THURSDAY, SEPTEMBER 12, 1872

THE POTATO DISEASE

THERE seems little doubt that the present season will prove one of the most unfavourable within this generation as regards the yield of the fruits of the earth. The steady rise in the price of corn indicates a widely-spread fear that the harvest will turn out to be considerably below the average, both in quantity and quality. The crop of fruits of nearly every kind may be described as all but a complete failure. The potatoes are estimated as irredeemably bad, to the extent of three-fourths of the yield. Hops are in many parts scarcely worth the pulling. The grass and root-crops have alone benefited by the wet and ungenial summer. The cattle are, moreover, suffering from the foot-and-mouth disease on almost every farm in some counties, and we hear of the outbreak of rinderpest in Yorkshire.

In this dismal list the palm of failure must be given to the potato, with the exception, perhaps, of the apple crop, which has been destroyed by causes not affecting the health of the tree. It is generally admitted that the potato crop is, taken as a whole, the worst since 1845 or 1846. The cause of failure is the same—one, in fact, that has been more or less in existence ever since—the attack of a parasitic fungus, *Botrytis* or *Peronospora infestans*, peculiar to plants belonging to the same natural order as the potato, and unknown before 1845, or some say 1842. The mycelium of this fungus eats into and completely destroys the tissue of the leaf and stem, and when once its ravages have commenced it is almost impossible to arrest them. When the disease made its first great onslaught in 1845, innumerable remedies were suggested, some of which have again cropped up during the present season. Unfortunately, no sooner does one experimenter announce in the *Times* a mode which he has found effective of preventing or arresting the disease, than another grower replies that he has tried the same plan, and with him it has utterly failed. The exact mode of action of the parasite, and the operation of the proposed remedies, we intend glancing at on another occasion. It is satisfactory, at all events, that Dr. Hooker has given in public the weight of his authority in favour of the statement that the starch of the potato is not affected by the complaint, if only some economical mode can be found of separating it from the diseased ingredients. This is some alleviation of a calamity which, according to a statement in the *Times*, threatens the country with a loss of between twenty and thirty millions sterling.

The point to which we specially desire to call attention at the present time, is the enormous material loss which the country is now suffering, and has suffered year after year, from causes which are unquestionably within the range of scientific means to prevent, or at all events materially to alleviate. We are satisfied that we are within the mark when we say that the increased expenditure in most middle-class families within the past eight years, caused by the enhanced price of butchers' meat, milk, and potatoes, represents an income-tax of from a shilling to eighteen-pence in the pound. A portion of this rise is no doubt due to increased consumption, caused by the general prosperity of the country; but the greater part is owing to the prevalence of epidemic diseases in our crops and our herds. Surely Science can find no worthier object than in an earnest attempt to find a remedy for this. And yet what is English Science doing? It was cogently asked a few days since in the *Times*:—"What are we doing, or what have we done, to obviate the recurrence of a disease which is always impending? Probably all we can remember is that there is always a talk of the potato rot, and that some years it has been worse than others. We can only say that this is a disgraceful confession. There is no matter in which Science could interfere with more advantage; and we seem to have all the conditions of the subject under control." We fear that the rebuke here given to English Science is not wholly undeserved.

This brings us to the question which has so often been debated in these columns:—Where are we to find the proper individual or body to start and to carry on scientific investigations of this nature—in private individuals, in societies like the Agricultural or the Horticultural Society, or in the Government? Few will probably contend in favour of the first alternative. Individuals, no doubt, have been found, and will be found, to spend their lives and lavish their fortunes in investigations in which they have no or only a remote pecuniary interest. But it is surely unwise in the extreme to subject our national prosperity to the hazard of private generosity. The societies we have named, and others of a more local character, such as the Highland Society, have done eminent service in promoting sounder views and practices in agriculture and horticulture; but it is questionable whether inquiries of this nature are not beyond their scope, or whether any conclusions at which they might arrive would obtain the universal acceptance which would be desirable. We are, therefore, driven once more to the third alternative; and compelled to inquire whether we have not a right to look to the Government of the country to "interfere" in the matter, as Mr. Gladstone would term it, that is to institute and to promote an investigation into the Origin, Cause, and Remedies for the Potato Disease.

Little objection can be anticipated to the course we advocate on the ground of the money value at stake in the question. We are at the present time spending a large sum of money and employing the highest talent in the country in the settlement of a claim for a few millions; to save the country several times as much per annum cannot be objected to as a matter unworthy the attention of our rulers. And yet, because the one infliction will fall upon us in the form of an additional twopence to our Income-tax for a single year, the other in the form of a much heavier addition to our butchers' and greengrocers' bills for many years in succession, we are content in the latter case to grumble and bear it, without making any serious efforts to relieve ourselves from it. Science is often charged with being "unpractical;" indeed, in the minds of perhaps the majority of people there is a kind of hazy feeling of a necessary antagonism between what is scientific and what is practical. It is time for Science to redeem herself from this imputation, and no better opportunity could be found than in discovering a remedy for the Potato Disease. The questions which would present themselves for solution in such an inquiry are numerous. It would not be difficult to collect the facts; but they have never yet been tabulated or presented to the public in such a form that any conclusions can be drawn unquestionably from them. A competent authority on these subjects, the *Gardener's Chronicle*, recently remarked:—"Though for nearly a quarter of a century, more or less, cultivators have had to wince under the losses inflicted by the enemy, they have not yet learnt either the mode of invasion or the method of destruction." The Commission would have to inquire whether the disease is most prevalent on any particular soil; whether, as some assert, seed left in the ground through the winter enjoys comparative immunity as contrasted with that sown in the spring; whether seed introduced from a distance is safer than that grown in the neighbourhood; whether old varieties are dying out and new ones comparatively healthy; whether, if the disease can by any means be warded off till August 10, the crop is then comparatively safe, and very many others, on which every diversity of opinion exists at present? On one point almost all authorities are agreed, viz., that the disease generally makes its first decided appearance during thundery weather. The exceptional amount of electrical disturbance which extended over almost the whole country during July of the present year appears to have been most unfavourable to the potato crop; while a clergyman, writing from a district where thunderstorms are remarkably rare, in the portion of the county of Devon to the south of Dartmoor, averaging about six in twelve years, states that it is there almost free from disease.

It is worthy of note that an unusual development of the potato blight has been hitherto accompanied by murrain or epidemic diseases in animals and in other crops, and that a certain periodicity appears to be manifested. The present year has witnessed the most virulent outbreak since 1846; the worst of the intermediate years were nearly midway, from 1859 to 1861, showing an approximate recurring interval of about twelve years. A writer in the *Gardener's Chronicle* thus describes the crops in the latter year:—"My potatoes are in as bad a state as I ever remember to have seen them; my turnips are rapidly rotting, and many are filled with a semi-fluid offensive matter; the lettuces in various parts of the kitchen-garden are nearly all rotten; the roots are found generally diseased; the cabbages, savoys, and others of the *Brassica* are what gardeners term blind; the beans are spoiled by the black fly; the peas are all more or less blighted or mildewed; many of the plum and cherry trees are destroyed; I never witnessed anything more lamentable and disheartening." Other accounts agree in the main with this, at least as regards the potatoes in that year. Now, it is very remarkable that an interval of from eleven to twelve years coincides with the period of maximum sun-spots. The present time is near the maximum of sun-spots, so was 1860, so was 1848, the curve showing but little decline for one or two years on each side of the actual maximum. Now, if it can be shown that epidemics like the potato blight are connected with great cosmical cycles, an important step is gained. Physicists are now nearly of accord that a connection exists between the sun-spot period and the recurrence of electrical and other disturbances in the earth's atmosphere. It may be urged that such a conclusion as this would make cure hopeless, and paralyse, instead of stimulating, energy, by inducing a kind of hopeless fatalism. Not at all. An evil which cannot be avoided may, nevertheless, be greatly mitigated by scientific knowledge and skill. To be forewarned is to be forearmed, and a knowledge of the cause of a disease is already halfway towards its cure. If we were certain that in another twelve years we should be liable to a recurrence of the blight with unusual severity, the farmers might be persuaded to plant only so much as would be likely to yield seed for the next year, and that only under the most favourable circumstances, where comparative immunity might be predicted; and large breadths might be devoted to turnips, beet, or other root-crops which experience showed to be likely to yield good results, and which would furnish some substitute for the lost potato.

We have endeavoured to sketch out only a few of the questions which would present themselves for solution were we in earnest to institute a thorough scientific investigation of the cause and cure of the potato blight, and to point out that few subjects are more worthy the attention of a commercial and practical nation.

SHARPE & DRESSER'S BIRDS OF EUROPE

The Birds of Europe. By R. B. Sharpe and H. E. Dresser. Parts xi. and xii. (Published privately.)

THE completion of the first volume of this important work by the issue of Parts xi. and xii., affords the authors an opportunity of expressing their determination to continue the monthly issue with as much punctuality as is compatible with the fulness and accuracy at which they aim. This volume has occupied eighteen months in its publication; but as it contains 101 coloured plates and about 800 or 900 pages of letterpress of large quarto size, the wonder is rather that so near an approach to regularity has been attained in a work which is taking so much larger dimensions than was at first anticipated.

The present parts show no lack of the energy and care hitherto exhibited. In addition to the seventeen species figured and copiously described, we have three additional plates with eight figures of the Sparrow Hawk in various states of plumage, and two others with additional figures of the Ring Ouzel and the Rock Thrush. As an example of the great care bestowed by the authors in the accumulation and critical comparison of specimens from all parts of Europe, and from other quarters of the world where necessary, we may state that the present part discriminates between several birds that have hitherto been confounded, and thus adds two species to the list of European birds, and one to that of Britain. A fine Woodpecker (*Picus lilfordi*), found in Greece and Turkey, has been separated from *Picus leuconotus* which inhabits the more northern parts of Europe; while the British form of the Cole Tit (*Parus ater*) is found to be so constantly different from that which inhabits the Continent as to require a distinct specific name, and it has accordingly been called *Parus brittanicus*. To illustrate these minute specific differences the excellent plan is adopted of giving figures of the allied species on the same plate.

We cannot, however, equally praise the system of including American and other stragglers as European birds. It needlessly encumbers an already very bulky work, and leads to misconception, and it will also have the effect of making the book apparently imperfect whenever fresh stragglers reach our shores. Is it not absurd in a book of European birds to have seven pages devoted to the American Stint, with full details of its distribution over North America, and the statement that it has occurred "twice in Britain" as the sole justification for including it? Another seven pages is devoted to the American Hawk Owl on the strength of its occurrence four times in Britain. Such birds should be rigidly excluded from the body of the work, and only described in notes or an appendix when it is necessary to do so in order to avoid confusion with the allied European species.

It is a pity that the temporary paging of the letterpress to each species had not been altogether omitted, as it is of no use whatever, and occupies the prominent position which should have been left for the permanent paging. As the only means of remedying the evil, we would suggest that when the work is completed a series of numbers be printed in squares reaching to the highest number of pages in a volume, and be issued with the last part on gummed paper, so as to be cut out and fastened in the proper position over the temporary numbers.

The figures by Mr. Keulemans continue to be as spirited and lifelike as ever, and the authors devote the same attention as heretofore to giving the fullest and most reliable information obtainable. The work will thus satisfy the requirements both of the scientific naturalist and of the general reader and amateur. The former requires accurate descriptions and figures, careful measurements, and precise indications of distribution and habits. The latter wants to determine readily any bird he may meet with at home or on the Continent, with an intelligible and interesting account of its habits and distribution, and other topics of general interest. To both these classes of readers we can cordially recommend this book, and we believe that it is calculated at once to take a high position as a scientific work, and at the same time to popularise the delightful branch of natural history of which it treats.

A. R. W.

GEOMETRICAL CONIC SECTIONS

Geometrical Conic Sections: an Elementary Treatise, in which the Conic Sections are defined as the Plane Sections of a Cone, and treated by the Method of Projections. By J. Stewart Jackson, M.A. (Macmillan and Co., 1872.)

The Geometry of Conics. Part I. By C. Taylor, M.A. (Deighton, Bell, and Co, 1872.)

MR. TAYLOR'S present work is by no means a second edition of his "Geometrical Conics" (1863). His object in this volume is a highly laudable one; from more than one quarter has recently come the complaint that the subject of geometrical conic sections is in an unsatisfactory state. The work under consideration is stated to be "the result of an attempt to reduce the chaos of geometrical conics to order, the subject having suffered not a little from desultory treatment." As in the earlier treatise, our author does not define the conics in question to be sections of a cone; and here he is at direct issue with Mr. Jackson:—"I am unable, despite his skilful advocacy, to acquiesce in the primary definition of conics from the solid."

This feud among writers on the conic sections is of old date. Simson, in his preface, stated that Wallis (1655) treated of these curves not as being sections of a solid (*nullâ coni habitâ ratione*), and that he was followed by De Witt and De la Hire. T. Newton, in his "Treatise" (1794), remarks that in the University of Cambridge the preference seems to have been given to that method which begins with a description of the curves *in plano;* whereas in the sister University, the Savilian professor, Abram Robertson, in a nearly contemporary work (1802), adopts the more ancient definition, and bases on it a very interesting exposition of the principal properties of conics. This latter method is the one we are inclined to prefer in a school book, though it is not that adopted by our standard writers, as Drew, Besant, and Taylor. Mr. Wilson, we were glad to see, has adopted it in his very handy though concise introduction to the study of these curves.

Putting on one side the numerous typographical errors in Mr. Jackson's work, and some few inelegancies, as we think, in the proofs—the results, doubtless, of too great haste in bringing it out—we have much pleasure in commending this volume, and hope that he will soon have an opportunity of removing these slight blemishes. If he has this opportunity, we are sure it will not be the result of luck ("in case this work should be so fortunate as to reach a second edition"), but the reward of genuine merit.

It is hardly needful to enter into any details respecting Mr. Taylor's mode of treatment of his subject. He is too well known and approved a writer upon it to need our commendation. Suffice it to say that many waifs and strays which he has previously communicated to the mathematical journals here find a fitting place. His leading principle, and that which tends so much to the clearness of his exposition, is that "Chord properties should take precedence of the Tangent properties, the latter being deduced from the former and not the former from the latter." A noteworthy feature is the prominence assigned to the treatment of a curve usually hurriedly passed over—the rectangular hyperbola. To this curve he devotes pp. 61—77. He very fully acknowledges his indebtedness to Prof. Wolstenholme's investigations of the properties of the curve. He has himself elsewhere (*Messenger of Mathematics*, vol. i. pp. 121—127) treated of the curve in question.

The book is a valuable contribution to the literature of this branch of pure geometry; and though it may not take the place of Besant's fuller treatise, as it does not go over the same extent of ground, yet it is worthy of being ranked side by side with it. We shall hail with pleasure the remaining part or parts of the work.

