Nature

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

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THURSDAY, NOVEMBER 5, 1885

HYDROPHOBIA

Ὑδροφοβίαν Græci appellant : miserrimum genus morbi.

ONCE more M. Pasteur is attracting the attention of the civilised world by his brilliant investigations. The disease which he hopes to prevent and ultimately to erase from the records of human misery is happily rare, but those who have watched it know that it is one of the most terrible in its effects, and that it is incurable by any means at present known. So strange are its symptoms and its course, that it has been asserted to be no real malady but a mere result of fright and superstition.[1] But of its reality there is unhappily no room for serious question.

It never arises of itself. Like small-pox and syphilis, it is always the result of contagion, and the method and conditions of its transference from rabid dogs or other animals to man are well known. Hitherto the only chance, when a human being has been bitten by a mad dog, has been to remove or isolate or destroy the virus by suction, or ligature, or cautery. And it has been doubted whether these methods are really successful even when the disease does not manifest itself afterwards. For there is often reasonable doubt as to the nature of the disease in the biter. All vicious dogs are not "mad," and all mad dogs are not truly rabid. And when, as often happens, the dog has been at once destroyed, it is impossible to supply deficiencies of previous observation. Moreover, when bitten by a rabid dog, the sufferer may yet escape, for the teeth may only have grazed the skin, and not penetrated to the living tissues beneath, or the poisonous saliva may have been mechanically wiped off by the clothing which the teeth have pierced. As with the venom of snakes, so with the saliva of rabid dogs: it is not enough for it to be spread over the skin, for that will not absorb it, nor even to be swallowed and taken into the stomach, for there, as physiologists say, it is still "outside the body," and, before it can be absorbed, undergoes such changes by the process of digestion, as kill the germs or decompose the chemical compound. The virus must be introduced into the living tissues before it can be carried over the whole body by the channels of the lymph and blood, and reach the central nervous system, on which it exerts its characteristic poisonous action. But, when once so introduced, there is every reason to believe that the terrible effects are constant and uniform. The state of the receiver of the venom at the time may probably modify the rapidity of absorption, as is the case with stimulants and with poisonous drugs; but so far as we know there is no power in the most healthy organism by which the subtle venom, once absorbed, can be neutralised or thrown out. The methods above mentioned[1]—suction by the mouth or by cupping glasses, ligature, and caustics or the actual cautery—all aim at getting the poison out before it has been absorbed. Often they come too late, often they are impracticable or ineffectual from the first. However long the time of "incubation" may be, the interval between the reception of the virus and its spread over the body, no method of preventing the terrible result is known. The length of incubation is far longer than it is in the case of small-pox, of cow-pox, of syphilis, and other known contagions. In two-thirds of the cases collected by Prof. Bollinger, of Munich, the interval of incubation was under two months; and probably it never extends to so long a period as was formerly supposed. The length of this period makes it almost certain that we have to do, not with a mere chemical compound, as in the case of subcutaneous injection of morphia, and probably of the cobra-poison, but with a "particulate contagium," like that of small-pox and chicken-pox, with a living and growing organism, like those of relapsing fever and of anthrax.

Whatever the conclusions to which pathologists will at last be led on these points, the important fact remains that there is an interval of days or months in which the latent plague, established in the patient's body, but not yet ripe for mischief, may be attacked.

[1] So, in the last century, Sir Isaac Pennington, Regius Professor of Physic at Cambridge, and in recent times Prof. Mashka, of Prague.

[1] These are what were known to the ancients:—"Si rabiosus canis est, cucurbitulâ virus ejus extrahendum est. Deinde . . . vulnus adurendum est." Celsus de Medicinâ, lib. v. cap. xxvii. § 2.

Experience has shown that it cannot be mechanically removed by any surgical operation, nor chemically neutralised or destroyed by any drug. The only promising path of investigation is to seek for some method of forestalling the action of the virus by rendering the organism unfit for its action, as patriots have ravaged their fields and burnt their towns to save their country from an invading army.

By this method Jenner robbed small-pox of most of its terror and almost all its danger, so that where Jennerian vaccination is thoroughly carried out, as in the German army and in Ireland, small-pox is practically extinct.

Pasteur's method of dealing with hydrophobia is avowedly based on the practice of vaccination; but it is not the mere introduction of the poison in a way that makes its effects less dangerous, like the inoculation of small-pox practised in the last century. Nor is it exactly analogous to Jenner's vaccination, although that term is appropriated by Pasteur himself. For in vaccination an allied disease (or possibly small-pox itself, greatly modified by long transmission through other organisms) is inoculated. In either case the course and symptoms of cow-pox are distinct from those of the more serious disease against which it protects. But in the case of hydrophobia, as in that of "chicken-plague" and anthrax, the poison of the same disease is transmitted through a succession of "bearers" until it is so modified that it may be safely inoculated, and thus the altered virus protects from that which is unmodified.

The "bearers" chosen for these experiments were rabbits. The test of the result was made, not upon human beings but upon dogs, for M. Pasteur is a philanthropist first and a zoophilist after. Fifty dogs were inoculated with modified virus obtained from the bodies [1] of rabbits which had themselves been affected with rabies by inoculation. Would a dog thus inoculated show the ordinary symptoms of the disease? Would it, if bitten by a rabid dog, or designedly inoculated with the unmodified venom of rabies, be protected? Would it, if infected with the modified virus after such direct inoculation, still be safe from its effects? The results have, so far, proved the affirmative to each of these questions. None of the "vaccinated" dogs showed signs of the dreaded disease.

Then came two cases of human beings bitten by mad dogs who were sent up to M. Pasteur in Paris from their homes in Alsace. One of them, a grocer named Vone (? Wohn), had escaped without rupture of the skin, and was sent home with the comfortable assurance that he had never been infected with the disease. The other, a boy of nine years old, had been terribly worried on the 4th of last July; not only bitten in parts covered by his clothes but also on the hands. He was rescued covered with foam, and bleeding from no less than fourteen wounds. There was no question that the dog was mad, and in all human probability this child, Joseph Meister, was doomed to a certain and horrible death. Such was the opinion of the eminent pathologist, M. Vulpian, and he was supported in this judgment by Dr. Grancher.

Under these circumstances M. Pasteur felt himself justified in applying the means to this suffering fellow-creature, which had already proved efficacious in the case of brutes.[1]

[1] Not the marrow, as the *Times* states, but the spinal cord, *moelle épinière*.

The inoculations were made with a subcutaneous needle, began on the 7th, and were concluded on the 16th of July. "Control experiments" were made with the same injections upon rabbits, and proved that the virus was active. Moreover, since the effects of the modified virus, when introduced into an unprotected animal, are rapid and severe, and its period of incubation extremely short, the result of the attempt to rescue the child from a horrible death would soon be apparent. If he had died of hydrophobia, it would probably have been within a month. If he survived this period there was every reason to hope that he would be as much protected against its future manifestation as the dogs which had been tested before.

