square roots of the densities of the respective gases, and agree with the theoretical *times of diffusion* usually ascribed to the same gases.

These latter results were obtained by the graphite diffusiometer of which a sketch is given (Fig. 1). It stood over mercury, and was raised or lowered by an arrangement introduced by Prof. Bunsen.

Mr. Graham subsequently employed the barometrical diffusiometer shown in Fig. 2. It consists of a tube in which a Torricellian vacuum could be produced. The upper end was closed by the porous septum, and a slow stream of the gas under examination was allowed to pass over the plate through the india-rubber hood by which it was covered.

I might mention that the very exact and illustrious experimenter, Prof. Bunsen, was led to doubt the accuracy of Graham's law of the diffusion of gases, but he employed plugs of plaster of Paris which impaired the results by introducing the phenomenon of transpiration; and probably also as Mr. Graham observed to me, by an actual retention of hydrogen in the pores of the plaster It is interesting from our point of view, because it shows that the simple apparatus employed by Mr. Graham really gave the only trustworthy results.

The results of the later experiments led him to prove that mixed gases might be separated from each other by diffusion. Stems of tobacco-pipes were employed, arranged inside a glass tube, which could be rendered vacuous, the mixed gases being passed through the tobacco-pipe. For example, when this explosive mixture of 66 per cent. of hydrogen, and 33 per cent. of oxygen is passed through this tube (Fig. 3) a mixture is obtained containing only 9·3 per cent. hydrogen, and is therefore non-explosive. With air it was found possible to concentrate the oxygen by 3·5 per cent.

With the apparatus now before us (Fig. 4) Mr. Graham subsequently worked on liquid transpiration in relation to chemical composition. He started from the discovery of M. Poiseuille, that a definite hydrate of one equivalent of alcohol with six equivalents of water is more retarded than alcohol, containing either a greater or a smaller proportion of water. The rate of transpiration depending upon chemical composition and affording an indication of it, it thus appeared probable that a new physical property might become available for the determination of the chemical constitution of substances, and the experiments appeared to establish "the existence of a relation between the transpirability of liquids and their chemical composition. It is a relation analogous in character to that subsisting between the boiling point and composition so well defined by Hermann Kopp." [1] The apparatus consists of a strong glass jar closed at the top by a brass plate into which a condensing syringe is screwed. This plate also had a tube screwed into it, and into the tube the glass bulb with a long capillary tube was fixed. The fluid under examination was placed in the bulb, which communicated freely with the interior of the jar, containing compressed air.

To revert to the chronological order. His next paper in December, 1849, formed the Bakerian lecture of the Royal Society. It was on the *Diffusion* of liquids, and the only apparatus employed was very similar to that adopted in his earliest paper on the diffusion of gases; it consisted of a bottle and glass jar (Fig. 5), the fluid under examination being placed in the bottle, which was immersed in the water with which the jar was filled. With this simple apparatus he found that when two liquids of different densities, and capable of mixing, are placed in contact, diffusion takes place between them much in the same manner as between gases, except that the rate of diffusion, which varies with the nature of the liquids, the temperature and the degree of concentration is slower. Common salt when placed in the inner vessel will diffuse twice as rapidly as sulphate of magnesia, and this salt will diffuse twice as rapidly as gum arabic. Subsequently Mr. Graham modified the disposition of the apparatus and simply introduced the salt to be diffused by means of a pipette to the bottom of a jar filled with water. These experiments led to the very remarkable and important discovery that different compounds might be separated from each other by diffusion, and this was not all, for it was proved that a partial decomposition of chemical compounds was effected by diffusion. Thus ordinary alum was partially decomposed into sulphate of potassium and sulphate of aluminium, which is less diffusible than the first-named salt. Mr. Graham considered this research to be very important, and he remarks, "in liquid diffusion we appear to deal no longer with chemical equivalents or Daltonian atoms, but with masses even more simply related to each other in weight." We may suppose that the chemical atoms "can group together in weights which appear to have a simple relation to each other. It is this new class of molecules which appear to play a part in solubility and liquid diffusion, and not the atoms of chemical combination."

Continuing the investigation he described in a paper of singular beauty, his well-known experiments on the varying rates of liquid diffusion of various soluble substances, which led him to divide them into crystalloids and colloids, the former having a rapid diffusion rate, the latter being marked by low diffusibility. He placed the substance under experiment in a tambourine of parchment paper (Fig. 6) which was floated on the surface of a comparatively large volume of water, the highly diffusive crystalloid passed through the membrane, the colloid remained behind, for "the diffusion of a crystalloid appears to proceed even through a firm jelly with little or no abatement of velocity."

I have here the very interesting series of colloids prepared by Mr. Graham, and of these perhaps the most interesting is the soluble silicic acid. If silicate of soda is poured into diluted hydrochloric acid, the acid being maintained in large excess, a solution of silicic acid is obtained. But this solution also contains, in addition to the silicic acid, chloride of sodium, from which it may be freed by the action of dialysis, and by this means a solution, which is not in the least viscous, is obtained, containing 14 per cent of silicic acid. The coagulation of the silicic acid is effected, however, by the addition of a solution containing the $\frac{1}{10000}$th part of any alkaline or earthy carbonate. Mr. Graham therefore described this gelatinous state as the "pectous," as distinguished from the "peptous" or dissolved form.

By a similar process Mr. Graham obtained specimens of soluble alumina, peroxide of iron, chromic oxide, and stannic acid, all of which have their pectous and peptous states. And he showed that in most cases alcohol, sulphuric acid, and glycerine can replace part of the water of these colloids. I cannot describe these interesting substances now, nor can I do more than remind you of the use of dialysis in medico-legal inquiries. I must content myself with summing up a few of Mr. Graham's conclusions with reference to crystalloids and colloids. Although chemically inert, in the ordinary sense, colloids possess a compensating activity of their own, arising out of their physical properties. While the rigidity of the crystalline structure shuts out external impressions, the softness of the gelatinous colloid partakes of fluidity, and enables the colloid to become a medium for liquid diffusion like water itself. Another and eminently characteristic quality of colloids is their mutability, as fluid colloids often pass from the fluid to the pectous or gelatinous condition under the slightest influences. The colloid is, in fact, the dynamic state of matter, the crystalloid being the statical condition. The colloid possesses *energy*, and it may be looked upon as the primary source of the force appearing in the phenomena of vitality."

The next instruments to be considered are those with which Mr. Graham studied osmotic force. When a solution of a salt, or a liquid, is separated by a membrane or porous diaphragm from a mass of water, a flow of liquid takes place from one side of the septum to the other. This action was discovered by Dutrochet, and is known as osmose. Dutrochet and Mr. Graham both used a narrow glass tube, having a funnel-shaped expansion at the bottom, covered at that end by a piece of bladder (Fig. 7). Mr. Graham also used porous earthenware and albuminated calico.