OUR BOOK SHELF

An Introduction to the Practical and Theoretical Study of Nautical Surveying. By J. K. Laughton, M.A. (London: Longmans and Co., 1872.)

THIS work is intended to supply a want that has long been felt by young officers of the navy who have not had an opportunity of gaining a knowledge of the methods of conducting a coast survey used on board vessels regularly employed on such work. We are accustomed to quote with pride the old saying, that wherever wood would float an English pendant was to be seen, and it is true at the present time, that every sea, well known or slightly known, is visited more or less frequently by our men-of-war. But unfortunately many of these places are roughly surveyed, the coast lines inaccurately laid down, and the positions of the principal dangers doubtful. Here much valuable work can be done by those not surveyors, who have time and are willing to take the opportunities often given them, to improve our knowledge by making a correct survey or verifying the charts of the coasts they may visit. To these Mr. Laughton's book will be exceedingly valuable, and though in his introductory chapter the author modestly says that he writes "not for the guidance of surveyors, but for those who know little or nothing at all about it," we are sure that many old surveyors will find their work easier from having the principles so clearly brought before them. The work is the more valuable in showing what can be done with the means at hand on board every vessel, though not especially equipped for the work. The second chapter describes the choice and measurement of the base line, and the methods for determining the exact latitude and longitude of the first position. The rules given are exceedingly clear and simple, and can be readily followed by anyone in the habit of using the sextant and artificial horizon. The hints on the choice and adjustment of the sextant will be found very useful to every navigator. Mr. Laughton's practical way of dealing with the subject is shown in his suggestion to get an old sextant and let it fall on the deck in order to acquire a thorough acquaintance with its mechanism in putting it to rights again. But it is a pity that the description of the instruments should be placed between the rules for the choice and measurement of the base line, indeed it would be better if this chapter were re-arranged. A great deal more might be said on the selection of objects for triangulation, this is a point on which the beginner encounters his greatest difficulty; some hints also as to the best way of noting angles would be useful, this want is supplied when levelling is treated of. Chapter III. is devoted to the construction of charts and various projections of the sphere, it is very clear and concise, and will prove valuable not only to the chart-maker, but also to the navigator, who will here gain a clearer knowledge of the plan on which the chart he uses is laid down, than is to be found in most books on navigation. We recommend, especially to young surveyors, the method advocated for graduation of charts according to the gnomonic projection, it is more comprehensive and certainly more mathematically correct than the methods usually employed, and we do not remember to have met it described in any other work. The part of Chapter IV. relating to the determination of positions is perplexing, and would with difficulty be understood by an inexperienced surveyor, without examples. The author might have well supplemented this part by showing graphically the way of protracting the angles, and finding the points of intersection. It is not clear why he has omitted from the description of instruments all mention of the protractor, an instrument as essential to the surveyor and navigator as his pair of compasses. The remarks in the last few pages on the "danger angle," or as it was called by old surveyors the "approximative angle," will be found very useful by all navigators, especially those who since the introduction of iron ships have experienced the difficulty and uncertainty of determining positions quickly by the compass when the course is changing rapidly. The running survey is ably treated, but we regret there is no illustration of the mode of surveying a harbour; this is a serious omission, but notwithstanding this, and the want of illustration of the choice of stations and selection of objects, we can recommend the book as the best out on the subject.

The Lepidopterist's Guide, intended for the Use of the Young Collector. By H. Guard Knaggs, M.D., F.L.S. Second Edition, illustrated. (London: Van Voorst.)

THE want of such a "Guide" as the present was long felt by "young collectors" before the appearance of this book; but now this want is so well supplied that a second edition has not only been issued, but nearly exhausted, and we call attention to it with confidence, because, although eminently popular in its style and treatment, it is the work of a practical hand, and is as reliable as it is full and complete. In these days of cheap books it is marvellously cheap, and we are led to wonder how a scientific manual of upwards of 120 pages, closely printed, and copiously illustrated, can be produced for one shilling. Everything that the young collector is likely to require information upon will be found by a little searching, which a copious index would greatly facilitate, and which we hope to see appended to a future edition. We have no doubt this Guide will continue to receive the support it so well deserves. C.

LETTERS TO THE EDITOR

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

The Variation in Outline of American "Flint" Arrow-heads

I FIND, after a careful perusal of the sixteenth chapter of Mr. Evans's magnificent work on British Stone Implements—on javelin and arrow-heads—that he has considered the American forms far more uniform, less varied in outline than they really are. I am familiar with many collections made at distant parts of the Union, and have an immense assortment of my own collecting now in the Museum of the Peabody Academy, at Salem, Mass. In these several collections is every form that Mr. Evans has figured, and several that he has not mentioned.

On page 362 of Mr. Evans's work, I find the author asserting as a prevailing type, "that with a notch at the base on either side." While this form unquestionably is very common, it cannot be considered as the "prevailing" one, inasmuch as several distinct patterns equal it in numbers found, and some exceed it, as those that "have merely a central tang, with little or no attempt at barbs." A second statement of Mr. Evans strikes me as very remarkable. He says, "the leaf-shaped form is very rare." This is a very great error. In any locality where arrow-points are to be found at all, they are always to be met with; and I have gathered scores of them that for symmetry far excel any of the figures given by Mr. Evans.

Nor can I admit the correctness of Mr. Evans's assertion concerning arrow-points, that "for the most part the chipping is but rough, as the material, which is usually chert, hornstone, or even quartz, does not readily lend itself to fine work." I believe no arrow-points have ever been discovered that can exceed, in beauty of finish, those I have myself gathered from the fields and meadows of central New Jersey. And I am the more surprised at Mr. Evans's remarks, inasmuch as the specimens I have found, that have been wrought from white or rose quartz, are remarkable for the smooth surfaces and sharp edges they present. So, too, of our jasper and hornstone specimens. Remarkably diversified in form, uniformly well finished, they strike the beholder with astonishment, when the "intractability" of the material is recognised. I have seen but few specimens of arrow-points not found in the United States; but judging from them and the illustrations of Mr. Evans's work, I unhesitatingly assert, that although we have no convenient flint in New Jersey or near it—Prof. T. A. Conrad has discovered true flint and chalk in Colorado—we have, in the jasper, chert, hornstone, quartz, and slate arrow-heads, examples of such weapons, as are in no wise inferior to those of Europe in beauty of finish, or less diversified in the various so-called "types."

Mr. Evans seems to have based most of his impressions concerning our antiquities upon Schoolcroft's ponderous tomes, which present little or nothing of value, of our "antiquities," whatever may be their reliability as concerning the "Indians," at the time when the volumes were compiled.

In conclusion, I will give a list of the arrow-points gathered on Wednesday, July 31, during the course of a three hours' search, and over fields that have yielded hundreds during the past and present summers.

Nos. 1—5, genuine leaf-shaped arrow-heads; four of black jasper or hornstone; all symmetrical, perfect. The largest specimen measures five-eighths of an inch in width at widest part, which is near the base, which is a beautifully wrought half-circle. The length is one inch and eleven-sixteenths. The other four specimens are somewhat smaller; one a little broader; and none can be considered as rough or badly-made examples.

Nos. 6—8 are what may be called triangular arrow-points, but are different from the ordinary examples of that pattern, in that they have very concave sides and base, and a rounded rather than pointed tip. Nothing in any way similar is figured by Mr. Evans, nor was I acquainted with this pattern when I wrote of our arrow-heads in the April No. of the *American Naturalist*. These arrow-points vary little in length and width; being about an inch and a quarter to an inch in length, by about one in width. The main portion of the specimen and the projecting barbs are nearly the same length, and have all the same degree of finish. One specimen is of brown jasper, one of hornstone, and the third, we suppose, is what Mr. Evans means by "chert."

Nos. 9—14 are triangular arrow-points, with straight or very slightly convex sides, and well-marked concave bases. None measure over an inch in length, by three-quarters of an inch in width. One specimen is of "chert," three of hornstone, one of green, and one of chocolate jasper. The finish of all is good, and of two in particular very fine. The chocolate-coloured jasper example has a row of uniformly shaped notches or serrations, throughout the greater part of one side.

Nos. 15 and 16 are triangular arrows, both of which have straight bases, and one with straight sides, the other with very convex sides. Both are well finished, and the smaller quartz specimen with the convex sides is as smooth, well-edged and pointed, as though it had been "rubbed" down.

No. 17 is a yellowish "flint-like" stone, chipped into an arrow-point of the triangular pattern, but with a notch in the base, and also at each side. This form I have figured in the *American Naturalist*. It is but sparingly met with, and is there called a stemmed arrow-head, or one with a projecting base, which I think now is scarcely correct; the notches at the sides and base give it a "stemmed" appearance only.

Nos. 18—20 are three fine specimens, having projecting stems, which are narrower than the body of the specimens, and are not notched, but taper to a blunt point. Mr. Evans's figures 300 and 301 and the base of 302 well represent the specimens now lying before me.

Nos. 21—25 are stemmed arrow-points, with notches, that is, the "base" projects beyond the base of the body of the specimen, which gives "barbs" to the weapon—a style not given by Mr. Evans; or the base or "tang" is narrower than the body of the specimen, and flaring at its termination, produces the notches, by which the shaft was attached. A poor example of this pattern is Mr. Evans's figure 303. One of these "tanged" arrow-points has a projecting "tip," like that figured by Mr. Evans, as a peculiar feature of his leaf-shaped arrow-head, figure 283.

Nos. 26—33 are plain "tanged" arrow-heads, very similar to Mr. Evans's figure 304, which he refers to as "a magnificent specimen." The only marked difference in the little series before me and the illustration mentioned is that the tangs are all broader and a little shorter. The specimens themselves are not much smaller. They are of slate, jasper, hornstone, and "chert."

No. 34 is a lozenge-shaped arrow-head, very similar to Mr. Evans's figure 277, but is somewhat smaller. It varies from everything I have found as yet, and is a reproduction of those lozenge-shaped specimens, only of handsomer outline, that Mr. Evans has found on the Yorkshire wolds. The finding of this specimen lessens the number of forms found in Europe, that have not occurred here.

Besides these thirty-four specimens, which are all perfect, I gathered innumerable "chips" and broken specimens, some of them being of patterns not enumerated in my list. I have here briefly referred to nine distinct patterns, numbers of which, save two, were found during one day's hunting; and the result in numbers and varieties was nothing more than "a good average." I cannot therefore admit any one form to be a "prevailing" type, and the idea of inferior finish and of general elegance of appearance, is, we respectfully assert, a very great mistake.

CHAS. C. ABBOTT

Trenton, New Jersey, Aug. 5

Millions of Millions

THE fact that I have myself slipped into an error by writing eleven noughts instead of ten in setting out a number expressed by a row of sixteen integers, only serves to confirm my former remark that millions of millions are awkward numbers to deal with, and that it will be well to avoid them by making use of the very simple rule-of-three sum indicated at the end of my list of errata to Professor Mayer's paper.

A COWPER RANYARD

Fertilisation by Moths

IT has recently been suggested to me that the following note on the readiness with which moths wander, and their efficiency in fertilising orchids, is worth publication; I therefore forward it to you.

In the summer of 1869 I caught here on an island of less than six acres, in the middle of Derwentwater, twenty specimens of the common 'shark' moth (*Cucullia umbratica*); of these, seven had the pollinia of the butterfly orchis (*Habenaria chlorantha*) sticking to their eyes. I know for certain that there were no plants of *H. chlorantha* growing on the island, and all the moths must have come from places separated from the island by half a mile of water.

W. C. MARSHALL

Derwent Island, Sep. 9

Origin of Insects

MR. J. J. MURPHY, in writing "that it is true that the water-beetles are wingless" (NATURE, No. 140, p. 373), has surely made a *lapsus calami*, since many waterbeetles are not only winged but use their wings. Other orders furnish examples of an aquatic winged insect fauna. The hemipterous genera *Notonecta*, *Corixa*, &c., are well-winged, and use their wings (especially *Notonecta*). *Corixa* affords an example of the elytra (*i.e.* the front wings) assisting in respiration, but probably not in the way that Mr. Murphy means. At the base of the anterior margin of the elytron there is a channel which retains a supply of air. Of course everybody knows the use of the elytra in *Dytiscus* to catch and retain air.

The Lepidopterous genus *Acentropus* affords another instance. The perfect winged insects frequently descend into the water. The females are sometimes winged and sometimes apterous, and the winged male has been seen entering the water in pursuit of —it is supposed—the apterous virgin female.

I think that it is possible that these apterous females exhibit the same kind of "parthenogenesis" as occurs in the *Psychidæ*. It would be well if those observers who have an opportunity would try to ascertain if parthenogenesis ever occurs in *Acentropus*.

F. BUCHANAN WHITE

Solar Spots

BY an observation of the sun this morning at 11h. 25m., I find that several parts of his surface are in a disturbed condition, and that several largish spots (*maculæ*), surrounded with penumbræ, are visible. In the north-west quadrant of the disc, near the west limb, there was a group seen, in which two rather conspicuous spots were situated, and below these, in the southern hemisphere, there were three others of somewhat considerable dimensions. In the same hemisphere there was an irregular train of spots of various forms and sizes, extending almost to the margin of the south-eastern part of the disc. In the north-east quadrant I could discern no spots at all. Light clouds were continually passing over the sun during the time of observation. I used a 4-inch metallic-mirror reflector, with the aperture contracted to three inches.

WILLIAM F. DENNING

Bristol, Sept. 8

Correlation of Colour and Music

A VERY brilliant rainbow, which occurred on the evening of September 6th, recalled to my mind the note on the correlation of colour and music by Mr. W. F. Barrett, which appeared in

NATURE of January 13, 1870, and the subsequent correspondence. The violet of the primary bow passed into red at its concave edge, and within this violet-red arc there was a faint appearance of prismatic colours, blue or green (and I think yellow), and then a distinct red arc, and within this again yet another very faint red arc. Between these last two the other colours of the spectrum, if they existed, were too faint to be seen; but the impression given by a *coup d'œil* was that of three complete series of colours. There was nothing beyond the red on the outside of the primary bow, except, of course, the secondary bow, at some distance.

This is the phenomenon alluded to by Mr. Justice Grove, in his letter to NATURE of January 20, 1870, in which he queries whether these colours are repetitions of the spectrum, such as are suggested by Sir John Herschel. Your correspondent, Mr. C. J. Munro (NATURE, February 3, 1870), appears to regard them as analogous to "Newton's Rings." I should much like to see the point more fully elucidated. Is it established that under no circumstances can the spectroscope show visible rays beyond the violet? GEORGE C. THOMPSON

Cardiff, Sept. 8

Cat's Teeth

I HAVE in my collection the skull of a cat, which has the peculiarity of possessing an extra molar tooth on the left maxilla; this tooth is tricuspid, and is situated between the last premolar and the carnassial tooth, on their interior side, so that it does not disturb their normal position. Will some of your readers inform me whether this is not very unusual? and whether from its position it does not overthrow Professor Owen's theory, that the two premolars are respectively third and fourth?