Joseph Meister was in perfect health at the end of August, at the end of September, and at the end of October. M. Pasteur believes that he is safe from hydrophobia for the rest of his life.

If similar cases should be followed by similar results, medical science has for the first time a method of combating a frightful and incurable disease.[2] But beyond this, by inoculating dogs, as infants should be vaccinated, they will be rendered insusceptible to rabies. Any mad dog will be destroyed, and the dogs he has bitten will escape. Thus the disease may, it is hoped, be extirpated altogether.

These, however, are but hopes; at present the whole question is *sub judice*. Other competent observers must repeat the experiments, and every result must be submitted to searching criticism. This is no slight on M. Pasteur, it is only worthy respect to his genius and his skill. For the credentials of the champion who has undertaken the task of ridding the world of this horrible plague of hydrophobia are well known.

M. Louis Pasteur won his spurs as a chemist. It was his discovery of remarkable forms of crystallisation of racemic acid which first made his name known, and which gave M. Renan the opportunity for the exquisite raillery with which the man of letters welcomed the man of science to the Academy.

In dealing with the disease of silk-worms in the south of France, Pasteur first handled a physiological problem, and his thoroughness of research, fertility of resource, and felicity in experiments ended in the best result—practical success as the result of strictly scientific investigation.

Pasteur subsequently investigated the so-called cholera of domestic fowls, and by the method of "attenuated" inoculation has succeeded in protecting them from a destructive epidemic.

His far larger and more important work on the prevention of splenic fever (*charbon* or *anthrax*), the most destructive plague among cattle, has had important and useful results. It has in all probability saved countless multitudes of sheep and oxen in France. In Algeria the results were less satisfactory, and also in Hungary. On the other hand Dr. Roy found the method valuable in La

[1] "La mort de cet enfant paraissant inévitable, je me décidai, non sans de vives et cruelles inquiétudes, on doit bien le penser, à tenter sur Joseph Meister la méthode qui m'avait constamment réussi chez les chiens" (*Comptes Rendus* de l'Académie des Sciences, October 26, 1885).

[2] One other patient, a shepherd boy, who was bitten while gallantly attacking a rabid dog, has been inoculated, and the result is to be seen.

Plata. The results of Pasteur's experiments on "pig-typhoid" have also been criticised, and not without reason, by Prof. Klein. It is foolish for newspaper correspondents to attribute hesitation in accepting scientific results to jealousy. Much scrutiny will be necessary. Adverse criticism will be welcomed. M. Pasteur's fame stands in no need of artificial protection.

His past achievements are great: his last attempt was prudent in conception, and carried out with untiring zeal and admirable care. It deserves to succeed. If so, he will again receive the applause of the civilised world; if not, he will have the sympathy and respect of every pathologist.

It is melancholy to reflect that it would be practically impossible for any duly qualified man in England to repeat, to confirm, or to correct his results. We must wait till a wiser and more humane public opinion repeals the present restrictions upon investigations like Pasteur's.

TOPINARD'S "GENERAL ANTHROPOLOGY"

Éléments d'Anthropologie générale. Par le Dr. Paul Topinard. (Paris: A. Delahaye et É. Lecrosnier, 1885.)

THE study of anthropology has been pursued, especially of late years, with great zeal by many leading *savants*, both in the Old and New World, and many valuable contributions to our knowledge have been made in all departments included under its extensive range. This is more particularly the case with respect to that part of the subject which deals with the anatomical characters of the human body. Until this branch of anthropology was so vigorously and successfully studied by Broca, complete ignorance of many fundamental questions prevailed. The direct result of the work of that great anthropologist was immense, while the indirect result due to the incentive which he gave to the study of anthropology generally cannot be over-estimated, but may be inferred from the numerous societies devoted to its study which have rapidly sprung up in various countries. Broca must be considered the great pioneer of modern anthropology, but his untimely death left his work by no means complete, and many extensive fields remained almost untrodden by the foot of the investigator. By the accumulated observations of his followers these deficiencies have been in great part made good, and the time had arrived when it was possible to form generalisations from sufficient data, and when a comprehensive work embracing the whole subject was urgently needed. For the production of such a work no one more highly fitted could be found than Prof. Paul Topinard, trained at the feet of the great master himself, possessed of an extensive knowledge of his subject, and intimately acquainted, by personal visits to the chief centres of anthropological research, with the methods employed by his contemporaries.

The volume before us deals with the elements of general anthropology, and is the first part of Prof. Topinard's contemplated work, which, when completed, will consist of three parts, the second and third parts being devoted to special anthropology and a general survey of the whole subject, concluding with man's place in time, his origin and future.

Prof. Topinard begins by giving an historical account of the origin and development of anthropology, and claims that it is not a new science developed during the latter half of the present century, but that it has, during the last twenty years, attained its adult age and gained its independence.

He divides its history into different periods: (1) from antiquity till the year 1230, the date of the birth of human anatomy; (2) from 1230–1800, when anthropology asserted itself under the influence of Buffon, Blumenbach, Sœmmering, and White; (3) from 1800–1860, during which time three important events occurred that materially assisted its development—viz. the founding of the Society of Anthropology of Paris, the demonstration of the high antiquity of man, and the promulgation of the doctrine of evolution by Darwin. To these a 4th and more recent period is added—viz. that during which Broca's personal influence, aided by the advance of natural sciences, gave great impulse to anthropology. Each of these periods is considered in detail, and many matters of much interest are discussed.

Chapters VII. and VIII. are devoted to generalities including under this a definition of anthropology, its object and the subjects which it embraces. Anthropology is defined as the branch of natural history which treats of man and of the human race. It includes two distinct departments of study—viz. anthropology proper and ethnography; the former treating of the human species and its varieties or races from a purely animal aspect, and therefore essentially anatomical and physiological in its nature; the latter dealing with people and intimately connected with sociology. For the study of anthropology proper, anatomical and zoological knowledge is essential; but such knowledge is not necessary for the study of ethnography, as questions of race are excluded from it. Having discussed the various essential and accessory anthropological sciences, the place of anthropology in science, the meaning of the terms, "characters," "types," "races," "people," "nationalities," &c., he proceeds in the ninth chapter to consider general methods of anthropological research. The different kinds of physical characters and their study are first discussed. These are of three kinds—morphological and anatomical, descriptive and anthropometrical, and finally zoological and anthropological. After a few remarks on anthropometry, and on the comparison of measurement on the skeleton and on the living, which are stated to be not generally directly comparable, an observation which entirely agrees with our own experience, the subject of craniology is discussed, the various points on the skull to which it has been found convenient to give technical names are defined, and derivations and meanings of various terms such as "brachycephalic," &c., applied to skulls to express their form, are explained. In discussing the merits of instruments for measuring the skull, their simplicity is insisted upon. The elaborate instruments used in Germany, and by those who follow the German school (of which happily there are few) are very justly condemned. Broca's *compas d'épaisseur* and the *compas glissière* are figured and recommended. These are certainly simple, but, after considerable experience in their use, we rather take exception to the former, as not being very exact, on account of the measurements being read off on a scale reduced to one-half the actual length of the measurement. This may be avoided by using Flower's craniometer, which has the further advantage that it combines both Broca's instruments in one.

