THURSDAY, JULY 22, 1880

VICTORIA UNIVERSITY

IT was only the singular moderation and good sense with which the promoters of the New Manchester University movement conducted their case that could have secured that no Parliamentary opposition should be made to the late Government taking a step so momentous, and affecting so many rival interests, as the foundation of a new English university. They were compelled, indeed, like many other strategists, to change front once or twice, and to accept a charter different in two vital respects from that which they had asked. They wanted a university in England on the model of the Scotch and German universities—a university of a single college in a great centre of population. They were compelled, however, to make provision for affiliating Leeds and other colleges, when they become adequately equipped, with full faculties of arts and science, and when it is completed the new University will have to carry out an experiment completely novel. It will occupy a midway place between the Scotch single-college universities, the English universities with their families of colleges bound together by their common locality, and the Central Examining Board for all qualified applicants, which is known as the University of London. The separate colleges will in fact be Universities of the Scotch type, complete in themselves before they are affiliated in respect of two important faculties. They will differ vitally from the single colleges of Oxford and Cambridge, each with three or four tutors of its own, but each requiring to lean on the private tutors and the resident university professors and lecturers for the necessary supplement of their teaching. It will be most interesting to see how the University authorities will conciliate the independence and originality of the teaching of the individual colleges with the examination system which must govern and regulate them all. The new University will more nearly resemble the late Queen's University in Ireland than anything else of which we have had experience. It will differ from the Queen's University only in the greater importance of the separate colleges. Meanwhile all these arrangements are *in posse*. The University will be started on the familiar lines of the Scotch and German universities, with a single college, with which for the time being it is practically identified, and whose teaching it will be its sole business to influence.

The other important modification is in the temporary absence of the medical faculty. An important medical school is attached to Owens College. The last Government were occupied with a Medical Bill, the main object of which was to diminish the number of licence-granting medical centres, and to substitute a single authority for the nineteen medical bodies which confer the right to practise on the bodies of Her Majesty's subjects. It was strongly represented to them that it would be an anomaly that they should add a twentieth licensing body to the nineteen at the very moment when they were attempting to fuse the nineteen into one. The charter they have issued to the Victoria University grants it the right to confer all degrees and titles of honour that it is competent to other universities in the United Kingdom to grant, except in the single faculty of medicine. Although the medical professors of Owens College become professors in the University, they will remain in an exceptional position, at all events until the new Government have made up their minds what course to adopt with the Medical Bill. Should the agitation for a medical uniformity die out, and the Government resolve upon no disturbance of the existing arrangements, it will be impossible for them not to complete the charter of the new University by conferring on it the right to grant medical degrees. Should they revive the proposals of their predecessors and succeed in passing them into law, the new University will stand in the same position as that which the older universities will then be reduced to occupy.

The public will be most interested to see on what lines the Victoria University will be developed. Will it strike out a new line for itself? Every university in this country aims at being a *studium generale*, but every university has in practice shown a tendency to the exceptional development of special studies. Oxford is in the main a great classical, and Cambridge a great mathematical, school, and London has been exceptionally distinguished for the high attainments and reputation of its medical graduates. In the Victoria University, so far as it is possible to forecast its future, a similar position seems likely to be asserted by the scientific faculty. It is in that respect that Owens College has been specially strong. In all the older universities the scientific faculties have had to assert for themselves a higher position than they originally occupied, and they have generally done so during the last century of their history. They will start in the Victoria University from a position at least equal to that occupied by the elder "Arts" studies. It would be a mistake if they were to attempt to claim an exclusive predominance, and the first step which the University has taken indicates that there is no such danger. They have appointed as their Chairman of the Board of Studies their Professor of History and English Literature. Every one who has followed the movement in which the University originated knows how deeply it has been indebted, from its commencement to its close, to Prof. Ward, and it is safe to say that no sounder appointment could have been made, and none more likely to secure the impartial appreciation of all the competing claims of the old and the new learning. The authorities of the Victoria University will begin their new career on the broad and satisfactory lines indicated by the words of their founder. Mr. Owens' will pointed to the creation in Manchester of a seat of learning in which the subjects taught in the English universities should be taught in the best way, and the promoters of the movement have never advocated any scheme for making themselves a scientific college, or what is called a technical university. But it will be as difficult as it would be imprudent to ignore the fact that Manchester has special opportunities for becoming a great scientific school, and the eminent teachers who represent its scientific faculty may be confidently trusted to maintain the position which they have secured for their subjects. We may reasonably hope to see the new University set itself to the task of proving that science is as educationally effective an instrument as literature and philosophy. Literature,

history, and language will hold their own adequate place in its scheme of instruction, but the newer sciences of animate and inanimate nature will certainly start from a fairer platform than usual, in the North of England. The Victoria University will not be hampered, like its elder sisters, by the traditions of the past. There is a great career before it, and the people of England will watch its development with the deepest interest. They may be reasonably confident of one thing, that the new educational "brand," to adopt Prof. Huxley's felicitous expression, will be of as select a character as any of the "brands" with which they are familiar.

ON THE RELATION BETWEEN THE MOLECULAR WEIGHTS OF SUBSTANCES AND THEIR SPECIFIC GRAVITIES WHEN IN THE LIQUID STATE

UNDER this title I have communicated to the Chemical Society the results of a prolonged investigation on the connection existing between the weights of unit volumes of liquid substances and their relative molecular weights (see *Journal* of the Chemical Society for March, April, May, and June, 1880), and in obedience to a request from the Editor of NATURE I will briefly indicate the scope of the inquiry, and point out the main conclusions to which I have been led. The inquiry, I may say in the outset, has resolved itself into a critical and experimental examination of what are known as Kopp's laws of specific volume. That some definite connection between molecular weight and specific gravity would be traced had been surmised more than forty years since, but all our exact knowledge on the subject is contained in the series of classical memoirs which we owe to Hermann Kopp. Kopp first clearly recognised the necessity of comparing the liquids when under strictly analogous conditions. By dividing the specific gravity of a liquid taken at the temperature at which its vapour-tension is equal to the standard atmospheric pressure—that is, at its ordinary boiling-point—into its molecular weight, we obtain its specific volume. If the specific gravity be referred to the point of maximum density of water, this value represents the number of cubic centimetres occupied by the relative molecular weight of the liquid expressed in grams at its boiling-point under the standard pressure. The numbers thus obtained were first shown by Kopp to exhibit certain definite relations which may be briefly stated as follows :—

I. *In many instances differences in specific volume are proportional to differences in corresponding chemical formulæ.*—Thus a difference of CH_2 in a homologous series corresponds to a difference of about 22 in the specific volume, or $(CH_2)x = 22x$. On comparing the specific volumes of similarly constituted haloïd compounds, it is seen that the substitution of n atoms of bromine for an equal number of chlorine atoms increases the specific volume by $5n$.

II. *Isomeric and metameric liquids have, as a rule, the same specific volume.*—Exceptions are exhibited by certain oxygen and sulphur compounds.

III. *The substitution of an atom of carbon for two of hydrogen makes no alteration in the specific volume of certain groups of organic liquids.*

On the basis of these conclusions Kopp was able to calculate certain numerical values for the specific volumes of the elements in combination. These values are as a rule constant for the particular element: thus, according to Kopp, carbon has invariably the value of 11, hydrogen that of 5·5. Exceptions are observed in the case of the chemical analogues oxygen and sulphur. Each of these bodies has two values depending, it would seem, on its mode of combination, or on its relation to the remaining atoms in the molecule. For example, acetone and allyl alcohol have each the empirical formula C_3H_6O, but the specific volume of acetone is 78·2, whilst that of allyl alcohol is 73·8. In the case of acetone the combining power of the oxygen atom is wholly satisfied by carbon; that is, we have reason to know that the oxygen atom is more intimately associated with one of the carbon atoms than it is with any one of those of the other elements; whereas in allyl alcohol a moiety of the combining value would seem to be satisfied by carbon and the remainder by hydrogen. It appears, then, that when oxygen is united to an element by both its affinities its specific volume is 12·2; when it is attached by only one combining unit its specific volume is 7·8. The corresponding values for sulphur are 28·6 and 22·6.

I have already pointed out that these differences in the values for the specific volumes of oxygen and sulphur may be employed to throw light upon the constitution of such bodies as the phosphoryl and thiophosphoryl compounds, and that we may in this way obtain evidence as to the particular affinity-value that an element such as phosphorus, which is variously regarded as a triad and a pentad, exerts, and in the present paper I give additional instances to show that a knowledge of the specific volume of a body is often calculated to furnish valuable information concerning its constitution.

The most accurate method of ascertaining the specific volume of a liquid is (1) to determine its specific gravity at some convenient temperature; (2) to ascertain its boiling-point with the utmost exactitude; and (3) to determine with great care its rate of expansion, say between 0° and this boiling-point.

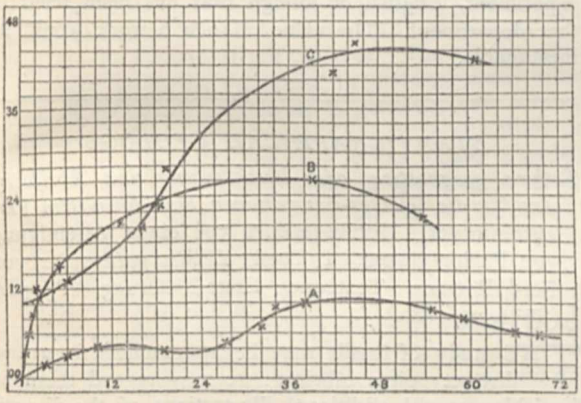
The space at my disposal forbids me attempting to show how these various physical data were determined for the purpose of the present inquiry. Full details of the methods employed are given in the original paper, and the errors incidental to the various processes are fully discussed. The observations necessitated among other things the frequent determination of the fixed points of the thermometers employed, and the accompanying figure shows how these were found to rise during the progress of the investigation. The abscissæ represent the times in months at which the several observations were taken, and the ordinates the extent of displacement in hundredths of a degree. A represents a thermometer ranging from − 10° to 50° C., B from 50° to 105° C., and C from 98° to 144° C. It will be seen that the extent of the displacement is evidently dependent on, or at any rate is greatly influenced by, the amount of molecular disturbance to which the glass envelope is subjected.

The accuracy of the results is of course in great measure dependent upon the purity of the liquids employed, and this fact to some extent limited the number of compounds which could be investigated. Whenever the mode of

preparation was not a sufficient guarantee of the purity it was established either by analysis or by the determination of its vapour density—a most rigid test, provided that this could be ascertained with sufficient accuracy. I have ventured to modify the original form of the Gay-Lussac-Hofmann apparatus, and I think I may claim that this modification admits of all the precision which the process is capable of yielding. It obviates some of the disadvantages of the original method, such as the liability to crack the tube, and the use of a large quantity of mercury and of liquid to vaporise the body under investigation, and it also permits of a more certain application of the necessary corrections.

Among the many problems suggested by a review of our present knowledge of the subject, the following seemed to me to be specially worthy of solution.

I. Is it definitely established that an element in combination has as a rule an invariable specific volume? May not the volume be modified by the number of the atoms of that particular element in the molecule? Is it



Curves showing rise of fixed points in thermometers.

altogether independent of the general complexity of the molecule, or may not the specific volume of the molecule be a function of its weight?

II. Do the various members of a family of elements possess identical specific volumes, or may not the volume be a function of the atomic weight?

III. Would a re-examination of the cases of so-called variable atomic value serve to show that the specific volume of an element is a function of that value, as Buff supposes?

IV. The hypotheses of Mendelejeff and Meyer indicate the need of additional and more exact determinations of the values for the specific volumes of the elementary bodies?

This scheme of work required the determination of the specific gravities, boiling-points, and thermal expansions of about fifty liquids, and the results of the observations afford material for the calculation of the specific volumes of seventeen elementary bodies. The rates of expansion are represented by formulæ of the form—

$$V = A + Bt + Ct^2 + Dt^3.$$

The labour of reducing the observations, and more especially of calculating the empirical formulæ for so large a number of substances, has been materially lightened by the use of the arithmometer of Thomas (de Colmar). The investigation has therefore incidentally added very considerably to the data upon which the determination of the general laws affecting the thermal expansion of liquid bodies must depend.

After a discussion of the errors of the observations and a comparison of my results with those obtained by previous observers, whenever these were applicable, I have summarised the main conclusions to which I have been led as follows:—

1. It seems certain that many isomeric liquids, even of the same chemical type (using that phrase in the sense in which it is employed by Kopp) have not identical specific gravities at their respective boiling-points, and hence have not identical specific volumes. Such exceptions are more commonly met with in compounds containing carbon and hydrogen; this fact appears to indicate that the specific volume of one or both of these elements is not absolutely invariable. Benzene derivatives especially show a greater departure from the general law than can be fairly attributed to experimental error. Their variations are of the same order as has been shown to occur in the refraction values for these compounds.

2. We must also suppose that of the additional elements, oxygen, sulphur, and nitrogen have likewise variable specific volumes in conformity with Kopp's conclusions.

3. There is at present no experimental evidence for assuming that any other element has a variable specific volume.

4. Hence in the case of these elements the volume is not modified by the number of the atoms of the particular element in the molecule, and it is therefore altogether independent of the general complexity of the molecule.

5. The different members of a family of elements do not possess identical specific volumes; the volumes of the elements are periodic functions of their atomic weights.

6. The inquiry affords no evidence in support of the hypothesis that the specific volume of an element in combination is modified by any possible variation in the affinity value which it may possess. T. E. THORPE

GORDON'S "ELECTRICITY AND MAGNETISM"

A Physical Treatise on Electricity and Magnetism. By J. E. H. Gordon. (London: Sampson Low and Co., 1880.)

THE author, in the first paragraph of his preface, draws a distinction between the physical and mathematical points of view in treating the Science of Electricity. Unfortunately, the distinction is at present a real one. Many mathematicians, fascinated by the beauty of the instruments they handle, are disposed to treat physical problems as though the principal function of the universe were to suggest problems to the pure mathematician, instead of the principal function of the pure mathematician being to provide suitable tools for solving physical problems. On the other hand, there are skilful experimentalists who fail to appreciate those powerful methods of deductive quantitative reasoning which they are themselves unable to handle. Mr. Gordon does not profess to be a mathematician, and adopts the experimental point of view.

The book makes no claim to be a complete treatise, but rather to deal with those branches of the science with which the author is best acquainted, one might almost say, those parts at which he has himself worked, either originally or by way of verifying the work of others. As might be expected from such a scheme, the descriptions of apparatus and phenomena are admirable, but, unfortunately, the theoretical explanations, intended to give the book more or less the character of a systematic treatise, are neither clear nor accurate. So early as page 2 we read: "It is found that if equal quantities of the electricity of glass and the electricity of sealing-wax be added together they neutralise each other." But this is not preceded by any explanation of what is meant by equal quantities of the electricities of glass and sealing-wax. If the sentence had been cast as a definition, it would have been comprehensible. On page 20 there is an extraordinary illustration of the medium supposed to transmit electrostatic forces:—

"The transmission of strain may be very beautifully seen at any railway-station when shunting is going on, if a train of carriages is being pushed by an engine which happens, instead of giving a steady pressure, to strike a slight blow on the carriage nearest to it. The furthest carriage does not move at once, but the buffer springs are compressed—that is, the first carriage is for an instant strained by having its total length shortened by some inches. It instantly recovers from this strain by the expansion of the springs; but as it cannot expand towards the engine, it expands away from it, and transmits the strain to the next carriage by compressing its buffer-springs, and the process is repeated all the way from the engine to the carriage furthest from it."

This buffer experiment is an illustration of wave-motion, an idea we do not need in any theory of electrostatics. On page 23 there is a popular explanation from the pen of Prof. Ayrton of the easy discharge of electricity from points; this remarkable explanation does not in any way depend on the greater electric surface density at and near a point, and it suggests that the force near a conductor is *not* normal to its surface. It is unnecessary to pursue this criticism further; we have said enough to show that Mr. Gordon's strength does not lie in the systematic exposition of electrical theory.

The book is divided into four parts—Electrostatics, Magnetism, Electrokinetics, and Electro-optics. In the third part is included all the phenomena of current electricity. This is an unsatisfactory classification. Electrokinetics should be confined to those phenomena of current electricity which involve the kinetic energy of current, such as electromagnetism and electromagnetic induction. The author would have been wiser to have followed the arrangement of Maxwell, and have classed the steady flow of electricity in conductors at rest rather with electrostatics than electrokinetics. Adams's experiments on equipotential lines and surfaces in conductors are interpolated between diamagnetism and the induction coil; they are, of course, naturally a part of the theory of electrical resistance, and have no near connection with the chapter preceding or following.

Great care has been bestowed on the illustration of the work. We know of no book on electricity so beautifully illustrated. Nor are the pictures merely pictures. They show well the details of apparatus; often, too, some leading dimensions are given when perspective does not admit of a scale. We would recommend this practice to all writers on science. It is a great help to the imagination to know how large a thing is, and better that this information should be upon the picture than in the text only.

In the construction of this book the freest use has been made of the scissors, whole pages being quotations. This is both wise and modest, for when the original works of the man who discovered and stated a fact are suitable for a treatise, there can be no use in paraphrasing them. Some of the chapters are excellent analyses of the several investigations which have been made into the subjects of which they treat. This is notably the case with the chapter on "Specific Inductive Capacity." When Mr. Gordon has occasion to prepare a new edition he will do well to expand where he is strongest, to omit as far as possible systematic exposition, but to make each chapter a history to which the reader may refer with confidence that he will there find a clear account of every original experiment, English or foreign, that has been tried in that department. The value of such a work would be inestimable.

STRATIGRAPHICAL GEOLOGY

Lethæa geognostica, oder Beschreibung und Abbilding der für die Gebirgs-Formationen bezeichnendsten Versteinerungen. Herausgegeben von einer Vereinigung von Paläontologen. I. Theil: *Lethæa palæozoica*, von Ferd. Roemer. Textband: Erste Lieferung. Pp. 324. (Stuttgart, 1880.)

THE study of fossils may be approached from two distinct points of view: we may regard them as furnishing us with additional illustrations of the diversities of form and structure in the animal and vegetable kingdoms, or we may study them as making their appearance in a certain definite order, and thus as characterising particular geological formations. The former is the point of view of the biologist, the latter that of the stratigraphical geologist. Palæontology, or the study of fossil forms, must necessarily be pursued as a branch of biology, for only by the study of their nearest recent analogues can we hope to interpret the fragmentary and often obscure relics of former inhabitants of the globe; but, on the other hand, the progress of systematic geology has been bound up with the study of fossils ever since it has been clearly recognised that strata can be identified by the organic remains which they contain.