R. LYDEKKER

Harpenden, Sept. 2

DANISH EXPEDITION TO THE FAROES

THE United Steamers Company (*forenede Dampskibselskab*) in Copenhagen, having got a grant from the Government for the exploration of the Faroe coal-fields, is about to send an expedition to these islands, for the purpose of scientifically examining into the extent of the coal-fields in the north of Süderoe, and discovering in what manner coals may be best transported from that island to Copenhagen.

Besides having in view commercial purposes, the expedition will be accompanied by men of science, who will investigate the natural history of these little-known islands. The Government has asked Prof. Johnstrup to visit the different coal-fields on the southern island, and to investigate the geological features. The managers of the steam company, represented by Consul Koch, have also kindly allowed the writer of these lines to accompany the expedition for zoological purposes.

The geological features of the islands are best known from Forchhammer's researches, published in the "Transactions of the Danish Society of Sciences" (1828). The rocks of the Faroes are for the greatest part of volcanic origin, dolerite-porphyry being found in large masses in all the islands. Coal sediments are only to be seen in the south (Süderoe), and in the little islands of Myggenäs and Tindholm. To what formation these beds belong has not been cleared up, as fossils have hitherto not been discovered. But as the coal-fields of Iceland and Greenland, in which fossil plants have been found, belong to the miocene-tertiary period, it is very probable that those of the Faroes belong to the same formation. The researches which now are to be made by Prof. Johnstrup and his assistant, Cand. Geisler, will, we hope, throw further light upon the nature of these deposits.

The fauna of the islands, as far as the vertebrates are considered, was already tolerably well known at the beginning of this century, as may be seen from Landt's "Beskrivelse over Faeröerne," published in 1800. The only wild mammals inhabiting the interior of the islands are a few species of the genus *Mus*, which follow man's steps wherever he goes. But the shores of the Faroes are visited by a large number of *Pinnipedia* and *Cetacea*, from the capture of which the inhabitants have every year a good profit. The birds—those inhabiting the rocks of Store and Lille Dimon, as well as those of some of the other islands—have been made known by Graba, and, so far as they also occur in Iceland, by Faber. Later publications, especially by Swedish authors, are well known to have thrown much light on the natural history of these inhabitants of the north. Reptilia and Amphibia do not occur at all in the Faroes; but fishes of various species come to the shores and ascend the rivers in considerable numbers. They have been collected with great zeal by Sysselman Müller, of Torshavu, who has sent a list and specimens of all the species known to him to the zoological museums of Copenhagen. The lower animals are less known; we have lists of echinoderms and molluscs by Lütken and Mörch, and we know something about the worms from the investigations made there by Prof. Oscar Schmidt, who for a short time visited the Faroes. The writer of these lines hopes to gather further information about the lower animals by dredging on the shores of the islands; and, while collecting the fishes for the Munich Museum, he will continue his researches into the natural history of their parasites.

The expedition will leave Copenhagen early in September, and, when returning from the Faroes, may perhaps pay a visit to a Scottish port.

RUD. V. WILLEMOES-SUHM

Copenhagen, Sept. 4

NATURAL HISTORY EDUCATION AT HARVARD UNIVERSITY

WE reprint the following interesting article on the scientific instruction given in Harvard University from the pages of the *American Naturalist*:—

The changes which have been made in the departments of Natural History at Cambridge within the last two years have been very great, greater perhaps than in any other school within the same time. As there are many persons of both sexes who are seeking opportunities for study such as the University now offers, we give a sketch of the plans of education in the different schools as far as they concern the student of natural history. There are five schools in the University where natural history is taught: the College, the Museum of Comparative Zoology, the Botanic Garden, the Scientific School, and the Bussey Institution. Let us trace in a general way the course of a student in these departments.

The student who enters the college to-day is no longer compelled to follow the one uniform road over which the boy of twenty years past had to go; after his first or freshman year, he may begin to turn himself into the paths of natural science. At the commencement of his second year he may begin his studies by courses which lay the foundations of a knowledge of chemistry, taught in the laboratory; of physical geography, geology, and meteorology, taught by text-books, lectures, and excursions in the field. The time allowed for these studies during the year is estimated at twelve hours per week. It is expected that the student will in this year lay the foundations for the work he may wish to do during the following years, by getting that general idea of the physics of the globe which forms the necessary basis for the work of the naturalist in any department of labour.

With the junior year the studies of a strictly biological character begin. One course includes the elements of comparative zoology, with elementary teaching in microscopy, another the elements of botany, a third the elements of comparative anatomy. The principle on which the teaching of zoology is based is that the student should at the very beginning be put into the position of an investigator. With this object in view the student is at first required to do all his work upon natural objects. Beginning with the solid part of a Fungia, or some other object of equal simplicity, the student is then required to draw and describe the specimen, aided only by such questions and suggestions as may be necessary to get him over the worst obstacles. As soon as he has done the little he can do in the way of close observation, he is given a Manacena or Agaricea, which he proceeds to compare with the Fungia, and so making at least diagrammatic drawings with a dozen other specimens of Polyps, Halcynoid and Actinoid. Thus the student gets some idea of the general relations which exist among the members of that group. When, say, in thirty hours of labour he has got through this work, a few lectures serve to supplement and connect the knowledge he has obtained from the personal study of the dry parts, illustrated by a sufficient series of alcoholic preparations, and helped out by such individual teaching as can be given without weakening the habit of self-reliance. In this way he goes through group after group, until, from a study of about one hundred species, he has gotten a general idea of the organic forms above the Protozoa. In this stage of the student's work care is taken to avoid the use of diagrams; this avoidance being dictated by the conviction that the student remembers the diagram and not the object. During this year botany is also taught, with the same object and by much the same method. In connection with the zoological instruction the students are taught the elements of microscopy, the development of the subject being left to the next year.

The second-year courses are advanced zoology, palæontology, historical geology, geography, and advanced botany. The first two have one common feature; three lectures or readings are given each week to the discussion of the history of zoology and palæontology, with special reference to modern opinions concerning the relations of animals. An effort is made to acquaint the students with the character of the greater works in the science, by giving them constant opportunities for consulting them in their studies, and by showing them the methods of the masters in the several departments. Besides this, each student is required to pursue some special line of work. In the choice of subject the largest liberty is allowed, but the student is, however, recommended during a half-year to study advanced microscopy; in this work the aid of an instructor is given for four hours a week. In this four months he should acquire a sufficient knowledge of the practical management of the instrument in all ordinary investigations. The laboratory is well supplied with instruments of instruction in this branch of work.

Besides the course in the history of the science, the student who takes the elective in palæontology is required to traverse the ground covered in that part of "Dana's Manual" which is entitled historical geology, acquainting himself in a practical way with the most important characteristic fossils of the several periods.

The greatest value in this work is set upon the keeping of full and accurate note-books in both the last described courses. The rank of the student turns upon the condition of his note-books as much as upon the quarterly examinations which he is required to pass.

Those students who desire to contend for honours at the graduation in zoology or in palæontology are required to have taken, besides their junior election in natural history, one election in physical science, and at least three natural history elections in the senior year, in all of which they must have attained excellence. They are moreover required to write an acceptable thesis, which must contain an original discussion of some question in biological science. Hereafter the junior electives will consist of a course in anatomy and physiology, one in zoology, and one in botany; and the students in this as well as in the last year will be allowed to substitute for the themes required in other branches theses upon scientific subjects prepared under the direction of their instructor.

The natural history education of the scientific school has undergone a great change within a year; hitherto the students have worked with the professors of the several departments, giving their whole time to any speciality which they might select. This plan, admirably suited as it was to the needs of the trained student who had fitted himself in other schools for the work of a special department, was not adapted to the needs of those to whom this teaching was to fill the whole office of higher education. With the introduction of the doctor's degree into the plan of the school, it became necessary to make a change which has long been desirable, by fixing a definite scheme of general scientific instruction in place of the imperfect system which had hitherto prevailed. A three years' course has been arranged which secures to the student a broad view over the whole field of science, and the advantage which comes from a knowledge of the methods of research in use in its several branches. It gives to those persons who may not have the desire or the means to go through a regular college course a systematic training which will occupy their full time for three years, and give the best results of culture which can be attained in any scientific course. Students who can pass the required examinations are admitted to the degree of bachelor of science. Graduates of colleges where science is taught in an effective way should be able to enter this course in advanced standing. Students of the college, graduating with honours in the departments of natural history, should be able to obtain the degree in this course in a year of study. The student is trained in the important art of expressing himself clearly on the matters which he is studying, by requiring him to keep carefully planned note-books; and he is urged to the preparation of theses which may embody the results of some research. Ample opportunities are given for the prosecution of studies in the field, by excursions during term time and vacation, led by the instructors in zoology, botany, and geology.

After two years' further study, one of which must be spent in Cambridge, the student may apply for the degree of doctor of science, which is given after an examination conducted by a committee appointed by the Academic Council of the University.

The study done, the preparation for the degree must be in some special department, when the student will generally become the private pupil of some one professor. The degree will be a certificate of capacity as an investigator or teacher in the science which the student has made his specialty.

The resources of the University for teaching science are, it is believed, not only unrivalled in this country, but unsurpassed in Europe. The scientific departments have a list of twenty-four instructors, and the material resources which they afford have cost in the aggregate over a million and a half of dollars. There are six museums in the University—the Museum of Comparative Zoology, the Botanical Museum, the Museum of Comparative Anatomy, the Museum of Morbid Anatomy, the Museum of Mineralogy, and that of Ethnology. These collections are unsurpassed by those of any educational institution in this country; and, taken together, they furnish an efficient basis for the acquisition of the wide ranging knowledge on which a scientific career must be based. The opportunities for contact and intercourse in scientific societies are excellent. There is a working society of natural history in the University, and the Boston Society of Natural History, one of the largest and most efficient of the American institutions of this nature, is also open to all students of the science.

MELTING AND REGELATION OF ICE

IN NATURE of January 4th of this year, there is a most interesting account of some experiments on melting and regelation of ice by Mr. James T. Bottomley. These experiments of Mr. Bottomley's suggested the possibility of passing large bodies through ice in the same way as he caused the wires to pass. I accordingly placed a sixpence on a block of ice, and applied pressure to it by means of a fine steel wire about one-sixteenth of an inch in diameter. On examining the block of ice sometime afterwards, I found the sixpence had passed into the centre of the block, and that the space through which it had passed, except the small part occupied by the steel wire, was again solid ice. I tried the same experiment with a shilling, and found that it also easily passed through the ice, the experiment was then repeated with a half-crown with the same result. I did not attempt anything larger, but have no doubt much larger discs of metal might be made to pass through ice if sufficient pressure were applied. The ice in the parts of the blocks through which the coins had passed did not look very solid, but was rather full of air-bubbles; on breaking the block, however, it did not seem much weaker than the rest of the ice. Another form of the experiment was then made, a block of ice was supported on two boards placed near each other. A loop of fine wire was passed over the ice, and hung down between the two boards and a weight attached to it, as in Mr. Bottomley's experiments, pieces of wood were placed so as to stop the wire when it had passed half way though the ice. After the wire had passed into the centre of the block, the weight was removed, the wire cut, and a disc of metal half an inch in diameter was attached to one end of the wire, and a weight to the other end. In this manner the disc was drawn through the ice, leaving apparently perfect solid ice behind. The path of the disc could only be traced by its slightly cloudy appearance, it looked as if the few air-bubbles passed through by the disc had been broken up into a great number of small ones. On breaking the ice afterwards it seemed quite as strong where the disc had passed as elsewhere.

The explanation of these experiments is of course the same as for the experiments with the wires; Professor James Thomson showed that the freezing point of water is lowered by pressure, and also that ice has a tendency to melt, when forces are applied which tend to change its form. So that the ice under the coins has a tendency to melt, and has its freezing point lowered by the pressure. The under side of the coin will thus have a lower temperature than the upper; there will therefore be a transference of heat from the upper to the under side of the coin, this heat melts the ice under the coin, the water so formed passes round the edges of the coin to the upper side. This water being at a slightly lower temperature than the freezing point at ordinary pressure, a very small proportion of it will freeze and raise the temperature of the rest to the freezing point. The water arrived at the upper side of the coin, the coin being at a temperature a little below the freezing point, the water will be frozen, giving out its latent heat, which will pass through the coin and melt an equal quantity of ice on the under side, this having absorbed its latent heat of liquefaction will in turn pass to the upper side, and will there be converted into ice, giving out its latent heat to melt another quantity, and so on.

A slightly different form of the experiment was then made, a small metal cup was filled with water and laid on a piece of ice, and a heavy weight placed on the cup. After some time the water in the cup was frozen. The freezing point of the ice under the cup being, owing to the pressure, lower than that of the water in the cup, the water in the cup parted with its heat to the ice outside. A quantity of ice outside the cup was thus melted equal to the quantity of ice formed in the cup.

At first sight these experiments might seem to have an important bearing on the motion of glaciers. It might be thought, that if large bodies flowed thus easily through ice, why should not ice flow easily in its channel? But when we consider the circumstances, we find they are not so similar as might at first appear. When a body flows in this way through ice, there is not only a displacement of matter but also a displacement of heat, and the displacement of the matter cannot take place till there has been a displacement of the heat. In the preceding experiments, circumstances were most favourable for both displacements taking place quickly. The heat easily flowed through the very small thickness of the good conducting silver discs, and the water had only to flow from the one face to the other round the edges of the coins, whereas in glaciers, the ice and the rocks over which it moves are bad conductors of heat, and the distance to which the heat has to be conducted is so much greater than in the above experiments, that the exchange of heat can take place but very slowly; and when we further remember the very small difference of temperature between the freezing point of ice under pressure and not under pressure—if the lowering of the freezing point is the result of hydrostatic pressure alone, a pressure of one hundred atmospheres not lowering the temperature one degree centigrade—we can easily see that there will not be sufficient difference in temperature between the different parts of the glacier to cause the heat to flow quickly from one part to another, through such bad conductors.

In the explanation given of the passage of the coins through the ice, it has been assumed that the passage depends on the exchange of heat from the freezing ice on the one side of the coin to the melting ice on the other side. If this explanation is correct, then, if the coins had been non-conductors of heat, they would not have passed through the ice. The test was put. A shilling was placed on a block of ice, and over it a disc of a non-conductor (india-rubber), the same size as the shilling and over that another shilling; a weight of 90lbs. was applied by means of a small steel rod. After four hours it was found that the shillings had only sunk about an eighth of an inch into the ice, most of the heat to sink it this short distance being, in all probability, got by radiation from surrounding objects; as other two shillings and non-conducting disc placed on a block of ice and similarly situated, but not under pressure, had sunk to nearly the same depth.