The consideration of the characters used in the classification of races is begun in the tenth chapter. The first of these discussed is the hair. A very concise *résumé* is given of the anatomy of the hair follicles and the development of hair, its distribution, size and form in various races. Six types of hair are described, and good illustrations of each are given. The characters of the nose are next considered. The anatomy of the soft and hard parts forming it are described and illustrated by means of beautifully executed woodcuts. The nasal indices of the skulls of various races are tabulated, and show clearly the value of the form of the nasal opening as a race character. In the living subject eight forms of nose are recognised and figured. All of these are easily distinguishable, and we would suggest the desirability of having cards with these forms printed separately for the use of travellers as a means of obtaining much more accurate information than we now obtain from descriptions of this part of the face, which are very frequently extremely vague and unsatisfactory. If furnished with such a card the traveller would be able to record the form of the nose by simply noting the number of the type to which the nose of each person examined corresponds. The table of nasal indices in the living will prove useful for comparison with those of the bony parts.

The colour of the skin, eyes, and hair are dealt with in the following chapter in the same systematic manner as the previous characters treated of. Prof. Topinard concludes that there are only two types—the blond and the dark; that the other so-called types—yellow and red in particular, can only in a very minor degree serve to distinguish races, and that colour as a rule is an uncertain character, liable to alter in individuals, and difficult to determine and express. As a concession, however, to the general practice, he gives a table of classification of races by their colour under the three denominations—white, yellow, and black.

The cephalic index, unlike colour, is described as a character of prime importance in the classification of races, since it indicates the general form of that portion of the skull which contains the brain. Before the cephalic index can have the same value in all cases, it is absolutely necessary that there should be complete uniformity in the manner of measuring the length and breadth of the cranium, the two measurements from which it is deduced. Unfortunately this has not hitherto been the case. French anthropologists have uniformly measured the cranial length as that between the most prominent points of the glabella in front and the occipital behind in the mesial line, and the breadth between the most widely distant points on the same plane of the parietal or squamosal bones at right angles to the length. This we contend is the only satisfactory method of measuring these diameters. In England the anterior point of length has been taken until recently from the ophryon, while in Germany the length is measured from the glabella to a point on a line perpendicular to the most posterior part of the occiput at right angles to a plane adopted by the Frankfort agreement as the horizontal of the skull. The breadth likewise has been differently measured on the parietal bones or on the squamosals. Fortunately the methods of measuring these diameters is uniform now in France, England, and most other countries, except Germany. Skulls are classified according to their cephalic indices into three groups—dolichocephalic, mesaticephalic, and brachycephalic; but the limits assigned to each group by different anthropologists vary very considerably, as the tables in Prof. Topinard's work will show. The limits assigned by the author to each group are such as to commend his classification generally. He subdivides the dolichocephalic and brachycephalic groups—the former into dolichocephalic and sub-dolichocephalic, and the latter into sub-brachycephalic and supra-brachycephalic, and gives these subdivisions and the mesaticephalic group each a limit of five units. Thus we have practically five groups—viz. dolichocephalic, where the index is between 65 and 69 inclusive; sub-dolichocephalic, 70-74 inclusive; mesaticephalic, 75-79 inclusive; sub-brachycephalic, 80-84 inclusive; and supra-brachycephalic, 85-89 inclusive. Skulls with indices below or above the extreme limits of these groups are termed ultra-dolichocephalic and ultra-brachycephalic respectively. This classification and the limits of each class agree with the ideas on the subject most generally entertained, and we would earnestly urge their acceptance. In one small point the nomenclature might be improved by the insertion of the word "sus," or in English supra, to distinguish the higher group of the dolichocephalic class (if its omission is not an overlook in the correction of the proof sheets of the work) so as to make the nomenclature of this subdivision correspond to that of the higher division of the brachycephalic class—"sus-brachycephalic." The tables of cephalic indices of skulls and of the heads of various races will prove extremely useful for reference.

Chapters XIII. and XIV. are devoted to stature. The development of the skeleton and its variations in height are first considered; then, secondly, the stature of the inhabitants of different countries. These chapters contain much information collected together from many sources.

The two following chapters treat of the weight and size of the brain at different ages, and in different persons and races, its relation to the weight and stature of the body, and other questions of much interest regarding it, which will well repay perusal by those interested in neurology as well as anthropologists.

The next chapter (XVII.), on the cubage of the cranial cavity, will be read with much interest, being a subject to which Prof. Topinard has given special attention. It reveals the great diversity of opinion which still exists regarding the best method of measuring the capacity of the encephalon. A system of cubage easy of application which would yield constant results in the hands of different operators, and at the same time indicate the actual size of the encephalon would probably be readily accepted by most anthropologists. Broca's system, which is perhaps the one most generally used, gives constant results, but is somewhat complicated and does not indicate the absolute capacity. Even with its faults Prof. Topinard considers it is the best method we have at present, he however contemplates some modifications of it which will simplify it and make it more satisfactory. This being the case it is needless to criticise the chapter further at present, but pass on to the next subject—viz. the skull itself, its measurements, and its characters—a most important part of the work, occupying ten chapters. In the limited space at our disposal it is impossible to enter into an examination of this part of the work adequate to its importance. When it is studied in conjunction with Broca's "Instructions Craniologiques," the results of more extended researches on a larger amount of material and more matured views are observable. Many measurements recommended by Broca in his work published in 1876 were abandoned by him before his death or delegated to a place of secondary importance. If any exception can be taken to this part of Prof. Topinard's work it is that it is too much an exposition of Broca's views to the exclusion of those of the author. Broca's methods are strictly adhered to in some instances where more independent consideration with knowledge acquired since his death might have resulted in a modification of the opinions expressed regarding them.