In some cases the flow of liquid into the bulb is sufficiently powerful to sustain a column of water many inches high in the glass tube. Dutrochet inferred from his experiments that the velocity of the osmotic current is proportional to the quantity of salt or other substance originally contained in the solution. He attributed the action of the septum to capillarity, but Mr. Graham ultimately considered that the water movement in osmose is "an affair of hydration and dehydration of the substance of the membrane or other colloid septum," and that the diffusion of a saline solution only acts by affecting the hydration of the septum. The outer surface of the membrane being in contact with pure water, tends to hydrate itself in a higher degree than the inner surface does, the latter surface being supposed to be in contact with a saline solution. When the full

[1] Phil. Trans., 1861, p. 373.

hydration of the outer surface extends through the thickness of the membrane and reaches the inner surface, it there receives a check. . . . The contact of the saline fluid is thus attended by a continuous catalysis of the gelatinous hydrate, by which it is resolved into a lower gelatinous hydrate and free water. Now this question of hydration is perhaps the most remarkable instance of the persistent continuity of Mr. Graham's work, as Dr. Odling has pointed out,[1]—"it is noteworthy that for him (Mr. Graham) osmosis became a mechanical effect of the hydration of the septum; that the interest attaching to liquid transpiration was the alteration in rate of passage consequent on an altered hydration of the liquid, and that the dialytic difference between crystalloids and colloids depended on the dehydration of the dialytic membrane of the former class of bodies only."

I must now direct your attention to a section of Mr. Graham's work, which, although it was the last, was a reversion to some of his very earliest experiments. In 1829, under the title, "Notice of the Singular Inflation of a Bladder," he described the following experiment:—A bladder two-thirds filled with carbonic acid was introduced into a bell jar filled with carbonic acid gas; after the lapse of some hours the bladder was found to contain 35 per cent. of carbonic acid, and to have become distended. Mr. Graham observes:—"M. Dutrochet will probably view in these experiments the discovery of endosmose acting upon aëriform matter as he observed it to act on bodies in a liquid state. Unaware of the speculations of that philosopher at the time the experiment was made, I fabricated the following theory to account for them:—The jar of carbonic acid standing over water, the bladder was moist, and we know it to be porous. Between the air in the bladder and the carbonic acid without there existed capillary canals through the substance of the bladder, filled with water. The surface of the water at the outer extremities of these canals being exposed to carbonic acid, a gas soluble in water would necessarily absorb it. But the gas in solution . . . permeated the canal, and passed into the bladder and expanded it."[2]

You will remember that in the concluding experiments on the diffusion of gases Mr. Graham employed a tube, closed with a graphite disc (Fig. 2), in which a Torricellian vacuum could be produced. In his experiments on the penetration of different gases through membranes the same apparatus was employed, only the disc of graphite was replaced by a film of india-rubber. He found that gases penetrated to the vacuous space at the rates given in the last column of the table (p. 512). You will observe that the gas which penetrates most rapidly is carbonic acid, and you will also see that the rates of passage are in no way connected either with those of diffusion or transpiration.

A comparison of the relative rates of passage of oxygen and nitrogen led to a most remarkable experiment. Oxygen penetrates 2½ times as fast as nitrogen, therefore by dialysing air Mr. Graham actually increased the quantity of oxygen from 20·8 to 41 per cent., just as he had effected, by the aid of a tobacco-pipe, a partial separation of oxygen from air by the slightly greater diffusion velocity of nitrogen. The Torricellian vacuum was ill adapted for the experiments, and Mr. Graham gladly availed himself of the mercurial exhauster devised by Dr. Hermann Sprengel, and he considered that without the aid of this instrument it would have been impossible to conduct certain portions of the research. He was thus able to use larger septa of india-rubber, bags of waterproof silk being found to be most convenient (Fig. 8). The vacuum was not even absolutely necessary, for the penetration of the nitrogen and oxygen of air through rubber into a space containing carbonic acid could be readily effected, the gas being absorbed by potash at a certain stage of the operations.

Mr. Graham considered this penetration to be due to an actual dissolution of the gas in the substance of the india-rubber, for, as he observes, "gases undergo liquefaction when absorbed by liquids and by soft colloids like india-rubber," words I think of interest, when we remember that the sentence only marks a slight extension of the view he expressed in his first paper in 1829.

These discoveries led Mr. Graham to inquire whether it was probable that the discovery of MM. Troost and Deville of the penetration of red-hot platinum and iron tubes by hydrogen, could be due to an actual absorption and liquefaction of the gas in the pores of the metal, and by submitting the question to the test of experiment it was proved that such an absorption did take place.

[1] Lecture on "Prof. Graham's Scientific Work," Royal Institution, January, 1870.

[2] Quart. Journ. Sci., 1829, p. 88.

For instance, palladium was found to act as platinum only in a more marked manner. A tube of palladium when attached to the mercurial exhauster did not allow hydrogen to pass in the cold, but when heated to redness in an atmosphere of hydrogen the gas passed through the walls of the tube at the rate of 4,000 cubic centimetres per square metre in an hour (Fig. 9). This led to the remarkable discovery of the absorption or occlusion of gases by metals. It was found that nearly all metals appear to select one or more gases. Silver, for instance, absorbs many times its volume of oxygen, and under certain circumstances gives it out again on cooling. Iron is specially characterised by its absorption of carbonic oxide, but it also retains hydrogen, and this fact led Mr. Graham to extract from meteoric iron, the gas that probably affected its reduction to the metallic state, and which certainly exists in the atmosphere of certain stars.

The most remarkable results were obtained with palladium. I called your attention at the beginning of the lecture to the index which you will observe has moved six inches.

I will now describe the apparatus; it consists of a tall jar filled with acidulated water; at the bottom of the jar two wires are fixed, and these wires are parallel throughout the entire length of the jar. Each is attached to the short arm of a lever, the longer arms of which are about five feet long. One wire is of palladium, the other of platinum, and they form the electrodes of a small battery capable of decomposing the water. The palladium now forms the negative electrode, and is freely absorbing hydrogen, the excess of which is escaping from its surface. The absorption of hydrogen has been attended by a considerable expansion, as is shown by the fall of the index. The index attached to the platinum wire has of course remained stationary.

This expansion enabled Mr. Graham to calculate the density of the gas in its condensed form, and for reasons which I cannot give you now he was led to believe that hydrogen gas is the vapour of a white magnetic metal of specific gravity 0·7.

Now by taking palladium which has been charged in the manner you have seen, and heating it *in vacuo*, I can actually extract and show you the hydrogen it contained. This little medal of palladium contains an amount of gas condensed into it which would be equivalent to a column of gas more than a yard high, and of the diameter of the medal.

The story of Mr. Graham's work has been much better told by Odling, Williamson, Hofmann, and Angus Smith, but what does it teach us from a point of view of a collection of scientific apparatus? Surely that, although in certain researches or for accurate observation and measurement, delicate and complicated instruments may be necessary, the simplest appliances in the hands of a man of genius may give the most important results. Thus we have seen that with a glass tube and plug of plaster of Paris, Mr. Graham discovered and verified the law of diffusion of gases. With a tobacco-pipe he proved indisputably that air is a mechanical mixture of its constituent gases. With a tambourine and a basin of water he divided bodies into crystalloids and colloids; and obtained rock crystal and red oxide of iron soluble in water. With a child's indiarubber balloon filled with carbonic acid he separated oxygen from atmospheric air, and established points, the importance of which, from a physiological point of view, it is impossible to overrate. And finally, by the expansion of a palladium wire, he did much to prove that hydrogen is a white metal.