German scientific literature is now being enriched by the publication of two very valuable works in which fossils are treated of, in the one case from the stand-point of the biologist, in the other from that of the stratigraphical geologist. The admirable treatise on palæontology by Zittel and Schimper gives an excellent account of the chief types of fossil plants in their relations to living forms, and the work of which we have placed the title at the head of the present article, promises to supply an equally important contribution to stratigraphical geology.

The title of "Lethæa Geognostica" was first employed by Bronn, who between the years 1835 and 1837 published a work under this name, in which he described all the

fossil genera then known in the several geological formations. This book, which was accompanied by an excellent atlas of plates, passed through three editions during the author's life-time, but in the preparation of the last of these he was aided by Dr. Ferdinand Roemer.

The number of fossil forms now known to geologists is so vast that it would be impossible to find any palæontologist competent to deal equally well with the faunas and floras of all the geological periods; and hence it has been decided to commit the palæozoic, the mesozoic, and the tertiary divisions of the work to different hands. Dr. Ferd. Roemer has been selected to describe the life-forms of the palæozoic rocks, and in the work before us we have the first instalment of the result of his labours.

The work commences with a sketch of the succession and correlation of the palæozoic strata in all the different areas in which they have been studied. The author divides these rocks into the four groups of Silurian, Devonian, Carboniferous, and Permian, using the term Silurian, after the manner of Murchison, to embrace all the lower palæozoic strata. This plan is, of course, open to the objection that his first division is at least equal in value to the other three put together. The account of the palæozoic strata as developed in different areas, which extends to ninety-two pages, is generally very carefully drawn up. We notice on pages 11 and 29 an unfortunate error in the grouping together of the Lower Llandeilo and the Tremadoc slates, while in his account of the succession of strata in Sweden the author has failed to avail himself of the most recently-published results arrived at by the palæontologists of that country.

The next twenty pages of the work are devoted to the palæontological literature of the palæozoic rocks, 146 pages to the palæozoic plants, and seventy-seven pages to the Protozoa. The author describes each genus, and gives also an account of some of the more important species. In noticing the earliest palæozoic plants, Roemer follows Schimper in regarding the puzzling forms from Bray Head, called *Oldhamia* by Edward Forbes, as belonging to the Algæ. With regard to the so-called *Eozoon canadense* of Dawson, Dr. Ferd. Roemer accepts the verdict of Möbius against its organic origin, and rejects it from the list of palæozoic fossils.

The atlas of the "Lethæa Palæozoica" was published four years ago, the plates, sixty-two in number, being well executed and of the same size as the text, thus getting rid of the inconvenient arrangement in the former work, where the text was in 8vo, and the plates in folio. It would almost appear as if the atlas were drawn up previous to, and quite independently of, the present work, so that the connection between the illustrations and the text is not so close as might be wished. We cannot help remarking, too, that unless much greater expedition is used in publishing the remainder of the work, the earlier portions will become obsolete before the later portions make their appearance.

Although the atlas appeared in 1876, the text has now only just reached the commencement of the Cœlenterata. Possibly some unavoidable cause of delay has arisen, which, we may hope, is now removed. We look forward with interest to the completion of this most valuable work.

OUR BOOK SHELF

A Treatise on Elementary Dynamics, for the Use of Colleges and Schools. By William Garnett, M.A. Second Edition. (Cambridge: Deighton and Co., 1879.)

MR. GARNETT'S second edition does not differ in appearance from its predecessor. There is the same number of chapters, the headings of which for the most part are also the same, but new matter and more detailed explanation have resulted in the addition of some twenty-five pages. It may be noted as a feature of Mr. Garnett's work that there is a chapter on "The Dynamical Theory of Gases," and a good one on "The Dimensions of Units." We have used the first edition with great advantage, as the author fully discusses and illustrates the *cruces* of this subject, which is often so difficult to beginners, and we commend this improved edition to such readers and to all others.

Elementary Applied Mechanics. By Thomas Alexander, C.E. (London: Macmillan, 1880.)

THE object of Mr. Alexander's work is to serve as a companion volume to the late Prof. Rankine's "Applied Mechanics and Civil Engineering." This *first part* treats of internal stress and strain, the divisions being elasticity, resilience; pure strain, simple and compound; the ellipse of stress; and the application of earthwork. All these points appear to us to be well illustrated by the numerous worked-out exercises, with carefully drawn figures, and by the exercises left for the student to try his skill upon. This small book, drawn up, we presume, with reference to Prof. Alexander's Japanese students at the Imperial Engineering College at Tokei, is likely to be of service, the more so as it appears, to the extent we have tried it, to be correctly printed.

LETTERS TO THE EDITOR

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

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

The Recent Gas Explosion

"THE explosion took place *by the conversion of potential energy into motion.*"

It may be fairly asked whether physicists are really satisfied with this account of the tremendous development of energy recently witnessed in the neighbourhood, or whether this phrase "potential energy" is not a useless bugbear which is closing the door to discovery. Why not believe rather that the motion exhibited was not really created (as motion) at all, but already existed in a concealed form? For we have plenty of proof that motion can be stored up to any intensity and yet be quite imperceptible to the senses, so long as all is in equilibrium. Why assume a supernatural (?) cause, when we have a natural one of transferred motion? Why rush into the inconceivable assumption of the existence of an energy *without motion*, when the conceivable remains for appreciation? An important and highly interesting problem in the discovery of the *modus operandi* of the transference of the motion from matter in space would thus be ever present to the mind (which is the sole condition for hoping to solve it) in place of an unrealisable and—may we not justly add?—therefore shallow and pretentious mysticism which obstructs the pathway of progress.

S. TOLVER PRESTON

July 8

[It seems to us that Mr. Preston makes rather too much of a chance newspaper expression, probably employed (for the sake of appearing scientific) by a writer who had no notion of the tremendous metaphysical problem which underlies it. It is very probable that all energy is kinetic, but this has not yet been proved.—ED.]

THE dangers of an explosion of gas, such as that which occurred on the evening of the 5th inst. in Bedford Street, are not, it would seem, limited to the immediate vicinity of the accident.

At about 7 p.m. on that day I was reading in a room, which from its position at the back of the house being rather dark, required a light, when I was startled by a sudden rush of the flame from the single gas-burner upwards for about two feet—it immediately subsided, again blazed up, and repeating this a third time sank, and went out altogether.

I thought something had gone wrong in the pipe, and that the passage of the gas was interrupted, but on applying a match it ignited and burned naturally, though with a feebler flame than before.

It was fortunate that I was in the room to turn off the escaping gas, or some serious mischief might have occurred when next any one had entered the room to find gas and air mingled into an explosive compound. I found that two other gas lights in passages had been extinguished at the same time, attention having been called to them by the smell of escaping gas.

As the distance of my residence—Granville Place, Portman Square—is more than a mile from the site of the explosion, it is interesting to note the distance to which the impulse extended.

As no further disturbance occurred, and as the phenomena noted happened synchronously or nearly so with the explosion, and as the gas-pipes here are, I believe, branches of the same source of supply, I assume that what I observed and have described was in some way caused by the explosion.

Fortunately it was at an hour when the gas was not generally burning, or other accidents might have resulted. It would be interesting to know if others observed similar effects of the explosion. J. FAYRER

July 10

The Tay Bridge

THERE are two interesting scientific questions, apart from engineering proper, which are suggested by the late inquiry, although no reference seems to have been made to them in the reports.

The first is the origin of the extraordinary flash seen at the moment of the downfall of the bridge by many spectators several miles away. It is scarcely doubtful that an impact was the only possible cause.

The second is the important question of the amount of wind-pressure which would suffice to force a train bodily off from the top of the bridge at a place where it was *not within* the girder. No strength of columns could then prevent an accident.

The flash seems to prove that the train had been blown off the rails, and had come into violent contact with the sides of the high girders. Then, and not sooner, the piers were subjected to a strain they were unable to bear. G. H.

"Geology of the Henry Mountains"

I LATELY received, through the Home Office at Washington, a "Report on the Geology of the Henry Mountains," by G. K. Gilbert, being a portion of the "Geography and Geology of the Rocky Mountains." With the merits or demerits of this paper I am not concerned. I am not prepared, however, to pass in silence and without protest the following paragraphs, which I find at p. 76:—"Bischof attempted, by melting eruptive rocks in clay crucibles, to obtain their ratios of expansion and contraction, but his method involved so many sources of error that his results have been generally distrusted. He concluded that the contraction, in passing from the molten to the crystalline state, is greater in acidic than in basic rocks. Delesse, by an extended series of experiments in which crystalline rocks were melted and afterwards cooled to glasses, showed that acidic rocks increase in volume from 9 to 11 per cent. in passing from the crystalline state to the vitreous, while basic increase only 6 to 9 per cent. Mallet concluded, from some experiments of his own, that the contraction of rocks in cooling from the molten condition is never more than 6 per cent., and that it is greater with basic than with acidic rocks; but considering that the substances which he treated were artificial and not natural products, that his methods were not uniform, and that he ignored the distinction between the vitreous and the crystalline, of which Delesse had demonstrated the importance, no weight can be given to his results."

It would be difficult to compress into the same number of lines a greater amount of erroneous statement than is to be found in the above quotation. Bischof's results were never distrusted by geologists, by whom they were repeatedly quoted, until in my paper on the "Nature and Origin of Volcanic Energy," read to the Royal Society, June, 1872, and printed in *Phil. Trans.*, I pointed out the errors incidental to Bischof's method of experiment, and at the same time directed attention to the strange arithmetical blunder of Bischof himself, by which his deductions from his own experiments are rendered still wider from the truth.

The experiments of Delesse, which I presume are referred to, were made on so small a scale that no deduction as to the total contraction between the liquid and solid state of any rock can be inferred from them. Coming now to Mr. Gilbert's summary condemnation of my own experiments on the total contraction of basic slags from the iron-smelting furnaces of Barrow (Cumberland), an account of which is given in my paper already referred to, and printed in the *Phil. Trans.* for 1873, some of the chief results of which are to be found in p. 201, I have to remark that no other experiments on the subject, conducted on the same great scale, and with equal precautions to insure exactness, have ever been made and published. No experiments have ever been made upon the contraction of lava as flowing from a volcano and its solidification on cooling, but I have given comparative analyses of natural lavas, and shown their almost identical composition with that of the slags employed by me. It is incorrect to state that I have ignored the difference between the vitreous and crystalline condition; all the melted matter experimented on by me having, from the large bulk of melted matter, cooled in the crystalline state. Whether then any justification can be adduced for Mr. Gilbert's sweeping and unsupported statement that "no weight can be given" to the results of my experiments I leave to the judgment of men of science who have impartially read my results. ROBERT MALLET

London, July 7

Intellect in Brutes

THE Central Prison at Agra is the roosting-place of great numbers of the common blue pigeon; they fly out to the neighbouring country for food every morning, and return in the evening, when they drink at a tank just outside the prison walls. In this tank are a large number of freshwater turtles, which lie in wait for the pigeons, just under the surface of the water and at the edge of it. Any bird alighting to drink near one of these turtles has a good chance of having its head bitten off and eaten; and the headless bodies of pigeons have been picked up near the water, showing the fate which has sometimes befallen the birds. The pigeons, however, are aware of the danger, and have hit on the following plan to escape it. A pigeon comes in from its long flight, and, as it nears the tank, instead of flying down at once to the water's edge, will cross the tank at about twenty feet above its surface, and then fly back to the side from which it came, apparently selecting for alighting a safe spot which it had remarked as it flew over the bank; but even when such a spot has been selected the bird will not alight at the edge of the water, but on the bank about a yard from the water, and will then run down quickly to the water, take two or three hurried gulps of it, and then fly off to repeat the same process at another part of the tank till its thirst is satisfied. I had often watched the birds doing this, and could not account for their strange mode of drinking till told by my friend, the superintendent of the prison, of the turtles which lay in ambush for the pigeons.

The same friend had a couple of Hill Mynahs (*Gracula religiosa*) the most wonderful bird for mimicry which I have come across, not excepting the grey parrot of the West African coast. One of these birds, when hung out in the verandah during the afternoons, used to amuse itself by calling the fowls together, imitating the call of their keeper so well that they used to flock together under the cage, when the bird would burst out into a very good imitation of a human laugh, as if it quite enjoyed the fun of taking in the fowls. Have birds the sense of amusement? This one certainly seemed to derive gratification from the way in which it had cheated the fowls.

Roorkee, June 21 W. W. NICHOLLS

The Volcanic Dust from Dominica

SOME months ago, through the kindness of Messrs. Alexander Agassiz and S. H. Garman, some of the volcanic ashes which fell in Dominica on January 4 were placed at my disposal. On

account of the notices that have appeared in NATURE (vol. xxi. pp. 330, 372, and vol. xxii. p. 77) and in *Comptes rendus* (xc. 622–26), this note would be needless, were it not that some may regard these ashes as of recent origin.

Microscopically the material (already described by Prof. Delesse) is seen to be decomposed to a considerable extent. The materials evidently filled an old crater, and have been subjected to secondary action, so that of the original constituents only the feldspar and augite are left. The other constituents are the results of the alteration of this andesitic (probably) *débris*. No trace of *recent* volcanic material could be found in that examined by me. In no sense can these ashes be called a recent product; they have simply been transferred from one place to another. The transfer is recent, but the ashes have for ages been at or near the surface of the earth. M. E. WADSWORTH

Museum of Comparative Zoology, Cambridge, Mass., U.S.A., June 30

Large Meteor

ON Friday evening last, July 9, at 9h. 45m., I saw a very fine meteor about equal in brightness to Venus at her maximum, moving very slowly from nearly west to south-west. I did not see its origin. It passed about 4° above *Spica*, and disappeared soon afterwards, as nearly as I could estimate, in altitude 16° and azimuth 50° west of S. Its apparent course was only slightly inclined to the horizon, approaching it at an angle of about 1 in 10.

Its apparent angular velocity was about 8° in a second, its light yellowish till the moment of extinction, when it became blue and fainter, and disappeared without any sign of explosion. Its course was somewhat wavy, and the trail it left behind it very evanescent. My latitude and longitude was 51° 25′ and 0° 14′ W. F. C. PENROSE

Coleby Field, Wimbledon, July 14

Ball Lightning

ON Saturday night, the 17th inst., an instance of this form of lightning came under my observation.

The day had been hot, the thermometer registering a temperature of about 71° F. in the shade during the middle of the day, which was bright and clear. In the evening, however, a curious haze or mist spread rapidly over the landscape, while the temperature had fallen to about 68° F. This haze was very much denser and more analogous to the smoke-fog of a town than I have ever observed in the country at this time of year, yet the air did not seem particularly damp or chill.

About 9 p.m. frequent flashes of sheet-lightning occurred, with rumblings of distant thunder at intervals, both of which continued more or less up to midnight, about which time, the mist having somewhat cleared off, I saw when returning home, apparently about a quarter of a mile ahead, a ball or globe of fire of considerable size descend slowly from the clouds, and when near to or touching the earth suddenly disappear, its disappearance being accompanied by two slight but quick concussions, which may have been an explosion and its echo. The fire-ball could not have been visible more than five or six seconds. I cannot ascertain that any damage was done by it.

As this somewhat rare and curious phenomenon seems to be manifesting itself at this period, accompanying the thunder-storms we are having (see NATURE, vol. xxii. p. 193), may I be permitted to suggest that those interested in electrical science should be on the alert to observe any repetition of the occurrence with its concomitant circumstances? W. F. SMITH

Sutton Valence, Kent

E. M. F. should read Prof. Ayrton's Sheffield lecture on "Electricity as a Motive Power" (see NATURE, vol. xx. p. 568); any decent text-book—Noad's, for example—will tell of the older attempts of Jacobi to propel boats by electricity.

THE RECENT EXPLOSIONS

ALTHOUGH it is difficult to say anything new on the subject, or give instructions more effective than such as have been given over and over again, still the recent remarkable and destructive explosions in London, Wolverhampton, and Monmouthshire seem to call for some remarks at our hands.

Two serious explosions of gas following close on each other, in the streets of large towns, announce to every one that the difficulties of supplying gas to large numbers of consumers have not been completely overcome.

The special feature in the London accident was the occurrence of a series of explosions, at first at nearly regular, and then at increasing intervals, along the gas main. The first explosion blew out the "cap" of the main with great violence; the rush of heated air, doubtless mingled with more or less gas, in the other direction seems to have carried the flame—probably by a rapidly occurring series of small explosions—to a point at which a mass of explosive gas was again reached and fired. The mass of gaseous mixture fired in the second explosion appears to have been about equal to that in the first, but towards the close of the series either the gas became much more diluted with air, or the air became much more charged with gas. It seems just possible that vibrations propagated by the first explosion passed rapidly through a gaseous medium, consisting of much air and little gas, until they came in contact with a mass of gas and air, which they threw into rapid vibration, and so caused to explode. But from the experiments of Abel and others one would scarcely expect this to occur under the conditions which—judging from the evidence given at the inquest—appear to have existed.

A second point, illustrated more markedly by the Wolverhampton explosion, is the apparent readiness with which a soil may be charged with coal-gas and retain this gas for long periods of time. The passage of such gas into drain-pipes, and perhaps even into unfilled gas-mains, seems to be of ready occurrence.

Experiments might well be instituted by the gas companies to determine the power of soils for absorbing and retaining coal gas, and secondly, the conditions of diffusion of mixtures of gas and air through the walls of pipes of different materials. If it can be shown with certainty that the valve at the junction of the main in which the explosion occurred with the Howland Street main was absolutely impervious to gas, then the explosion may almost be regarded as proving the permeability of the material of gas mains to mixtures of air and coal-gas.

The practical lesson of the explosions is that some means of certainly determining whether a gas main does or does not contain gas must be found at once, and that this means must *not* be the application of a light to an opening in the main. The foreman who applied the fatal match said that the pressure gauge showed the absence of gas in the main; but as the main contained a quantity of gaseous mixture at rest, and not flowing through the pipe, the gauge could not be expected to indicate the presence of this mixture.

It is almost amusing to read of the simple astonishment of the two foremen when the fact was announced to them that mixtures of coal-gas and air are explosive: twenty or twenty-five years' experience in gas-works had failed to teach them this fact. Yet the lives of the inhabitants in the neighbourhood of Tottenham Court Road were practically in these men's hands for the last three or four months.

With regard to the Risca disaster, of a different and unhappily more fatal kind than the former, clouds of smoke are said to have accompanied the explosion which devastated the pits soon after midnight on Thursday last (15th inst.), and we have it from the lips of a credible eye-witness that fused and coked coal-dust is found adhering to the timbers in those parts of the workings which have been already visited, though not so conspicuous as in some cases. In these respects therefore the recent explosion is only a repetition of similar events which have

taken place before, and we need not again go over the ground which we have already traversed several times in these pages, when we have endeavoured to point out their most probable origin and mode of propagation.