After discussing the general development of the skull and the relations between the configuration of the exterior of the cranium and of the brain, the measurements of the skull are considered. The skull is divided into a cranial and a facial portion, and the measurements of each are detailed and their relative importance pointed out. The measurements of the cranial portion recommended and the method of making them are those usually adopted; those of the facial portion, however, will give rise to some discussion. The ophryon of Broca is shown to be somewhat unsatisfactory in its determination; Prof. Topinard with much pains shows that a better point is the supercilliary point, which corresponds to the most anterior part of the brain, and is situated in the mesial line immediately above the glabella on the level of a line drawn horizontally above the supercilliary ridges. It seems to us absurd to give a second name to a point so closely corresponding to the ophryon, and we would consequently recommend that the definition of the "point intersourcilier" should be considered only as an amendment of Broca's definition of the ophryon. Natural or pathological and artificial deformities of the cranium and their effect on the brain are very fully and ably considered and illustrated by woodcuts. The vexed question of the proper plane of orientation of the skull receives due consideration, and the condylo-alveolar plane, which was determined by Broca after much research, is recommended as the best and simplest. Of all the positions proposed we also consider this the best, and hope to see it universally adopted. From the skull in this position the prognathism of the several parts of the face is easily determined by means of a vertical equerry and a small triangular one. Prof. Topinard finds that the prognathism which is most important in distinguishing race characters is the alveolo-subspinal, and he figures five different typical modifications of the form of the face in this region. In his remarks on Prof. Flower's method of indicating prognathism we think Prof. Topinard has misunderstood the object of selecting the basio-nasial line as the standard of comparison. This line is specially chosen as being as nearly as possible the primary line of development of the skull, and because it is more constant than perhaps any other measurement of the skull. By means of the indices measurements from the basion to the alveolar point, or to the sub-nasal spine, with the basio-nasial radius, the relative prominence of the various parts of the face can be easily expressed, and compared in different races. Though Prof. Topinard's method is perhaps the more strictly correct one, that of Prof. Flower has the advantage in being the more practical, from its being simpler.

We may here remark regarding certain measurements recommended by Prof. Topinard between the occipital point and various points on the face, with the object of indicating its profile outline, that we consider it would be preferable if the basion was selected as the starting point for them, instead of the occipital point, on account of the former being much more fixed than the latter. The relative proportion which these radii bear to one another according as the occipital point is situated high up or low down on the occipital bone is very great; indeed so much so as to render their indices almost valueless for purposes of comparison. This fact has probably been overlooked by Prof. Topinard in his desire to obtain a method of measuring the skull, which would be applicable also to the head of the living person.

In treating of the facial index, Prof. Topinard adheres to Broca's method of measuring the length of the face from the ophryon. This point we consider very unsatisfactory, as two observers will seldom place it at exactly the same spot. The facial height is best measured from the nasion, and we prefer the facial index of Kollmann to that of Broca. The lines of contour of the face are valuable in demonstrating the relative proportions of the upper and lower parts of the face to the maximum or bizygomatic width, and supplement the facial indices.

The number of measurements of the mandible have been much reduced by Prof. Topinard, and it is studied more in connection with the skull, as it should be, than as a mere isolated bone.

Chapter XXVII. contains a useful *résumé* of the various systems of measurements of the skull employed in Germany and England, a table of the measurements considered by the author to be of prime importance, and a more extended list to be used in making more minute researches. The method of orientation of the skull and of making measurements in relation thereto, advocated by the Frankfort agreement, is very justly condemned, but in an unoffensive and truly scientific spirit.

The last chapters of the work treat of the characters of the trunk and extremities, and contain valuable tables of the proportions of these parts of the body in different races. Throughout the work the characters in the living subject are carefully considered side by side with those of the skeleton, which is of great practical value not only to the anthropologist alone but to artists and others wishing to make themselves acquainted with the subject of human morphology.

The work concludes with a carefully drawn up table of directions and measurements of the body for the use of travellers, which will doubtless prove very valuable, and we hope will be the means of bringing us more exact information regarding the physical characters of many races yet imperfectly described.

The work is one in every respect worthy of the author, and cannot fail of being highly appreciated by anthropologists everywhere. We hope the time may not be far distant when the other volumes promised will be in our hands.

J. G. GARSON

OUR BOOK SHELF

Our Insect Enemies. By Theodore Wood. 220 pp. small 8vo. (London: Society for Promoting Christian Knowledge, 1885.)

WE have read the book through without discovering anything (save in some questions that may be regarded as essentially controversial) to find fault with. The illustrations are not numerous, but to the point, and, although somewhat coarse, are better selected than is sometimes the case in books of this nature. There are fourteen chapters in all, of which four are not inappropriately devoted to Aphides. The important subject indicated by the title is treated calmly, and apparently with a view to discourage the undoubtedly ill-effects produced by panic-mongers in economic entomology. The first (or "introductory") chapter is well considered and well reasoned.

Some Account of the "Palan Byoo," or "Teindoung Bo," (Paraponyx oryzalis), a Lepidopterous Insect-pest of the Rice-Plant in Burma. By J. Wood-Mason, Officiating Superintendent, Calcutta Museum. (Calcutta, 1885.)

A PAMPHLET of 12 pp., with a plate, concerning a lepidopterous larva that damages, but does not, as a rule, appear to kill the rice-plant. It is more useful as a contribution to pure biology than to economic entomology. It describes one of the few Lepidopterous larvæ that breathe mainly by gills (or branchiæ), and from this cause is considered an ally of our common little aquatic moth known as *Paraponyx stratiotalis.* The vernacular names by which the insect is known are not such as to be readily remembered by "foreigners;" yet it might have been better had the author not applied a scientific name based solely on larvæ and habits. All babies are supposed to be very much alike, save to the fond parents of each in particular.

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 insure the appearance even of communications containing interesting and novel facts.]

Krakatão

ALTHOUGH I have not yet had the good fortune of reading Dr. Verbeek's "Krakatão," yet in the review published in NATURE of October 22 (p. 601) there are one or two points I would like to draw attention to. In speaking of the earthquake of September, 1880, we are told that it may have facilitated the entrance of water by the Sunda fissure. If this were so, it certainly seems a strange thing that no less than three years should be necessary to heat the water before the explosion took place. I think that at present few geologists believe in water gaining access to the magma by fissures while we neglect percolation through porous rocks. It seems to me that the above earthquake was the result of rupture and extension of the magma-filled fissure towards the surface, in consequence of which the final outburst was put off for a short time by increasing the space for, and so lowering the tension of, the magma-filled fissure. By a careful study of the products of many volcanoes I have shown how the magma gradually dissolves or takes up within it water from the surrounding rocks, and as this is a slow process, the longer a volcano remains inactive, other things being equal, the more violent will be the subsequent eruption and the more vitreous will be the pumice owing to the rapid cooling of the magma froth in consequence of the large absorption of heat in converting the dissolved water into the gaseous state of steam, in the samé way that the temperature of seltzer water falls on allowing the gas to escape on removal of the cork. The above earthquake has its parallels in A.D. 63 at Vesuvius, those of 1536 and 1537 at Monte Nuovo, and in the late Ischian shocks.

The thickness of ejected materials is certainly gigantic, for the maximum thickness of the Plinian eruption at Vesuvius was under 10 metres, or just one-sixth that of Kratakão.

There is reference made to round concretions called "Krakatão marbles" that are met with amongst the ejectamenta, as being things so far unobserved. Of course, it is not possible to judge clearly from the description, but I have little doubt that they may be similar to those met with in the marl-like tufa of Ischia and others, commonly found amongst the ejectamenta of Monte Nuovo, which at the latter locality are fossiliferous. They are simply concretions in a marine resorted tufa.