GERMAN EXPEDITION TO SIBERIA[1]

"WE stayed in Lepsa until May 17. We obtained some varieties of lizards, one kind of frog, and a toad, a kind of fish like the barbel, and all sorts of varieties of cobitis, but no salmon. We obtained only a few beetles and butterflies, but we had a rich collection of the flora. On May 13 and 14 we made a short excursion into the mountains and found several new kinds of birds differing decidedly from the European kinds, *e.g.*, the *Cinclus leucogaster*, with the white belly, the *Motacilla personata*, the *Pica leucoptera*, a fine Carduelis, and a splendid specimen of the red-finch.

"On May 15 we made a long excursion to the Dschasyl Kul (green lake), 6,000 feet above the level of the sea. The abundance of trees and bushes has a most agreeable effect, and above all is the mild red and pink of the wild apple-tree (*Pirus Sieversianus*) pleasing to the eye. The lake, lying amongst high

[1] The second letter dates from Saissan, in Russian Turkestan, May 27, 1876. Continued from p. 359.

mountains covered with snow, is surrounded by beautiful fir and other trees. We threw out our dredge but without success, neither did we see any large game, *e.g.*, steinbok or maral. The maral is a kind of stag entirely different from ours, with immense antlers, which are very rarely to be obtained, as they are considered a delicacy by the Chinese, who eat these antlers before they are quite developed, *i.e.*, in their *soft*, hairy state. For a pair of antlers scarcely eight inches high, the Kirghiz asked twenty rubles.

"On May 17 we left Lepsa and turned again towards the lake Ala Kul, this time to its east side. While crossing the height that closes the valley of Lepsa on the north, we mounted a peak whence we had a most beautiful view, especially of the high distant Ala Tau with its cones covered with eternal snow. On the 18th we descended into the steppe after having once more camped in yurts upon the mountains; it began to be very warm. The road leads through the steppe; it is for the greater part covered with reeds, and shows everywhere traces of boars, so we guessed to be near the lake, which we reached towards night. Numerous cranes, ducks, pelicans, gulls, and other water-fowl and moor-fowl animated the shore.

"On the 19th our road led through a grass-steppe covered with hemlock and rhubarb, and interspersed with bare alkali-soil; near the rivers were numerous 'auls' of the Kirghiz, with herds of cattle, and here and there showing some cultivation rendered possible by artificial irrigation; the Kirghiz understand perfectly the methods of damming and irrigating. Towards evening we reached the village Urdshar inhabited by Cossacks and Tartars, and continued our journey on the 20th, accompanied by a picket of twelve Cossacks from Bagti, who for ten days had been awaiting our arrival. The steppe was here by no means monotonous, it was even rendered picturesque by the view of snowy mountains around. Perhaps larks, in six or seven varieties, are the commonest birds here, besides these the black-headed wag-tail, the red-throated tit-lark, steppe-fowl, bustards, and cranes: of these mostly *grus virgo*. Wild geese (*Anser cinereus*) animate the steppe in great numbers, wherever there is stagnant water. We find our house-sparrow near the solitary yurt camp, and the swallow (*Hirundo rustica*) tries continually to build her nest on the top ring of the yurt. Where the grass is higher the quail is to be seen, and our cuckoo belongs to those birds which first greet the early morn. Everywhere we found the *Charadrius gregarius* single; the females already bringing out their young ones, are so tame that they allow you to approach within ten steps. Here we saw for the first time the saiga antelopes; they were unfortunately too shy and kept out of range. Late at night we arrived in Bagti, a clean but small military village, with barracks and soldier's houses; on May 21 we entered the Celestial empire, and advanced towards Tschugutschak, only twenty-one versts from Bagti. We passed over a hillock and the town was lying before us; we saw the brown clay walls of low, flat houses, little differing in colour from the steppe. We passed through the narrow streets, and the many-cornered bazaar (partially roofed) to the houses of the Governor-general (Dschansun) Djun, the great Barrack; all along our road we were followed by the astonished-looking faces of strange, queer figures. At the gate we had to get off our horses and, according to Chinese custom, ask permission to enter; we were then received at the hall-door by an elderly gentleman of about fifty, and introduced to his general. It was very hard to keep up a conversation, as every word had to be translated from Chinese into Kirghisian, Russian, and German, and *vice versâ*; on the whole the old gentleman treated us with the well-known speeches of Chinese politeness, placing everything at our disposal, &c. We went to see the bazaar, which contained little really Chinese ware, and so we bought nothing worth mentioning; from there we went into the quarter of the Tartars and had a very good dinner with a rich Tartar, whose very pretty wife, picturesquely dressed, presided. Tamar Bey, our Kirghisian friend, a Mahometan, had to remain outside. The governor kindly offered to provide night-quarters but we declined, and proceeded on our journey before evening; we were told that the nearest yurts were only eighteen versts distant, and so I too determined to ride in spite of my great fatigue. Unfortunately the yurts were thirty versts distant instead of eighteen, moreover the Cossack who accompanied me lost his way and so we arrived after having done thirty-five versts.

"We rested now for thirty-six hours and then went on with telegas, but could not get on very quickly on account of the intense heat (100° F. at noon in the sun and 108° F. in the yurt).

"The road to Saissan led over a steppe more than 3000 feet high, bordered on both sides by mountain ranges. We were still on Chinese territory, yet near small, rapid mountain streams, we passed here and there yurt camps of the Kirghiz and Kalmucks, Russian subjects who pasture their herds quietly on Chinese ground and grow oats and rye by help of Chinese irrigation; they are unmolested by the owners of the land or the 'Tungans,' who are mortally afraid of everything called Russian. Late in the evening of May 24 we reached a plateau high up in the mountains, and rested the whole of the 25th, enjoying the cool refreshing mountain air. The place is called Bugutusai, and is a frontier picket. During summer there are twenty-five Cossacks stationed here who have to chastise immediately any inroads of the 'Tungans.' There is always a post on a pretty high mountain, whence there is a good view far into China, as far as the snow-covered heights of the Urkandscha mountains. Not far from there are great heaps of stones, the remains of Chinese frontier posts, the garrisons of which were killed this spring by the Tungans. Near our place was a small river in which were crab-like animals. Towards evening came Dr. Pander from Saissan; he is the son of the famous anatomist who, together with d'Alton, published valuable atlases; besides refreshments he brought letters, the first which we obtained since leaving St. Petersburg. We started again early on the morning of the 26th, and descended into a plateau bordered for about fifty versts by the northernmost range of the Tarbagatai. The steppe consisted nearly throughout of gravel and stony soil hardly covered with plants; it was the most monotonous steppe we had seen so far with the exception of the pure salt steppe. The mountains by which it was surrounded gave it the appearance of a pleasant picture, but the heights danced in the heated air in a most fantastic way. After having crossed the plateau we found Aarantassas awaiting us; they brought us towards evening into Saissan, where we were most hospitably received in the house of Major Techanoff, the chief of the district who had accompanied us hither from Lepsa. The road was very good, but leads uninterruptedly through bare ravines in the fantastically weathered slate and green but treeless cones of mountains down into the steppe of the black Irtish, bordered at the horizon by the dim snowy heights of the Altai. As soon as we reached the plain we found ourselves on the regular post-line with its verst poles. Saissan is only a military post and consists of small neat-looking houses, broad streets with canals and planted with willows. It is an important place for the trade with China, and will be more important after being made a city. Even now large camel caravans pass through Saissan providing the Chinese army with flour; therefore there is more life here than is elsewhere to be found in this region."