We propose, however, in this place to devote a few lines to the discussion of a question which we think has not as yet received the attention it deserves, namely: When is a mine in such a state that it may be termed *well-ventilated?* and our principal reason for doing so is that a statement has been already put forth to the effect that the ventilation of Risca Colliery was as perfect as it well could be, the total volume of air passing through it being considerably over 100,000 cubic feet per minute.

An air-current of given dimensions may be sufficient to thoroughly ventilate the workings of a fiery mine at one time, and it may be quite insufficient at another: for the degree of sufficiency is obviously wholly dependent on the amount of fire-damp given off per unit of time. Each unit of volume of coal contains a certain volume of fire-damp in a state of great compression—it may be in a liquid or solid condition—and this gas begins to be given off when the workings approach to within a certain distance of the space within which it is confined. The greater proportion of the fire-damp is probably given off immediately before the coal is laid bare, and at the instant it is being detached from the face; but some of it still continues in the coal long after it has left the mine.

If the workings of a fiery mine are stopped abruptly and allowed to remain unworked for a considerable time, we find that the amount of fire-damp given off gradually decreases, until in the course of a year or so it is not more than one-tenth of what it was when the mine was in full work. If, on the other hand, the output of a fiery mine is largely increased, we find that the workings soon lapse into a dangerous condition unless the ventilation has been largely in excess of its requirements in the first place. The character of the ventilation is thus dependent upon the output of coal for the time being as well as on the amount of air.

The daily output of Risca Colliery is stated to have been 1,000 tons, and supposing the amount of gas given off to have been 2,880 cubic feet per ton of coal, which is the actual amount we have found by observation and calculation in similar mines, then we know that, if the volume of the ventilating current had amounted to 30,000 cubic feet per minute, the whole of it would have been explosive as it returned from the workings; if it amounted to 50,000 cubic feet per minute it would show a cap half an inch high in the small oil-flame of a lamp, and when charged with coal-dust it would form a *highly explosive* mixture; if it amounted to 100,000 cubic feet per minute it would still show a small cap $\frac{1}{8}$ to $\frac{3}{16}$ inch, and it would still produce an explosion when mixed with coal-dust, and ignited.

It is notorious, however, that as a rule the volume of air which reaches and passes round the working faces is much less than that which descends the down-cast and ascends the up-cast shaft; and when we are told that the ventilation of a mine is represented by a certain number of cubic feet of air per minute, we are on the safe side if we estimate the useful volume to be little more than two-thirds of the stated one.

It is further notorious that the practical miner of almost every grade regards a small cap on the flame of the lamp, even if $\frac{1}{4}$ to $\frac{1}{2}$ inch high as a very trivial matter, so long as he finds little or no explosive gas in the mine; and he only begins to speak of the return air as being heavy or rather heavy when the size of the cap on the small oil-flame reaches or exceeds a height of $\frac{3}{4}$ of an inch; but still even in this case he is not much troubled with thoughts of immediate danger.

What then constitutes a well-ventilated mine?

We say in reply that no mine containing dry coal-dust is well-ventilated when the cap on the small oil-flame of a lamp is over $\frac{1}{8}$ or $\frac{3}{16}$ inch in height, that is to say, when the return air contains more than 2 per cent. of gas. Even with that amount, as we know, it will form an explosive mixture with coal-dust, and we should prefer to see a standard insisted upon in which not more than 1 per cent. was allowed.

This aspect of the question is well worthy of the attention of the Royal Commissioners on Accidents in Mines, and we hope they will not allow their present opportunity to pass without endeavouring to arrive at some definite settlement of such an important question.

NORTH AMERICAN GEOLOGY—IDAHO AND WYOMING[1]

IN spite of the revolution that was recently effected among the Government geological surveys of the American Union, provision has wisely been made for the completion of the Reports of the different corps which have been abolished. It is pleasant to welcome still another of the stout black volumes issued annually by the Geological and Geographical Survey of the Territories. On the completion of the Survey of Colorado in 1876 Dr. Hayden and his corps of active coadjutors moved northwards across the belt of country included in the Survey of the 40th Parallel under Mr. Clarence King, with the intention of mapping the territories of Idaho and Wyoming to the north and west. A number of reconnaissances had been made by various observers in these regions since the days of Bonneville and Fremont, some of the earlier work of Hayden's Survey having been accomplished there. But no general survey of the whole area had been attempted, and many parts of it had never been penetrated by white men. It was a vast territory, including within its borders the sources of the Green, Snake, and Yellowstone Rivers, and embracing the most varied forms of surface and the greatest diversities of geological structure. To survey this unknown domain and bring its geography, geology, mineralogy, ethnology, zoology, botany, and general economic capacity to the knowledge of the world was the aim with which Dr. Hayden and his staff started in the summer of 1877. During the season the primary triangulation was extended over an area of 28,000 square miles, from West Long. 107° to 112° and between North Lat. 41° 10′ and 43° 50′, and was connected with the stations made by the Survey of the 40th Parallel, and by the Boundary Survey of Wyoming. Topographical field-work was carried on by three parties, each having an area assigned to it of about 11,000 square miles. The total area thus surveyed amounted to about 29,000 square miles. The geological staff was likewise divided into three divisions, each being intrusted with a separate district, viz., the regions of the Sweetwater, Teton, and Upper Green River.

In the report of Dr. Endlich of the Sweetwater division, one of the most interesting features is his account of the structure of the Wind River Mountains. This important portion of the true Rocky Mountain range is formed of three parallel chains, of which the western, and chief, rises to heights of more than 13,000 feet and forms the watershed of the continent. Even now its huge snow-fields, which, through the clear summer air can be seen gleaming from a distance of more than 100 miles, suggest the presence of glaciers. When Dr. Endlich and his party traversed these mountains in 1877 they found, indeed, no recognisable glacier, but abundant freshly-grooved and polished rocks and moraine mounds, showing the comparatively recent existence of land-ice in these elevated regions. On the west side of the

[1] "Eleventh Annual Report (1877) of the United States Geological and Geographical Survey of the Territories, embracing Idaho and Wyoming." (Washington: F. V. Hayden, 1879.)

mountains the evidences of glacial action are specially striking, one valley in particular bearing witness to the former presence of a glacier sixteen to eighteen miles long, extending for several miles into the low country, where it threw down its heaps of moraine-stuff in mounds a mile and a half broad, and from 800 to 900 feet high. Next summer, however, the covering of snow having partially melted, true glaciers of small extent were found in the Wind River and Teton ranges.

East of the Wind River Mountains there lies a suite of palæozoic formations from the Potsdam sandstone to the top of the Permian group, having a united thickness of 3,350 to 3,750 feet, and covered by 2,500 to 2,920 feet of Triassic, Jurassic, and Cretaceous rocks. Dr. Endlich computes the total depth of stratified formations in the Sweetwater region at more than 16,000 feet. Underneath them in the Wind River range lies a great series of crystalline rocks. According to Dr. Endlich the Potsdam rocks have been converted into quartzites by the same metamorphic action which has changed the rocks immediately below them into granites and schists. His section shows three zones of granite in descending order, the lowest of all being what he terms prozoic, while the youngest, from its stratified or schistoid character, and the coincidence of the inclination of its strata with that of the overlying stratified formations, he classes as of metamorphic origin.

The researches of Prof. St. John were devoted to the exploration of that wonderfully interesting region round the head waters of the Snake River and the Teton Mountains. The traveller who journeys wearily over the vast desert lava-fields of the Snake River plains looks wistfully from time to time at the great snow-rifted peaks which the Teton range far to the east raises into the sky. What would he not give for a glass of the cool water which dashes down so profusely among these far mountains and disappears so utterly before it reaches that thirsty desert? Extending the observations of Hayden, Bradley, Comstock, and others, Mr. St. John has given us an interesting narrative of the structure of the mountain region and of the lower territory on its flanks. The core of the Teton range, culminating in Mount Hayden, consists of massive granites, gneisses, and schists, flanked by quartzites and slates. On these ancient rocks lie from 500 to 1,000 feet of limestones, shales, and sandstones, containing Lower Silurian fossils, and from 400 to 600 feet of a buff-coloured magnesian limestone referable to the Niagara group of the Upper Silurian. The Carboniferous system, consisting mainly of limestones and sandstones, reaches a thickness of from 2,500 to 5,000 feet. Secondary formations, referred to the Triassic, Jurassic, and Cretaceous systems, attain depths of from 2,300 to more than 5,000 feet. The volcanic history of this portion of America is specially noticeable. According to Mr. St. John's observations the usual chronological sequence obtains in the areas traversed by him. The early eruptions have been of a trachytic nature, great variety of aspect and lithological structure being traceable among the various outflows. The surface presented by the trachytic areas is markedly uneven—the result doubtless partly of original irregularities of extrusion and partly of subsequent extensive denudation. The latest eruptions were of basalt, which has flooded the bottoms of the valleys, and now covers an area of many thousand square miles. Mr. St. John speaks of the difference of level between different plateaux of basalt as being due to subsequent elevation. But it is not necessary to suppose that there ever was any common level for the outflows. Some were no doubt poured out at much higher elevations than others even in their vicinity. The same observer calls attention to the remarkable volcanic conglomerates described by Hayden from this and the Yellowstone region, and by Whitney from the Territories lying further west. These deposits, 3,000 feet or more in thickness, consist of angular and subangular or rounded blocks of trachytes, basalts, and other volcanic rocks imbedded in a dull brown tuff-like matrix. They cover wide tracts of country in the volcanic districts, and point to a phase of volcanic or inter-volcanic action which is not yet well understood.

Dr. A. C. Peale contributes an interesting report on the varied region lying to the north of the 41st Parallel between Green River City, Wy., and Ogden, Utah. He estimates the total mass of stratified formations in that region from the base of the Lower Silurian system to the top of the Quaternary series at upwards of 30,000 feet. He has added some additional fossils to the list of Lower Silurian forms collected from the district in 1872 by the late Prof. F. Bradley. He has likewise made important additions to the Carboniferous fauna of that area, and has shown how dominant a part is taken by the 6,000 feet or more of Carboniferous limestones and quartzites. The Jura-Trias attains a depth of between 5,000 and 6,000 feet, consisting of the usual red sandy and argillaceous strata below, and passing up into laminated limestones and shales. A considerable number of organic remains were obtained from several zones in these beds, but they do not yet appear to be sufficient for drawing a satisfactory line between the Trias and Jurassic series in the Rocky Mountain region. To our knowledge of the Cretaceous and Tertiary geology of the district Dr. Peale was enabled to make some valuable additions.

Besides these geological reports, the labours of the Survey in 1877 included a detailed palæontological research in the field by Dr. C. A. White, who contributes an important report of his work, and the first of what we hope will be a series of papers on invertebrate palæontology. He specially treats of the Cretaceous fossils of the Western States and Territories. The topographical work of the year was well done by Messrs. Nelson and Gannett. As subsidiary but very valuable parts of the work accomplished by the Survey, reference may be made to the researches on fossil insects by Mr. Scudder of Boston, which have been aided by the Survey and will be published among its memoirs; to the great monograph by Dr. Leidy on the Rhizopods, which has already appeared as one of the Survey's quarto volumes; and to the interesting particulars collected by the Survey regarding the archæology of the San Juan and South-Western Colorado.

There will be, we presume, one further Report for 1878—the last year of the existence of the Geological and Geographical Survey of the Territories. Though this mode of annual publication necessarily involves incompleteness, and is apt to overload the reports with unimportant detail, there can be no doubt that the series of volumes issued by this Survey form a permanent record of great value, which for the districts to which they refer will serve as the basis of all subsequent work. It is not without regret that one can regard the cessation of these volumes. On this side of the Atlantic, where they can be calmly considered apart altogether from scientific rivalry and political entanglements, they have been received with general approbation. It is impossible not to be struck by the largeness of the plan conceived by Dr. Hayden for the scope of his survey. Not geology merely, but every branch of inquiry touching the natural history, archæology, geography, and meteorology of the Territories, was embraced within his plan, and has been illustrated as far as the means at his disposal would allow. To have conceived this broad and scientific scheme, and to have possessed the administrative power to secure and keep in working concert so large and able a body of observers, are qualities of no mean order, and deserve grateful recognition wherever an intelligent interest is taken in the general progress of science and in that human advancement which scientific progress insures.

ARCHIBALD GEIKIE

THE RUSSIAN IMPERIAL YACHT, "LIVADIA"

IT is not surprising that the character of the great steam-yacht *Livadia*, just launched upon the Clyde for the service of the Emperor of Russia, is exciting widespread interest. Since Noah built the Ark, no floating and moving structure has been constructed in such direct contrast as this vessel with all that has gone before it. Every other ship afloat has, in its chief features, been a development of the ships that preceded it, not excepting even the circular ironclads of Russia, for they were not the first circular vessels that had been designed and constructed, and although they had some steaming pretensions, these were too moderate to challenge seriously either the principles or the practice of naval architects. In the new yacht of Admiral Popoff's design, however, we have a steamship that, by its very existence, challenges the fundamental principles upon which fast passenger steamers are constructed by all the rest of the world.

We give herewith illustrations, of which the first (Fig. 1) is an external view of the *Livadia* as seen out of water; it is taken from a model which was constructed under the care of Admiral Popoff, and shows at a glance the general form of the ship. Another (Fig. 2) is a cross section, showing among other things the transverse distribution of the boilers and machinery. The third (Fig. 3) is a plan showing the horizontal distribution of the same, and indicating more clearly than the other the positions of the three propelling screws.[1] It is obvious that such a form of vessel, propelled in the manner exhibited, suggests many questions of scientific interest; but most of these will be best discussed after the steam trials of the vessel have taken place. For the present it will be sufficient to take notice of the general characteristics and qualities which she presents to view.

It is desirable at the outset for the reader to observe that the *Livadia* consists of a shallow hull 235 feet long, 153 broad, and drawing, when supporting all its burdens, but 6½ feet of water. From a foot or two above the water's surface arch upwards and inwards with considerable curvature until they each meet (at about one-sixth of the whole breadth of the ship from the side amidships) the fore and aft sides of a naval palace, which extends from stem to stern. Although the width of the ship at the water-line is 153 feet, her width at a few feet above the water-line is therefore much less—about 110 feet, we believe. In smooth water, therefore, the resistance to onward motion will be those encountered by a vessel 153 feet broad and 235 feet long; but when the ship gets into heavy seas they will be free to pass over her low sides, and the ship that will have to divide and encounter them will be 110 feet by 225. As the object of this vessel is to furnish ample accommodation for the Emperor and his suite at sea, it may be fairly presumed that the width of the superstructure has been kept greatly within that of the hull proper, and the accommodation thus restricted, for the purpose of materially improving the behaviour of the vessel at sea. The arrangement will doubtless contribute greatly both to the speed and to the steadiness of the ship in great waves, its value for diminishing rolling having already been demonstrated in the circular ironclads, which have superstructures of less width than the ship, and which are remarkably steady even in seas that roll freely along the decks of the hulls proper.

The primary and chief fact concerning the anticipated steadiness of this exceedingly short, broad, and shallow ship, is that it is to be secured by means the very opposite of those which have lately obtained in this country, viz., by aid of enormous stability. Since the general acceptance of Mr. Froude's theory of rolling, the aim of the naval architect has been to send his ship to sea with sufficient stability for safety, and with no more than is ample for that purpose; because steadiness at sea is, under the modern theory, promoted by keeping the stability or righting force as small as possible, within the limit just named. The metacentric height, which is from 12 to 15 feet in the American monitors, which have great proportionate breadth of water-line, has been restricted to 6, 5, 4, and even less than 4 feet in many of our large war ships; indeed the *Sultan*, which is one of the steadiest of our large ironclads, has a metacentric height of only 2½ feet, while the *Inconstant's*, the steadiest of our unarmoured ships, is but very slightly in excess of this. This reduction of metacentric height increases proportionately the "period of oscillation," and makes vessels reluctant to accept the disturbances which waves endeavour to impose upon them. But while the tendency of modern science has thus been to diminish metacentric height and stability, the effect of the *Livadia's* form and proportions will be to give her enormous metacentric height and stability, the object in both cases being identical, viz., improved steadiness in waves. Nor is this course pursued, strange as it may seem to some, and violently antagonistic as it is to modern practice, without the sanction of science. For while a ship with very small stability, and consequently very long natural period of oscillation, is ordinarily secured against rolling by her slowness to accept the wave impulses, the ship with very large stability, and consequent very short period of oscillation, is ordinarily secured against excessive rolling by the very readiness with which she accepts those impulses and conforms to the mean movements of the waves. It is true that in the latter case the exemption from rolling motions is not so great as in the former, because a certain considerable amount of rolling is undoubtedly and necessarily involved in this conformity to wave motions; but this amount of rolling is very much less than that to which a ship is exposed which has neither stability so small as to render her comparatively indifferent to wave-pressures, nor stability so large as to force her to keep her decks approximately parallel to the wave-surface. Ships with intermediate degrees of stability are liable to roll much and to accumulate large rolling motions, especially when subjected to successive impulses from similar waves, whereas the ship of enormous stability, while always obeying each wave, is by that very means exempted from the tendency to accumulate the effects of a succession of waves. In all this reasoning—the generality and meagreness of which we fully recognise—it is of course assumed that the waves in question are of sufficient magnitude in proportion to the size of the ship to stand in individual relation to her. The immense breadth of the *Livadia* will doubtless preserve her from being rolled by small waves, including under that designation waves which would cause many ordinary ships to roll with violence. As regards longitudinal rolling, which is usually called pitching, if we neglect the onward motion of the ship, and consider the matter from the same point of view as that just adopted in speaking of transverse rolling, we may say with confidence that the longitudinal stability of the *Livadia* will be in excess of the transverse, and that no excessive pitching need be feared. Owing to the shortness and light draught of the vessel, she would probably (if not advancing) tend to accompany pretty closely the motions of the wave-surface when heading to waves of sufficient size to cause her to pitch. As her length is so small (less than half that of several transatlantic steamships now at sea), the vertical motions of the bow and stern will of course be correspondingly small for given angles of pitching.