The cooling of the atmosphere, referred to, at Batavia and elsewhere at a moderate distance around the volcano, might be explained by the vortex inrush of air towards the vapour column. Observations of wind direction would be interesting as settling this point.

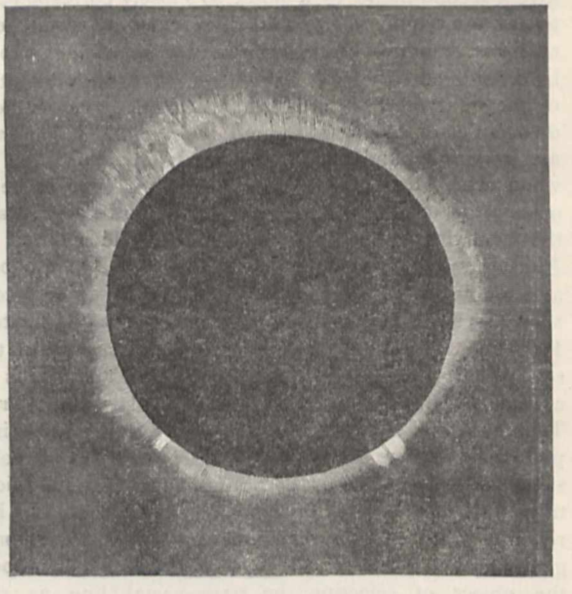
Another question of interest that was raised is the cause of non-correspondence of one part of the earth with another in seismic or volcanic activity. If we suppose a volcano to be supplied with magma by ramifications from large extensions of fluid rock within our globe, the gradual absorption of water by one of these ramifications, and the consequent increase in its tension may be quite independent of another ramification not far off, yet perhaps more or less favourably placed in relation to porous strata and superincumbent pressure and the necessary results.

I have drawn attention to these few points not with any intention to undervalue the report, which has all the characters of being one of the most important additions to the vulcanological literature of the nineteenth century, but simply to prevent certain unsound theories from becoming current.

Naples, October 26 H. J. JOHNSTON-LAVIS

The Recent Total Eclipse of the Sun

IT may be interesting to your readers to supplement the description given in NATURE, vol. xxxii. p. 631, with the following notes which I have just received from a friend who observed the eclipse at Nelson, N.Z.: "As the period of totality passed away, a bright point of light as from a diamond



Total Eclipse of the Sun, Nelson, N.Z., September 9, 1885.

of wonderful brilliance shot forth from the upper surface of the moon, and at first this seemed to be only a flame, but it speedily extended to the moon's shadow, passed downwards and to the right, and totality was over." Another feature was the fall in the temperature: "A thermometer which registered 50° at seven o'clock, stood at 30° immediately after totality; the keen breeze which was blowing before the sun was shadowed died completely away at the time of totality." I inclose a photograph which clearly shows the protuberances noticed by all the observers. KILLINGWORTH HEDGES

Westminster, October 30

An Earthquake Invention

THE object I had in view in my former communication to NATURE (vol. xxxi. p. 213) on this subject, has been attained, as the following quotations from Prof. Milne's letter in NATURE (p. 573) show: "I have no desire to claim the authorship of the aseismatic joint;" and again, "I am as yet in the dark as to who was the first inventor of the aseismatic joint."

Well, I can enlighten him, and I claim the invention for Mr. David Stevenson, whose paper describing it was read before the Royal Scottish Society of Arts in 1868, and published in their *Transactions*; whose firm designed, superintended the construction of, tested and sent out to Japan seven lighthouse apparatus, carried on tables 8 feet in diameter, fitted with this contrivance. Further Messrs. Stevenson designed two lighthouse *buildings*, iron towers 29 feet in diameter at the base and 46 feet in height, with an aseismatic joint *at their base*, which were constructed and *erected* in the work-yard of the contractors in Edinburgh, and finally, in 1869, shipped to Japan, but unfortunately they never reached their destination, as the vessel went down on the voyage out.

There are three points in Prof. Milne's letter on which I wish to make a few remarks. The first is to give the explanation Prof. Milne asks as to the part the late Mr. Mallet took in the invention of the aseismatic joint which I may observe Mr. Mallet never claimed for himself. Mr. Stevenson consulted with Mr. Mallet as to what was the exact *mécanique* of an earthquake shock, and how he thought it would affect the delicate apparatus usually placed in a lighthouse. This information Mr. Mallet furnished, but so far from suggesting a ball and plate joint, he expressed a fear that the superstructure, if placed on balls as proposed by Mr. Stevenson, would be thrown down, and in a letter dated March 14, 1868, acknowledging a copy of the *Scotsman* newspaper, containing a notice of Mr. Stevenson's paper, he says that if the balls and plates proposed are confined to the apparatus in the light-room, he "would augur much more favourably of the result being satisfactory," but that his "own notion for Japan or other shaky places would be to make all the towers rather of timber or of boiler plate work." This, I think, should put Prof. Milne's mind at rest on this point.

The second point is with reference to ball and plate seismographs. I never described a seismograph, but my brother did, in 1883, in NATURE, vol. xxviii. p. 117, though, so far from claiming the *idea* as original, he says: "The idea of the instrument I propose was suggested to me by the aseismatic arrangement designed by my father, Mr. David Stevenson, for averting damage to buildings and lighthouse apparatus in countries subject to earthquakes."

I entirely agree with Prof. Milne that the joint employed in ball and plate seismographs, lamp tables in Japanese lighthouses, model houses, and the Professor's own dwelling-house, all "involve the same principles, and they only differ in their dimensions," and my point is that Mr. David Stevenson was not only the original inventor of this contrivance, but, what is of far more importance, suggested and carried into practice *the* only known method of mitigating the effects of earthquake-shocks on buildings, and the astatic house of which Prof. Milne reported such good results to the British Association of 1885, which is described in NATURE, vol. xxxii. p. 527, as being "rested at each of its piers upon a handful of cast-iron shot each a quarter of an inch in diameter" placed "between flat iron plates," is obviously merely a modification of the same principle.

The third point is as to the success of the aseismatic joint. It does seem a little curious that Prof. Milne, in the *Transactions*, British Association of 1884, when he appeared to me and to others to claim the invention for himself, thought it perfection, though now he appears to have changed his mind. I do not think, however, it affects the question at issue, whether the aseismatic joint is a success or not; but that it is a success will be seen from Prof. Milne's own reports in the *Transactions* of the British Association, and from the following information which was supplied by Mr. Simpkin in 1884, who had just returned from Japan, where he was engaged in the lighthouse service. At Isuragisaki and Kashmasaki lighthouses the aseismatic tables were firmly strutted with timber to prevent any motion, as inconvenience was felt from the oscillations of the table when winding up the machine, the steadying screws sent out with the apparatus for the purpose of temporarily doing so having for some reason not been put in at these stations. These two are the only lighthouses at which any damage has been done by earthquake, while those stations at which the tables are in operation have never suffered at all, although they have been repeatedly subjected to shocks; but for full particulars as to this see NATURE, vol. xxx. p. 193, and vol. xxxii. p. 316.