THE "CHALLENGER" EXPEDITION

WE publish with pleasure the following additional testimony to the value of the *Challenger* Expedition:—

To the Editor of "Nature."

20, Palmerston Place, Edinburgh, October 2, 1876.

DEAR SIR,—Perhaps you will kindly allow me through your pages to make known to my colleagues of the *Challenger* Expedition the accompanying gratifying resolution passed at the late meeting of the Naturalists and Physicians of Germany.

Believe me, yours very faithfully,
C. WYVILLE THOMSON.

To Sir Wyville Thomson, Professor of Zoology at the University, Edinburgh.

Hamburg, September 21, 1876.

THE forty-ninth meeting of German Naturalists and Physicians, the first which has taken place since the return of the expedition of the *Challenger*, has, in its general session of September 20, unanimously resolved to express its recognition and thanks to the promoters and to the members of this expedition, by which the knowledge of the physical and biological conditions of the ocean has been so greatly extended.

We have the honour to communicate to you this resolution by forwarding the accompanying extract from the Protocol, and pray you to make it known to all concerned.

The Presidents of the Forty-ninth Meeting of German Naturalists and Physicians,

SENATOR KIRCHENPAUER,
DR. DANZEL.

Extract from the Protocol of the Second General Session of the forty-ninth meeting of German Naturalists and Physicians. Hamburg, September 20, 1876.

Prof. Möbius proposed the following motion:—

GENTLEMEN,—I have had frequent occasion to allude to the great expeditions of the *Challenger* and of our *Gazelle*. I could only give you mere indications of what has been so promptly communicated to us by the leaders and scientific explorers of these expeditions, and been thus made the common property of all nations which cultivate science. This assembly of naturalists is the first which has met since the completion of the expedition of the *Gazelle*, commanded by Baron v. Schleinitz, and extending over nearly two years, and since the termination of the expedition of the *Challenger*, under the command of Nares and the scientific directorship of Thomson, after a voyage of three years and a half. I therefore take the liberty of proposing that this assembly express to the promoters and to the members of the expedition of H.M.S. *Challenger* and of H.I.M.S. *Gazelle*, its recognition and thanks for their successful labours in the domain of oceanic exploration.

The motion was then put and passed with acclamation.

I. ARTHUR F. MEYER
Secretary of the forty-ninth Meeting of German Naturalists and Physicians.

NOTES

THE fifth "Exposition des Insectes utiles et des Insectes nuisibles," arranged under the auspices of the Société Centrale d'Apiculture et d'Insectologie, has been held during the last four weeks in the Orangery of the Tuileries, and closed on Sunday. The first exhibition of the kind was held at the Palais de l'Industrie, in 1865, there was a second in 1868, and at the third, in 1872, it was determined to make it bi-annual. The society has three separate committees, one on apiculture, one on sericiculture, and one on general insectology, which sit once a month, and the exhibitions are likewise divided into three corresponding sections. The section devoted to apiculture was much like the bee shows held at the Crystal and Alexandra Palaces, and included a show not only of different breeds of bees, but all appliances employed or suggested as improvements. We naturally have not in England any shows analogous to the section of sericiculture as silkworm rearing is here, only an amusement and not a business. Nor, unfortunately, have we any exhibitions analogous to the section of general insectology, and here it would be well if we learnt a lesson from our French neighbours. The society is endeavouring in various ways to educate the country to a knowledge of the distinction of what insects are useful and what are destructive to crops, granaries, garden-produce, wood, textile fabrics, &c. For this purpose they encourage the formation of collections of insects, each destructive species being accompanied by an illustration of what it preys on. In this respect we are in point of quality still ahead, for the best collection there was not so good as ours at Bethnal Green, made by Mr. Andrew Murray, F.L.S. They were, however, able to show several collections, while we have but one. But besides this they use the elementary schools of the country as a channel for instruction. They offer prizes to these schools for essays and for magnified drawings of insects, the work of the pupils. On one of the tables in the exhibition, a number of the essays were exhibited, and on the walls many of the drawings were shown. The *Morning Post* in speaking of the entomological collection at the Bethnal Green Museum alluded especially to the drawings made by Mr. Andrew Murray, and suggested they should be used as copies in art schools, and that thus the information they teach would be scattered over the country. This same kind of idea is, it seems, already carried out in France. The drawings there, however, are outline pen and ink sketches only, sometimes made from the teacher's copy, sometimes the result of the pupil's own dissections. We have in England a machinery ready at hand for teaching practical entomology, viz., the Science and Art Department. It would not be a very difficult matter to add that to the list of subjects on which teaching is given and examinations are held. Those who know how much the country loses annually by insect ravages would best estimate the value of such teaching that might be turned to practical account.

A LETTER has been received from Capt. Allen Young, of the *Pandora*, who it will be remembered was to endeavour to communicate with or bring back letters from our Arctic Expedition. Capt. Young's letter is dated Upernivik, July 19. He has absolutely nothing to tell of the expedition, as might be expected. He has every reason to believe that the weather in the far north has been favourable to progress. Capt. Young does not state what his next course is, and refers to a previous letter, not received.

OBSERVATIONS have been published by several French provincial papers on the meteor of September 24. One of the most accurate was in the *Echo du Nord*, published at Lille. The apparent diameter of the meteor is stated to have been equal to the moon in opposition; the same measure was given by M. Bamberger, the member for Dunkirk, as reported by that gentleman in a letter to M. Leverrier. The position of the meteor was below Ursa Major, on the eastern side, at 20° from the horizon for Lille. The time in Dunkirk and Lille was the same, 6h. 40m. local time, Dunkirk being a few minutes behind owing to the western longitude. The colour was almost the same, having been described as reddish-blue at Dunkirk and reddish-violet at Lille. A surgeon at Dunkirk said he had heard a hissing sound; a sound was also heard at Lille by a number of people. It was an explosion (*fracas*) according to ear-witnesses, and took place three minutes after the appearance. If correct, that observation shows a distance of about 60 kilometres. M. Leverrier is collecting and examining statements before entering into a calculation. The light was seen by him at the observatory, as reported before the French Academy of Sciences on the following day. It was seen by a number of persons in Paris. The cloud of burning matter and ashes was observed for a considerable time—at least fifteen minutes.

WE are glad to see that means have been taken to obtain subscriptions in aid of the family of the late Mr. George Smith, as a public testimonial of respect to his memory. Contributions to "The George Smith Fund" should be sent to Mr. J. W. Bosanquet, 73, Lombard Street, E.C., in the name of Sir Henry Rawlinson and Dr. Birch.

WE learn from the *Chronique de l'Acclimatation*, that in the just completed New York Aquarium immense basins have been constructed for the reception of the large cetaceans. A number of Otaries have already been received from Behring Strait, and the proprietors hope to be able to exhibit to the public the famous seal Ben Butler, which has for many years frequented the island of San Domingo, in the Bay of San Francisco; the director has offered 5,000 dollars for this curiosity. For the purpose of facilitating scientific researches, the central building contains a library of the best works in natural history, pictures, scientific journals, a laboratory, microscopes, drawing-tables, dissection-room, and all the necessary materials for modelling and photography. Finally, the establishment contains a restaurant in which will be served fish and crustaceans caught before the eyes of the consumer.