There is another point in these experiments in their relation to glacier motion, which requires to be noticed. In all the experiments referred to, ice at the melting point was used. Sir William Thomson showed that the freezing-point of water was lowered $0^{\circ}\cdot13$ C. by a pressure of 16·8 atmospheres. We should therefore expect that, if we lowered the temperature of the ice by half a degree or a degree below the freezing-point, a much greater pressure would be required to cause the coins to pass through the ice. In order to test this, a block of ice was surrounded with ice, salt, and water. After it was cooled about a degree below the freezing-point, a shilling was placed on the block of ice, and a pressure of 90 lbs. applied. On examining it three and a half hours afterwards, the shilling was found not to have entered in the slightest degree into the ice. The freezing mixture was then removed, and within an hour the shilling had passed some distance into the ice. It would therefore appear, considering the enormous resistance offered by ice at a temperature of even one degree below the freezing-point to change of state, that the motion of glaciers at the higher parts, where their temperature is below the freezing-point, is, in all probability, not caused by the melting and regelation of the ice in the same manner as in the experiments.

Darroch, Falkirk JOHN AITKEN

A GIGANTIC "PLEASURING GROUND": THE YELLOWSTONE NATIONAL PARK OF THE UNITED STATES

THE Americans do their pleasuring as gigantically as they do everything else. This is the first and strongest impression made upon one by an Act of Congress of March 1872, to which we alluded in a recent number of NATURE, enacting that a district about half the size of Wales, and 1,000 square miles larger than the largest Swiss Canton, be "dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people." It is forbidden that anyone shall hereafter settle upon or enclose any part of the immense area thus set apart, and only such buildings can be erected upon it as the Secretary of the Interior, who has the exclusive control of this "park" (what an inadequate name!), may deem conducive to the accommodation and comfort of the visitors.

The estimated extent of the district thus set apart is 3,575 square miles, and coincides to a large extent with the area contained between the 110th and 111th degree of W. long., and the 44th and 45th parallels of N. lat. The southern boundary, however, is about eight miles farther north than and parallel with the 44th degree, and about seven miles westward of and parallel with the 111th degree, the whole district forming very nearly a square, and looking on the map like a huge slice out of one of the most mountainous parts of Switzerland; one of the heights, Mount Washburne, is 10,575 feet above sea level. Even the lowest part toward the south, containing the basin of Yellowstone Lake (330 square miles), "one of the most beautiful lakes of the world," is about 7,000 feet above the sea. Besides the huge mountains that form the most prominent features of this pleasure ground, the

FIG. 1.—Natural Walls in Yellowstone Park.

beautiful lake just mentioned, and a large part of the upper courses of the picturesque Yellowstone and other rivers, the district embraces some of the most remarkable natural phenomena that are to be seen in any part of the world—wonderful falls, multitudes of hot springs, steam springs, mud geysers, mud puffs, water geysers, some of them rising to a height of 200 feet, and other objects of interest. This whole region was in comparatively modern geological times the scene of wonderful volcanic activity. The hot springs, geysers, &c., represent the last stages, the vents or escape pipes, of these remarkable volcanic manifestations. All these hot springs are adorned with decorations more beautiful than human art ever conceived, and which have required thousands of years for the cunning hand of Nature to form. The geysers of Iceland sink into insignificance in comparison with the hot springs of the Yellowstone and Fire-hole basin. No portion of this tract could ever be made available for mining or agricultural purposes. The mountains that wall it in on every side form one of the most remarkable watersheds on the continent. From whatever point of view we survey this remarkable region, it is unsurpassed in interest, and the Act is one that should cause universal satisfaction throughout the States. "This noble deed," Mr. F. V. Hayden truly says, "may be regarded as a tribute from our legislators to science, and the gratitude of the nation, and of men of science in all parts of the world, is due to them for this munificent donation."

Several exploring parties have lately visited the district, and from an account of one of these, under Mr. F. V. Hayden, U.S. Geologist, to whose courtesy we are indebted for the accompanying woodcuts, we condense the following description of some of the most remarkable phenomena to be witnessed.

Nine-tenths of the area is covered with volcanic material in some form. The base rocks are the usual metamorphic granitoid series of the country, with basalts and basaltic conglomerates in every variety. The sedimentary rocks belong to the Carboniferous, Jurassic, Cretaceous, and Tertiary ages. The Triassic is probably wanting. The sedimentary rocks occur in patches, covering very restricted areas, yet presenting evidence that, up to the period of the Eocene Tertiary inclusive, they were extended uninterruptedly over the whole country. In the Yellowstone valley, as in the valleys of all the streams of the West, there is a chain of lake basins that must have existed during the Pliocene period. There was a continuous chain of these lakes of greater or less size to the source of the river; thence it expanded into an immense double lake, of which only a remnant, Yellowstone Lake, now remains. This lake was once much larger than at present, and it was partially connected with another lake about 30 miles long and 20 wide, which terminated at the Grand Cañon, at the upper falls of the Yellowstone.

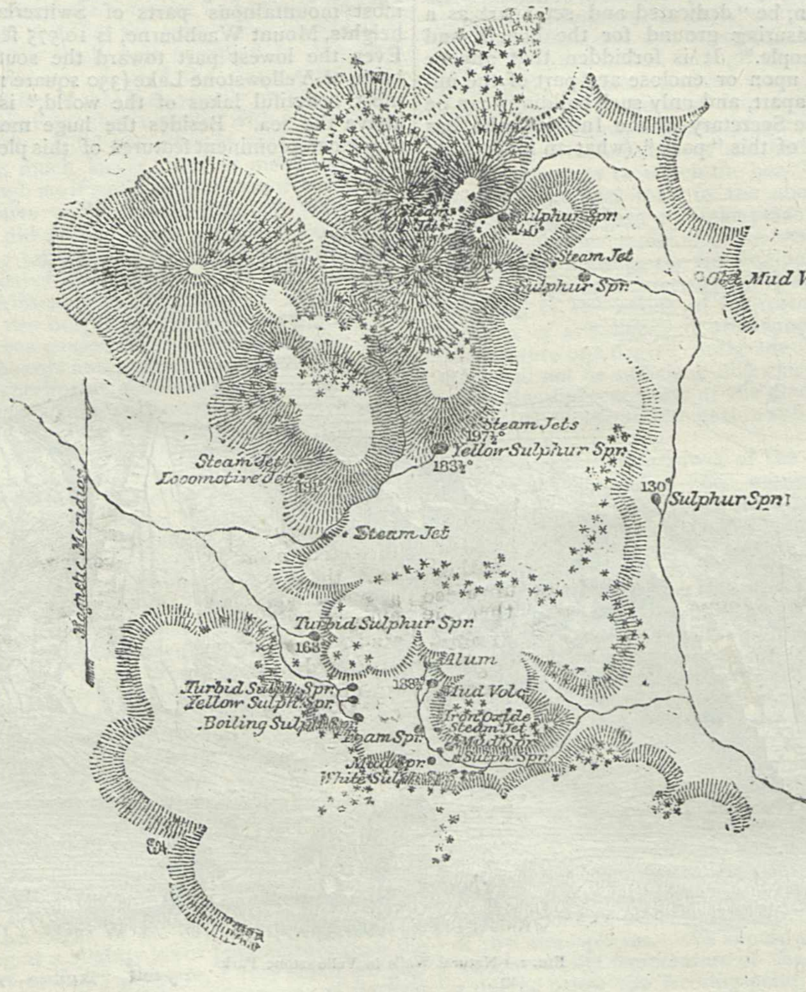

FIG. 2.—Sulphur and Mud Springs, Eight Miles below Yellowstone Lake.

The term Yellowstone Basin is sometimes applied to the entire valley; but the basin proper comprises only that portion enclosed within the remarkable ranges of mountains which give origin to the waters of the Yellowstone, south of Mount Washburne and the Grand Cañon. This basin is about 40 miles in length from north to south, and on an average 30 miles in width from east to west. It might be called the vast crater of an ancient volcano made up of thousands of smaller rents and fissures, out of which the fluid interior of the earth, fragments of rocks, and volcanic dust have been erupted in unlimited quantities. Hundreds of the nuclei or cones of these volcanic rents are now remaining, some of them rising to a height of nearly 11,000 feet above the sea. Indeed, as has been said, the hot springs and geysers of this region are only the closing stages of that wonderful period of volcanic action which began in Tertiary times. Even at the present time there are connected with these manifestations of internal heat earthquake phenomena which are well worthy of attention. Earthquake shocks are not uncommon, and are at some seasons of the year very severe.

Yellowstone Lake itself has at all seasons the temperature nearly of cold spring water, and its area is gradually but very slowly diminishing. Mr. Hayden estimates that since the period of volcanic activity the depth of the lake has been about 500 feet greater than at present, the shore line having then been high up on the sides of the surrounding mountains.

Warm springs are not uncommon in the valley of the lower Yellowstone, but the temperature is seldom higher than 60° or 80°. It is not until we reach Gardiner's River, a small branch flowing into the Yellowstone on the left side, opposite the third cañon, that the true hot springs commence in their full force. About three miles above its junction with the Yellowstone, the valley bottom is covered with a thick calcareous crust, the deposits of hot springs which are now extinct; but flowing swiftly from beneath this crust is a stream of hot water six feet wide and two feet deep, with a temperature of 132°. A little distance farther up is a high hill, on the slope of which has been formed a system of terraces, each from 200 ft. to 300 ft. in height, and covered with a thick deposit of lime. On the ascent of the hill, about three-fourths of a mile from the river bottom, there is to be met with one of the most remarkable exhibitions of hot spring deposits that is to be seen in this land of wonders. In the distance it looks like a vast glacier of snow and ice, on which account it has been named the White Mountain. Indeed, the different terraces can be compared, for their wonderful beauty, only to a frozen cascade. The remains of once active springs are plainly visible;

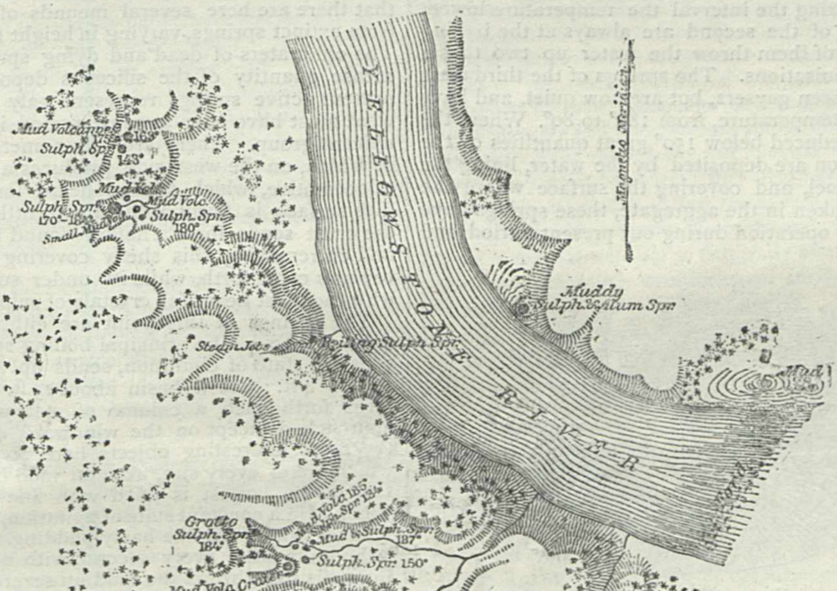

FIG. 3.—Sulphur and Mud Springs, Six Miles below the Lake.

old chimneys, irregular openings, like entrances to caverns, which extend beneath the crust, are numerous. This crust is probably from 20 ft. to 50 ft. in thickness, and underneath it is supposed that the surplus water from the active springs above flows down to the river. A little farther up is a series of basin-like pools, from 4 ft. to 8 ft. in diameter, and on a terrace about 200 ft. farther still are numbers of active springs, with basins 20 ft. to 50 ft. in diameter, some of them with several centres of violent ebullition in the same basin. The temperature at the outflow varies from 150° to 162°.

Upon the terrace, down about midway on the side of the mountain covered with this deposit, the principal active springs are now located, and here is presented another picture to the eye which transcends any description in words. The water is perfectly transparent, and down in the clear depths can be seen distinctly the minutest ornament upon the inner sides of the basin; and the exquisite beauty of the colouring and the variety of forms baffle any attempt to portray them, either with pen or pencil; various shades of red, from the most brilliant scarlet to light purple; yellow, from deep-bright sulphur through all the shades to light cream colour; and green of various shades. These springs also are full of a kind of vegetation, which under the microscope proves to be composed of diatoms, among which Dr. Billings discovers *Palmella* and *Oscillaria*. There are also in the quiet springs, and in the little springs that flow from the boiling springs, great quantities of a fibrous, silky substance, apparently vegetable, which vibrates at the slightest movement of the water, and has the appearance of the finest quality of cashmere wool. A qualitative analysis made at the springs shows that the water contains sulphuretted hydrogen, lime, soda, alumina, and a slight amount of magnesia. Carbonate of lime predominates over all other elements in the deposits, and they may therefore be called calcareous springs.

There are two classes of springs in the Yellowstone valley, one in which lime predominates, in the other silica. With the exception of the White Mountain Spring in Gardiner's River, and one or two of not much importance, the other springs of the Yellowstone and Firehole basins are siliceous. They may be divided again into intermittent, boiling and spouting, and quiet springs. Those of the first class are always above boiling point during the period of action, but during the interval the temperature lowers to 150°. Those of the second are always at the boiling point, and some of them throw the water up two to six feet by regular pulsations. The springs of the third class may have once been geysers, but are now quiet, and have a wide range of temperature, from 188° to 80°. Where the temperature is reduced below 150° great quantities of the sesquioxide of iron are deposited by the water, lining the inside of the funnel, and covering the surface where the water flows. Taken in the aggregate, these springs have been in constant operation during our present period, and

FIG. 4.—Hot Spring.

Mr. Hayden estimates that under favourable circum stances, at least six feet of this deposit have been preci pitated within the space of one century.

We must omit an account of the basaltic columns in the cañons of the Yellowstone and Gardiner's river, and of the great cañons, falls, cascades, and other wonders of this unique region, and pass to the hot springs of the upper basin. A few springs are seen at the mouth of Tower Creek, at the lower end of the Grand Cañon; but it is not until we pass the range of mountains which forms the north wall of the upper basin, about twenty miles above the lake, that the great hot spring district of the Yellowstone commences. There is here an area, within the drainage of the Yellowstone, forty miles in length, and on an average fifteen miles in width, that either is at the present time, or has been in the past, occupied by hot springs. The old deposits cover the region, and here and there are groups of active springs—mere remnants of what formerly existed. The Grand Cañon is a deep channel 1,000 to 1,500 ft. in depth, carved out of the basaltic rocks, and hot spring deposits, and on the sides of the walls may be seen the irregular fissures which communicate from the surface with the heated interior. Resting upon an irregular surface of basalt are immense deposits of silica of all colours, every shade of red, yellow, and white. Much of the deposit is as white as snow.