It is when we come to consider the case of her enormous steam power being applied to force her ahead through large waves that we experience some difficulty in predicting her behaviour. For we here touch upon a question which has been but very imperfectly investigated; we might even say, has scarcely been more than

[1] We are indebted for the second and third engravings to the kindness of the editors of *Engineering*; the first has been specially engraved for us.

mentioned. A few facts and figures bearing upon it may nevertheless be given. It is estimated that a wave with a 4-seconds period and 82 feet long advances at a speed of 12 knots an hour; an 8-seconds wave 328 feet long has a speed of 24 knots; a 12-seconds wave 740 feet long a speed of 36½ knots; and a 16-seconds wave 1,300 feet long a speed of 48½ knots. If the *Livadia* were steaming at 14 knots against waves equal in speed to her own, she would of course encounter them at a speed of 28 knots, and that is a speed corresponding to a length of wave of about 450 feet, whereas the waves which she would actually be meeting would be but little over 100 feet in length. Again, if we may for a moment imagine her to be steaming at 18 knots an hour, and encountering similar waves, she would of course be meeting them at a speed of 32 knots an hour. But a wave of that speed would be nearly 600 feet long, whereas that which she would, under the last hypothesis, be encountering would be only 100 feet long, as before. It is obvious, therefore, that so short a ship, steaming at high speeds, would develop conditions unknown alike to vessels of low speed (such as sea-going vessels of her small length usually are when steaming against head seas) and to vessels of high speed but of great length. If we take for example the case of waves about 500 feet long from hollow to hollow, and therefore of a half-length of about 250 feet, it is obvious that whereas a fast steamship 500 feet long would receive the support of a second wave while the crest of a previous one still gave her bodily support, the *Livadia* is so short as to be capable of steaming down the wave slope, at an angle to the horizon approximately equal to that of the slope itself. If doing this at a speed of 15 knots an hour, or 25 feet per second, with the on-coming wave advancing upon her, as it would be, at 30 knots an hour, or 50 feet per second, it is easy to see that the behaviour of the vessel would be of an unusual kind. We do not give this as by any means the most notable or critical of the cases which might be selected, but it will serve to show that Mr. Froude was not speaking heedlessly when he said that the purely circular ships would tend to "dive," and to indicate that those persons are probably correct who see in departure from the circular form in the present case evidence, not so much of a desire to diminish resistance, as of a desire to correct the diving propensities of very short ships.

And this brings us to notice the steaming qualities of the *Livadia*. The enormous steam-power with which she is being supplied has naturally excited much notice, and the *Times* gave an interesting comparison between her power and proportions and those of the *Shah*. It will assist the further elucidation of the subject if we invite attention to a different kind of contrast, and compare the *Livadia* with the largest and most powerful of our finished armoured turret-ships, the *Dreadnought*. This huge ship, which steams at 14½ knots per hour, although very much more than twice the immersed size (displacement) of the *Livadia*, has very much less steam-power. The following is a comparison between the two ships:—

	Dreadnought.	*Livadia.*
Length	320 feet ...	235 feet.
Breadth, extreme	64 ,, ...	153 ,,
Immersed depth of hull (mean)	23 ,, ...	6½ ,,
Displacement	9,100 tons ...	3,900 tons.
Indicated horse-power	8,200	10,500

Allowing for the curvature in the form of the hull at and near the bottom, we should of course more than double the *Livadia's* displacement by carrying her sides at the load-water line vertically upwards, and immersing her another 6½ feet; we should probably, by this process, bring her displacement up nearly to that of the *Dreadnought*. As between the two ships, all this extra displacement is, so to speak, saved in the *Livadia*, while, as regards the steam power, hers is in excess of that of the *Dreadnought* by more than 25 per cent. It will be seen from these conditions under what immense advantages the experiment of driving a broad and shallow ship very fast is to be carried out in the Imperial Russian yacht. So far as is known, the designer of the *Livadia* has not promised more than 14 knots of speed; but if we allow her the same speed as the *Dreadnought* (14½ knots) she will have a large excess of steam power (no less than 2,300 I.H.P.) applied to the propulsion of a hull weighing very much less than one-half the weight of the ironclad. The speed reached by the latter vessel was sustained throughout a six hours' trial.

As the *Shah* is a long fine-lined ship, 15 feet longer than the *Dreadnought* and 12 feet narrower,[1] with about the same mean depth, the *Dreadnought* may be regarded as a considerable departure from her in the direction which has been pursued so very much farther in the *Livadia*. It will be instructive therefore to compare these two vessels—

	Shah.	*Dreadnought.*
Length	335 feet ...	320 feet.
Breadth, extreme	52 ,, ...	64 ,,
Depth (mean)	23 ,, ...	23 ,,
Displacement	5,900 tons ...	9,100 tons.
Indicated horse-power	7,500	8,200
Speed	16½ knots ...	14½ knots.

If we compare the performances of these two extremely different ships—different as regards length and breadth, but not as regards depth—we shall find a material reduction in the steaming efficiency of the short and broad ship, but not one of so marked a character as many might anticipate. Applying to both the well-known formula for comparing displacements, powers, and speeds, viz.:—

$$\frac{\text{Speed}^3 \times \text{Disp.}^{\frac{2}{3}}}{\text{Ind. H.-power}},$$

we have—

Shah ... ... 195 | *Dreadnought* 163

Or, viewing the matter with reference to the midship sections propelled through the water, or to the volumes of the excavated channels, and adopting the Admiralty formula—

$$\frac{\text{Speed}^3 \times \text{Mid. Sec.}}{\text{Ind. H.-power}},$$

we have—

Shah ... ... 587 | *Dreadnought* 480

Here we have a loss of, say, 16 per cent. upon the performance constants as regards displacement, and a loss of more than 20 per cent. as regards midship section, by passing from the fine narrow form of the *Shah* to the broader and bluffer form of the *Dreadnought*, observing that the loss would probably have been in greater proportion had the *Dreadnought* been of no more than equal size or displacement with the *Shah*.

Although the *Dreadnought*, as compared with the *Shah*, advances towards the *Livadia* type, the advance is but very small indeed, the *Livadia* being much more than double the breadth of the *Dreadnought* upon a length of 75 feet less. We have in the great Russian yacht an experiment lying far outside of all former experience, and ranging itself under no laws or formulæ with which naval architects are familiar. But it may be well to exhibit her in the guise of the formulæ which we have just employed, and to do this first upon the assumption of a 14 knots speed, and secondly upon that of a speed of 17 knots—the highest, perhaps, which Admiral Popoff has allowed himself to hope for even in his most sanguine moods, and equal probably to that which his ardent disciple and assistant, Capt. Goulaeff, has ever evolved from the most plastic of his calculations—although we must acknowledge that we cannot say this with any great confidence in view of the published paper of the latter

[1] The *Dreadnought's* breadth diminishes by some feet, we believe, at a depth of 6 or 7 feet below the water's surface, but this will not materially interfere with the comparison about to be given.

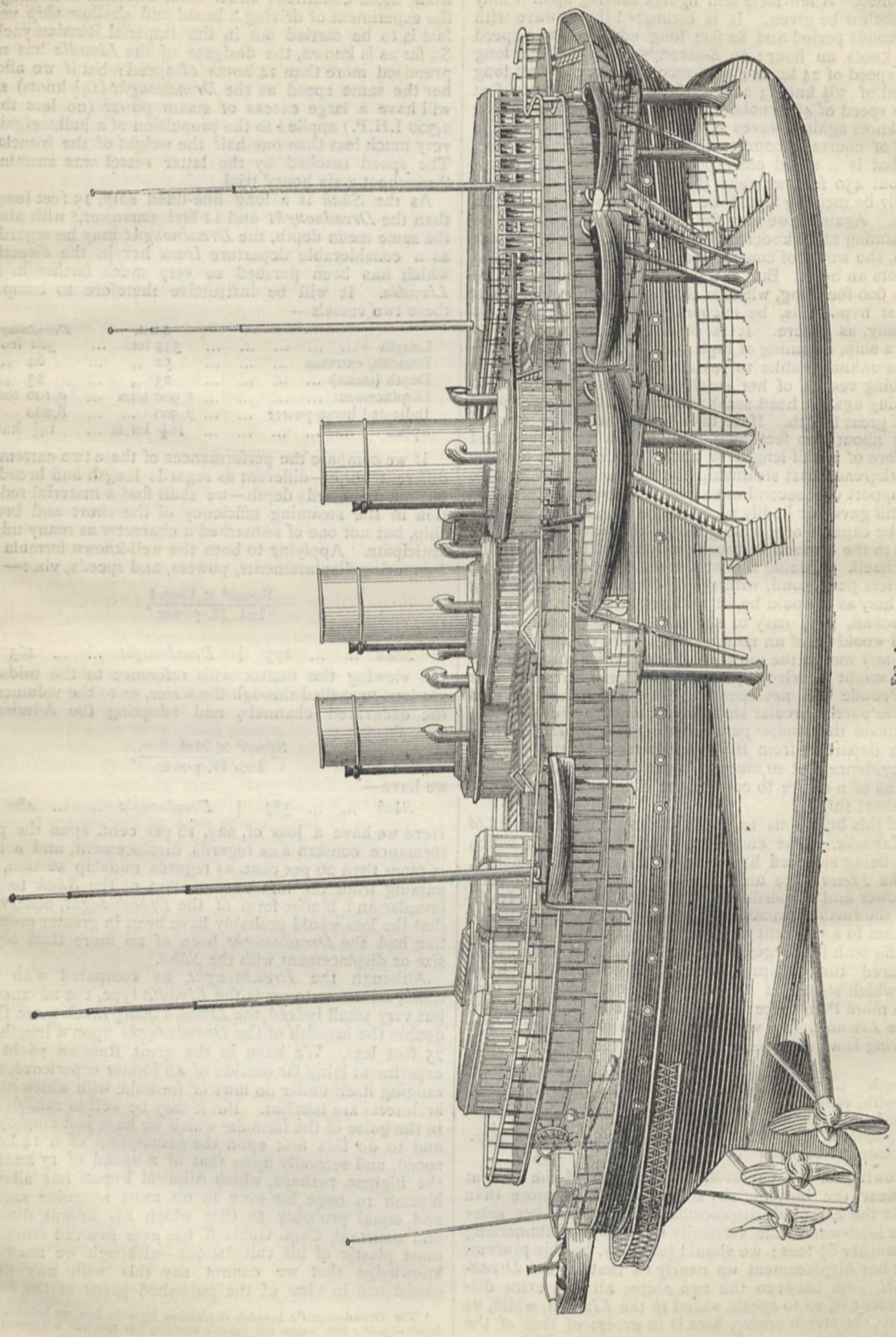


Fig. 1.

officer. The formulæ give the following results for the *Livadia* :—

	Speed 14 knots.	Speed 17 knots.
Displacement constants ...	65 ...	116
Midship sec. ,, ...	234 ...	419

These figures illustrate the margins within which the performances of the *Livadia* may range when steaming at above 17 knots and 14 knots respectively. It cannot be expected that her constants will fall so low as the former of the pair just given, and therefore it cannot be doubted that her speed will surpass 14 knots.

We have intimated that Capt. Goulaeff, in his paper on

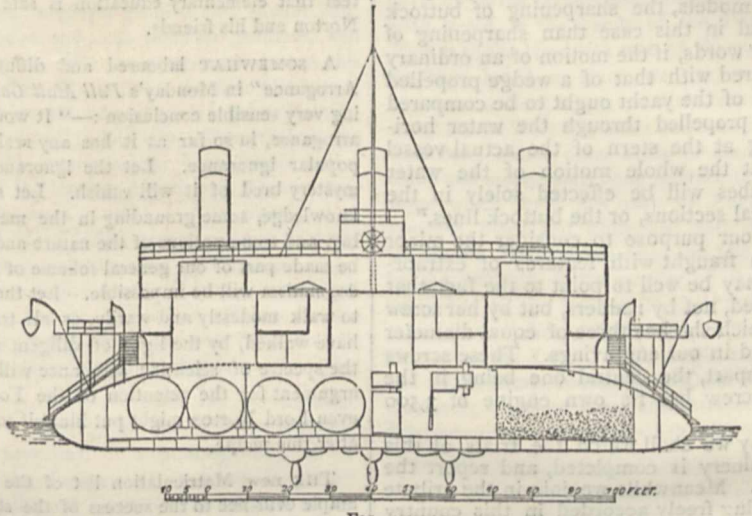


FIG. 2.

"the *Fairfield* yacht of the Czar," has written with great confidence on the favourableness of this vessel's form to speed. He says that an addition of 25 or even 50 feet of length would not have reduced the resistance, the increase of friction being more than the improved form of the water-lines would have compensated for. But it is to her shallowness that he looks for her facility of propulsion, contending that experiments on both a small and a large scale have shown that it is better for speed to have great breadth rather than great depth. He even says that "at certain speeds a very much broader vessel requires only half as much power compared with another vessel of similar form whose draught is double." It is on this ground that he chiefly bases his anticipation that great

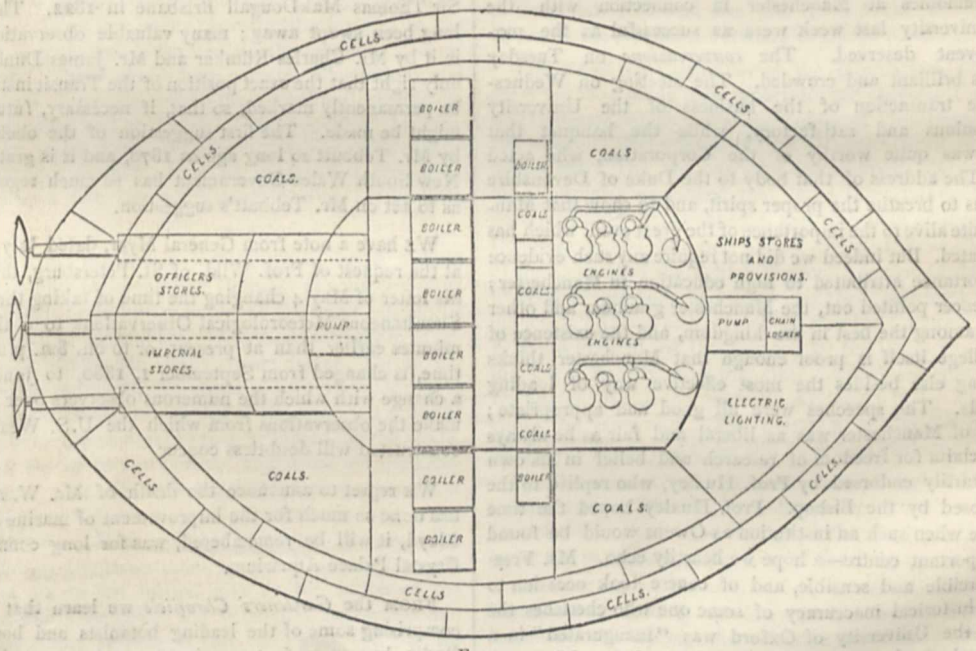


FIG. 3.

speeds are not incompatible with the form given to the *Livadia*. The form of the vessel below water has been very carefully considered. Capt. Goulaeff says :—

"The form of underwater portion was made a subject of very careful study. Besides the great experience of the designer of the ship, Admiral Popoff—experience which he derived by spending the greater portion of his lifetime either on the ocean or in constructing novel ships and trying them at sea—Dr. Tideman, member of the Academy of Amsterdam, was invited to assist in the determination of questions connected with the resistance of the yacht. In the case of this shallow-draughted

vessel, the fine lines must be the vertical sections, whereas the fine lines of the ordinary steamer are the water lines or horizontal sections. Such change has been brought about by passing from long, narrow, and deep forms of ordinary vessels to the proportions of short, broad, and shallow ones; and, as has been demonstrated by experiments with paraffin models, the sharpening of buttock lines is more essential in this case than sharpening of water lines. In other words, if the motion of an ordinary vessel may be compared with that of a wedge propelled vertically, the motion of the yacht ought to be compared with the same wedge propelled through the water horizontally. On looking at the stern of the actual vessel you will observe that the whole motion of the water between the stern tubes will be effected solely in the direction of the vertical sections, or the buttock lines."

It is needless for our purpose to consider the minor details of a vessel so fraught with features of extraordinary interest. It may be well to point to the fact that the ship is to be steered, not by rudders, but by her screw propellers only, of which she has three of equal diameter (16 feet), as illustrated in our engravings. These screws are spaced 18½ feet apart, the central one being in the line of keel. Each screw has its own engine of 3,500 I.H.P.

We need hardly say we shall watch the trials of this ship when her machinery is completed, and report the results to our readers. Meanwhile we join in the tribute of praise which is being freely accorded in this country alike to her bold and adventurous designers, and to His Imperial Highness the Grand Duke Constantine of Russia, a highly scientific and accomplished naval officer, by whose influence, and under whose personal care, some of the greatest problems in steam navigation are being developed.

NOTES

THE ceremonies at Manchester in connection with the Victoria University last week were as successful as the momentous event deserved. The *conversazione* on Tuesday evening was brilliant and crowded. The meeting on Wednesday for the transaction of the business of the University was harmonious and satisfactory, while the banquet that succeeded was quite worthy of the Corporation, who acted as hosts. The address of that body to the Duke of Devonshire seemed to us to breathe the proper spirit, and to show that Manchester is quite alive to the importance of the great event which has been celebrated. But indeed we did not require any such evidence of the importance attributed to high education in Manchester; as Earl Spencer pointed out, the Manchester grammar and other schools are among the best in the kingdom, and the existence of Owens College itself is proof enough that Manchester thinks of something else besides the most effective way of loading cotton goods. The speeches were all good and appropriate; the Bishop of Manchester was as liberal and fair as he always is, and his claim for freedom of research and belief in his own line was heartily endorsed by Prof. Huxley, who replied to the toast proposed by the Bishop. Prof. Huxley hoped the time would come when such an institution as Owens would be found in every important centre—a hope we heartily echo. Mr. Freeman was forcible and sensible, and of course took occasion to correct the historical inaccuracy of some one who cherishes the belief that the University of Oxford was "inaugurated" in a desert instead of what was at the time a busy industrial centre.

IT is comforting to receive the assurance given by Mr. Mundella at the opening of the Central Schools of Sheffield last week, that as long as he has the honour to occupy the place he does in her Majesty's Government the quality of education and the standard of education should not be lowered. The State, he maintains, having decided that the children of the country should receive education according to their needs and capacities and prospects in life, ought to give that education not only thoroughly, but generously and with an unstinting hand. With such a sentiment actuating the Vice-President of the Council, we feel that elementary education is safe from the raids of Lord Norton and his friends.

A SOMEWHAT laboured and diffuse article on "Scientific Arrogance" in Monday's *Pall Mall Gazette* comes to the following very sensible conclusion:—"It would appear that scientific arrogance, in so far as it has any reality, is but the obverse of popular ignorance. Let the ignorance be dispelled, and the mystery bred of it will vanish. Let some rudiments of exact knowledge, some grounding in the methods of scientific reasoning, and some notions of the nature and ends of scientific work, be made part of our general scheme of instruction, and scientific dogmatism will be impossible. Let the mind be trained betimes to walk modestly and warily, as all true leaders of knowledge have walked, by the light of diligent and patient inquiry, and the spectre of scientific arrogance will disappear." One more argument for the retention of the Fourth Schedule. Perhaps even Lord Norton might put himself to school to some advantage after this recipe.

THE new Matriculation list of the London University bears ample evidence to the success of the step recently taken by the Council in admitting women to its degrees. In the Honours Division the third place is occupied by Edith Sophia Callet, from the North London Collegiate School. Altogether about one-sixth of the names on this Division are those of girls, and the proportion on the other Divisions is quite as great.