Prof. Milne excuses himself on the ground that he was 10,000 miles away from a library and never saw Mr. Stevenson's paper, but surely NATURE finds its way out to Japan, and this subject has been referred to in your columns frequently; it was also discussed in 1876 before the Institution of Civil Engineers, and an account of it was published in their *Transactions*; but, after all, the apparatus was actually at work in Japan where he was living. D. A. STEVENSON

84, George Street, Edinburgh, October 19

The Mithun

I WAS glad to see in NATURE of July 16 (p. 243) that Mr. W. F. Blanford had drawn attention to the extraordinary mistake made by Dr. Kuhn in considering the gayal and gaur specifically identical, and their differences as due to domestication. If this latter were true we should see endless intermediate forms instead of two invariably distinct. To those who know them in their habitat the confusion must seem extraordinary, even though both are here called "Mithun." The gayal (*B. frontalis*, v. *gavæus*) is known (domestic only) all through these hills, and not in the plains; is pied black and white, with pink muzzle, white legs, and the tips of the horns point *outwards*. The gaur (*B. gaurus*, v. *cavifrons*) is only known wild, in the hills and also plains, never pied, has white legs, and the tips of adult horns invariably point *inwards*. The gayal domestic, and never known wild; the gaur wild, and never known domestic; and they do not cross. I have known both here now many years, and had good opportunities of observing and contrasting them. I have had a fine bull gaur feeding along beside me at twenty yards in short grass for over quarter of an hour, as I sat motionless in my Rob Roy canoe, an enormous Dontal (tusker) elephant at the same distance off on the opposite bank; each occasionally left off to sniff me, but resumed again, taking me, in brown-grey costume and grey-coloured canoe, for a snag in mid-stream (which stream was deep and stagnant). It is not always easy or possible to point out to such a man as Dr. Kuhn that the study of the "dry bones" of an animal is really but half the battle in comparing it with its allies. The study of specific distinctions should include the whole animal, alive as well as dead.

But the clearest proof that these two distinct forms are not due to domestication is that, instead of endless intermediate forms, we find absolutely none. S. E. PEAL

Sibsagar, Asam, September 26

On the Behaviour of Stretched India-rubber when Heated

I SHOULD like to make the following remarks with reference to the letter of Mr. H. G. Madan which appeared in the last number of NATURE:—

(*a*) Though the fact that india-rubber becomes *hot* when *stretched* might be, and no doubt is to be, *partly* attributed to molecular friction, we cannot thus account for the *cooling* which resulted from *contraction* in the experiments of Joule and Sir William Thomson.

(*b*) Text-books as a rule are not, I am afraid, sufficiently explicit as to whether the stretched india-rubber is contracted in *volume* when heated, or only in *length*. Thermodynamic theory does not require, in order that longitudinal pull should produce rise of temperature, that the *volume* should be diminished when the temperature is raised, and the results of Joule's experiments are in reasonable accord with theory.

(*c*) The real state of things seems to be that the effect of heating a stretched piece of india-rubber is to *lengthen* it if the tension is *small*, and to *shorten* it if the tension is large (Hr. Schmulewitsch, *Vierteljahrschrift der Naturforsch. Gesellschaft, Zürich*, xi. 202); thus, for a certain tension there will be neither elongation nor contraction, and my own experiments on the effects of stress on the physical properties of matter lead me to infer that the critical tension will be lower the higher the temperature. HERBERT TOMLINSON

King's College, Strand, October 31

The Resting Position of Oysters

As your correspondent, Mr. J. T. Cunningham, expresses a doubt as to the evidence on which the current belief of conchologists is founded that oysters rest on the convex valve, I beg to inclose a cluster of three, brought to me among others from Torbay this morning. They are all attached by their convex valves, and confirm the descriptions of Messrs. Woodward, Jeffreys, and Huxley.

Mr. Cunningham's Sertularia and Thuiaria go to prove that he has seen oysters from the Firth of Forth that rested on their flat valves. This is easily accounted for. Solitary, unattached oysters, resting on the sea-bottom, would easily, from their peculiar form, be turned over by wave-currents (if exposed to them); or they might fall on their flat valves when thrown overboard by dredges as too young for market. In either case, once overturned, they would be powerless to regain their natural position.

With regard to the Pectens, Mr. Cunningham does not specify the species found covered, as to the convex valves, with Balanus, &c. In two such common sorts as *P. maximus* and *P. opercularis*, we find in the one the under-valve more convex, in the other the upper valve. In each case the mollusk rests on the same valve. ARTHUR R. HUNT

Torquay, October 27

Salmo salar and S. ferox in Tasmania

IN your issue of October 29 is a communication from Mr. Saville Kent, in which he "concludes that no true salmon has yet been established in the lakes and rivers of Tasmania. The fish of large size which abound in the great lakes and other large sheets of water are really essentially the same as the great lake trout, *Salmo ferox*, of Great Britain."

Respecting the salmon, although very possibly Mr. Kent has not yet seen a true one in Tasmania, such does not absolutely prove their absence. In the *Field* of last May I drew attention to an undoubted salmon smolt, 9 inches long, which was sent home from Tasmania by Mr. Robins, on January 3, 1880, and is now in the national collection.

As regards the great lake trout, I observed in the *Proceedings* of the Zoological Society, January 15, 1884, that the original stock of British fresh-water trout from which ova were procured to send to Tasmania, were solely obtained in Hampshire and Buckinghamshire, localities where the great lake trout is not found, *unless it is merely a variety of the brook trout.*

The late Mr. W. Arthur, whose recent death at Dunedin will prove an irreparable loss respecting these investigations, sent me two specimens in ice in July 1883. One was a male, 32½ inches long, the other a female, one inch less. I remarked that "these two beautiful specimens of trout are so exceedingly similar to so-called lake trout, that any ichthyologist who believed in the numerous species of this fish, and was unaware from whence they came, would undoubtedly term them *Salmo ferox*."