PROF. TURNER, of Edinburgh, desires us to correct a misapprehension which appears in our brief notice (NATURE, vol. xiv. p. 485) of his paper on the Placenta, read before Section D of the British Association at Glasgow. He states that the restriction of area in the more complicated forms of placenta does not diminish but increases the danger of hæmorrhage after parturition. Prof. Turner also wishes us to say in reference to the note on p. 466, as to M. Broca, that that anthropologist in the *Revue d'Anthropologie*, 1876, t. v. No. 2, has given a critical account of Prof. Turner's paper on Cerebral Topography, as also of the writings of MM. Gratiolet, Heftler, and Féré. We may here also state in reference to the report of Prof. W. C. Williamson's paper at the Brit. Ass. (vol. xiv., p. 456), that what Prof. Williamson really said was that the fossiliferous rocks would be the true battle-field on which the problems of evolution would be fought out.

IN the *Aftonblad* of the 19th Sept. a letter was published from Dr. Théel (of Nordenskjöld's Siberian Expedition), in which he states that, after travelling for ten days by steamer, first on the rivers Tura and Tobol, and then on the Irtisch and the Obi, his party arrived on June 3 at Tomsk, and on the 8th at Krasnojarsk. Starting from the latter town on June 16, they arrived at Jeniseisk on the 18th, and at Turuchansk on July 16, and were at that date hoping to be at Dudinskoj by the 25th of the same month. The party had made rich collections, both zoological and botanical.

THE Russian Count Oovarof, is preparing a great work on the "Stone Age in Russia," which will be published in Moscow, with numerous illustrations. Such a work is much wanted, owing to the large accumulation of material during the last few years, and to the absence of any systematic account of them. So far as we know, there have appeared in Russia during recent years, only two monographs devoted to the subject, one by M. Holmberg, on the stone and bronze implements of Finland ("Bidrag till kännedom of Finlands natur och folk," 1858), the other by M. Poliakoff, on the stone age in the Olonetz province ("Mem. R. Geogr. Soc.," 1874).

IT is proposed among the physicians and hygienists of St. Petersburg to open there a Hygienic Society, which will be in close connection with the London Sanitary Institute and with the Paris Société Nationale d'Hygiène. Hygiene obtains great attention among Russian physicians, and the fortnightly periodical, *Zdorovie* (*The Health*), has already published, during the first half year of its existence, some very valuable original papers by MM. Arkhanguelsky, Skvortsoff, Shapiro, Gué, Ucke, Hübner, Erisman, Tarkhanoff, Dobroshavin, and others.

THE investigation of the upper parts of the atmosphere by means of balloon ascents continues to interest Russian *savants*. Some very valuable additions to our knowledge of the subject have been made during recent years by Prof. Boltzang in Kasan, and by Lieut. Rykatcheff, of the Central Physical Observatory, who took advantage on many occasions of the public ascents of M. Berg. But neither was able to extend their observations to great heights. Now, the Professor of Chemistry of the St. Petersburg University, M. Mendéléeff has devoted to further researches in this direction all the profits which may be received during the next five years from his widely-circulated "Handbook of Chemistry" and other works, as well as the whole profits of a just-published Russian translation, under his editorship, of Prof. Mohn's "Meteorology." It is proposed to construct a large captive balloon, of from two to three thousand cubic metres, and to fill it by apparatus specially devised or modified for the purpose by the Professor.

THE last numbers of the *Bulletin* of the Siberian branch of the Geographical Society, published in Irkootsk, contain an elaborate monograph of the fishes of the Baikal, by M. B. Godlefsky.

PREPARATIONS are being made in St. Petersburg for the celebration of the hundred and fiftieth anniversary of the Academy of Science, which will be held in the same manner as the fiftieth and hundredth anniversaries in 1776 and 1826. It is rumoured that the Academy purposes largely to increase the number of its honorary and corresponding members, both foreign and Russian, and that a special meeting will be held in honour of the library of the Academy, the first scientific library opened for the public in Russia (October 25, 1728), and which is now one of the richest in Europe in its Natural Science Department, and in the valuable collections of scientific periodicals received from nearly all the scientific societies of Europe and America.

A WEST Siberian branch of the Russian Geographical Society, receiving a yearly subsidy of 2,000 roubles from the government, will be opened at Omsk. It is hoped that the new section (the sixth section of this large society) will do as much for the extension of our knowledge of the little-known Western Siberia as the East Siberian branch at Irkootsk has done for Eastern Siberia. This last, which enters upon the twenty-sixth year of its existence, has largely contributed to the exploration of nearly every part of its region, from the Polar Sea to the interior of China, and from the Jenissei to Behring Strait, and has published (besides the works which have appeared in the periodicals of the St. Petersburg Geographical Society, of the Imperial Academy, &c.) the well-known Travels of M. Maack, Annual Reports, and a very valuable series of *Memoirs* (eleven vols.) and *Bulletin* (five vols.). We hope that the new section will take more pains to circulate its periodicals than has been the case with her older sisters, the periodicals of the Irkootsk branch being, we are told, almost bibliographical rarities even in St. Petersburg.

THE remarkable palæontological and mineralogical collections of the deceased Prof. Folborth, being the result of more than forty years' labours in Russia, are now, according to his bequest, in the possession of the St. Petersburg Academy of Science.

ON Wednesday, September 20, an earthquake was felt at Digne, the chief town of Basses Alpes, at seven in the morning. The motion was considerable, although the damage was slight. The last time Digne was visited by a similar phenomenon was in 1873. A destructive one took place on August 14, 1708, and from that time slight disturbances have been comparatively frequent.

A FEW days since there died in Paris, at the age of sixty-one, M. Joseph Julien, a clockmaker, who had succeeded in directing a small elongated balloon with a screw moved by a spring. The experiment was tried with success in the Hippodrome at Paris, in 1849–50, and attracted much notice. M. Julien died an inmate of St. Anne's Asylum for the Insane.

MR. JOHN EVANS, F.R.S., has just published a *brochure* likely to be of great service to collectors of bronze implements, weapons, and ornaments; it is entitled "Petit Album de l'Age du Bronze de la Grande Bretagne" (London: Longmans and Co.), for the letter-press is in French. This is explained by the fact that the collection was prepared for the meeting of the Prehistoric Congress at Buda-Pest, the official language of which is French. This *brochure* is a mere scintillation from a much larger book which Mr. Evans has been preparing for some years, but which unfortunately does not seem to be near completion. There are twenty-six plates altogether, each with an average of about six figures of various bronze articles, embracing specimens of almost everything in prehistoric bronze that has yet been found. The plates are beautifully executed, and are accompanied by descriptions of all the articles represented.

THE death is announced, on September 30, of the Rev. Henry Wilkinson Cookson, D.D., the Master of St. Peter's College, Cambridge.

MR. W. H. PREECE (Memb. Inst. C.E.) is about to proceed to America, under instructions from the Postmaster-General, to inspect and report upon the technical and scientific arrangements of the telegraphs in the United States. This is one result of the report of Dr. Lyon Playfair's Select Committee.

A BERNE observer has registered the number of days when the shade temperature had exceeded 20° C. in the last twenty-eight years (1849–1876). The number in each of the twenty-eight years is as follows:—31, 19, 22, 27, 22, 11, 17, 29, 30, 26, 47, 10, 37, 16, 34, 20, 30, 24, 31, 56, 31, 56, 31, 44, 38, 26, 40, 55. No regularity whatever is exhibited.