THE New South Wales Government have done a creditable thing in erecting an obelisk on the spot occupied by the Transit instrument in the old observatory at Parramatta, established by Sir Thomas MakDougall Brisbane in 1822. The building has long been swept away; many valuable observations were made in it by Mr. Charles Rümker and Mr. James Dunlop, and it was only right that the exact position of the Transit instrument should be permanently marked, so that, if necessary, future verification might be made. The first suggestion of the obelisk was made by Mr. Tebbutt so long ago as 1870, and it is gratifying that the New South Wales Government has so much regard for science as to act on Mr. Tebbutt's suggestion.

WE have a note from General Myer, dated July 1, stating that at the request of Prof. Wild, of St. Petersburg, the date fixed in his letter of May 4 changing the time of taking the International Simultaneous Meteorological Observations to a time thirty-five minutes earlier than at present, or to 0h. 8m. p.m., Greenwich time, is changed from September 1, 1880, to January 1, 1881, a change with which the numerous observers over the world who make the observations from which the U.S. Weather Maps are constructed will doubtless concur.

WE regret to announce the death of Mr. W. A. Lloyd, who has done so much for the improvement of marine aquaria. Mr. Lloyd, it will be remembered, was for long connected with the Crystal Palace Aquarium.

FROM the *Gardeners' Chronicle* we learn that a committee, comprising some of the leading botanists and horticulturists of Berlin, has set on foot a project to erect a memorial stone on the grave of the late Karl Koch, and appeals through the press to his friends and admirers for subscriptions wherewith to carry out the project in a manner worthy of him whose memory it is desired to perpetuate. Subscriptions may be sent to Herrn Späth, Baumschulbesitzer, 154, Köpenickerstrasse, Berlin, S.O., and will be publicly acknowledged.

PROF. MCK. HUGHES, of Trinity College, Cambridge, writes to us as follows:—"I am writing the life of Prof. Sedgwick, but I want much which I fail to find in the mass of MS. placed in my hands, especially letters from himself giving an account of contemporary persons and events. Can any of your readers help me in this matter?"

WE take the following from the New York *Nation*:—"For the English-speaking race, wherever planted, we should have supposed NATURE to be a sufficient scientific medium, and entitled to universal support. We are partly confirmed in this view by the quotations from NATURE in the first number of *Science*, a quarto weekly journal, edited by Mr. John Michels, and published at 229 Broadway, in this city. Nevertheless, the editor's statement that the enterprise has been begun 'after consultation with many of the leading scientists in this country,' and his list of co-labourers seem to point to a real want, and to entitle this new 'record of scientific progress' to a friendly welcome. Its present size is sixteen pages, including the advertising sheet. The opening article, on the United States Naval Observatory, is from the pen of Prof. E. S. Holden." We wish our new contemporary every success, and trust that it may be the means of spreading a wide interest in science on the other side of the water.

THE half-yearly general meeting of the Scottish Meteorological Society was held yesterday. The business was: (1) Report from the Council of the Society; (2) Proposed Inquiry by the Society into the Relation of Climates in Scotland to the Growth of Trees, by Sir Robert Christison; (3) Relations of Weather to Deaths from Scarlet Fever and Whooping Cough, in Thirty-one British Large Towns, by Dr. Arthur Mitchell and Alexander Buchan, secretary; (4) Anemometer for ascertaining the Direction of the Wind with reference to a horizontal Plane, by Alexander Frazer, M.A., optician.

PROF. A. H. CHURCH, late of the Royal Agricultural College, Cirencester, has begun a course of lectures on Agricultural Chemistry at the Wilts and Hants Agricultural College, Downton, near Salisbury. There are many characteristic features in the farming of the district, well illustrated on the extensive farm of the new college. These afford both valuable illustrations and important subjects of investigation to the agricultural chemist as well as to the botanist and geologists. We hope that this new institution, over which Prof. Wrightson presides, will occupy itself not only in agricultural teaching, but in agricultural research, and develop, after a time, into a "Versuch-Station" of no little value.

THE continued wet weather at Carlisle, which lasted without intermissionfrom Monday evening to Thursday at noon, rendered it extremely difficult to do justice to one of the finest exhibitions ever held by the Royal Agricultural Society. Among the most important of the novelties was Mr. Darby's steam digger. This instrument is intended to supersede the steam-plough by producing at once a pulverising effect superior to that of the combined action of plough and cultivator, and equal to that produced by the spade. The idea is old, but up to the present time it has not been successfully applied. Mr. Darby's digging-machine consists of three sets of prongs of fourteen each, arranged on three cross-bars twenty-feet wide. Each cross-bar is worked independently and in succession by a separate crank-shaft. The earth is moved to the depth of six to ten inches, and by the action of the revolving crank-shafts the raised sod is pitched backwards and neatly inverted. The surface is left somewhat too flat for harrowing, but a second digging renders the work much more efficient. The greatest drawback to this ingenious machine lies in its weight. When charged with coal and water the engine and digger unitedly weigh fourteen to fifteen tons. Experiments in the trial fields showed that three-fifths of the power were absorbed in moving the implement over the ground. There were no new forage plants exhibited, and the stands devoted to manures and feeding-stuffs contained no articles save those with which we were familiar. In the live stock sheds the most interesting exhibits were the mountain-sheep peculiar to Cumberland and the adjoining counties. The Herdwick sheep are hardier than the Scotch black-faced breed. They are able to thrive on the poorest land imaginable, and manage to leave a good profit in the hands of the Dalesmen who own them. Thanks to the Herdwick race of sheep, the bad times of which we have heard so much are unknown in the Lake district. Another excellent breed, not often seen out of their own locality, which lies in West Yorkshire and East Lancashire, is the Louks. This race, unlike other kinds of sheep, is well suited to the damp and mossy lands lying between the hills of mountain limestone which form this part of England. Their faces are speckled, black and white, and both sexes are horned. They are readily distinguished from the Highland black-faced breed by the evidently better quality of their wool. A third race unfamiliar to the bulk of English farmers is the "Crag' or "Limestone" sheep, which occupies the highlands of the same district as the Louks. The crag-sheep are adapted for a dry and poor pasture, and can do without water. The louk and the crag-sheep therefore offer good instances of the adaptability of different races of animals to their environment.

THE Zoological Station established last year in connection with the University of Aberdeen, at Stonehaven, is at present in process of erection near Cromarty. The work will be carried on throughout August and September, and part of October, under the superintendence of George J. Romanes, F.R.S., and Prof. J. C. Ewart. Those desirous of taking advantage of the station are requested to communicate with Dr. Ewart, Dunskaith, Ross-shire.

THE Sydney papers state that some important gold discoveries have been made in the Bathurst district near Tuena, and that in one claim a bushel of broken quartz yielded two pounds of gold. A very rich gold-field has also been found at the Margaret River, in the Northern Territory of South Australia.

THE Executive Committee of the International Medical Congress for 1881 made their report to the General Committee of this Congress, which met at the College of Physicians on Tuesday last week. The officers of the Congress were proposed and nominated. The sections were agreed upon, and the treasurer, Mr. Bowman, announced that large subscriptions had already been received. It was agreed that the time of meeting of the Congress should be from August 3 to 9, 1881. The president of the Council of the British Medical Association stated that the Council of that body had postponed their meeting to the following week. It was also announced that the Congress would meet in rooms granted for the purpose by the University of London, the Royal Society, and the other learned societies meeting in Burlington House, so that the sections will be all practically under the same roof. The president of the Congress will be Sir James Paget, and there will be fifteen sections in all.

IT is intended to hold an International Congress of Commerce and Industry at Brussels, from September 6 to 11. M. Antoine Dansaert is to be the president, and the meeting will take place under the patronage of the King of the Belgians.

ACCORDING to the *Electrician*, a remarkable instance of telephony is exciting considerable interest throughout South Australia and among the scientific world in particular. By means of an improved telephone the Adelaide Post Office chimes have been clearly heard at Fort Augusta, a distance of 240 miles.

MR. G. F. H. MILNE, owner of the fossil forest recently discovered at Oldham, and referred to in NATURE at the time,

has offered to allow the Oldham Corporation to have care of it, and make a charge to visitors, the money to be applied towards a public museum. No doubt the Corporation will accept this handsome offer.

AT the Rheims meeting of the French Association M. Gariel will give a public lecture on Radiant Matter, with Mr. Crookes' experiments, and M. Perier on the Law of Selection. The meeting of 1881 will be held at Algiers, and an excellent paper has been published in connection therewith by M. Macarthy, president of the Society of Natural Sciences of Algiers. This physicist settled in Algiers thirty years ago, and holds the position of librarian of the National Library of Algiers; in his *brochure* he reviewed all the different topics which might be submitted to the several sections of the Association.

A VIOLENT shock of earthquake occurred at Manila and throughout the Island of Luzon on July 18, which did immense damage, totally destroying several government buildings and other houses. Some of the native inhabitants were killed, but no Europeans suffered any injury. A slight shock was felt also on the 17th inst.

ON July 14 the French Chamber of Deputies adopted a proposition of M. Lockroy, that a sum of 3,700,000 francs originally intended to rebuild the Palace of the Tuileries should be devoted to enlarge the national library, which will be quite isolated from other houses. The sanction of the Senate will be asked next session, but not a single representative having objected, the result is not dubious, and preparatory steps will be taken very shortly to execute this great measure of preservation and improvement.

IN an interesting article on "Mistakes about Snakes," by Mr. Arthur Stradling, in the *Field* of the 17th inst., the author gives an *exposé* of the famous Indian basket trick, in which a boy is shut up in a basket and apparently put to death by sword-thrusts, but suddenly appears among the company uninjured. The narrative is too long for quotation, and we recommend our readers to obtain a perusal of the original.

THE following is the title of the essay to which the "Howard Medal" of the Statistical Society will be awarded in November, 1881. The essays to be sent in on or before June 30, 1881. "On the Jail Fever, from the earliest Black Assize to the last recorded outbreak in recent times." The Council have decided to grant the sum of 20*l.* to the writer who may gain the "Howard Medal" in November, 1881. Further particulars or explanations may be obtained from the Assistant Secretary, at the office of the Society, King's College entrance, Strand, London, W.C.

M. HERVÉ-MANGON, the director of the Conservatoire des Arts et Métiers, has compiled a catalogue of the celebrated Vaucauson collection; it will be very shortly placed at the disposal of the public in the Portefeuille Industriel, a special library opened in the Conservatoire for the communication of designs and documents relating to industry. The course of public experiments is attracting an unprecedented number of visitors to the galleries. Every week a programme of the exhibits is posted on the walls outside the buildings.

THE Manchester Scientific Students' Association is a busy society, as its Report for 1879 shows. It contains reports not only of various lectures and papers read at its meetings, but interesting accounts of the numerous excursions made by the members; these are occasionally illustrated, the illustrations being sometimes rather rude.

SUPPLEMENT No. 5 to the U.S. *National Board of Health Bulletin* contains a report of the proceedings at a conference on Vital Statistics held at Washington on May 6 last. There is an interesting discussion on the subject of a Standard Nomenclature, with special reference to that adopted by the Royal College of Physicians of England; and appended is a very detailed nomenclature of ophthalmology and otology, by Dr. S. M. Burnett, of Washington.

AMONG the papers in the forthcoming number (vol. iii. No. 1) of the *American Journal of Mathematics* are the following:—"Regular Figures in *n*-Dimensional Space," by W. J. Stringham; "On the Algebra of Logic," by C. S. Peirce; "On the General Equations of Electromagnetic Action, with Application to a New Theory of Magnetic Attraction, and to the Theory of the Magnetic Rotation of the Plane of Polarisation of Light," by H. A. Rowland; "On Certain Ternary Cubic-form Equations," by Prof. Sylvester.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mrs. C. Salvin; a Common Badger (*Meles taxus*), British, presented by Mr. Frank G. Haines; a Huanaco (*Lama huanacos*) from Bolivia, a Common Rhea (*Rhea americana*) from South America, presented by the Marquis of Queensberry; a Common Paradoxure (*Paradoxurus typus*) from India, presented by Col. Sturt; four Ring-tailed Coatis (*Nasua rufa*) from South America, presented by Lieut.-Col. J. A. Smith, 1st W.I. Regt.; a Common Hedgehog (*Erinaceus europæus*), British, a Greek Land Tortoise (*Testudo græca*), European, presented by Mr. L. C. Brook; two American Darters (*Plotus anhinga*) from Brazil, presented by Mr. Gerald Waller; a Goffin's Cockatoo (*Cacatua goffini*) from Queensland, presented by Miss Bartlett; two Red-legged Partridges (*Caccabis rufa*), two Common Buzzards (*Buteo vulgaris*), European, presented by Mr. W. H. St. Quintin; a Common Heron (*Ardea cinerea*), European, deposited; a Common Seal (*Phoca vitulina*), British Seas, two Japanese Pheasants (*Phasianus versicolor*) from Japan, a Bar-tailed Pheasant (*Phasianus reevesi*) from North China, purchased; a Burchell's Zebra (*Equus burchelli*) from South Africa, received in exchange; two Lions (*Felis leo*), an Eland (*Oreas canna*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE COMET OF 1668.—There is one point in the history of this comet which we do not remember to have seen mentioned since its supposed reappearance in 1843 revived the attention that was directed to it early in the last century, and it is one which, if accepted, bears materially upon the question of identity. Pingré has no reference to it in the account of the comet of 1668 in his "Cométographie." In the report of the observations made by the French Jesuit Valentin Estancel at San Salvador, in the *Philosophical Transactions*, No. 105 (1674, July 20), which is stated to be a translation from the *Giornale de' Letterati*, No. 9, published at Rome in September, 1673, we read after the description of the evening observations commencing March 5, 1668:—"It may be taken notice of that a month before, upon a report that a comet had been seen towards the morning in the horizon of the rising sun, and certain Carmelites that live upon a hillock of the said town having affirmed that they had observed it several times, our P. Estancel began to doubt whether the comet he saw were not the same which, more swift than the sun, according to the succession of the signs, might within that time have got clear of the solar rays; and his suspicion grew the stronger because the head was then turned towards the sun and the tail towards the west, opposite to the same." But if the comet of 1843 were in perihelion near the time which Henderson found it necessary to assume in order to satisfy the indications of his Goa chart, it would not have preceded the sun in the first week in February, but would have had considerably greater right ascension, so as to be visible only in the evening. Henderson's direct orbit, however, which upon the whole accords much better with his data, would place the comet in R.A. 311°, Decl. $-7\frac{1}{2}°$ on February 5, at 17h. San Salvador time, so that it would precede the sun, which was then in R.A. 320°.

If this circumstance is adverse to the identity of the comets of 1668 and 1843 there is another which would rather tend to support it, were it not that there appears to be an oversight in the record. Zach in an article, "Ueber einige unberechnete Cometen, deren Bahnen man vielleicht noch auffinden und berechnen könnte," in vol. xxviii of his *Monatliche Correspondenz*, refers to the comet of 1668, and, after mentioning the observations of Cassini and others, he adds that in the *Philosophical Transactions* for 1668 there is an observation of a comet, which places it on March 7 in longitude 16°, with 20° 30′ south latitude, and he asks, "Ist diess die *Cassinische Spina?*" referring to the title of the tract in which Cassini gave his observations of the phenomenon in March, 1668, viz: "Spina, Celeste meteora osservata in Bologna, il mese die Marzo 1668" (Bologna, 1668 in fol.). If we suppose the comet of 1843 to have arrived at perihelion February 24·284, Greenwich time, at 8 p.m., on March 7, its place would have been in longitude 16°·0, with 20°·4 south latitude, as observed, and the agreement gives an importance to the reputed observation, if it could only be traced. It was first remarked by Schumacher (*Astron. Nach.*, No. 484) that the observation mentioned by Zach does not occur in the *Philosophical Transactions:* his words are: "Diese Beobachtung 1668 März 7, Länge 0ᶻ 16°, südliche Breite 21½° steht nicht in dem von Herrn v. Zach angeführten Bande der *Philos. Transactions* und, wenn das Register der *Phil. Transact.* genau ist, in keinem der ersten 70 Bände." We find on a careful examination of the volumes or numbers of this work containing reference to the comet of 1668 as indicated in Maty's Index, that there is no such observation recorded. There are two articles bearing upon this comet: (1) in vol. 3 for 1668, in No. 35, May 18, 1668—which gives a translation of Cassini's description of its appearance, from the Italian, and a notice of its having been observed at Lyons, Toulouse, Toulon, &c., though not at Paris, and (2) in vol. 9 for 1674, in No. 105, July 20, 1674 (though not occurring in the list of contents to this number on the first page): this second notice chiefly refers to the observations of P. Valentin Estancel in Brazil, taken from *Giornale de' Letterati*, September 31 (*sic*) 1673—a journal printed at Rome.

Perhaps some of our readers may have opportunity of making further search in the libraries for information relating to the comet of 1668, though we are aware that much was done in this direction in 1843. It would be of interest more particularly if the observation which Zach would appear to have somewhere met with, could be traced.

VARIABLE STARS.—The following times of maxima and minima of variable stars during the ensuing two months are extracted from the ephemeris prepared by Prof. Winnecke for the first part of *Vierteljahrsschrift der astronomischen Gesellschaft* for 1880 (15. Jahrgang):—

Aug.	2. S Ursæ maj., *min.*	Aug.	30. R Comæ.
	3. R Leonis.	Sept.	2. U Virginis.
	4. S Sagittarii.		3. R Draconis.
	11. S Pegasi.		5. W Scorpii.
	12. R Sagittarii.		8. R Virginis.
	15. V Tauri.		9. R Arietis, *min.*
	16. R Persei.		10. R Vulpeculæ.
	18. R Ursæ maj.		16. R Ophiuchi.
	21. T Herculis, *min.*		19. R Camelopardi.
	24. S Vulpeculæ, *min.*		20. T Virginis.
	25. S Herculis, *min.*		20. R Aquilæ, *min.*
	28. R Aurigæ.		21. S Cephei, *min.*
	28. R Sagittæ, *min.*		21. S Vulpeculæ.
	29. S Aquarii.		29. R Bootis, *min.*

Prof. Winnecke has August 2 for the date of approaching maximum of *Mira Ceti;* the formula in Prof. Schönfeld's last Catalogue gives August 10·8; perhaps some reader of NATURE may be able to say, in due course, when the maximum actually occurs. The amount of perturbation by the formula for Epoch 15 = + 37d·3.