Whether Mr. Saville Kent in the note in question considers the great lake trout, *S. ferox*, a distinct species from the brook trout, *S. ferio*, seems left to the reader to surmise. Should he be correct in his identification (as I believe him to be), then the great lake trout has been raised from the eggs of the small brook trout, showing it to be merely a variety which, under favourable conditions, will attain to a large size. FRANCIS DAY

Cheltenham, October 30

A Right-footed Parrot

IF my memory does not deceive me, Mr. Romanes asked some months ago for an account of any peculiarities shown by parrots, in which case you may be able to find a corner for the following incident:—

Last Sunday I gave our parrot—an ordinary grey bird—the hardest walnut I could find, as when busy cracking the shell she is less noisy. After struggling for a long time in vain, at first on the perch and then on the bottom of the cage, holding the walnut as usual with the right foot, she changed feet, whether because the right foot was tired or not I cannot say; but now utterly failed to make the walnut reach her beak. Time after time the walnut was raised above the bird's head, rather over the neck. At the same time she was unable to stand steady, but fell over and rested on her right wing. After about a dozen fruitless attempts, and by the time every one in the room was shaking with laughter, she flung the walnut down with a shriek and returned to her perch. C. V. BOYS

The New British Myzostoma

SINCE recording the discovery of an encysting *Myzostoma* on the Comatulæ of Milford Haven (NATURE, August 27, p. 391) I have examined a large number of other examples of *Antedon rosacea* from different British localities; and I have found *Myzostoma*-cysts or other modifications of the pinnule-joints on individuals from Torquay, Cumbræ, Arran, and Oban, while in one or two cases the arm-joints are also affected. Prof. A. C. Haddon has kindly sent me some Comatulæ which he dredged last summer in Berehaven, County Cork, and in Dalkey Sound, County Dublin, and I have found slightly malformed pinnules in one individual from each locality, though there are no traces of definite cysts. It is clear, however, from what has been said above, that this encysting *Myzostoma* has a tolerably wide distribution in the British area; and I shall be very glad to hear of its discovery on Comatulæ from other localities than those which I have mentioned.

The cysts are fairly conspicuous on the Cumbræ specimens (dredged by Mr. Sladen), though nothing like the size of those which occur on the Crinoids of more tropical seas; and I suppose that this is the cause of their having so long escaped the notice of the many naturalists who have dredged at this locality. Now, however, that attention has been directed to them, it is quite possible that they may be discovered at Roscoff and at various localities in the Mediterranean, where *Antedon rosacea* is equally abundant. P. HERBERT CARPENTER

Eton College, October 31

Tertiary Rainbows

THE following extract from my journal may be of interest with regard to the subject of "Tertiary Rainbows":—

"May 5, 1885.—Extraordinary display of rainbows at 4.30 p.m. on Grand Trunk Railway between Kingston and Montreal. *Six* bows in all were seen. The primary was flanked on the inside by four bows quite near, and on the outside at some distance by a fifth."

The bows were all quite distinct, but of course of decreasing brightness in passing from the primary inward. They were noticed by several persons besides myself.

W. L. GOODWIN

Queen's University, Kingston, Ontario, October 15

"Furculum" or "Furcula"

DR. SCLATER in his letter to NATURE (vol. xxxii. p. 466) calls attention to a very interesting point in regard to the use of the word *furculum*, asking, as he does so, for its authority. Not only are the eminent anatomists—Balfour, Huxley, and Rolleston—mentioned by him, authorities for it, but the majority of anatomical writers, both of the Continent and Great Britain; they having also lent their influence, through custom, to the introduction of this word. In this country the same holds true, and the use of the term *furculum* for *furcula* receives the support of such high authority as Marsh ("Odontornithes," p. 58, Fig. 14*f.*) and many others.

Dr. Sclater further states that he has failed to find its use sanctioned by any dictionary. For the large dictionaries of the language this no doubt is true, but in quite a number of works upon anatomy that present us with a "glossary of terms," we find the word *furculum* given, and not *furcula*, as, for instance, see "Elements of Zoology," by M. Harbison, Head Master, Model School, Newtownards, and "Handbook of Vertebrate Dissection," Part II., by Martin and Moole. More than this, *furculum* is the only word given in certain scientific dictionaries, as Dunman's "Glossary of Scientific Terms," London, 1878, and published by D. Appleton and Co., New York, 1879.

I find myself also in the same category, deserving the censure of your correspondent, and agree with him entirely in the incorrect use of the word *furculum* for *furcula*, or still more properly as he suggests, though perhaps less convenient term, *os furculatorium*.

R. W. SHUFELDT

Fort Wingate, New Mexico, October 8

Metric or English Measures?

WOULD any of your readers have the great kindness to give me their opinion on the following question?

In writing a school-book in which such branches of physics as dynamics and heat are to be treated in a very elementary but exact way, would it be best to use the metric system or the English system of weights and measures?

Personally, I am strongly inclined to take the former course; it seems to me that as soon as a boy's scientific education begins he should make acquaintance with the units of measurement now generally adopted by scientific men throughout the world.

E. R. P.

CHARLES ROBIN

ON the 6th of last month died in Josseron (Department l'Ain) Charles Robin, sixty-four years old. He was one of the few men in Europe who may be justly considered the founders of modern histology. Although some of his views, as, for instance, on the formation of cells out of a blastema, are now only of historical interest, there remain a considerable number of valuable facts which he has contributed to histology, anatomy, and zoology. A chair of General Anatomy was created for him in 1862 in the Paris Faculty of Medicine, and here he always collected round him a number of ardent students who, under his direction and imbued with his ideas, did excellent work in histology. He was, in fact, until a few years back (until Ranvier) the only exponent of and original worker in histology in France. There is hardly a chapter in this science to which he has not largely contributed. His chief works are "The Natural History of Vegetable Parasites in Man and Animals"; "On the Tissues and Secretions"; and his many articles in the "Dictionnaire Encyclopédique des Sciences Médicales."

THE LIVERPOOL INTERNATIONAL EXHIBITION

THE credit of the inception of the idea of the practicability of carrying on an International Exhibition at Liverpool appears to be due to Alderman David Radcliffe, the present Mayor of the City, who laid it before Lord Derby, who at once became the first guarantor of a fund which now exceeds 60,000*l*. The support this movement has now secured in England and on the Continent renders its success assured.

It is a matter of surprise that no International Exhibition has ever yet taken place in the North of England, when the fact is remembered, commented on by Lord Derby at the last annual banquet given to him by the Mayor of Liverpool, that the inhabitants of that City and the district lying within a radius of fifty miles of it are as numerous as those of the City of London, and the greater London, which lies within a radius of fifty miles of St. Paul's. The value of exhibitions it is difficult to over-estimate. Visitors however unintelligent must of necessity learn something of the processes and methods carried out by their countrymen in the arts and manufactures, while the exhibitors increase their technical grasp, and get their thoughts removed from stereotyped grooves by the inspection of products from countries where workmen obtain so much larger a share of technical education, based on practical science, than is accorded by the education department of this country.

Placed as is Britain, as it were between Europe and America, an Exhibition of Navigation and Travel would at all times appear to be singularly appropriate: but this has still greater significance at Liverpool, itself the second, if not the first, seaport of the world. This is rendered still more important from the evident care evinced by the projectors that the Exhibition should be on a scientific basis, and that it should be the means of spreading accurate scientific and technical knowledge in the construction and manipulation of all the appliances of locomotion, travel, and transport by sea and land, by rivers, by air, or through cultivated lands, or across the desert. In addition to this it is proposed, should, as is hoped, a surplus be realised at the end of the Exhibition, that it be devoted to the foundation of a school of technical education, to be called after the late Prince Leopold, whose last public appearance in Liverpool was marked by special advocacy of the claims of technical education.