IT is rumoured that the Colorado beetle is amongst us, and unfortunately not confined to the cabinets of collectors.

A BILL is being framed to be brought before Parliament next session for the incorporation of the Andersonian University, Glasgow. The Bill will provide for a change of name and several important modifications in the constitution.

THE progress of education in Russia has in recent years been very marked. In April 1866 the Czar appointed Count Tolstoi Minister of Education. In commemoration of his first ten years of official activity, this minister has recently published a "comparative map of the higher and middle educational institutions of the ministry of education in the years 1866 and 1876." The facts expressed by the map are given in tabular form, in a recent number of the *Russische Revue*, and the following extract will show, in general form, the increase in number of higher and middle educational institutions during the decennium in question:—

	1866	1876
Universities and other higher institutions ...	8	18
Gymnasia	101	133
Pro-gymnasia	7	69
Real-schulen and Real-gymnasia	11	53
Technical institutions	—	11
Seminaries for teachers	9	60
Girls' gymnasia and schools of first rank ...	39	66
Girls' pro-gymnasia and schools of second rank	55	148
	222	540

UNDER the title "L'Erborista Toscano," the eminent professor of botany at Pisa, Prof. Caruel, publishes an analytical key to the natural orders, genera, and species of Phanerogams and Vascular Cryptogams (or, as he terms them, Prothallogams) found wild in Tuscany.

UNDER the title "Contributions to the Flora of Iowa," Mr. J. C. Arthur prints a list of the flowering plants of the State, 979 in number, including varieties and introduced species, with critical notes on some of the species.

WE have before us the *Bulletins* of the Torrey Botanical Club of New York, Nos. 17–20 of vol. vi. They comprise a list of the Musci and Hepaticæ of Colorado collected by T. L. Brandegee in 1873–75, and determined by E. A. Rau; notes on some rare southern plants, by H. W. Ravenel; and several minor papers, chiefly of local interest.

WE have a useful contribution to botanical biography in a sketch by Prof. E. Morren, "Mathias de l'Obel (Lobelius), sa vie, et ses œuvres, 1538–1616."

THE additions to the Zoological Society's Gardens during the past week include five Perch (*Perca fluviatilis*) from British Fresh Waters, presented by Master B. L. Sclater; a Rüppell's Spur-winged Goose (*Plectropterus rüppelli*) from East Africa, a Grey Struthidea (*Struthidea cinerea*) from Australia, two Chinese Jay Thrushes (*Garrulax chinensis*) from China, deposited; four American Darters (*Plotus anhinga*), two Boatbills (*Cancroma cochlearia*), a Sun Bittern (*Eurypyga helias*), two Black-faced Ibises (*Geronticus melanopis*), a Stilt Plover (*Himantopus nigricollis*), two Bahama Ducks (*Pœcillonetta bahamensis*), a Red-billed Tree Duck (*Dendrocygna autumnalis*) from S. America, a Slaty-headed Parrakeet (*Palæornis schisticeps*) from India, purchased.

SCIENTIFIC SERIALS

THE recent numbers of the *Journal of Botany*, Nos. 161–165 (now edited solely by Dr. H. Trimen), contain no one article of very special interest; but several interesting contributions to foreign and British botany of a more or less technical character, and strongly illustrating the present tendency of British botanists to devote themselves to systematic and nomenclatorial, to the almost entire exclusion of morphological and physiological work. —Dr. R. Spruce describes a new genus of Hepaticæ, and the Rev. M. J. Berkeley two new genera of Fungi, under the names respectively of *Anomoclada*, *Kalchbrennera*, and *Macowania*; and the Rev. J. M. Crombie some new Lichens from Rodriguez. —Mr. Hemsley and Dr. Hance add to our stock of information on the botanical products of China and Cambodia.—Dr. M. T. Masters identifies the pear recently discovered in Britain and described under the name of *Pyrus communis* var. *Briggsii* with the well-known continental *P. cordata* of Desvaux.—Mr. J. G. Baker continues his useful work on the hitherto little-studied Irideæ, his contributions in the present number including the Ixieæ and the genera *Aristea* and *Sisyrinchium*, with descriptions of a new *Xiphion* and *Crocus* from the Cilician Taurus.—There are many minor notes of much interest.

THE *Nuovo Giornale Botanico Italiano*, edited by Prof. Caruel, has increased its number of pages in each part; but, with its increase in quantity, has suffered no deterioration in quality. Indeed, the Italian botanical journal is now among the most important of European serial publications in botany. In the two numbers before us, the second and third for the present year, the articles of interest are so numerous that we can only glance at some of the most important, at the risk of doing scant justice to the remainder. The longest article is one which extends over the two numbers, on the alimentation of cellular plants, by G. Cugini. The result evidently of great labour and research, it is impossible even to give an abstract of the conclusions at which the writer arrives. With regard to the relative importance of the various elementary substances of which the food of plants is composed, he differs somewhat from the results arrived at by Sachs and detailed in his "Text-book," especially in considering potassium, calcium, magnesium, and iron as of nearly equal value in the vegetable economy. He thinks that potassium has a somewhat similar relationship to the carbohydrates to that which phosphorus bears to albuminoids. Signor Cugini's list of the essential food-materials of plants comprises organic carbonaceous substances, water, ammoniacal salts, sulphates of potassium and iron, phosphate of magnesium, and an alkaline silicate; and that of non-essential ingredients, in the order of their importance, the chloride, iodide, or bromide of sodium or potassium, the phosphate, nitrate, or sulphate of calcium, and salts of zinc, manganese, and aluminium.—Prof. Delpino contributes a paper on dichogamy and homogamy in plants, which is of great interest in view of Mr. Darwin's promised work on cross-fertilisation and self-fertilisation. After classifying plants into homogamic and dichogamic, he further subdivides the former class into homoclinic, in which the pollen fertilises the ovules in the same individual hermaphrodite flower; homocephalic, in which it fertilises ovules in flowers belonging to the same inflorescence; and monœcious, in which fertilisation is effected on ovules contained in flowers on a totally different part of the same individual. A series of experiments indicated that the fecundity resulting from pollination was in an inverse order to that given above.—Dr. G. Gibelli has made a careful examination of the infolded leaves of *Empetrum nigrum*, a common plant on our mountain heaths, and finds a striking resemblance, on a miniature scale, to the pitchers of *Nepenthes*, *Sarracenia*, &c., suggesting also an analogy of function. The paper is illustrated by two well-executed plates.—Cryptogamic botany comes in for its full share of attention.—In addition to papers On the Bacteria parasitic on fungi, by Dr. Lauzi, On the structure of *Pilularia globulifera* and *Salvinia natans*, by G. Arcangeli, and On *Isoëtes Duriæi*, by A. Piccone, there are others on the fungi of Venetia, on the Hepaticæ of Borneo, on new Italian fungi, and on the mosses of Liguria.