On the west flank of Mount Washburne, in the north of the area, there is a remarkable group of springs, in a constant state of action at the present time. Alum, sulphur, soda, and common salt, are found upon the surface in considerable quantities. Sulphuretted hydrogen is emitted from the spring in such quantities as to fill the air, rendering it oppressive with sulphurous odour. This group extends across the Yellowstone to the eastward for several miles. The springs, which are now in active operation, are only a few out of hundreds which once covered the entire area, but which are now dead or dying out.

Two remarkable groups deserve particular mention, the sulphur and mud springs, shown in Figs. 2 and 3. The largest group (see Fig. 2) is found on the east side of the Yellowstone, at Crater Hills, eight miles below the lake. This district covers an area of about half a mile square, and is sometimes called the "Seven Hills," from the fact that there are here several mounds of siliceous deposits from extinct springs, varying in height from 50 ft. to 150 ft. The old craters of dead and dying springs, and the immense quantity of the siliceous deposits, show that the present active springs represent only the last stages of what must have been at some period in the past a magnificent group. There are still numerous steam-jets, one of which, on the west side, produces a sound like that of a locomotive, which can be heard for a long distance. The surface is fairly riddled with little steam vents, and the crust sends forth a hollow sound beneath the tread; and on removing this shelly covering at any point, hot vapours come forth, while its under surface is encrusted with the most beautiful crystals of sulphur.

The springs at this point are either boiling, mud, or quiet springs. The principal boiling spring, which is in a constant state of ebullition, sends up a column of water 2 ft. to 4 ft.; has a basin about 15 ft. in diameter; and gives forth such a column of steam that it cannot be approached except on the windward side. But perhaps the most interesting objects here are the mud springs, which are of every size, from an inch in diameter to 20 ft. One of the largest is filled with fine light brown mud, which is in a constant state of agitation, the surface covered all over with puffs like hasty pudding. Others send forth a thud-like noise every second, with an impulse at long intervals that throws the mud up several feet. The water in the vicinity, as well as the mud, seems to be thoroughly impregnated with alum. In an adjoining valley are little mud or turbid water vents, which keep up a simmering noise, showing the nature of the earth beneath the crust.

Two miles above, on the same side of the Yellowstone, is the other group of springs, similar to those just noticed. Besides these are the geysers, to be alluded to presently. One of these is a true intermittent spring, and throws up a column of water 10 ft. in diameter, from 15 to 30 ft. high. The crater becomes filled with boiling water; suddenly immense columns of steam shoot up with a rumbling noise, the water overflows the basin, another column of water is thrown up for the space of 10 or 15 minutes, when it quiets down, and the basin is nearly empty. This operation seems to be performed about eight times in 26 hours. Upon the side of the hill bordering the river is one of the most terrific mud-cauldrons seen by Mr. Hayden during his visit. A large column of steam is constantly ascending, 500 ft. or more, from a deep funnel-shaped basin, 25 ft. in diameter; when the wind carries away the steam for a moment, the thin, black mud may be seen 25 ft. below the rim in the most violent state of agitation, with a noise like distant thunder.

On the shore of the south-west arm of the lake is an interesting group of hot springs, which extend along the margin, covering a belt about three miles long and nearly a mile in width. Many of these, which might be called pulsatory springs, are in a constant state of quite violent ebullition, but rise and fall every second or two, and with each pulsation throw out a quantity of water. Quite a pretty, symmetrical, funnel-shaped crater is formed with a circular rim, varying from a few inches to several feet in diameter. Some of these funnel-shaped chimneys (see Fig. 4) extend out into the lake several feet, and the hot spring deposits may be seen through the clear depths for fifty yards. The same variety of colours, quiet springs, mud springs, old ruins, &c., that have before been described, occur here. No geysers have been observed, but the group of mud springs keep up a constant thud-like noise, which can be heard with great distinctness for half a mile. At Steamboat Point are two vents, which keep up a constant pulsatory noise like a high-pressure engine on a river steamboat; columns of steam are thrown out at each pulsation to the height of 100 feet or more.

(*To be continued.*)

NOTES

WE may hope that we and the public have now heard the last of the unfortunate Hooker and Ayrton dispute. We learn that Mr. Ayrton has expressed himself satisfied with Dr. Hooker's explanation of the "offensive" matter in his letter to Mr. West, and here the matter will probably rest. It would be more satisfactory to know that all probability of similar unpleasantness for the future had been removed, and that the Government recognises the principle that a servant selected to control a great scientific establishment must necessarily be entrusted with all the details of its management.

THE rejection, by the Committee of Recommendations of the British Association, of the resolution of Section D respecting the treatment of Dr. Hooker as Director of Kew Gardens, resulted in the sending up to a subsequent meeting of the committee of a more strongly worded resolution to the same effect, which was then passed, not only by the Committee of Recommendations, but by the General Committee.

AT the meeting of the French Academy on the 2nd instant, the President presented to M. Chevreul a medal which had been procured by a subscription among his *confrères*. M. Dumas in a speech "à la manière anglaise," as the President expressed it, touched upon the chief services rendered by M. Chevreul to science in acknowledgment of which this medal was presented to him. Each subscriber is to receive a copy of the medal, and according to a slip inserted in the *Comptes Rendus*, the subscription list is still open.

IT is with great regret that we have to record the death, at the early age of 38, after a long and painful illness, of Mr. John Cargill Brough, F.C.S. He was a man of most accomplished mind and great general culture, and had personally endeared himself to all his acquaintances. Mr. Brough had filled, for about two years before his death, the office of secretary and librarian to the London Institution in Finsbury Circus, and had brought new life into its management.

WE hear from Paris of the death, at the age of 42, of one of the most promising of the younger generation of French botanists, M. Gris. He had written largely on both systematic and physiological botany, and held the post of assistant in the botanical department of the *Jardin des Plantes*.

THE inaugural address of the winter session of the Birmingham and Midland Institute will be delivered on Oct. 7, by Canon Kingsley, who is the president for the year.

MR. G. F. RODWELL, F.R.A.S., &c., has just been appointed Lecturer on Natural Philosophy at Guy's Hospital, still retaining his position as science teacher in Marlborough College.

THE Royal Polytechnic Institution appears, under its new management, to be assiduously encouraging the cultivation of Science. We have received a prospectus of classes held in the Institution in quite a number of branches of Natural and Physical Science.

WE notice from the *School Laboratory of Physical Science*, published in Iowa, U.S., that the total number of pupils who have attended one or more courses of lectures at the physical laboratory of the State University during the school-year of 1871-2, has been 340, representing all the departments of the University. Of these students, 270 have practised at the stands of the laboratory from two to ten hours a week each, and from the reports of the work done and the results, carefully calculated, of the examinations, it would appear that the teaching is varied and thorough. The high importance of laboratory work in the teaching of students is becoming more and more widely recognised in practice in the United States, and from this Report we learn that the great majority of the students themselves like the laboratory practice very much; those who do not, we are told, are those who are not fond of any serious mental work. As the opinion of the writer of the *Laboratory News* in the above work we quote the following note:—"One of the principal drawbacks to the perfect success of the Laboratory has been the admission of some students of advanced standing in the dead languages; we find these students almost invariably less careful in their work, and more hasty and illogical in their conclusions, than the regular beginners; they also have made the greatest blunders in calculation. As a result, such juniors have failed in competition with common sub-freshmen. I should not refer to these facts, if it were not so frequently asserted that the study of the dead languages constituted an auxiliary to the study of science."

THE Marlborough College Natural History Society has issued its Report for the half-year ending Midsummer 1872. In the Preface praise and blame are impartially dealt out to the members of the Society; the zeal and industry of individual members are commended in not undeserved terms; while the apathy and want of energy of the majority of the Society come in for severe censure. In the Botanical department some good work appears to have been done, and the president, the Rev. T. A. Preston, continues his Flora of Marlborough, the present instalment embrace the Calyciforæ. In Geology nothing has been done; in Ornithology a few of the members have shown active interest in "*genuine* Ornithology, not merely the taking of eggs, but observations of the birds themselves and their habits." The greatest triumph has been, however, in Entomology, where, thanks to the energy of two or three individuals, upwards of thirty moths have been added to the Society's list. Of the papers printed we may notice a useful one on Shells, by F. J. H. Jenkinson, and one on Thermo-Electricity and a new Thermo-Electric Battery, by Mr. Rodwell; others, however, are alluded to in the Preface. We cordially encourage the Marlborough College Natural History Society to continue its work.

MR. GOULD is now engaged on the preface to his great work on the "Birds of Great Britain," and will issue the last two parts, completing the whole, in 1873.

A VERY good "Flora of Liverpool" has been published by the Liverpool Naturalists' Field Club. The area included is within fifteen miles of Liverpool and two of Southport, and embraces some very interesting districts. The work has been performed by a committee of the society appointed for the purpose, with the assistance of amateurs and previously published records, which have all, when possible, been verified. It appears to have been carried out with great care, and some valuable notes are appended to the records of some of the species.

AMONG the most recently-published foreign flora we may note Dr. J. A. Knapp's "Plants of Galicia and the Bukowina," just published by Braumüller, of Vienna, in one thick volume.

THE last number of the *Quarterly Journal of the Meteorological Society* contains a letter from M. Hoffmeyer, Director of the recently established Meteorological Institute of Denmark, giving some details of the work it is intended to accomplish. The sphere of the Institute embraces all the branches of Meteorological Science, and it is especially intended to establish in favourable situations a series of stations, furnished with accurate instruments, by which it will be possible, every morning, to send telegraphic communications to the chief station at Copenhagen, and from that, according to agreement, to foreign societies. When the stations are fairly in working order, observations will be published monthly. It is also proposed by the Institute to establish about ten complete meteorological stations at the Faroe Isles, Iceland, and in Greenland; half of these are expected to be in trim by next winter. Besides the general interest attaching to these stations, it is hoped they may tend to foster a system of international meteorology, and pave the way for the laying down of a northern telegraphic cable between Europe and America. The observations at these stations will be specially published. The establishment of this Institute is likely to be of the greatest service to general meteorology.

IN "Railways or No Railways; the Battle of the Gauges Renewed," those who take an interest in the subject will find the case on behalf of the narrow gauge fully and ably set forth.

A "DISSERTATION on the Use of the Stethoscope in Obstetrics," by Æneas Munro, M.D., read before the Royal Medical Society of Edinburgh, seems to be a valuable contribution to the science of the subject to which it relates.

WE have received a pamphlet, "Irrigation not necessary in Upper India," by Major A. F. Corbett, Superintendent Budaon Police, in which the author attempts to prove that irrigation, instead of fertilising that country, will inevitably render it an almost barren waste. The statements he adduces, and the opinions of eminent scientific men and others that he quotes, certainly appear to bear out the writer's theory, and on that account his pamphlet deserves the attention of all who take an interest in the welfare of India.

THE "dead season" has brought up its usual crop of reports of the re-appearance of the sea-serpent, mostly easily resolvable into masses of floating sea-weed. The following extract from an evening contemporary well illustrates the hazy ideas prevalent as to the extinct Saurian monsters of which the sea-serpent is supposed to be a descendant:—"If the sea-serpent continues in its present sociable state of mind, we may perhaps have an opportunity of deciding the vexed question regarding the formation of that portion of his figure which, according to English observers, he keeps concealed under the water. The legend of the Lambton Worm, a popular tale in the North of England, describes the worm as a serpent of enormous size, who used to coil himself round a hill overhanging the River Wear, just as thread is wound round a reel, but a very ancient stone effigy of the creature which lately existed at Lambton Castle, represents it with ears, legs, and a pair of wings. If this effigy was made, as it probably was, *from some recollection* or recent tradition of the Lambton Worm, these adjuncts would indicate that the beast was one of the *winged land monsters* which existed at the same time as the *Ichthyosaurus*, but would naturally become an extinct species far sooner than the *fish lizard*, which can conceal itself in the depths of the ocean from the curiosity and violence of man."

IT is not for want of good examples that the British Government is so backward in encouraging deep-sea dredging; other governments seem to think it their interest or duty to do so. The United States, as we know, have fitted out an expedition under MM. Agassiz and Pourtales, to explore the Gulf Stream, the Straits of Magellan, and the Pacific Ocean. A second American expedition will, in the same way, explore the northern regions of this ocean; the German Empire has undertaken to search the depths of the Atlantic; while Sweden has sent to Baffin's Bay two ships fully equipped for deep-sea sounding.

THE BRITISH ASSOCIATION

SECTION A—MATHEMATICAL AND PHYSICAL SCIENCE

Fifth Report of the Committee for investigating the Rate of Increase of Underground Temperature downwards, and in various localities of dry land and under water, by Prof. Everett.

IN December last, intelligence was received from Prof. Sismonda that the administration of the railway owning the Alpine tunnel had given permission to Father Secchi to carry on a series of observations in the tunnel concerning terrestrial magnetism, and that this distinguished observer was willing at the same time to conduct observations of temperature in accordance with the plans of your Committee. Two maximum and two minimum thermometers were accordingly placed in Father Secchi's hands; but it appears that the arrangements for commencing the magnetic observations are not yet completed, and that accordingly no observations of temperature have as yet been taken.

Prof. Lubimoff of Moscow, on receiving a copy of last year's report, wrote to the secretary, correcting a mistake in the description of the thermometer used in taking observations in the Moscow well. The thermometer was enclosed in a hermetically sealed case containing air, and was therefore completely protected against any possible effect of pressure. Prof. Lubimoff at the same time asked to be furnished with a thermometer of the new pattern described in the report (the upright-Negretti pattern), and one of these instruments was accordingly sent.

Dr. Wild of the Central Observatory, St. Petersburg, wrote in January, requesting that two thermometers for observations in bores might be ordered in his name. At this time, the Secretary was in correspondence with Sir Wm. Thomson, who entertained doubts as to the successful working of the new thermometer, and expressed a preference for the Phillips pattern (which has been described in preceding reports) and the Casella-Miller pattern (a modified Six) which has been extensively used for deep sea temperatures. Thermometers of these two patterns were accordingly ordered and despatched to Dr. Wild.

A letter was received from Prof. Henry of the Smithsonian Institution, Washington, in April, stating that the Chief Engineer of the Hoosac Tunnel had promised to have observations of temperature taken in the tunnel, if thermometers were sent. Its total length will be $4\frac{3}{4}$ miles, about two-thirds of which has been penetrated, by working from both ends and from a central shaft 1,028 feet deep. The mountain has two ridges, under which the tunnel passes, and their heights above it are respectively 1,720 and 1,420 feet. Four thermometers have been sent, viz.: two large minimum Rutherfords, for observations in the tunnel, and two upright Negrettis, for observations in the shaft.