M. Ceraski of the Moscow Observatory draws attention to an object which evidently deserves close observation. On June 23 he remarked that the *Durchmusterung* star R.A. 0h. 49m. 39s., Decl. 81° 5′·6, 7′·5m., increased from 9m. to about 7′·5m. between 17h. 40m. and 19h. 35m. Moscow sidereal time. Carrington estimated this star 7′·9. Schwerd observed it four times, and his estimates of magnitude are strongly indicative of variability; thus it is called 8 on December 11, 1827; 6·7 on March 11, 1828; 8 on the following night, and 10 on May 12 in the same year. It is No. 130 in Carington's Catalogue, the place for 1855·0 being in R.A. 0h. 49m. 38·9s., Decl. 81° 5′ 33″. The star was also observed by Lalande in March, 1790, as an eighth magnitude (Fedorenko 145).

BIOLOGICAL NOTES

THE EVOLUTION OF DIBRANCHIATE CEPHALOPODS.—Dr. J. Brock, in the last number of Gegenbaur's *Morphologisches Jahrbuch* (vol. vi. p. 185), gives his reasons for dissenting from von Ihering's conclusions on this subject. He has dissected spirit-preparations of many of the principal genera, and he discusses the evidence derived from the shell, the funnel, the muscular system, the radula, the nervous system, and the vascular excretory and reproductive systems. Three anatomically well-marked phyla or groups of genera are made out, of which the Œgopsidæ are the most ancient, and from this group the other two—the Myopsidæ and the Octopods—are derived. The Œgopsids he further divides into two groups—the Ommastrephidæ and the Loligopsidæ, the comparative antiquity of which cannot yet be determined; they are of great interest because they both show important connections with the two other phyla. The Œgopsid forms are primarily true Belemnites, and later developed into the Sepia type, from which stock also the decapods with simple horny shells sprang independently. The octopods, the most highly differentiated phylum, but with an organisation showing a very early origin, and branching from the main type, afford some evidence of relationship to the type of Loligopsis, although they cannot be regarded as having originated from them. Most probably they had a common origin from the primordial dibranchiate form with ten arms. Dr. Brock relies considerably on the oviduct being double in the Œgopsidæ, and single (by reduction) in Myopsidæ; but unless he can support his theory by more developmental facts it can hardly attain sufficient credit for practical use in classification.

ON A CASE OF APPARENT INSECTIVORISM.—Prof. Baillon, at a recent meeting (April 7) of the Linnean Society of Paris, read the following notes:—*Peperomia arifolia*, Miq., of which the variety argyreia is cultivated in so many greenhouses, has the leaves more or less deeply peltate. I have seen stalks on which the peltation on certain leaves was so exaggerated as to show on a cross-section a depth of nearly four centimetres. When the concave stalks take a suitable direction, water, principally that from sprinkling, would accumulate and rest in these receptacles, so well prepared to preserve it. Many small insects would fall into this water and be drowned. Last year, when the season was warm and when the windows of the house were often open, the number of insects was very considerable, and these, soaking in the water, gradually fell into decay, and it was remarkable that there was during this not the least sign of any putrescent odour. Those who believe in the doctrine of insect-eating plants may perhaps in this be led to find an argument favourable to such theories. They will add that the variety of colours so strikingly seen in these leaves constitutes the agent of attraction for the insects to come and be devoured. Three reflections, each of a different sort, here present themselves: 1. Is it not remarkable that the exaggerated peltation of these leaves is in this case accompanied by an apparent insectivorism, and that the leaves of the plants known up to this by botanists as carnivorous owe their sac-like, horn-like forms only to an excessive peltation of their limb, as we demonstrated in the evolution of the leaves in Sarracenia (*Comp. rend.*, lxxi. 630)? 2. How can it be considered as a proof of insectivorism, that plants such as the Urticularia grow better in a fluid containing albuminoid compounds, when other plants grow equally favourably in the same kind of fluid, which latter are never for a moment thought of as carnivorous? 3. How do the chief priests of our science reconcile the two ideas, that the surface of the leaves of plants are unable to absorb pure water in contact with them, and that the same surface daily absorbs water charged with albuminoid substances and the like?

INTESTINAL WORMS IN THE HORSE.—H. Krabbe has published in the *Oversigt over det K. Danske Videnskabernes Selskabs*, No. 1, 1880, p. 33, an interesting account of the occurrence of intestinal worms in the horse. As this animal is spread over the greater part of the habitable world, and under conditions of life very varied, it might be supposed that, like man and the dog, it would not be equally affected with these parasites, nor with the same species. For to determine with some degree of accuracy the worms which in Denmark are found in the intestinal

canal of the horse, Mr. Krabbe examined, during the last four years, the bodies of one hundred horses which were brought for anatomical purposes to the Veterinary College at Copenhagen, between the months of September and April in each session. In these horses he found *Tænia perfoliata*, 28 times; *T. mamillana*, 8 times; *Ascaris megalocephala*, 16 times; *Strongylus armatus*, 86 times; *S. tetracanthus*, 78 times (in 67 horses out of 86); and *Oxyuris curvula*, twice. Of *T. perfoliata* the number found was mostly less than 25; sometimes it was over, and twice between 100 and 200 were found, while once no less than 400 were met with. In general they were lodged in the cæcum. *T. mamillana* of Mehlis, a species overlooked by Dujardin and most French writers on the subject, was described and figured by Gurlt in 1831; generally less than 25, but sometimes up to 72, were met with, mostly in the anterior part of the small intestines (*T. plicata*, R., was never met with). The Ascaris never occurred in larger numbers than 11. *S. armatus* was never met with in the small intestine; in the cæcum it was common; much less so in the first portion of the colon, where very fine specimens of a dark bluish red colour were found; generally the number met with was below 25, but once nearly 200 were found. Of 1,409 samples, 1,029 were females and 380 males. *S. tetracanthus* was found in the cæcum and throughout the colon. The literature of this subject would appear to be very scanty, and the author hopes that the attention of veterinary surgeons in other parts of the world may be attracted to this subject. Ample opportunities of following it up exist in British India, America, and the Cape of Good Hope district.

The Domestication of Deer.—A very interesting correspondence is published in the *American Naturalist* for June between Mr. Brown, the superintendent of the Philadelphia Zoological Gardens, and Mr. J. D. Caton. It relates chiefly to the question of the domestication of species of deer. Of the twelve species kept in the Philadelphia Gardens the mule deer (*Cervus macrotis*) have bred during 1878 and 1879; of five fawns one died when two days old; the other four, though most carefully nursed and fed with astringent food, as well as supplied with iron water and gentian powders, &c., all died of a diarrhœa caused by malignant disease. Five specimens of moose-deer and eight of caribou died at periods varying from three months to two years and five months in the moose and not beyond nine months in the caribou from hypertrophy of the heart. The pronghorn (*A. americana*) all died speedily from diarrhœa or hypertrophy of the heart; change of food and tonics seemed to have no effect upon them. Of ten or twelve individuals none lived more than fifteen months. The wapiti and common deer (*C. virginianus*), however, have done well, and several fawns were raised of *C. campestris*, *C. aristolelis*, and *C. dama*. Of *C. leucurus* the Gardens possessed but a single specimen. In the case of the mule deer Mr. Brown is disposed to account for the mortality by the difficulty of supplying them with a sufficient amount of their proper (arboreal) food, which has to be replaced by dry food and grass. Mr. Caton, writing from Ottawa, Illinois, states that he had lost the last of his stock of mule deer and also of *C. columbianus*, and that he is satisfied that they cannot be successfully domesticated in his grounds. He concludes that they get at something which does not agree with them; indeed all his experimen's with ruminants, *fera naturæ* whose natural habitat is confined to the United States west of the Missouri River, have proved failures. Mr. Caton has succeeded well in hybridising the Virginian deer with the Ceylon deer and the Acapulco deer. The hybrids seem to be perfectly healthy and prolific, several of the hybrids from the Virginian deer and Acapulco buck having borne perfectly healthy twin fawns. On some of the hybrids the metatarsal gland is wanting, and on some it is present, while some have it on one hind leg and not on the other.

The Fiddler Crabs.—Mr. J. S. Kingsley, in a further contribution to the *Proceedings* of the Academy of Natural Sciences of Philadelphia, revises the genus *Gelasimus*, and as a result he makes a great reduction in the number of species. This has been done, not with any desire to overturn the work of others, but as the result of a study of the forms known all over the world. The range of many species is greatly extended. He refers the genus to the family Macrophthalmidæ of Dana; and it is characterised by its rhomboidal carapace, broad in front, elongated eye-stalks, and a great inequality of the chelipeds or nipping feet of the male. The latter is the most constant character of value. The species fall into two groups according as the front between the eyes is very narrow or wide; and the latter have males with a five-jointed or seven-jointed abdomen.

Organs of Deep-Sea Animals.—During his researches on the fauna of the Caspian Sea, M. O. Grimm has studied the modifications which are undergone by the organs of sense in animals which inhabit great depths. Among them several have well-developed organs of sight, which seems to prove that even at very great depths light is not completely absorbed. Such are the Caspian *Mysis*, the *Gammaracanthus caspius*, several *Bœckiæ*, and others, but on the contrary, there are at the same depths many species whose eyes are quite atrophied, and in these species we observe that other organs of sense receive a greater development. Such is the case in *Niphargus* and *Onesimus*. But, whilst *Niphargus caspius* bears well-developed organs of smell and of touch on its antennæ, in *Onesimus*, which, as well as the former, has but rudimentary eyes, only organs of touch are to be found on its jaws. M. Grimm explains this last difference by the circumstance that the former species usually remains in water, whilst *Onesimus* likes to remain in the mud at the bottom, where it searches for its food very much like a mole.

CHEMICAL NOTES

In the *Journal* of the American Chemical Society, vol. ii., Mr. P. Collier describes a new mineral from the Champlain iron region, which resembles thorite in its physical properties, but differs therefrom in containing a relatively large quantity of uranium. Analysis showed 9·96 per cent. of uranic oxide, and 52·07 per cent. of thoric oxide, with 19·38 per cent. of silica, the remainder consisting of oxides of lead, aluminium, iron, calcium, magnesium, and sodium, with moisture and combined water.

Mr. Collier gives an account, in the same journal, of experiments he has made, which seem to point to a new possible source of crystallisable sugar. He finds that the juice of various varieties of fully ripe sorghums contains from 13 to 15 per cent. of sucrose, with 1 or 2 per cent. of glucose.

Special attention has been recently given to the liquids included in the microscopical pores of certain minerals, and it has been shown by Zimmler that these pores contain not only water, but also sometimes carbonic acid. Prof. Karpinsky publishes now in the *Memoirs* of the St. Petersburg Society of Naturalists the results of his experiments on the liquid contained in the pores of the Uralian amethyst. The mineral having been broken in a tube filled with mercury, the fluid immediately evaporated, and being brought in contact with a solution of oxide of barium, proved to be carbonic acid (1·07 cubic millimetres at 30°). The pressure under which the carbonic acid was liquefied may be estimated as seventy-three atmospheres, which would correspond to a pressure of a column of water 2,336 feet high.

At the meeting of the French Academy of May 17, 24, and 31, notes were read by MM. Ditte and Berthelot, on the cold produced by the action of acids on hydrated salts, *e.g.*, hydrochloric acid on hydrated sodium sulphate. The action is regarded as complex: an exothermal chemical reaction occurs in accordance with Berthelot's "law of maximum work," but unless the products of this action are totally insoluble, secondary changes take place; these changes are chiefly conditioned by the amount of heat evolved in the primary action. In the special cases in question the heat disengaged in the chemical change is less than the heat absorbed in the liquefaction of the water of crystallisation which separates from the hydrated salt, hence the sum of the heat changes is negative.

The densities of chlorine, bromine, and iodine at high temperatures cannot yet be regarded as determined. Victor Meyer, in a recent paper in the *Berliner Berichte*, admits the justice of Crafts' criticism of his determinations of temperature (see Nature, vol. xxi. p. 561, letter by Dr. Armstrong); his latest results give for iodine at about 1,050°, a density equal to $\frac{8}{9}I_2$, and at an extremely high temperature (exact numbers not yet given), a density of 4·55, which nearly corresponds with that calculated on the supposition that at this temperature the iodine molecules are entirely dissociated into atoms (calculated number = 4·39). Meyer and Crafts, working by Dumas' method, and using an iodine thermometer, find the density at 1,468° to be 5·05 (calculated for $\frac{8}{9}I_2$, 5·83; for I, 4·39). The density for free chlorine seems to be normal (Cl_2), even at extremely high temperatures; but if the chlorine be produced in the vapour-density

apparatus—by heating platinous chloride—the density at about 1,400° agrees with that calculated for $\frac{3}{2}Cl_2$. Bromine produced by heating platinic bromide in the apparatus gave a density equal to $\frac{3}{2}Br_2$ at about 1,400°. Meyer and Crafts published numbers in *Comptes Rendus*, which gave for free bromine at about 1,400°, a density between that calculated for Br_2 and that for $\frac{3}{2}Br_2$, viz., 4·43 ($Br_2 = 5·52$, $\frac{3}{2}Br_2 = 3·64$). Meyer's vapour-density method is somewhat adversely criticised in the last number of the *Berliner Berichte* by Pettersson and Ekstrand, who give numbers which they regard as proving that the method does not give good results at high temperatures when the substance under examination is a solid. Solids, they say, condense on their surfaces considerable quantities of air, and when the solid is thrown into the highly-heated apparatus this air is evolved, is measured with the air representing the volume of the gasified substance, and so vitiates the result. It is certainly worthy of note that both Crafts and Meyer obtained a normal density for chlorine—the only halogen element gaseous before being brought into the apparatus—at the highest temperature at which they experimented. Pettersson and Ekstrand regard Dumas' method as the only altogether satisfactory one; they describe a modification of this process. It is to be remarked that the density of mercury vapour—which chemists generally regard as consisting of atoms—is shown by Meyer's results to be remarkably constant through a large range of temperature.

ALEXR. NAUMANN has arranged Meyer and Crafts' results on the density of iodine vapour in a table (in the *Berichte* for June 14) showing the percentage dissociation of iodine molecules at various temperatures; the results are in keeping with the deduction made by Naumann from the kinetic theory of gases, viz., that equal temperature-intervals correspond to a regularly increasing amount of dissociation up to 50 per cent. but after this to a decreasing amount of dissociation. Naumann regards this agreement between the theoretically-deduced, and the actual results as affording evidence in favour of the correctness of Meyer and Crafts' measurements of high temperatures. This subject is likely to receive a considerable amount of attention, as it has an all-important bearing on the question of the elementary nature of the so-called elements. Deville and Troost, in a recent number of *Compt. Rend.*, estimate the boiling-point of zinc as 940°, which is 100° lower than the number generally accepted on the evidence of older determinations by the same authors.

CHEMICO-PHYSICAL investigation has lately led to some important results. Schneider, in a recent number of the *Berliner Berichte*, has shown that any solution of malic acid containing more than 34·24 per cent. of the acid rotates the polarised ray to the right, whilst a solution containing less than this amount is lævarotatory. Solutions of sodium malate are dextrorotatory when of greater strength than 47·43 per cent., but lævarotatory when containing less than this quantity of the salt.

SOME little time since Brühl published—also in the *Berichte*—an important paper on the connection between the refraction equivalents and the chemical structure of carbon compounds; he showed that if the refraction equivalents are calculated for a number of carbon compounds, by the help of Cauchy's formula, for a ray of infinite wave-length, a distinct connection can be seen to exist between the numbers thus obtained and the number of "doubly-linked" carbon atoms in the compound. A further communication by the same author appears in a recent number of the same journal. The refraction equivalent of a carbon compound is equal to the sum of the atomic refractions of its constituent elements; the value of the atomic refraction of carbon varies according to the "linking" of the carbon atom—for every pair of doubly-linked carbon atoms present in a compound, the refraction equivalent of the compound is greater by 2 than that calculated by the use of the number expressing the ordinary atomic refraction of carbon. The atomic refraction of oxygen when doubly linked to carbon is 3·29, when in the group OH, or when linked to two atoms, it is 2·71. The atomic refraction of the halogen elements is constant. Brühl concludes that the atomic refraction of a monovalent element is independent of the atom-linking of its compounds, but that this statement does not hold good for polyvalent elements.

IN connection with this work of Brühl, the recent experiments of Prof. Janovsky (*Wien. Akad. Anz.*, June 3) are of interest. According to Janovsky the linking of carbon atoms is of subordinate influence in determining the refraction equivalents of carbon compounds, for isomers with similar linking have unequal refractive indices. In homologous series a similar difference of refractive indices corresponds to an equal difference o groups only where the series belong to similarly saturated hydrocarbons (alike in position). The refractive power of unsaturated hydrocarbons is greater than that of saturated. Lastly, the author shows that the determination of refraction-coefficients of solid bodies from their solutions is unreliable, as the refractive power depends on the state of aggregation.

IN the *Annals Chim. Phys.* Long shows that a connection exists between the velocities of diffusion and other physical constants, and the composition of various salts; thus the values of the velocity of diffusion, molecular volumes, and electric conductivity, are in the same order for the chlorides, bromides, and iodides of the alkali metals.

STÆDEL publishes in the *Berichte* the first part of an investigation on the vapour-tensions of substituted halogen derivatives of ethane; his researches, which are not however yet completed, seem to show that the increase of vapour-tension for 1° (between 400 mm. and 1,060 mm.) is equal for a bromo-derivative and that chloro-derivative which contains, in place of one bromine atom, two chlorine atoms linked to one carbon atom: *e.g.* $CH_3 - CH_2Br$ and $CH_3 - CHCl_2$: $CH_2Cl - CH_2Br$ and $CH_3 - CCl_3$, &c.

J. VARENNE continues in *Compt. rend.* his researches on the passivity of iron, which have been already noticed in NATURE. He finds that if a piece of iron be immersed in nitric acid of sp. gr. 1·325, oxides of nitrogen are evolved for a few moments; the escape of gas, however, suddenly ceases; after a time it begins again at one point of the metallic surface, spreads over the entire surface, again ceases, once more recommences, and so on intermittently. If an iron tube be very partially immersed in strong nitric acid, and after passivity is established, the passive part be placed in weaker acid for a time, it is found that by then slowly immersing the tube further in the acid the whole becomes passive, but that this passivity is very easily destroyed, *e.g.*, by shaking the tube. The passivity is less the more dilute the weaker acid, the rougher the metallic surface, and the greater the diameter of the iron tube.

IN the *Berliner Berichte* experiments are detailed by Reinitzer and Goldschmidt, whereby these chemists have succeeded in preparing the compound P_4O, about the existence of which there has been much difference of opinion. P_4O is a reddish-coloured amorphous substance produced by the action of phosphorus, or of zinc, on $POCl_3$.