Der Naturforscher, April—July.—In the numbers we note an account, by M. Hoffmann, of a singular phenomenon in an orchard near the village of Heuchelheim. A large fire occurred in the village in the beginning of September, and four weeks after it numerous trees in the orchard (pears and damsons, *e.g.*) that had been singed by the fire began to vegetate anew, putting forth tender green leaves and blossoms, often by the side of fruits which the fire had spared. Examining the wood with a microscope he found the starch contents of the cells transformed into a pulpy mass; sugar was present both in the singed and the unsinged trees. M. Hoffmann tried to reproduce the above phenomenon artificially, but failed, doubtless through not hitting the right temperature.—In another botanical paper M. Pringsheim maintains that the red in Florideæ is a modification of the green in these plants, and not an immediate modification of the chlorophyll of phanerogams.—There is an instructive abstract in the May number of M. Suess' recent work on the origin of the Alps. He considers the members of the Alpine chain to have been formed not through a pressure from below upwards, in the middle, but by a horizontal force acting towards the north or north-east and capable of being deflected by obstacles in its superficial action. In North America and in great part from the Pacific Ocean to the Caspian the same direction of force appears; but further east, *e.g.*, in the Red Sea and Indian Valley the direction is different; in the highlands of Central Asia the prevailing movement is towards the south and south-west. M. Suess specifies various forms of mountain-formation.—We note an interesting lecture by M. Jäger on the significance of gill-slits in taking of food. They permit rapid escape of the water sucked in (but not of the morsel) and in a backward direction, not interfering with advance of the fish. In fish that chase their prey the gills open widely. In flowing water fishes have in general wider gill-slits than in still. Gill-less amphibia get their food mostly in the air or on the surface. Tritons take food under water awkwardly as compared with fishes, and they prefer large bites that the outflow of the water may be facilitated.—In a paper on conceptions of the arrangement of atoms, M. t'Hoff denotes as an "unsymmetrical carbon-atom" one which is combined with four different elements or radicals. He affirms that every compound containing such an atom must be able to exist in at least two isomeric modifications. Further, the optical activity of an organic substance is caused by the presence of an unsymmetrical carbon atom.—We find in the June number a brief account of Dr. Bessel's observations on the intensity of heat radiation from the sun in high latitudes. This, it appears, increases with the altitude of the pole.—M. Sanson has been making observations on the excretion of carbonic acid in the larger domestic animals. Genus and species have influence on the respiration; thus, Equidæ excrete more CO_2 than Bovidæ. Males excrete more than females; young animals more than old. Food, so long as it maintains the normal state, has no influence on the breathing functions, nor muscular exertion when ended. The excretion of CO_2 is directly proportional to rise of atmospheric temperature, and is inversely as the barometric pressure—these two influences compensate each other.—It is shown by M. Gassend that plants lose in weight under coloured glass.—From experimenting on the phenomena of affinity in slow oxidation of hydrogen and carbonic oxide through platinum, M. v. Meyer concludes that carbonic oxide is much more strongly attracted by the platinum molecules than hydrogen, and forms an envelope round these, hindering access of the hydrogen molecules to the platinum, and only permitting it when a great part of the carbonic oxide is oxidised.—July.—Some observations by M. Serpieri lead him to an explanation of the zodiacal light as an electrical aurora.—The passage of electricity through gases forms the subject of an investigation by M. Oberbeck.

Journal de Physique, May—August.—In studying the propagation of heat in crystalline and schistous bodies, M. Jannettaz has improved on Senarmont's method by applying to the (larded) surface a small sphere or truncated cone of platinum, which is heated by means of a battery current. In minerals the heat is propagated less easily in the direction perpendicular to a plane of cleavage than parallely to this plane; in matters of schistous texture less easily in the normal direction than in directions parallel to the laminæ, both cases being included under the general rule that heat is propagated most easily between the surfaces that have most cohesion together. Planes of stratification (unlike planes of schistosity,) have no influence on the position of the axes of the curves of fusion. M. Jannettaz describes the plan by which he finds the orientation of the axes of the thermal ellipses relatively to certain guiding lines; he utilises the doubling of the curve by means of a birefringent prism.—M. Mannheim points out some new optical properties deduced from a geometrical study of the surface of the wave, and M. Mouton describes a rapid means of determining the interior resistance of a battery.—A new manometer for measurement of high pressures is described by M. Cailletet; it is based on the observed fact that a cylindrical glass reservoir is diminished in volume proportionally to the pressure on it, up to a point near that of rupture, and that this deformation is not permanent. Such a cylinder, with spherical calottes and a capillary tube, is filled with coloured liquid and screwed by means of a copper adjutage into the top of a strong steel cylinder in which the pressure is to be produced, the capillary tube projecting. The pressure sends the liquid up in the latter.—M. Marey describes an apparatus for showing the velocity of a ship at any instant, and which is an improvement on the methods of Pitot and Darcy. Two vertical tubes have their lower ends bent at right angles; the orifice of the one is turned forwards, that of the other backwards (in the water). The tubes are continued upwards and enter two capsules (like those of aneroids) placed opposite each other. The inner opposed faces of these are connected by a bar toothed on its upper edge, which catches in the toothed wheel of a dial pointer. Two caoutchouc tubes above connect the capsules with a T tube, by which water is first sucked up so as to fill the apparatus. The variations of pressure produced by the ship's motion are now revealed on the dial through expansion and contraction of the capsules. The advantage of the method is that no change in depth of immersion through pitching, &c., affects the position of the pointer, but any change in the ship's velocity is at once indicated.—It is shown by M. Mercadier that the duration of the period of a tuning-fork depends on the amplitude and the temperature, and that, using the instrument as chronograph or interrupter, identical results at different times will only be had if the temperature and the amplitude be the same. If, as is usual, complete identity and large amplitudes be not required, then, so long as an amplitude of 3 mm. to 4 mm. is not exceeded, and the temperatures are little different, one is certain of having the same number of periods per second to nearly 0·0001.—M. Gernez writes on determination of the temperature of solidification of liquids, particularly of sulphur; M. Duboscq describes, with figures, his improved apparatus for projection of bodies placed horizontally (*e.g.*, the magnetic curves) and his transparent projection-galvanometer; and M. Lippmann gives a *résumé* of theories of the radiometer.—M. Terquem having sought some alcohol varnish which would cover glass with an almost invisible layer, on which one might write or draw, recommends one composed of alcohol 100 cubic centimetres, mastic 7, sandarach 3.—M. Becquerel gives an account of his experimental researches on rotatory magnetic polarisation (which he has described to the Paris Academy).—M. Jannettaz has observed that in the process of piercing a crystal normally to the plane of symmetry, the air interposed between the deformed and the traversed lamina gives rise to elliptical coloured rings similar to ellipses of conductivity, and he has investigated the value of the coefficients of elasticity according to the radii vectors of those curves. He determined the coefficients of elasticity of flexure of gypsum plates in different direction, especially those parallel to the axes of the ellipses. Comparing their relations with those of the axes of conductivity, he found the former to be represented by the cubes of the second (the numbers being 1·939 and 1·247).