The Council of the School of Mines at Ballaarat, Australia, have, in compliance with a request addressed to one of their number by our observer, Mr. David Burns, C.E., consented to take charge of these thermometers, and furnish observations from the bores and shafts in that important gold-mining district. Most of the principal mining managers are connected with the school. Four thermometers have accordingly been sent, viz.: two upright Negrettis for observations in bores, and two simple mercurial thermometers, of large size, for observations during the sinking of shafts.

Some exceedingly deep Artesian borings have been undertaken in France in recent years; and the President of the Geological Society, Mr. Prestwich (who has allowed his name to be added to your Committee) has furnished your Secretary with introductions which will probably lead to the obtaining of very numerous and valuable observations from these wells.

The largest of them all is one which is now sinking for the municipality of Paris, at La Chapelle, St. Denis, a northern suburb of Paris, and has already obtained a depth considerably exceeding that of the Puits de Grenelle. It is expected that its final depth will be about 2,300 feet. Application was made by the Secretary to the eminent firm of well-borers, Messrs. Mauget, Lippmann, and Co., who are sinking the well, and these gentlemen at once in the most obliging manner consented to take observations of temperature in it. An upright Negretti thermometer was accordingly furnished; and about the 20th of June your Secretary had the pleasure of receiving from them two complete sets of observations taken on the 14th and 15th of that month with their own hands, at every 100th metre of depth, and also at the bottom of the well, 660 metres deep.

Depth in Metres.	FIRST SERIES. June 14, 15. Temp. Fah.	Time down. h.	m.	SECOND SERIES. June 17, 18. Temp. Fah.	Time down. h.	m.
	°			°		
100	58·0	0	35	58·0	3	30
200	61·1	0	30	61·0	2	0
300	65·0	0	30	65·0	2	0
400	69·0	3	10	69·0	11	20
500	72·6	0	30	72·6	2	0
600	75·8	0	30	75·4	2	0
660	83·25	15	45	83·25	2	0

The observations are given in the subjoined table, in which the third column shows the time that the thermometer was allowed to remain at the depth specified before hauling up and reading. The temperature at which the thermometer was set before letting it down is also given in Messrs. Mauget and Lippmann's report, but is not here inserted.

The agreement between the first and second set of observations is remarkably close; and as the time of leaving the thermometer in the water was about half-an-hour in most of the observations of the first set, and two hours or more in all the observations of the second set, it is obvious that half-an-hour is a sufficient time to give a correct observation. This conclusion is satisfactory both as regards the reliability of the observations themselves, and also as establishing the fact that this pattern of thermometer is not unreasonably slow in its working. The exactness of the agreement also serves to show that the thermometer can be depended on to the tenth of a degree, and that we may henceforth use it with confidence.

Before proceeding to discuss the observations, it will be convenient to give a few particulars respecting the well, which have been kindly furnished by Messrs. Mauget and Lippmann.

It was commenced by the municipal authorities as a masonry well, by the ordinary method of digging, until it had reached a depth of 34·5 metres. The intention was to carry it in this way to the depth of about 135 metres, the estimated depth of the tertiary strata covering the chalk; but the difficulties and dangers which were encountered, from the want of tenacity in the soil (*la nature essentiellement ébouleuse des terrains*), and latterly from the insufficiency of the pumps, rendered it necessary to abandon this intention; and in May 1865 the task of completing the well by boring was assigned to Messrs. Degousée and Laurent, the predecessors in business of the gentlemen to whom we are indebted for these observations. A small trial bore (0·2m. in diameter) was commenced, and continued till January 1866, by which time the machinery for the heavier work was ready. In order to support the masonry, which showed signs of giving way, it was tubed through its whole length with a tube 1 8m. in diameter and 0·02m. thick, cemented externally. From the bottom of this tube, at the depth of 34·5m., a bore 1·7m. in diameter was carried to the depth of 68·7m. from the surface of the ground. A second tube 1·58m. in internal diameter was inserted to the depth of 121·6m., and a third tube of internal diameter 1.39m. was carried down into the chalky marls and the upper portion of the chalk at the depth of 139·15m. from the surface. From this point downwards, the bore has been driven through the chalk, and tubing has been unnecessary, its diameter at the depth of 662m. being still 1·35m.

The thickness of the tertiary strata is 137m., and the elevation of the surface of the ground above sea-level is 48m. or 157ft.

The springs which were met with in the tertiary strata correspond to those found in other parts of the basin in which Paris is situated, and have not sufficient strength to spout above the surface of the ground at this elevation. They were encountered at the depths of 19·2m., 34·5m., 86·0m. and 97·0m., and the water now stands in equilibrium in the central tube at 16·5m. below the surface of the ground.

It was not practicable to take observations of temperature during the regular progress of the boring, but an interruption occurred on the 12th of June, and the tool was not at work from this date till after both sets of observations were finished. In reference to this point, Messrs. Mauget and Lippmann, say, under date April 29, "To obtain the natural temperature, it will be necessary to select a time when the work has been interrupted for several days; for the boring being executed by the fall of a heavy tool upon the bottom of the well, the percussion developes a considerable amount of heat, as we perceive by the mud (*les boues*) which we extract, and which in coming to the surface is found to have still a temperature of from 48° to 90° C. (118° to 194° F.)." In their letter of June 19, containing the report of the observations, they remark :—

"You will observe that though the water at the bottom of the well is still some degrees above its natural temperature owing to the action of the drill *(trepan)*, the latter has not been in operation since the 12th of the month. At a convenient time, we intend to observe the temperature of the mud as it lies at the bottom of the well, immediately after the withdrawal of the drill, when the latter has been working constantly, a temperature which will probably be found to depend upon the hardness of the rock."

The following table exhibits the successive increments of temperature showed in the second series, which purports to be more accurate.

Depth in Metres.	Increase in deg. Fahr.	Metres per deg. Fah.	Feet per deg. Fah.
	°		
100 to 200	3·00	33·3	109
200 to 300	4·00	25·0	82
300 to 400	4·00	25·0	82
400 to 500	3·60	27·8	91
500 to 600	2·80	35·7	117
600 to 660	7·85	7·6	25

The last two columns of this table show that the rate of increase is about four times as rapid in the last 60m. as in the rest of the well, a circumstance which naturally suggests the explanation given by Messrs. Mauget and Lippmann. There are however some difficulties in the way of accepting this view. Comparing the two sets of observations, one taken on the second and third day after the withdrawal of the tool, and the other on the fifth and sixth day, we have precisely the same temperature at the bottom of the well on both occasions, although the observations were sufficiently precise to detect a difference of a tenth of a degree where such difference existed. It seems difficult to believe that a temperature $2\frac{1}{2}$ degrees above the normal temperature could have remained for two days without sensible diminution. In connection with this question, the apparent cooling to the extent of 0°·4 at the depth of 600m. between the first and second observation demands attention, and is not very easily explained.

If the observed temperature at 660m. is to be taken as the normal temperature, the average increase from 100m. to that depth is at the rate of 1° F. in 22·1m. or in 72·5 ft. If the observed temperature at 600m. in the second series is adopted, the increase from 100m. to that depth is at the rate of 1° F. in 28·7m. or in 94·2 feet.

The observations prepared by Messrs. Mauget and Lippmann in the paragraph above quoted will be eminently calculated to assist in showing the correct interpretation.

Mr. G. A. Lebour, F.G.S. of H.M. Geological Survey, has furnished observations taken in a bore hole executed at the bottom of South Hetton Colliery, Durham. The observations were taken by Mr. J. B. Atkinson, a student at the Newcastle College of Physical Science, and appear to have been carefully made. Thanks are also due to the viewer of the colliery, Mr. Matthews, for granting the requisite facilities.

The hole is $2\frac{1}{2}$ inches in diameter, and was bored out of the pumping side of the South Hetton shaft, in order that the bore rods might be the more readily altered. The depth of the shaft is 1,066 feet; that of the bore hole 863 feet from the bottom of the shaft, or 1,929 feet from the surface of the ground. The section of the boring (not including the shaft) consists of 123 alternating beds of shale and sandstone,* with occasional thin seams of coal and some fire clays. The bottom of the boring has reached a very coarse white grit, which is supposed to be the topmost bed of the millstone grit series.

The bore was dry at the time of its execution; but has since become filled with water, probably derived from the shaft above it. Streams, in fact, pour down the shaft, and play about the hole.

*A complete list of the strata has been furnished, and will be preserved by the Secretary, with a view to future reference if required.

Two thermometers, one of them an unprotected Phillips, and the other a protected Negretti, were supplied by the Secretary to Mr. Lebour, as it was not certainly known at that time whether the bore was dry or wet. Mr. Lebour indeed believed it to be dry, but nevertheless selected the Negretti thermometer, as it was thought that the Phillips could not be read off accurately with the poor light which in the position of this bore hole was alone available.

The following table exhibits the results of all the observations which have been taken in the bore, including three which were taken in 1869, while the boring was going on. The boring was stopped, in the case of each of these three observations, only about 20 minutes before the observations were made; and the heat due to friction appears to have produced abnormal elevation of temperature, amounting to about 2° at the depth of 288 feet, to about 6° at the depth of 582 feet, and to considerably more than this at 858 feet. The other observations in the table are Mr. Atkinson's, taken with the Negretti thermometer.

Depth from bottom of shaft, in feet.	Depth from surface of ground, in feet.	Temperatures observed during boring, April 1869.	Temperatures observed April 1872.
100	1166	—	66
200	1266	—	$68\frac{3}{4}$
288	1354	72	—
300	1366	—	70
400	1466	—	72
500	1566	—	$74\frac{1}{2}$
582	1648	82	—
600	1666	—	$76\frac{1}{8}$
644	1710	—	75
670	1736	—	$77\frac{1}{8}$
858	1924	96	

The temperature 75° at the depth of 644 feet, a temperature lower than either of the two between which it stands, was taken on the first day of Mr. Atkinson's observations, and was confirmed by repeated trials at that time. This was the lowest depth that could then be reached, the remainder of the boring being apparently plugged up with "sludge." A spike was subsequently attached to the thermometer case, which enabled it to pierce deeper into the sludge; but the lowest depth which could be reached (670 feet) is still far from the bottom of the bore.

It is intended to take a fresh series of observations at every 50th foot of depth, and especially to re-examine the temperatures at about 650 feet, where the reversal of temperature was observed.

The following are the rates of increase deduced from Mr. Atkinson's observations, omitting the temperature 75° at the depth of 644 feet.

Depth in feet.	Increase in deg., Fahr.	Feet per deg.
100 to 200	$2\frac{3}{4}$	36
200 to 300	$1\frac{1}{4}$	80
300 to 400	2	50
400 to 500	$2\frac{1}{2}$	40
500 to 600	$1\frac{5}{8}$	62
600 to 670	1	70
		51·2
100 to 670	$11\frac{1}{8}$	

The average increase between the depths of 100 and 600 feet is 1° in 51·2 feet. These depths are reckoned from the top of the bore hole, which is 1,066 feet below the surface of the ground. Mr. Lebour assumes that the temperature at the depth of 600 ft. from the surface of the ground is 48°. Accepting this estimate, we have a difference of $29\frac{1}{8}$° in 1,676 feet, $(1,066 + 670 - 60 = 1676)$ which is at the rate of 1° in 57·5 feet.

Mr. David Burns, F.G.S., reports that, from changes in the management of the mines, and other causes, it has not been possible as yet to carry out the dry observations at Allenheads mentioned in last year's report.

Only one other shaft has been met with at all suitable for observation. It is called Brandon Walls shaft, and belongs to the Rookhope Valley Mining Company, to the courtesy of whose agent we are indebted for liberty to take observations. This shaft is some 6 miles east of those reported on last year, and is situated in the very bottom of Rookhope Valley. The mouth is covered over with a wooden shed, the shaft itself is free from all obstruction, and the water in it has not been disturbed for some ears. The shaft is 333 feet deep, and is full of water to within 25 feet of the surface of the ground. Observations (by Mr. Burns and Mr. Curry of Bolkburn) were taken in it on five different days in July of the present year; but though agreeing well with one another from day to day, they are so irregular that they throw little light on the rate of increase of underground temperature. At the depths of 83 and 133 feet from the ground, the temperature was 48°·5. In the next 50 feet there was an increase of about 3°, the temperature at 183 feet being about 51·4, and from this depth to the bottom (an interval of 150 feet) the temperature was nearly constant. The best determination of the temperature at the bottom was 51° 7.

It may be remarked that all observations in shafts thus far have exhibited irregularities of this kind. The water in such large openings seems to have its temperature governed by springs and other extraneous causes, rather than by the temperature of the surrounding soil.

The observations at every fiftieth foot of depth in the Kentish Town well, as given in previous reports, are so complete that it has not been thought necessary to continue them. A very delicate thermometer, reading by estimation to the $\frac{1}{100}$ of a degree, has however been procured, for taking observations from year to year at one constant depth (1,000 feet). It was constructed ten months ago, and being enclosed in a partially exhausted glass tube will probably not undergo much change of zero. It has been four times tested by comparison with standards, and has been found to have no error amounting to nearly so much as 0°·1. In consequence of Mr. Symons' illness, no observation has yet been taken with it in the well.

A thermometer which, through the breaking of a rope, had fallen into the mud at the depth of 1,090 feet from the surface of the ground, was extracted by Mr. Symons last November, more than a year after its fall. It had sustained no damage, and its indication when hauled up was 69°·4, nearly agreeing with the temperature previously observed at that depth.

In addition to the large numbers of thermometers above mentioned as having been issued during the past year, one has been furnished for observations which are to be made in the projected boring through the Wealden and underlying strata. With the exception of Mr. Symons' observations at Kentish Town (London, N.), we have as yet no observations of temperature from the Southern parts of England.

SECTION B—Chemical Science

Mr. Alfred Tribe read a paper *On the Precipitation of Silver by Copper*. In the course of experiments made in conjunction with the President, Dr. Gladstone, it was found that the silver obtained by precipitating the metal from the nitrate by means of copper always contained more or less of the latter metal. When an excess of silver remained in a solution only minute traces of copper were found, but as the silver solution became exhausted the proportion of copper rapidly increased. This co-precipitation of copper was shown to be due to the presence of atmospheric oxygen. In one experiment as much as 15 per cent. of copper was obtained after 48 hours exposure. When carbon dioxide was caused to bubble through the solution during the precipitation the quantity of copper deposited was greatly diminished. The author showed an eudiometric apparatus in which this property of absorbing oxygen was applied to determine the proportion of that gas in the air.

Mr. Gladstone gave a brief account of the physical and chemical characters of the *Volcanic Dust* recently ejected from Vesuvius. In some localities the fall of this dust was very heavy and extended over a considerable area: the sample examined was collected at Ischia, upwards of twenty-five miles from the mountain. It consisted essentially of a mixture of quartz and magnetite. No trace of titanium could be detected. Dr. Thorpe stated that he had recently examined the volcanic sand found in the neighbourhood of Etna, and its agreement in chemical and physical properties with the sand from Vesuvius was very striking. It also contained no titanium.