HOPPE-SEYLER publishes in the *Zeitschrift f. physiol. Chem.* a continuation of his work on chlorophyllan, a crystalline substance closely resembling chlorophyll, obtained from green grass. By treatment with alcoholic potash, chlorophyllan yields, amongst other products, an acid characterised by giving a splendid purple-coloured ethereal solution, which exhibits very marked rose-red fluorescence. For this compound—$C_{20}H_{34}O_3$—Hoppe-Seyler proposes the name of *dichromatic acid*. The absorption spectrum of the acid in ethereal solution is marked by two bands between C and D, whilst the spectrum of the fluorescent light from the same solution exhibits two bright bands in exactly the same positions.

ACCORDING to Adolf Mayer's experiments described in the *Berliner Berichte*, oxygen has no direct influence on fermentation. The addition of potassium-hydrogen tartrate to a strong syrup containing yeast causes the yeast cells to grow rapidly, and fermentation to proceed with ease.

THE meeting of the French Academy of Sciences, held on July 5, presented some interesting incidents which are not likely to appear in the *Comptes rendus*. A very interesting discussion took place between M. Wurtz and MM. Dumas and St. Claire Deville on the occasion of the presentation of a memoir on the density of vapour of iodine by M. Troost. M. Dumas and M. St. Claire-Deville asserted that it was impossible to accept the idea of a dissociation of vaporised iodine at a high temperature, as no permanent alteration resulted from this alleged change in the composition of this substance. M. St. Claire Deville said he was opposed to all theories of molecules and atoms, as science had only to deal with facts, and not with mere assumptions or speculations. It might be supposed that the coefficient of expansion of iodine increased rapidly with increase of temperature. M. Wurtz argued that the diminution of the density was too considerable to be accounted for otherwise than by a *dedoublement* of molecules. All the speakers agreed that these phenomena, which are very curious, should be carefully investigated with

increased attention and care. M. Wurtz having resumed his seat, M. Dumas presented a letter from Mr. Crookes, in which he summarises his theories of radiant matter, and submits them for discussion before the French Academy. After having explained the Crookesian view of the fourth state of matter, M. Dumas added that he felt confident these assumptions would be the occasion of discussions of the same character as that which the Academy had just witnessed.

PHYSICAL NOTES

HERR DORN of Breslau has published a fresh series of experiments on the propagation of electricity by current water in tubes, and allied phenomena (*Wied. Ann.*, Nos. 4 and 5). In agreement with Helmholtz's theory, he finds the electromotive force from current water in capillary tubes independent of the cross section and the length of these. The value of the "electric moment" of water and glass (3·936 Daniell) deduced from this electromotive force corresponds nearly to that deduced by Helmholtz from Quincke's observations on the propagation of water in glass tubes by the electric current. Observations of the electric current produced by water flowing in capillary tubes lead to a somewhat smaller value. For wider tubes (within pretty wide limits) the current strength, with a given mean velocity of the streaming water, proves empirically to be nearly proportional to the radius of the tube. Traces of a sliding of the water on the glass-wall may perhaps co-operate in producing the variations of electromotive force observed in course of time. Through motion of material particles in a liquid, therefore, an electric current arises.

THE diffusion of salts in aqueous solution has been investigated by Herr Long (*Wied. Ann.*, No. 4), by a method similar in principle to that of Schuhmeister (though different in detail), viz., making a continuous water-current flow over the salt solution and measuring the amount of diffusion by the quantities of salt that pass over in given times. Various interesting relations were found, *e.g.*, the chlorides, bromides, and iodides of the alkali metals form a series, in which NH_4 stands between K (the higher) and Na; and KCl, KBr, KI, and KCy have nearly the same velocity of diffusion. Such is the case also with the corresponding NH_4 and Na salts and with the chlorides of the bivalent metals Ba, Sr, Ca, and Mg, the nitrates, and the sulphates. It seems generally that those salts which diffuse most quickly also conduct best in aqueous solution. Salts with large molecular weight and volume seem to diffuse most easily, while among the waterless salts those which absorb most heat in dissolving or (the same thing) whose molecules, through the work done, finally reach the finest state of division, have the greatest velocity of diffusion. The chlorides of the alkalies stand in the same series with regard to molecular volumes, velocities of diffusion, conductivity, and absorption of heat. This is the case, too, with the corresponding bromides and iodides. Cyanide of potassium behaves as to diffusion and conductivity exactly like the chloride, bromide, and iodide of the metal. In the second group (nitrates) the order is the same as to conductivity and diffusion; but with regard to molecular volumes and heat-absorption the salts form a special series. In the group of sulphates the individual salts have the same order as to diffusion and conductivity, but the values for molecular volume and heat of solution are quite irregular; indeed as regards velocity of diffusion and absorption of heat the waterless salts seem to stand in inverse order. These results are fully discussed by Herr Long.

A CURIOUS physical phenomenon has been lately described by Dr. Grassi (*Reale Ist. Lomb. Rend.*, f. viii. and ix.). An apparatus is formed of three concentric vessels with an annular space of about two centimetres between the first and the second, and the second and the third. The outer space is filled with oil, the next with water. The oil is heated by a gas furnace to a little over 100°, and the water boils. Then hot oil, at *e.g.*, 150° is poured into the central space. This quickly cools to a temperature close on 100°. Dr. Grassi found that the central oil cooled more rapidly the higher the temperature of the outer oil; and with more delicate apparatus (in which the vaporised water was conducted and returned, and the outer oil kept at any required constant temperature) he arrived at definite numerical results, which he tabulates. With the outer oil at a mean temperature of 129°·9, *e.g.*, the time of cooling of the inner oil from 130° to 110° was 49s.; when the former was 105°·1, the latter was 57s. Alcohol and ether gave more decided results. The maximum difference was got with ether; the outer oil being at 57°·5°, the inner took 25s. to cool from 57° to 50° (7 degrees); whereas the former being 39°·3°, the latter became 39°·5s. In all the experiments the cooling of the inner oil commenced at a temperature little above the maximum of the external oil. When the outer oil is at a higher temperature, at a certain point the heat begins to prevail which is transmitted directly from the outer to the inner oil. An analogous phenomenon (to which Dr. Grassi refers) was that of some members of the Accademia del Cimento, who found that water in a vessel surrounded by ice cools more rapidly if the ice be heated to accelerate fusion.

DR. J. PULUJ lately communicated a paper to the Scientific Club of Vienna on "Radiant Electrode-matter," in which he traverses the researches of Crookes, Hittorf, Goldstein, and others upon the phenomena of electric discharges in high vacua. He maintains at the outset that the discharges of "radiant matter" observed by Crookes at the negative pole are not residual gas at all, but are particles of metal torn off from the surface of the pole. He thinks this proved by the mirror-like deposits of metal that are formed on objects interposed in the path of the discharge. That aluminium in this way forms no mirror is a difficulty in the way of this theory; but Dr. Puluj gets over this by remarking that the cause of this lies in the chemical constitution of the metal, and that the particles of an aluminium electrode fly round so far that they deposit themselves on the electrode! All the magnetic effects of these discharges Dr. Puluj regards as explainable by ordinary electro-magnetic laws, assuming that a stream of electrified matter acts as an electric current; but he apparently is not acquainted with the theory put forward by Maxwell on this point. Dr. Puluj has also constructed what he calls an *electrode-lamp*, which gives a bright light when worked by an induction-coil capable of affording a spark of 10 cm. length. In this lamp the radiant discharges of electrode-matter are concentrated upon a piece of carbon which glows with a white heat, but remains unchanged and unconsumed.

DR. CUSCO, ophthalmic surgeon in one of the hospitals of Paris, has invented a lens of variable focus, in which the pressure of a column of water or other transparent liquid is made to alter the curvature of the flat faces of a cylindrical cell of brass closed with thin glass disks. The pressure can be regulated by a manometer gauge to any required degree within the limits of working. It is said that the lens gives a sharp, well-defined focus. It is constructed for Dr. Cusco by M. Laurent.

M. HENRI BECQUEREL continues his researches on the magneto-optic properties of gases. He has recently examined the gases oxygen, nitrogen, carbonic dioxide, nitrous oxide, and olefiant gas, and finds that, except in the case of oxygen, the magnetic rotation of the plane of polarisation due to a field of given intensity varies inversely as the square of the wave-length of the ray, as is the case with solids and liquids. In an older research of Becquerel's it was shown that for non-magnetic solids and liquids the rotation R was proportional to a function of the refractive index n, very nearly represented by the expression $n^2(n^2-1)$; or, in other words, the quantity $\frac{R}{n^2(n^2-1)} = c$. For all non-magnetic solids and liquids the value of c lay between 0·26 and 0·59. In the case of gases in which the rotation is but a ten-thousandth part of that of most solids or liquids the same result holds good, and the values of c for gases fall between 0·26 and 0·59. The above law, that the magnetic rotation is *inversely* proportional to the square of the wave-length, implies that violet rays are more rotated than the red; or, in other words, that there is a positive dispersion. In the case of oxygen it is found that the red rays are rotated more than the green, affording an inverse or *negative* dispersion. This is the more curious as oxygen gives a positive rotation as if it were a diamagnetic body. In fact, Becquerel remarks, oxygen behaves as if it were a mixture of a magnetic and a diamagnetic body, the magnetic having small negative rotation and great negative dispersion, the diamagnetic having great positive rotation and small positive dispersion.

GEOGRAPHICAL NOTES

IN a private letter addressed to Herr von Hesse-Wartegg, the well-known explorer, Dr. Nachtigall, writes from Berlin:—"The German African Society (Deutsche Afrikanische Gesellschaft) has at the present moment not less than six different expeditions travelling through Central Africa. The large funds necessary for the outfitting of these numerous travellers are raised partly

through private subscription, partly through subsidies of the German Government. Among the travellers I may name (1) Dr. M. Buchner, who, starting from San Paolo de Loanda in an easterly direction, may have already reached the large lakes of the Upper Nile or the Upper Congo; (2) Dr. Oscar Lenz, who is on the way from Marocco to Timbuctoo, whence he will proceed to Senegambia; (3) a large expedition, comprising Dr. Böhm, von Schöler, De Kayser, &c., which will establish a station near the Tanganyika lake, in connection with the stations of the International Association; (4) Gerhard Rohlfs and Dr. Stecker will soon proceed to Abyssinia, and thence the latter through the Gallas country to the sea-coast; (5) Dr. Pogge, together with several other travellers, will shortly start from San Paolo de Loanda for the interior, to establish a German station in the neighbourhood of the Muate Janvo, about in the middle of the Continent; finally (6) Herr Flegel will follow the course of the Binué upwards, and explore the sources of that river." The German African Society has certainly developed under the presidency of Dr. Nachtigall a very unusual activity, and it is only to be hoped that these great efforts in the interest of the exploration of Africa may have good results.

THE French journal *L'Exploration* has much improved recently; its reports of geographical societies in all parts of the world are specially valuable. Its value would be still greater if it would aim at greater originality, and display more enterprise in the collection of news. It rarely gives any authorities for its numerous notes, thus minimising their value; and too much space is devoted to the translation of long articles from the *Times* and other popular sources. This may perhaps render it interesting to the general French public, but greatly detracts from its scientific and international value. However, if it goes on improving in the future as it has done during the last few months, it will ultimately become a really valuable geographical organ.

THE new number of *Le Globe* contains a useful account of geographical work in Central Asia, in 1878–1879, contributed by M. Vennikof.

IN view of the present importance of Asterabad, Her Majesty's Consul opportunely gives a brief geographical description of the province. It is situated in the south-east corner of the Caspian Sea; its inhabitants do not exceed 45,000, and the town can only boast of 8,000 souls. It is bounded on the south by the high range of mountains which separate the Caspian provinces from the other parts of Persia; on the north it is bounded by the Atrek as far as Chat, at the confluence of that river and the Sombar, while beyond that point the position of the boundary is doubtful. The west is bounded by the Caspian Sea and the province of Mazanderan, and in the east it adjoins the province of Meshed. Gez, Molla Kellé and Gumush Téppé are the only ports in use. The province is well-wooded, and is watered by numerous mountain streams. Its inhabitants belong to the Kajar tribe, of which the Shah is the personal head. The fertility of the soil is great, and the timber in the forests is magnificent, but unfortunately there are no roads worthy of the name.

M. BOUTHILLIER DE BEAUMONT, the President of the Geneva Geographical Society, has just published a pamphlet entitled *Choix d'un Méridien Initial Unique*.

THE *Colonies and India* publishes an interesting summary of a plan which Mr. G. J. Morrison, the engineer of the short-lived Woosung railway, has sketched for the restoration of the Grand Canal, which at present is usually impassable in places. The essential point in his scheme is the substitution of proper locks for the wasteful sluices now in use, with of course more extensive works at the crossing of the Yellow River.

THE same paper states that the Legislative Assembly of the Transvaal has before it a measure providing for a trigonometrical and geological survey of the country, in the course of which it is expected that abundant mineral wealth will be proved to exist in the colony.

ON July 13, at the end of the French legislative session, the Minister of Marine and the Colonies presented to the Lower House a credit of 1,300,000 francs for establishing fortified posts from Medina on the Senegal to Bafoulabe on the Niger, on the route which will be followed by the projected railway for connecting these two large rivers. It includes also several other items connected with the same scheme. It was adopted on the same day and voted by the Senate on the 15th, so that the first step may be said to have been taken for the establishment of the connecting link between Algiers and St. Louis, *viâ* Timbuctoo.

PLANTS OF THE COAL-MEASURES[1]

M. RENAULT has recently published a memoir, in which he reproduces the views of M. Brongniart respecting the relations which the Lepidodendra bear to the Sigillariæ, still insisting that the former are cryptogamic Lycopods, whilst the latter are exogenous Gymnosperms. In endeavouring to establish this position, the French palæo-botanist concludes that if the exogenous Diploxyloid stems (*i.e.*, Sigillarian ones) are but matured states of some Lepidodendra, every Sigillarian type of organisation ought to be found in a young or Lepidodendroid form, because, he contends, the type of the central organisation, once established, undergoes no further change with advancing age. In support of his position he affirms that there are three such Sigillarian types, viz. (1) *Sigillaria vascularis*, (2) Diploxyloid stems, (3) *Favularia* and *Leiodermaria*. At present he contends that only the second of these forms has been discovered in *Lepidodendron Harcourtii*. He further believes that there are three types of Lepidodendron known, represented by (1) *L. rhodumense*, with a solid central vascular axis, in which the vessels are not intermingled with medullary cells; (2) by *L. Harcourtii*, in which the vascular axis is a cylinder surrounding a cellular medulla; and (3) an undescribed plant, which he names *L. Jutieri*, in which the vascular cylinder is broken up into detached bundles of vessels.

The author of the present paper considers that the above conclusions are not in accordance with the facts, and he proceeds to give his reasons for this conclusion by demonstrating that we certainly have *two* of the three supposed Sigillarian types represented in a young or Lepidodendroid state: the first by *Lepidodendron vasculare* of Binney, and the second by *L. Harcourtii*, whilst, judging from M. Renault's own description, the *L. Jutieri* represents the third type. On the other hand, the author believes that of M. Renault's three Lepidodendroid types the first is only a young state of the second, as illustrated by the development of the Burntisland and Arran Lepidodendra described in previous memoirs, whilst the able Frenchman appears not to have been acquainted with the existence of the very characteristic type of the *L. vasculare* of Binney.

The author gives the series of facts upon which his opinions are based by tracing the history of the development, first, of *Lepidodendron Selaginoides*, the *L. vasculare* of Binney, and second, of *L. Harcourtii*.

Commencing with the declaration that the *Lepidodendron vasculare* of Mr. Binney is but the young state of the *Sigillaria vascularis* of the same author, he proceeds to show the successive stages by which the vasculo-cellular medullary axis of the former becomes not only inclosed within the exogenous cylinder of the latter, but that this cylinder ultimately develops into a very conspicuous example of the Diploxyloid form of stem. The growth of the exogenous cylinder begins at one point of the periphery of the vasculo-medullary axis, from which point it extends both laterally and radially. The exogenous growth thus first appears in the transverse section of the Lepidodendroid twig as a small crescent, thickest at its centre, but whose two horns creep gradually round the medullary axis, its constituent vascular wedges also growing radially as the lateral growth advances, until at length the exogenous zone forms a complete ring, inclosing the vasculo-medullary axis, in which state it becomes the *Sigillaria vascularis* of Mr. Binney and M. Renault. The various stages of this growth are represented in the plates, in addition to which a section is described and figured of a branch about to dichotomise, in which process the vasculo-medullary axis has divided into two equal halves, one being destined for each branch. One of these halves of the vasculo-medullary axis displays, with the utmost distinctness, the characteristic crescentic commencement of an exogenous zone, whilst the other half retains its primary non-exogenous state. The latter condition thus belongs to the *Lepidodendron vasculare* of Binney, whilst the former as clearly represents the *Sigillaria vascularis* of the same author, and the Sigillarian character of which is recognised by M. Renault. We thus have in one stem two branches, one of which, according to the views of the French savant, is a Crypto-

[1] "On the Organisation of the Fossil Plants of the Coal-measures. Part XI." Paper read at the Royal Society by W. C. Williamson, F.R.S., Professor of Botany in the Owens College, Manchester. Revised by the Author.

gamic Lycopod, and the other a Gymnospermous Sigillaria. The remarkable peculiarities characterising the central axis of these specimens make it absolutely certain that they all belong to one species of plant.

The typical *Lepidodendron Harcourtii* is then examined in a similar manner. In the details of its organisation it differs materially from *L. Selaginoides;* nevertheless, as its growth progresses, it displays typically similar changes. It attains to much larger dimensions than the latter plant does before developing its exogenous zone, corresponding in this respect with the Arran plant. Its earlier changes are chiefly seen in the rapid development of the bast or prosenchymatous layer of the outer bark and in the increase in the size and number of the vessels constituting its vasculo-medullary cylinder or medullary sheath—the "*étui medullaire*" of Brongniart; but in more advanced specimens a cylindrical zone of centrifugally developed vascular wedges begins to make its appearance in a quasi-cambian zone of the cells of the inner bark, these cells being arranged in more or less regular radiating lines. In this state the rudimentary vascular zone corresponds very closely to what is seen in young stems and roots of Cycads.

The author shows that, contrary to the views of M. Renault, very marked changes take place in the development of the vascular bundles destined for the secondary branches of the plant. In the first instance, each of these is but a concavo-convex segment of the entire vasculo-medullary cylinder, whose detachment leaves a large gap in the continuity of that cylinder, which, however, soon becomes closed again by the convergence of the disconnected ends of the broken vascular circle. The concavo-convex detached segment undergoes a similar change. Its two extremities meet, and before it escapes from the outermost bark it has assumed the cylindrical form of its parent stem.

The rootlets of *Stigmaria ficoides*, now well known to belong alike to Lepidodendron and to Sigillaria, present some peculiarities of structure which are only found in the Lycopodiaceæ and the Ophioglossæ, amongst living plants.