Archives des Sciences Physiques et Naturelles, April–August.—These numbers contain several useful papers. There is a review of Swiss geology for 1875.—The origin of the *Tchernozem*, or black earth covering the upper parts of the southern plain of Russia, from the Carpathian to the Oural, has been much discussed. M. Bogdanow finds in his researches on the subject, that the deposit consists, and continues to be formed, of the remains of vegetation both of steppes and of forests; its thickness, colour, and composition vary with the subsoil; the thickest layers are 1·8 m (Murchison said 6 m.), and indicate that the region has long since emerged. The Tchernozem has been met with in other countries, Transylvania, Moravia, North America, &c. M. Bogdanow traces the history of the plains of Russia and of their fauna.—M. Demole studies the action of bromine on ethylenic chlorhydrine, and a new simplification of the fundamental electro-dynamic law, viewed in relation to the principle of conservation of energy, is furnished in a note by M. Clausius.—In reply to the question: Has the age of a tree influence on the mean epoch of its foliation? M. de Candolle states that in only some few species, as the vine, the foliation is retarded by age. Young trees are often earlier than those of twenty, thirty, or forty years of the same species; but this may be due to nearness to the ground, or to other local circumstances, independent of age. Similar reasons will account for buds in the upper part of a tree opening later than those below; and in any case the influence of age on foliation is nil, or small, compared with the influences of climate.—M. Ebray contributes a paper on the impossibility of establishing the limits of geological formations, and discusses some other geological principles.—The July number is mainly occupied with a *coup d'œil* over the principal publications on vegetable physiology in 1875, by M. Micheli.—M. Wiedemann communicates two short notes on the specific heat of gases, and on the changes of the co-efficients of friction of gases with the temperature.—M. Hagenbach, in the August number, studies the equilibrium of a sphere on a jet of water. There are two cases of the phenomena. In one of these, the jet, divided into drops, strikes the sphere laterally at about 50° from the lowest point, and makes it turn rapidly about a horizontal axis. The sphere also often moves round the jet, sometimes in one direction, sometimes in the other. The water follows the sphere in its movement, flies off in a series of tangents, some of it, however, returning to the point of initial impact. The other case is that in which the sphere receives a homogeneous jet at the same point, and does not rotate about it, but passes to-and-fro across the jet between the two corresponding positions. It turns about the horizontal axis, now in one direction, now in the other. M. Hagenbach gives an explanation of these results.—M. Schmankewitsch replies to some criticism of his researches on the changes of *Artemia salina* in water of varying saltness.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 18.—Vice-Admiral Paris in the chair.—The following papers were read:—Examination of observations presented at various epochs regarding the transit of an intra-mercurial planet over the disc of the sun, by M. Leverrier. He cites eleven of these, comprised between 1761 and 1820 (the paper to be continued).—Theorems relating to systems of three segments having a constant product, by M. Chasles.—Note on the period of the exponential e^x, by M. Yvon Villarceau.—Lighting by means of products extracted from resinous trees, by M. Guillemare. Distillation of oil of turpentine resting on an equal volume of slightly alkaline water, removal of it by steam, and direct and prolonged action of concentrated solutions of alkaline carbonates on oils of resin, produces complete separation of the colophony and naphthaline these liquids contain; this effect is proved if ammonia no longer affects their limpidity. To utilise the large percentage of carbon for light, two lamelliform currents are arranged round the wick; the exterior, by means of a cone 8 centimetres in height, the other, interior, with a movable conical nipple. The draught is effected with a glass chimney, which has to be ground at the base, so intense is the light. This light is recommended for ships' lanterns and photo-telegraphic apparatus.—On a mode of treatment of phylloxerised vines with lime, by M. Pignede.—M. Lucan presented an instrument employed by the negroes in Congo for capturing serpents. This is a tube, the walls of which are made of pieces of reed interlaced; when the serpent enters they contract through the very efforts which he makes to escape.—On the capture of rattlesnakes, and the supposed association of these serpents with a small owl and a small dormouse, by M. Trécul. Travelling, in 1848, in the region west of Arkansas, he caught snakes by passing over them, when erect, a loop with running knot attached to his ramrod; they remained quite straight and were easily killed. The "villages of little dogs," or dormice, are sometimes pretty large, *e.g.*, half a kilometre in diameter. One was in a fertile district covered with high herbs, but the ground of the village was entirely denuded by the animals, and little earthworks thrown up, with holes in them, and communicating together. The dormouse takes a survey from the top of these eminences, with only his head thrust out. In coming out, which they do most cautiously, they give a small sharp bark. In another village the author saw a little owl issue from one of the burrows, which was also evidently frequented by dormice; and in another burrow was a rattlesnake, but this burrow had evidently been long deserted by the other animals.—Symbolic formula giving the degree of the position of points, the distances of which from given algebraic curves verify a given relation, by M. Fouret.—On the physical properties of gallium, by M. Lecoq de Boisbaudran. This subject is noted elsewhere in connection with the *Journal de Physique*. We here note that the density the author formerly obtained (4·7 at 15°) was different from that to which M. Mendeleef's theoretical views pointed (5·9), for a body between indium and aluminium to which gallium otherwise closely corresponded. Having lately, however, treated some gallium by keeping it half an hour at 60°–70° in nitric acid, diluted with its volume of water, washed, heated strongly, then solidified it in dry air, he obtained the number 5·956, which agrees with that of M. Mendeleef.—Anatomical and morphological researches on the nervous system of hymenopterous insects, by M. Brandt. He studies the metamorphoses which occur in the ganglionic chain in passage from the larval to the adult state.—Experiments and observations on vitreous rocks, by M. Meunier. He concludes (1) That vitreous rocks do not represent the product of a vitrification of crystalline rocks, but the latter are derived from the former by way of devitrification. (2) The direct devitrification of obsidian, gallinace, retinite, &c., cannot be produced, and the presence of gases and vapours in the vitreous rocks seems to be the opposing obstacle. (3) This devitrification becomes possible when the rocks, by fusion, are freed from their volatile elements.

ROME

R. Accademia dei Lincei, June 4.—On the specific rotatory power of asparagine, by M. Cossa. He extended the researches of Pasteur on this subject, varying the proportion of asparagine to the solvent and experimenting with other acid solutions. He refers the specific rotatory power (which, for most of the liquids experimented with, might be considered as a constant) to the yellow rays of the spectrum.—On the rotatory power of santonic, metasantonic, and hydrosantonic acid in various solvents, by M. Cannizzaro.—On the electrical state of bodies, by M. Volpicelli. The electricity manifested in bodies through the condenser is to be attributed to the electricity of the atmosphere, since it follows in quantity and quality the phases of that.—M. Volpicelli replied to memoir of M. Pisati, entitled "Defence of the Old Theory of Electrostatic Induction;" also to a note by M. Cantoni on a pretended reform of the theory of electrostatic induction: also to a letter of Maxwell's in NATURE (vol. xiv. p. 27).—Studies on microscopic images of medullary nerve-fibres, by M. Boll. He studies the alterations produced by a variety of chemical agents—sodic chloride, osmic acid, glycerine, ether, chloroform, &c. He finds that the myaline does not form a continuous sheath within the axis cylinder. The medullary sheath is composed of a series of segments placed one above another (in the sciatic nerve of a frog he counted twenty to twenty-five of these segments).—Duration of vitality of the *macula germinativa*, by M. Colasanti. Experimenting with hen's eggs, he found that in the first twenty days after the egg is deposited, development of a chicken may take place, but after that epoch development is not the rule but the exception. But the germinal spots which did not produce chickens always showed some development, though incomplete. This shows that the evolution is not the result of a force which exists or does not exist in a germ, but rather of a force subjected to quantitative modification, and which expires gradually.

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