Dr. Schenck read a paper *On the Amount of Heat required to raise Elementary Bodies from the absolute zero to their state of fusion*. If we assume that a body at — 273° is completely deprived of heat it is possible to calculate the total heat in it at any other temperature provided that the specific heats of the body in its three states of aggregation, its latent heats of fusion and vaporisation, and its melting and boiling points are known. Such calculations are limited from the fact that only in the case of one body—water—are the data sufficiently well known. In the course of the paper the author pointed out a remarkable coincidence between cadmium, tin, and lead, in the amount of heat required to raise gram-equivalents from — 273° to the state of fusion.

Mr. W. Lant Carpenter made a communication respecting the presence of *Albumen in Fats, and on a new method of obtaining Stearic and Palmitic Acids.* The paper mainly consisted of an account of Dr. Bock's remarkable process for the decomposition of Fats which is now being generally adopted on the Continent, in the manufacture of improved stearin candles. When fats are decomposed in the ordinary process by alkali, a considerable excess of the alkali above the theoretical quantity is required unless the operation is conducted under great pressure, when the risk of explosion increases the disadvantageousness of the process. When the fats are decomposed by oil of vitriol, or other strong acid (the method usually adopted in England), a considerable proportion of the fat is lost by being charred and burnt, and that which remains is so blackened that it is necessary to distil it, an operation of expense and of danger owing to the risk of fire or explosion. All these advantages are obviated by the use of Prof. Bock's process. Dr. Bock has shown that most neutral fats are made up of minute globules surrounded by albuminous envelopes, which form from 1 to 1·5 per cent. of the weight of the fat, and he considers that the action of the alkali, acid, or of heat or pressure was to break up these albuminous envelopes. The destroyed envelopes had a remarkable power of attracting the colouring matters contained in the fat or produced therein during the action of the acid or alkali. The existence of the albumen may be demonstrated by dissolving the fat in ether or benzol and adding water to the solution, or by boiling the fat with a strong solution of oxalic acid. In each case the albumen envelopes collect at the plane of juncture between the two liquids. In the new process the envelopes are broken up by the action of a small quantity of strong sulphuric acid for a limited time only and at a given temperature. The fat is then poured away from the destroyed envelopes and is ready for decomposition by water in open tanks. This operation requires some time for its completion; its progress may be readily determined by a microscopic examination of the crystallised fatty acid formed by slowly cooling a thin layer upon a glass slide. When the process of decomposition is at an end, the solution of glycerine is drawn off purified and concentrated for sale. The fatty acids thus obtained amount to 34 per cent. of the original fat: they are however far from pure and contain more or less brownish or black matter. By submitting the fatty acids in open tanks to the action of a dilute solution of certain oxidising agents, the dark coloured matters are partially oxidised and their specific gravity is so far increased that when the oxidation has proceeded far enough, they readily subside together with the envelopes to the bottom of the tank, and the supernatant fatty acids are rendered comparatively good in colour. After two or three repetitions of this process the resultant stearin is hot and cold pressed in the ordinary manner. The acid thus obtained is of a better quality, has a higher melting-point, and is yielded in greater quantity than that obtained in the ordinary way.

Mr. J. F. Walker contributed a paper *On Dinitrobrombenzene,* and Dr. Wright gave an account of the continuation of his experiments on *New Derivatives from Morphine and Codeine.*

Mr. John Williams described an improved method of preparing Guaranine, the active principle of *Guarana,* the fruit of the *Paulina sorbilis,* which is used by the Amazonian Indians for an infusion. This principle was isolated by Stenhouse, and pronounced by him to be identical with theine or caffeine, the active substance contained in tea and coffee. In the author's process the guarana is reduced to fine powder mixed with one-third of its weight of hydrate of lime and moistened with water. It is then allowed to stand for a couple of hours and thoroughly dried at a gentle heat. The mixture is exhausted with boiling benzol filtered, the benzol distilled off, when a small quantity of light coloured oily matter remains. This is treated with hot water and heated for some time over the water bath, filtered through a moist filter, and after concentration, the solution is set aside to crystallise. In about twenty-four hours the guaranine separates out perfectly pure. The same process is applicable to tea, but the author is inclined to believe that guaranine differs in several particulars—taste, solubility in water, &c.—from theine.

Mr. Wanklyn described a method of analysing the *Compound Ethers*—acetic ether, for example. It consisted in determining the amount of alcohol liberated in the decomposition of the ether by the known methods of alcoholimetry. The complete proximate analysis of a compound ether is thus rendered possible.

Prof. Crum-Brown made a brief communication on the subject of *Chemical Nomenclature.* Setting aside the trivial or proper names (names which are simply arbitrary words or marks each indicating in virtue of a convention applicable to each individual case, a particular substance), there are two systems or kinds of systems of chemical nomenclature. These may be distinguished as 1st, the composition system, and 2nd, the functional or relational system, or class of systems. In the first the name of a compound indicates the elements or radicals contained in it, and sometimes their proportions. Thus Chlornatrium, Chloriod, Dreifach chloriod, Silicium wasserstoff, &c. In English we have few names so distinctly compositional in form (we have indeed, Zinc methyl and all the other allied names) but many of our names, although apparently functional in form, are really compositional. Thus, chloride of A means with us nothing more than, or different from, a compound containing the elements chlorine and A: and chloride of sodium, chloride of iodine, ter-chloride of iodine, siliciureted hydrogen, not only represent the same substances as the German names just quoted, but tell us neither more nor less about the substances than these German names do. On the other hand, functional names present the chemical relations between substances. We may take as examples such names as the anhydride, the amide, the aldehyde, the nitride of acetic acid. These derivatives of acetic acid contain no acetic acid, but they stand in certain definite relation to that substance, and he anhydrides, amides, aldehydes and nitrides of other acids stand in the same relation to them. What is still, notwithstanding the efforts of modern chemists, the common popular nomenclature of salts, although originally intended as a compositional nomenclature, might, with perfect consistency, be retained as a functional nomenclature. The objection to the term "muriate of soda" was that the substance so named contains no soda. But the amide of benzoic acid contains no benzoic acid. Soda contains oxygen; muriate of soda contains none (unless chlorine be an oxide), but the nitride of benzoic acid contains no oxygen, although the acid itself does. The name muriate of soda originally meant the *compound* of anhydrous muriatic acid, $2HCl - H^2O$, and anhydrous soda $Na^2O - (2HCl - H^2O) + Na^2O$. We may now, if we please, use the name to mean the result of the action $2HCl + Na^2O - H^2O$. If we do so, the name becomes a functional one, and the phrase "muriate of," or, what is neither better nor worse, "hydrochlorate of," expresses the complex operation. Addition of hydrochloric acid and simultaneous separation of water. Similarly, in the case of such names as sulphate of potash, nitrate of oxide of silver, &c., the phrases "sulphate of," "nitrate of" express the complete operations, addition of sulphuric, or nitric acid, and simultaneous separation of water.

While the old view that salts are compounds of anhydrous acids and anhydrous bases is now abandoned by most theoretical chemists, a relic of this view still remains in the most advanced systems of nomenclature, producing an inconsistency really inconvenient to the teacher and student.

The objection taken to the name hydrochlorate of soda was not only that the substance contains no soda, but also that it contains no hydrochloric acid. This objection is perfectly valid against the name as a compositional one, but does it not equally hold against the words sulphate, nitrate, acetate, &c.? If we are to have hydric sulphate and hydric acetate for sulphuric and acetic acids, why not hydric muriate for muriatic acid? That this question is not altogether an absurd one will be obvious if we consider that all chlorides are not muriates. Those substances which are by general consent called salts stand in a definite genetic relation to the corresponding acids (or the hydric salts of the series), and it is inconvenient to have the same general name —chloride—applied to substances which do stand in this relation to hydrochloric acid, and also to those which do not. We may divide the chlorides into two groups, very different in character in their extreme members, and gradually shading into one another. We may take chloride of sodium as a representative of the one, and the chloride of phosphorus as a representative of the other. Chloride of sodium is a muriate; the chloride of phosphorus might be better described. We may call the acids and acid anhydrides negative, the hydratic bases, anhydrous bases positive—arranged in a series, we find the series a continuous one from the most positive or basic oxides or hydrates to the most negative; it is however convenient to have a zero point, and it is no disadvantage if this zero point be an arbitrary one. When we come to express numerically the amount of positiveness or negativeness of these oxides and hydrates, it will be necessary to have a zero point, and a very convenient one is that which corresponds pretty nearly to the generally understood limit between bases and acids, and depends upon the direction in which the action takes place.

SECTION C.—Geology

On the Cambrian and Silurian Rocks of Ramsey Island, St. David's, by Henry Hicks, F.G.S.*

In a report to the British Association in 1866, by the late Mr. Salter and the author, Ramsey Island was mentioned as a part of the district which had been examined and a short description of the rocks exposed there was given. At that time three distinct formations in succession had been recognised, and also correlated by their fossil contents and lithological characters with the Lingula flags, the Tremadoc group, and the Arenig group. Since then the author has further examined these beds, and recently along with Messrs. Homfray, Lightbody, Kirshaw, and Hopkinson.

During these researches numerous new forms have been discovered in these rocks, and many additional and interesting facts observed. In a section at the north end of the island the following rocks occur in succession:—

1. *Lingula Flags.*—A series of hard silicious sandstones with grey flaky slate, about 600 feet in thickness, and containing *Lingulella Davisii* in great abundance but no other fossils save worm tracks and burrows, and some plant-like markings.

2. *Tremadoc Group.*—Bluish grey flag, and earthy grey rock of a tough texture, from 800 to 1,000 feet in thickness. Fossils are very abundant throughout the whole series, and nearly all the species as well as many of the genera are new. They comprise Brachiopods of the genera *Lingula*, *Obolella*, and *Orthis*, and Lamellibranchs of the genus *Ctenodonta*. There are also two species of *Orthoceras*, a *Theca*, a *Bellerophon*, an *Encrinite* and a star fish, and nine species of Trilobites belonging to the genera *Dikelocephalus*, *Conocoryphe*, *Niobe*, *Asaphus*, *Cheirurus*, and *Calymene*, and a supposed land plant named *Sophyton explanatum*. Some of these genera are characteristic of the Cambrian rocks, and others of the Silurian; and there are several forms which had not previously been discovered in rocks of so early an age. Until the discovery of these rocks at St. David's the Tremadoc group was supposed to be a local formation only.

3. *Arenig Group.*—A series of ironstained slates and flags, having a thickness of 1,000 feet. The fossils comprise Trilobites belonging to the genera *Asaphus*, *Ogygia*, *Oeglina*, *Trinucleus*, *Ampyx*, *Calymene*, and *Agnostus*; also a *Conularia*, *Theca*, *Orthoceras*, *Bellerophon*, *Lingula*, and *Orthis*, and about 20 species of Graptolites.

In this section the succession from the Cambrian to the Silurian rocks is probably better shown than at any other place in Britain.

SECTION D.—Biology

Department of Zoology and Botany

Second Supplementary Report on the extinct Birds of the Mascarene Islands, by Alfred Newton, F.R.S.

The speaker stated that a portion of the grant unexpended at the last meeting of the Association had been expended by his brother in a renewed examination of the caves in the island of Rodriguez. This has been conducted by Mr. George Jenner, lately Chief Executive Officer of the island. No detailed account could at present be given. Several missing parts of the skeleton of Pezophaps, and of additional remains of the large Psittacine bird, described from a single fragmentary maxilla by Milne Edwards as *Psittacus* (?) *rodericanus*. This may enable its affinities to be more exactly determined, and also allow more light to be thrown on *P. mauritianus* of Owen. A bird described by Leguat, and hitherto believed to be extinct, had been found still to exist, and had been described by himself as *Palæornis exsul*. The remains of a Ralline bird, considered to be allied to Ocydromus Milne Edwards, was disposed to identify with the "Gelinotte" of Leguat, the nature of which had hitherto only been a matter of guess.

Dr. Sclater said it was well to bear in mind that Rodriguez was one of the stations where it was proposed to place a staff of astronomers to observe the transit of Venus, and the opportunity of carrying on ornithological observation at the same time should not be lost sight of.

On the Perforating Instrument of Pholas candida, by Mr. John Robertson.

The author attributed the perforating action of the animal to a rasping effected by the rotatory movements of the shell and also by putting the valves together.

Prof. Allman said that the late Mr. Bryson, of Edinburgh, had observed the habits of the Pholas, and had come to the conclusion that the boring was effected by the foot charged with silicious particles and acting like the leaden wheel of the lapidary.

Mr. Gwyn Jeffreys was of opinion that in the whole of the perforating conchifera and some of the univalves the foot was the instrument of perforation. In *Cardium*, *Mactra*, and especially *Solen*, as well as other bivalve mollusca, the posterior extremity of the shell was shaped to receive the foot which worked like a gardener's dibble. In the case of *Pholas dactylus*, Mr. Caillaud thought that at Nantes the gneiss was perforated by the rasping action of the shell. Man might do this, but it was doubtful whether it could be accomplished in this way by the *Pholas*. In *Teredo navalis* he believed that, as Sellius had shown in 1733 in his work "De Teredine Marina," the foot was the sole instrument of perforation, and in this case the posterior extremity of the shell had a large excavation to receive the foot. Again, *Pholadidea* in a young state excavated by means of its foot, but afterwards the aperture was closed by gelatinous matter, the animal became encysted, and no further excavation took place. The limpet he had seen in Aberdeenshire excavate the rock to the depth of a fourth of an inch, and this could only have been accomplished by the foot. In *Pholas* also no part of the shell can act at the bottom of the excavation. The prickles it was supposed were renewed; but this could not take place throughout the shell, and many excavating shells had no prickles at all. Deshayes had advocated the chemical theory; but this too had been exploded, as Deshayes himself admitted.

Summary of Flowering Plants of Sussex, by W. B. Hemsley.

Taking Babington's Manual (5th Edition) as a standard, the Flora of Sussex includes 1,059 species of flowering plants, reckoning Ferns and Horsetails as well. These last amount to only 33, or about 3 per cent. Roughly speaking $\frac{3}{4}$ are Dicotyledons and $\frac{1}{4}$ Monocotyledons; $88\frac{1}{2}$ per cent of the species are herbaceous, and $11\frac{1}{2}$ woody; $27\frac{1}{2}$ per cent are annuals, and $72\frac{1}{2}$ perennial; 12 natural orders include rather more than half the whole number of species; 76 of the species are maritime, and 56 peculiar to the chalk. *Pyrola media*, *Habenaria albida*, and *Festuca sylvatica* are outliers of Watson's Scottish type not found in adjacent counties. The three species peculiar to Sussex, *Phyteuma spicatum*, *Lonicera Xylosteum*, and *Trifolium stellatum* are probably all introductions, the last being certainly so. In the centre of the county the heath grows as high as three or four feet, and covers considerable tracts of land.