The vascular bundle in the interior of each Stigmarian rootlet is inclosed within a very regularly circular cylinder, composed of the cells of the innermost bark; but the position of the bundle in relation to the cylinder is always, unless accidentally disturbed, an eccentric one. This position has not escaped notice, but it was regarded as accidental; it now, however, proves to be a normal one. The bundle begins to appear in very young roots, as one or two very small vessels developed in close union with the innermost cells of one side of the cylinder within which it is located; newer and larger vessels are gradually added centripetally, until the bundle occupies a considerable portion of the area inclosed by the inner bark cylinder. The remaining space is usually empty, but occasionally specimens are found in which it is filled with small delicate cells that have escaped destruction. These represent what in the living Lycopods are liber-cells. The outer cortical layer of the root, composed of well-preserved and rather thick-walled cells, is usually separated from the inner cylinder by a similar lacuna; but in a few specimens the cells of this usually destroyed middle bark are retained in good preservation. They consist of very delicate thin-walled parenchyma, separated by a sharp line of demarcation equally from the innermost and outermost cortical cylinders. The number of the vessels in each of the vascular bundles given off from any one section of a Stigmarian root is found to vary but little, but they steadily increase, both in number and size, with the size and age of the root. Young specimens of Stigmarian roots are described, the smallest of which is not more than one-fifth of an inch in diameter, and the vascular bundles of its small rootlets consist each of from three to five minute vessels. In the largest rootlets from old roots they number about forty, most of the additional ones being of larger size; intermediate examples exhibit a regular gradation on all these points.

The only living plants which possess rootlets with this structure being Lycopodiaceæ and Ophioglossæ, and it being sufficiently clear that the Lepidodendra belong to the former and not to the latter order of cryptogams, the existence of this Lycopodiaceous feature in the rootlets of Sigillaria is another indication of the Lycopodaceous affinities of these plants.

Many of the Diploxyloid forms of the Lycopodiaceous stems of the coal-measures have an abundant development of spiral or barred cells in their numerous medullary rays. Amongst living plants this characteristic seems to be almost, if not wholly, confined to the Gymnosperms.

Two important additional observations have been made in reference to the structure of the curious strobilus, *Calamostachys Binneyana*. The exact mode of the attachment of its sporangia to the Equisetiform sporangiophores has been ascertained; but what is still more important, it has also been discovered that it is provided with both micro- and macro-spores—an additional indication of its probable Lycopodiaceous affinities, already suggested by other features of the fruit.

The recently discovered Fungi of the coal-measures are investigated, especially the *Pernosporites antiquiorum* of Mr. Worthington Smith. The author finds, in the specimens he has examined, including that described by Mr. Smith, no traces of septa in the hyphæ or of zoospores in the Oogonia. He concludes that its affinities are probably with the Saprolegniæ, and not with the Pernosporeæ.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Professorship of Zoology in the Royal College of Science, Dublin, is vacant by the resignation of Prof. Bridge. The salary is 200*l.* a year, and at present the professor is only required to lecture during one term, commencing in February and ending in June.

THE University Court of St. Andrews have elected Mr. Arthur Stanley Butler, B.A., of Exeter College, Oxford, to the Chair of Natural Philosophy in the United College, St. Andrews, in the room of Dr. William Swan, resigned.

THE Calendar of the University College of Wales for 1879-80 shows that that institution is fairly well equipped in its various departments, science occupying a prominent place in its curriculum.

AT the end of the Legislative Session the French Chamber of Deputies voted a law establishing free primary education. It must go through the Upper House before becoming a definitive Law of the State.

SCIENTIFIC SERIALS

THE *American Naturalist*, June.—A. E. Brown and J. D. Caton, the domestication of certain ruminants and aquatic birds. J. S. Lippincott, the critics of evolution (concluded).—C. E. Bessey, the supposed dimorphism of *Lithospermum longiflorum* (the large flowers appear from April to May, the cleistogamous flowers from then until the autumn frosts).—Dr. J. Leidy, on some aquatic worms of the family Naides (describes and figures *Dero limosa*, perhaps = *D. digitata*, Oken; *Aulophorus vagus*, this forms a tube of the statoblasts of a species of Plumatella, and *Pristina flagellum*).—W. H. Dall, American work in the department of recent mollusca during 1879.

July.—G. Brown Goode, the use of agricultural fertilisers by the American Indians and the early English colonists (contains some interesting facts about fish manures).—C. S. Minot, sketch of comparative embryology (The Sponges).—O. B. Johnson, the birds of the Willamette Valley, Oregon.—J. F. James, a botanist in Southern California.—J. S. Kingsley, American carcinology in 1879.—A. S. Packard, jun., the structure of the eye of trilobites, with figures; concludes that the hard parts of the eye of the trilobites and of Limulus are throughout identical, while the nature of the soft parts of the former must ever remain problematical. There is good evidence that the retinal mass was like that of the king-crab; if so these forms as to their eye-structure will stand near each other and far apart from all other arthropods.

THE *Journal of the Royal Microscopical Society*, June, contains: Prof. Duncan, on a parasitic sponge of the order Calcarea (Plate 10), *Mobiusispongia parasitica*, growing within *Carpenteria raphidodendron*, from the reefs of Mauritius.—Dr. Cooke, on the genus Ravenelia (Plate 11).—Dr. H. Gibbes, on double and treble staining. An excellent suggestion is incidentally made by Dr. Gibbes, that the covering glasses used by microscopists should be of a known thickness. We would even go further, and advise that a fixed scale of thickness might be adopted. Dr. Gibbes uses two thicknesses, ·006 and ·004.—Dr. A. Grunow, on some new species of Nitzschia (Plates 12 and 13).—James Smith, on the illumination of objects under the higher powers of the microscope.—The most useful record of current

researches relating to invertebrates, cryptogams, &c., is continued as usual.

THE *Revue des Sciences Naturelles*, June 15, contains: M. Hesse, description of two new crustacea, male and female, of the genus Dinemoura (*D. mustela lævis*) (Plate 1). The figures are coloured from living specimens; the species lives not in the interior of the shark, but on its skin, and its mode of fixation is minutely described.—M. Duval-Jouve, on the species of Vulpia to be found in France.—D. A. Godron, on the giant maize (*Zea caragua*).—M. Rietsch, on Bobretzki's studies on the formation of the blastoderm and germinal lamellæ in insects.—A. Villot, the synchronism of the marls and clays with lignite of Hauterives with the group of St. Ariès.—M. S. Jourdain, on a very simple form of the group of worms *Prothelminthus hessi* (S. J.)=? *Inthosia leptolanæ*, Giard (Plate 2).—Scientific review of recent French writings on zoology, botany, and geology.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 17.—"On the Spectrum of the Flame of Hydrogen," by William Huggins, D.C.L., F.R.S.

Messrs. Liveing and Dewar state, in a paper read before the Royal Society on June 10, that they have obtained a photograph of the ultra-violet part of the spectrum of coal gas burning in oxygen, and in a note dated June 8 they add that they have reason to believe that this remarkable spectrum is not due to any carbon compound but to water.

Under these circumstances I think that it is desirable that I should give an account of some experiments which I made on this subject some months since without waiting until the investigation is more complete.

On December 27, 1879, I took a photograph of the flame of hydrogen burning in air. As is well known, the flame of hydrogen possesses but little luminosity, and shows no lines or bands in the visible part of the spectrum, except that due to sodium as an impurity.

Prof. Stokes, in his paper "On the Change of Refrangibility of Light,"[1] had stated that "the flame of hydrogen produces a very strong effect. The invisible rays in which it so much abounds, taken as a whole, appear to be even more refrangible than those which come from the flame of a spirit lamp." I was not, however, prepared for the strong group of lines in the ultra-violet which, after an exposure of one minute and a half, came out upon the plate.

Two or three weeks later, about the middle of January, 1880, I showed this spectrum to Prof. Stokes, and we considered it probable that this remarkable group was the spectrum of water. Prof. Stokes permits me to mention that, in a letter addressed to me on January 30, he speaks of "this novel and interesting result," and makes some suggestions as to the disputed question of the carbon spectrum.

I have since that date taken a large number of photographs of the spectra of different flames, in the hope of being able to present the results to the Royal Society, when the research was more complete. I think now that it is desirable that I should describe the spectrum of the flame of hydrogen, but I shall reserve for the present the experiments which relate to the presence of carbon and its compounds.

The spectrum of the flame of hydrogen burning in air is represented in the diagram. It consists of a group of lines which terminates at the more refrangible limit in a pair of strong lines, λ 3062 and λ 3068. At a short distance in the less refrangible direction, what may perhaps be regarded as the group proper commences with a strong line, λ 3090. Between the strong line λ 3068 and the line λ 3090 there is a line less bright, λ 3080. Less refrangible than the line λ 3090 are finer lines at about equal distances. The lines are then fine and near each other, and appear to be arranged in very close pairs. There is a pair of fine, but very distinct lines, λ 3171 and λ 3167. In this photograph the group can be traced to about λ 3290. This group constitutes the whole spectrum, which is due probably to the vapour of water.

I then introduced oxygen into the flame, leaving a small excess of hydrogen. A spectrum in all respects similar came out upon the plate. I repeated the experiment, taking both spectra on the same plate. Through one-half of the slit the spectrum of the oxyhydrogen flame was taken. This flame was about 7 inches long, and the spectrum taken of a part of the flame 2 inches from the jet. The oxygen was then turned off, and the quantity of hydrogen allowed to remain unaltered. A second spectrum with an exposure of the same duration was then taken through the second half of the slit. On the plate the two spectra are in every respect similar, and have so exactly the same intensity that they appear as one broad spectrum.

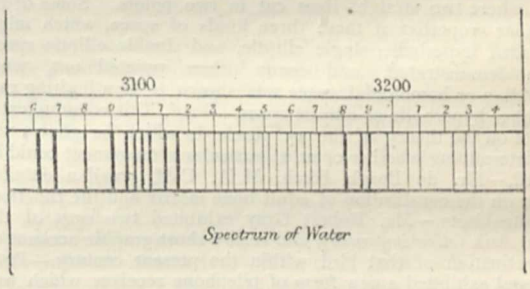
In all these experiments a platinum jet which had been carefully cleaned was used.

In these experiments the two gases met within the blowpipe and issued in a mixed state.

The jet was removed, and a flame of hydrogen was surrounded with oxygen. This spectrum shows some additional lines. In this case the jet was brass, and in this or some other way impurities may have been introduced; and I should at present incline to the view that the additional lines about λ 3429 and λ 3473, and the groups more refrangible than λ 3062, do not belong to the water spectrum, but to impurities.

Coal-gas was substituted for hydrogen in the oxyhydrogen blowpipe, and oxygen admitted in as large a proportion as possible. The inner blue flame rising about 2 inches above the jet showed in the visible part of the spectrum the usual "five-fingered spectrum." The light from this part of the flame was projected upon the slit. The spectrum contains the water group already described, and in addition a very strong line close to G, and two lines, λ 3872 and λ 3890; this latter line is seen to be the more refrangible limit of a group of fine lines shading off towards K.

The ultra-violet group, when carefully compared with the group in the spectrum of pure hydrogen, shows several small



differences. I am inclined to believe that there is the supposition of a second fainter group. There is strong evidence of this in some spectra of hydrogen taken under other conditions. There is also a broad band less refrangible than the strong line at G, and the light extends from this line on its more refrangible side.

A double Bunsen burner (Fletcher's form) with a strong blast of air was then fitted up. The spectrum was taken of the intense blue flame. It resembles the one last described. All the distinctive features are intensified, and a continuous spectrum and groupings of very fine lines fill up all the intervals between the groups already described, so that there is an unbroken strong spectrum throughout the whole region which falls upon the plate.

A spirit lamp was arranged before the slit. The spectrum is essentially the same as when coal-gas is burned, but as it is less intense only the strongest lines are seen. The water group, the strong line at G, and the pair of lines rather more refrangible than K, are seen. Probably with a longer exposure the finer lines would also show themselves.

The distinctive features of the spectra of coal-gas and of alcohol appear to be connected with the presence of carbon.

Table of Wave-lengths of the Principal Lines of the Spectrum of Water. No. 1.

3062	3095	3135	3171	3217·5
3068	3099	3139	3175	3223
3073	3102	3142·5	3180	3228
3074	3105	3145	3184	3232
3077·5	3111	3149·5	3189	3242·5
3080	3117	3152·5	3192·5	3252·5
3082	3122·5	3156	3198	3256
3085	3127	3159·5	3201	3262
3090	3130	3163	3207·5	3266
3094	3133	3167	3211	3276

[1] *Phil. Trans.*, 1852, p. 539.

Wave-lengths of other Lines in the Spectra described above.

2869·5	2910	2947	2991	3031
2872·5	2913	2951	2994	3039
2876	2917·5	2955	2999	3042
2880	2922·5	2959	3002	3046
2883	2925·5	2966	3005	3051
2887·5	2929	2967·5	3010	3057·5
2892	2932·5	2970·5	3013	3246
2895	2935·5	2975·5	3017	3271
2897	2940	2981	3019·5	3429·5
2904	2943	2989	3029	3473
2907·5				
	3872	3890		4310

EDINBURGH

Royal Society, June 7.—Prof. Fleeming Jenkin, vice-president, in the chair.—The Council having awarded the Keith prize for the biennial period 1877-79 to Prof. Fleeming Jenkin for his paper on the application of graphic methods to the determination of the efficiency of machinery, the medal was presented to him by Prof. Balfour.—At the request of the Council Prof. Chrystal gave an address on non-Euclidian geometry, and discussed in a most masterly and lucid manner the consequences which the non-acceptance of Euclid's axiom of parallels involved. Defining a straight line as the curve completely determined by two points, the lecturer pointed out that there were three simple cases that called for discussion: first, the case where two straight lines cut in one point only and are infinite in extent; second, the case where two lines still cut in but one point, but each line is finite in length returning into itself: and third, the case where two straight lines cut in two points. Some of the peculiar properties of these three kinds of space, which might be called hyperbolic, single elliptic, and double elliptic space, were demonstrated, and many others pointed out, while Euclidian or homoloidal space was shown to be a limiting case of either hyperbolic or elliptic space.—Prof. Tait communicated a note on the theory of the 15 puzzle, in which he gave a rule for determining whether or no a particular arrangement could be solved.—Mr. de Burgh Birch, M.B., C.M., read a detailed paper on the constitution of adult bone matrix and the functions of osteoblasts.—Mr. Robert Gray exhibited two eggs of the Great Auk (*Alca impennis*), and read a short graphic account of the extinction of that bird within the present century.—Prof. Chrystal exhibited a new form of telephone receiver which was simply a fine wire, whose extension and contraction under the influence of the heating and cooling caused by the varying intensity of the current through the microphone transmitter were sufficient to communicate musical notes to a vibrating membrane. Mr. Blyth's recent communication to the Society, together with certain observations of his own on the rapid cooling and heating of thin wires which he had made several years before, had suggested the arrangement as one likely to succeed.

PARIS

Academy of Sciences, July 12.—M. Edm. Becquerel in the chair.—The following papers were read:—Observations of the comet *b* 1880 (Schäberle) made at Paris Observatory, by MM. Tisserand and Bigourdan.—On the pendulum, by M. Faye. He announces a new apparatus with which M. Govi's system (see below) and others may be studied. The reductions are limited almost exclusively to temperature.—Observations on the density of iodine vapour, by M. Berthelot. The increase of total energy of the halogen gases with the temperature, as also that of the *vis viva* of translation, exceed those of the three other simple gases hitherto studied (nitrogen, oxygen, and hydrogen); the two orders of effects seem correlative.—On the heat of formation of hydrocyanic acid, and of cyanides, by M. Berthelot.—Densities of vapour of selenium and tellurium, by MM. Sainte-Claire Deville and Troost. This gives details of operations in 1863.—On the etiology of anthrax, by M. Pasteur. Putrefaction of the animal's body destroys the parasite, but some infected blood and other liquid matter escapes into the ground about the body, and there germs may be produced and remain with latent life for years, ready to communicate anthrax on opportunity. Curiously, the bacteridium-germs may be found in the surface-earth over the body, and they appear to come thither by agency of earth-worms, carrying them in their alimentary canal. The dust of this earth, with the worms' excrement, gets blown about the plants, which the cattle eat, and are thus infected. Germss of other diseases may perhaps be conveyed similarly.—Ammonia of the air and of water, by M. Lévy. *Inter alia*, contrary to what is observed in meteoric waters, it is in the hot season that ammoniacal nitrogen seems to be most abundant in the air. The annual averages in the case of meteoric waters are nearly identical.—Alternance of generations in some Uredineæ, by M. Cornu.—New theorems on the indeterminate equation $ax^4 + by^4 = z^2$, by M. Pepin.—On some remarks relative to the equation of Lamé.—New method for determining the length of the simple pendulum, by M. Govi. A pretty long, light, and rigid rod is suspended by one end from a horizontal axis, and a heavy runner, with centre of gravity in the axis of the rod, in fixed at different points, and the pendulum set oscillating is vacuo on solid supports.—Rapid synthetic method of establishing the fundamental formulæ relative to change of state, by M. Viry.—On the constitution of matter and the ultra-gaseous state, by Mr. Crookes.—On monochromatic lamps, by M. Laurent. *Apropos* of M. Terquem's note, he recalls his modifications of gas-burners and his æolipyle.—Telephonic effects resulting from the shock of magnetic bodies, by M. Ader. Any mechanical action which disturbs the state of molecular equilibrium of a magnetic core has the effect of developing, when this core suddenly regains its equilibrium, an electric current capable of affecting the telephone.—On the fluorised compounds of uranium, by M. Ditte.—On the atomic weight and on some characteristic salts of scandium, by M. Nilson. Atomic weight, 44.—Ultimate action of bromine on malonic acid; bromoform, by M. Bourgoin.—On the etherification of sulphuric acid, by M. Villiers.—On the reproduction of *Pleurodeles waltlii*, by M. Vaillant.—Salivary glands in the Odonates (Neuroptera), by M. Poletaieu. These glands exist in all the species (though they are denied by entomologists).—Action of high and moist temperatures and of some chemical substances (benzoate of soda, benzoic acid, sulphurous acid) on germination, by M. Heckel. Seeds of *Brassica nigra* sown in a wet sponge and kept at 48° showed numerous radicles in less than twelve hours (while seeds kept in water at 48° never germinated). After emitting their radicles the seeds stopped, but they developed quickly when the temperature was brought down to 20° or 17°·5. The three chemical agents suspended the germination of various seeds.—Action of strychnine in very strong dose on mammalia, by M. Richet. It acts somewhat like curare and somewhat like chloral.—Alterations of the nerve-tubes of the anterior and posterior nerve-roots and of the cutaneous nerves in a case of generalised congenital ichthyosis, by M. Leloir.—On immunity against anthrax, acquired through preventive inoculations, by M. Toussaint.

CONTENTS