Prof. Lawson in answer to a speaker who had inquired the useful purpose of these investigations into indigenous plants, and who had lamented the want of adequate knowledge how to keep them in their place, pointed out that the researches of Messrs. Lawes and Gilbert were likely to lead to practical methods of developing the useful constituents of pasture and of restraining the growth of the undesirable elements. He was especially struck with the presence of *Centaurea calcitrapa* about Brighton. This he had generally seen as a ballast plant, and thought almost certainly an introduction.

Diversity of Evolution under Uniform External Conditions, by Rev. John T. Gulick.

The terms "Natural Selection" and "Survival of the Fittest" present different phases of a law which can act only where there is variation. Does this variation ever produce from one stock distinct varieties and species, while the external conditions remain the same? When a species is subjected to a new set of conditions, does the change that is brought about in the organism expend itself in producing just one new species completely fitted to the conditions, or may it produce many that are equally fitted? Facts in the geographical distribution and varia-

* The discussion referring to this paper occurs at p. 383 (after Mr. Hopkinson's paper.)

tion of the terrestrial molluscs of the Sandwich Islands seem to throw light on the subject. A forest region on the island of Oahu, 40 miles in length, and 5 or 6 miles in breadth, furnishes about 175 species, represented by 700 or 800 varieties. The average area occupied by each species is about 5 or 6 square miles, though many are restricted to half that area. The valleys that lie on one side of the mountain range that traverses this district preserve, as far as we can observe, the same conditions; but the varieties, and in some cases the species, found in each valley, differ from those found in any other.*

If we would account for these facts on the hypothesis of evolution, it seems necessary to suppose: First, that these molluscs possess an inherent tendency to variation, so strong that all that is needed to ensure the divergence of type in the descendants from one stock is to prevent, through a series of generations, their intermingling with each other; and secondly, that either the tendency to variation in this family is very much greater than usual, or their tendency to migrate weaker, and their opportunities fewer than usual. An investigation of the conditions under which that species exist leads me to believe that the smallness of the areas occupied by each is due to freedom from that competition that retards variation in Continental species, rather than to any deficiency in the means of transportation. On the continents, "Natural Selection" arising from severe competition with species that have a wide range, tends to prevent the development of varieties, and to give a wider diffusion of forms, that would otherwise be limited in their range, and variable in their type.

Mr. Wallace agreed with the Rev. J. T. Gulick in his interpretation of facts which appeared to be exceedingly remarkable. He had had the opportunity of working at a limited group of organisms in a small part of the world. The results he had described were a type of what took place over whole continents, and exhibit an example of variation and geographical distributions, perhaps the most remarkable that occurs on the surface of the earth. With the general principle that variation does not depend on difference in external condition, he altogether agreed. He thought in this matter that there was a confusion of two distinct things, even in some cases by Mr. Darwin himself. Variation was confounded with the formation of varieties. That it was not dependent on the change of conditions was evidenced by the fact that the varieties of domestic animals and plants were not due to this cause, but only to advantage being taken of spontaneous variation and identical conditions. Horticulturists obtained new varieties of any plant that was introduced into cultivation by growing it upon a very large scale, and selecting the sports which were sure to occur. In this case variation was accumulated by artificial selection, just as it is accumulated in nature by natural selection. This requires, as a condition of its action, a change of external conditions. We all know that closely allied, though distinct species, were found inhabiting distinct areas—for example, islands; and with large continental areas it was the same. This had led to the very general idea that it was variation of condition over those areas which had produced the varieties, whereas it had merely selected them. In the Sandwich Islands there was no difference of physical conditions adequate to produce this result. This was seen in the number of intervening forms which existed. It seemed due to the absence of any weeding-out effect. The land molluscs had hardly any competitors to struggle with, and no enemies, quadrupeds and reptiles being absent, and birds few. The rivers were small and would only distribute any form through the same valley. All these conditions favoured this remarkable persistence of closely linked forms.

SECTION G—Mechanical Science

On Rolling in a Seaway, by Mr. W. Froude, F.R.S.

This was a description of an apparatus for automatically recording the rolling of a ship in a seaway and the slopes of the waves. The fundamental principles on which the performance of the apparatus depends are (1) that when waves act on a ship or other floating body which would stand stably upright in still water, she will be for the moment in equilibrium if upright or normal to the mean or effective slope of the wave which she occupies; and if she possess a given righting force when inclined to a given angle in still water, she will be urged by approximately the same righting force towards the normal position in wave water, if she at any moment deviate from it by the same inclination. (2) A plumb line or pendulum, if its point of suspension be at or very near the ship's centre of gravity, will be for the moment in equilibrium if it occupy the normal position, and if it have a very short period of oscillation it will instantly assume that position throughout the changes of the wave slope. These two propositions are but expressions of the interdependence which exists between the change of translatory motion which at any moment affects a mass or particle of matter, and the direction at the same moment proper to any force-direction-index carried by the man, whether it be a plumb-line, which lies in the direction, or a spirit level, which lies at right angles to it; the direction being simply the resultant of gravity, and of the disturbing forces which at the moment affect the mass. Mr. Froude described his apparatus as follows:—A revolving cylinder covered with paper and turned by rough clockwork receives the marks made by several pens. One of these pens records time, jerks being given it at successive equal intervals by an exact clock. The apparatus being placed at the centre of gravity of the ship, a pendulum of very short period and considerable power, oscillating in the plane transversely with the keel, records continuously by a second pen the angles made at each moment by the ship, with the mean or effective wave slope, that is to say, her relative inclinations. Another pen, actuated by a rocking arm kept level by the observer on deck, who points it to the horizon, records the angle made at the same moment by the ship with the horizon, that is to say, her absolute inclinations. From the records thus obtained, the amount of the roll of the ship with regard to the wave slope is at once shown, and the form of the wave can be easily worked out graphically, the wave slope at each moment being simply the difference between the records produced by the pendulum pen and the horizon pen respectively. But the graphic integration of the results supplied by the pendulum pen, if correctly performed, supplies what might be called the theoretical measure of the oscillations, which the ship ought to have performed with regard to the horizon during the period embraced in the record. For the pendulum record itself supplies, throughout, a measure of the accelerating force by which the ship's oscillation is governed; so that the integration of this gives a diagram representing the angular velocity which the ship should theoretically have acquired under the operation of that force. And the integration of the velocity diagram in turn gives the sequence or total of motions which the varying velocity involves. The performance of these integrations involves indeed a correct knowledge of the ship's dynamic constants, but these, so far as they are not already known by calculation, may be readily obtained by a single experiment with the ship in still water, where, if she be artificially brought into oscillation (an operation easily performed), and the instrument be made to record the oscillations as they subside under the influence of resistance, the natural period of her oscillation is at once known, and the coefficient of resistance is deducible in a shape which is approximately applicable to the ship's seaway oscillation. All the conditions required for the integration are thus supplied. Several series of diagrams thus obtained by the oscillation of ships in a seaway have been thus integrated, and the theoretical oscillations accord so completely with the recorded oscillations that the fundamental elements of the theory of rolling have been most satisfactorily verified. Mr. Froude said he had more recently contrived and executed an apparatus which would substitute an automatic record of the ship's absolute inclinations for that supplied by the observer on deck, as above described. For this purpose he employed a heavy stationary wheel, which was so delicately supported as to be incapable of receiving any rotation from the motion of a ship. This wheel, if placed transversely in the ship, would remain still at rest—that is to say, without rotation—and would thus, while the ship performed oscillations of rotation under it, communicate to one of the tracing pens a virtual motion along the record cylinder, so as to form a continuous record of the ship's absolute inclinations. The wheel is 3 ft. in diameter and 200 lb. in weight. Through the boss is carried out a strong steel axis, the prolonged ends of which are coated with hardened steel. The axis thus prolonged rests between two pairs of rocking arms, the ends of each pair forming a kind of V. The ends of the arms are, in fact, hardened steel plates, forming segments of circles struck from the axes or centres on which the arms rock, so that they are virtually portions of the circumferences of very large friction rollers. In order still further to reduce the friction of the working parts, the axes of

* A fuller statement of the fact has been given in an article on "Variation of Species related to their Geographical Distribution," in NATURE July 18th, 1872.

the rocking arms have been finally reduced to hardened steel pins of small diameter, and so mounted that their motions, when of small range, should be rolling not sliding motions, and great delicacy is thus obtained. The centre of gravity is brought to within 0·0065 in. of the axis of suspension, and the time of a single swing is over thirty-five seconds. Yet so great is the delicacy of the suspension, a weight of $\frac{1}{250000}$ part of that of the wheel itself, if placed at its extreme radius, will produce an oscillation of $1\frac{1}{4}$ in, in range, and which will continue for many minutes; or if the wheel be moved 90° from its position of rest, the oscillations will continue for nearly twenty minutes, the movement being so slow and solemn as to impress on the mind of an observer who had not seen it put in motion that the action was self-originated, or induced by some mysterious agency. The oscillation of a ship can scarcely communicate any motion at all to the wheel, and any minute rotation which is, in fact, communicated will assume the form of an oscillation, having so long a "period" that its effects will be easily separable from those proper to the oscillation of the ship. Thus the indications will be more exact than those produced by the rocking arm on deck. This improved apparatus has not yet been tried, but is ready, waiting a suitable day for trial on board a ship at Plymouth.

Mr. Froude stated that though the apparatus he had described was purely his own invention, it had interested him greatly to learn recently that an arrangement substantially identical with that combination which he first described had about two years previously been invented and successfully used by an able French naval architect (M. Bertin, of Cherbourg), with whom, partly in virtue of this circumstance, it has since been his good fortune to become acquainted and to correspond. It was, however, a satisfaction to him that he was at the present time ahead of his friendly competitor in the race, so far as regarded the delicately-hung heavy fly-wheel which was to furnish an automatic constant record of the angles or absolute rolling or deviations from the horizontal assumed at each moment by the ship.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Aug. 5.—Prof. Cayley presented a memoir on Orthogonal Surfaces.—M. E. Becquerel communicated a spectroscopic analysis of the light emitted by the phosphorescent uranium compounds.—M. Daubrée presented a note on the discovery of a second meteorite, which fell on the 23rd of July last, in the canton of St. Amand (Loir-et-Cher). This appears to have formed part of the fall noticed at the meeting of the Academy on July 29.—A long letter, illustrated with figures, from Father Secchi, on the solar eruption observed on July 7, and on the phenomena which accompanied it, was communicated. In this paper the author referred to the phosphorescent light emitted by certain animals, and upon this subject MM. de Quatrefages, Milne-Edwards, and E. Becquerel made some remarks.—M. Dumas read an important memoir on alcoholic fermentation, and a note on the ferments belonging to the diastase group.—MM. Favre and Valson presented a continuation of their researches upon crystalline dissociation.—M. G. Ville presented a memoir on the quick quantitative determination of phosphoric acid.—A note by M. Houzeau, on the decolorising power of concentrated ozone, was read, and upon this M. P. Thenard made some remarks.—M. Wurtz presented a note by M. E. Grimaux, on some derivations of tetrachloride of naphthaline.—A note was read by M. Sirodot on a bone-deposit situated at the foot of Mont Dol, containing bones and teeth of elephant, horse, ox, rhinoceros, and other mammals, generally broken and often calcined, with a few fragments of flints and at least one stone implement.—M. C. Sainte-Claire Deville presented a note by M. Gorceix, containing a summary of the phenomena presented by the volcano of Santorin at the close of the eruption of 1866, or from December 1869, to October 1871.—M. T. Lestiboudois presented a note on what he calls heterogeneous Dicotyledons, or those which do not produce their new tissues exclusively in the generative zone between the wood and the bark.—M. Duchartre communicated a note by M. J. Duval Jouve on a form of epidermic cell which appears to be peculiar to the Cyperaceæ.—M. de Quatrefages read a memoir on the Mincopies and the Negrito race in general, containing a discussion of the characters of the Andaman islanders, and of their relations to the other black races of man.—M. Blanchard presented a note by M. J. Kunckel on the development of the striated muscular fibres in insects, in which the author maintains that the primitive element of the muscle is a cell, which, by its elongation, forms the fibrilla, the fibre or primitive bundle being a secondary formation.—M. Blanchard also communicated a note by M. A. Tillot on the embryonic form of the Hairworms (*Gordius*), in which the development of those parasites from the egg is described, and they are shown to possess, in the embryonic state, some analogy with the *Echinorhynchi*.—A note by M. J. Gerbe on the formation of the adventitious products of the ovum of the Plagiostomi was presented by M. C. Robin.

August 12.—Prof. Cayley communicated a continuation of his memoir on orthogonal surfaces.—M. Yvon Villarceau presented a further memoir on the applications of his new theorem of general mechanics to the equilibrium of gases.—General Morin presented a report upon a memoir by M. Graeff, on the action which the breakwater of Pinay exerts upon the floods of the Loire at Roanne.—A note on the vibrations of cords and rods in liquids, by M. E. Gripon, was read.—M. Pasteur presented a note, by M. E. Branly, on the measurement of the intensity of currents by means of the electrometer.—A note, by M. Broun, on magnetic variations observed at Trevandrum during the eclipse of December 11, 1871, was presented; as also a note containing observations of meteors at various stations on August 9, 10, and 11, by MM. Le Verrier and Wolf.—A short note on the observations relating to presence of magnesium in the chromosphere of the sun, by M. Tacchini, was transmitted by M. Faye.—MM. Favre and Valson presented the continuation of their thermo-chemical researches upon crystalline dissociation.—M. Berthelot presented a note on the partition of a base between several acids in solutions, in which he treated of the monobasic acids; and M. Pasteur communicated a note, by M. E. Jungfleisch, on the conversion of right tartaric acid into racemic acid by exposure to heat in the presence of water.—M. Dumas called attention to some researches, by M. Latimau, on *Phylloxera vastatrix*.—M. Brongniart presented a detailed report upon a most important memoir, by M. Grand-'Eury, on the Carboniferous flora of the Department of the Loire.

BOOKS RECEIVED

FOREIGN.—Through Williams and Norgate—Alexander von Humboldt, 3 vols.: Karl Bruhns.—Etudes sur les Facultés des animaux comparés à celles de l'homme: J. C. Houzeau, 2 vols.—Oeuvres des Verdet, Tome vii.—Théorie mécanique de la chaleur: E. Verdet, Vol. i. and Vol. ii., Parts 1 and 2.

AMERICAN.—Report of the Palæontology of Eastern Nebraska: T. B. Meek.

CONTENTS

ERRATA.—Vol. vi., p. 382, Section C, Geology, line 7, for "graptolite" read "graptolites;" line 20, for "*T. serrus*" read "*T. serra*;" line 25, for "*Dictyograptus*" read "*Dichograptus*;" line 31, for "*Phyllograptus*" read "*Ptilograptus*;" line 35, for "not" read "two."