Commerce and manufactures are also to be represented, including all substances used in the arts derived from animals, from vegetables, and from metallic and nonmetallic minerals.

The Corporation of Liverpool has granted a site of 35 acres near the Edge Hill Station of the London and North-Western Railway; fountains, bands, and electric illuminated trees are to reproduce the features of South Kensington, and the scheme is not only supported by the cities of the north, but by Paris, Vienna, and Berlin, while Belgium, Sweden, and other countries, and the Isle of Man, are applying for courts. The Exhibition will be opened in May next year, and continue open for six months.

C. E. DE RANCE

DR. GOULD'S WORK IN THE ARGENTINE REPUBLIC

WE have from time to time during the last fifteen years recorded the progress made by Dr. Gould in his stupendous work on the southern stars. He has now returned to the United States, and we are glad to be able to give an account of the reception he met with on his return. Rarely has such a reception been better deserved, and carried out as it was it did credit to science all the world over, as well as to the country and the man most closely interested.

A letter signed by upwards of eighty of the most prominent men in Boston awaited Dr. Gould's arrival, asking him to fix a date "when it will be agreeable for you to meet us at a dinner, that we may welcome you home."

Pursuant to arrangement a reception and dinner took place at the Hotel Vendôme, Boston, on the evening of May 6, 1885. The Hon. Leverett Saltonstall presided, and, after the banquet, arose to introduce the guest of the evening. The president referred to Dr. Gould's early career and his hard work:—"We have thus met," he said, "that we may extend to Dr. Gould our most cordial welcome, to show him our high respect for his character and attainments, to express to him our deep sympathy for all the severe trials he has been called upon to encounter, and to prove to him in every possible way how proud we are of his high fame, world-wide, as one of the greatest astronomers of this or any former age. . . .

"When the opportunity presented itself for doing a far greater work than that, in my opinion, accomplished by any astronomer now living, and equalled in extent and importance by but few in any previous age, a work so vast in its design that its mere suggestion might well have staggered a much younger man, he already having passed what is considered the prime of life, courageously took the great step and exiled himself from home, conscious that it was a work which he could scarcely hope to live to complete. He buried himself in a country so far away and so little known that it might well have seemed another world, and with no hope of reward such as the world generally values for all the cause he loves with such devotion—the cause of science. He sailed with his family for Buenos Aires, and there for fifteen years he has been searching the heavens by night, and making his calculations by day, till he has finished a complete catalogue of the stars of the southern hemisphere. And in this great work, the greatest perhaps ever known, an exile from home, almost alone and unaided, feeling that on the continuance of his life and strength depended its accomplishment, he braved and endured all with a courage and devotion worthy of our highest admiration."

In reply to the toast of his health, Dr. Gould spoke as follows:—

My Dear Friends,—Would that I knew how to give some fit expression to my deep sense of your kindness, and to my gratitude for this delightful manifestation of your approval and regard. No man could fail to be profoundly moved, or to indulge a pardonable pride, under such circumstances; and it is only natural that one, who is perhaps too sensitive to the opinions of those whom he loves and esteems, should find it difficult to control his emotions or to give full utterance to his thanks.

If the pursuance of my appointed task has entailed sacrifices, the chief among them has certainly been the long separation from the friends at home, whose companionship, encouragement and sympathy were always my greatest source of happiness, outside the narrow limits of domestic life. But there has been something more than mere separation; for, however cherished and abiding may be our memory in the hearts of the friends spared to us for that reunion to which we are always yearningly looking forward, there still remains the consciousness that we have ceased to form an element in their lives, and that all human associations become dulled by the lapse of time. Had I been able to foresee this welcome from those to whom I am most closely bound by ties of affection, sympathy and respect, the anticipation would have lightened many a weary hour, and given new strength when courage threatened to fail.

You, my dear classmates of forty years ago, like the other friends around us here, need not be reminded that public speaking was never comprised in the short list of my attainments. It will not surprise you that fifteen years' disuse of our native language should have given me no greater command of it, nor that an unremitting employment of telescopes and logarithm-tables, should have made it no easier to face a large assemblage, even though composed only of kind and indulgent friends. All that I can do is to offer to all of you my overflowing thanks, and to assure you that the long severance from friends and country, now at last ended, shall give greater earnestness to my resolve to atone in the future, as well as may be, for the past neglect of my duties to them and to this community, in which I will never abdicate my priceless birthright.

As you have implied in your too flattering words, that incentive has never been wanting during my expatriation, which came from the consciousness that whatever it might be within my power to accomplish well, would be credited in part to our native land. It is a source of pride to the Argentines that their political organisation was modelled upon that of the United States—that their precedents in constitutional law are based upon the decisions of North American courts, and that the word "America" vibrates in their ears with the same melody we know so well. If a conquest from the realm of the unknown be made by American effort, they rejoice in it, before considering which is the hemisphere whence the soldiery came. And the success of any laudable effort emanating from this western hemisphere is doubly prized by them when the two Americas have united for its accomplishment.

Science knows no narrow bounds of nationality; yet who would be so cruel or so unwise as to censure, or attempt to weaken, the intense stimulus which is given by the hope that what honour may attach to a good work will be reflected upon one's own country? Does not a part of the world's tribute to a Franklin, Fulton, Bache, Henry, Agassiz, or Peirce—to an Irving, Bryant, Prescott, Motley, or Longfellow (I name only such as have left us)—belong to their country? And is it not a wholesome incentive to the labourer that he should feel that a portion of his reward will be assigned to his country, or even in a wider sense, to his own continent, when this has started late in the race, handicapped by the shortness of its history and the restrictions of its past opportunities?

From this point of view it may not be unseemly if I comply with the request to relate briefly what has been attained at Cordoba in these fourteen and a half years, chiefly by North Americans, labouring in the service of the Argentine nation, which has never failed to afford them all needful support and encouragement.

The undertaking began, as you know, with the project of a private astronomical expedition, for which my friends in Boston and its vicinity had promised the pecuniary means. The selection of Cordoba, as an especially desirable place, was chiefly due to our lamented countryman, Gilliss, whose astronomical mission to Santiago de Chile had resulted in extensive and valuable observations of southern stars, and in the establishment of a national observatory, while it had enabled him to form a sound judgment as to the relative advantages of different points in South America for astronomical purposes, notwithstanding the total want of trustworthy meteorological data. This choice of place was confirmed by the counsel of the Argentine Minister to this country. That minister was Sarmiento, a man who needs no encomium here, for, during his brief residence in the United States, he gained an exceptional number of friends and admirers. He transmitted to his Government, then under the presidency of Gen. Mitre, my application for certain privileges and assurances, all of which were at once cordially conceded; but his interest in the plan became furthermore so great that when, soon afterwards, he was himself elected President, he obtained the assent of the Argentine Congress to the establishment of a national observatory, and wrote asking me to change my plans accordingly. The official invitation was sent in due time by the Minister of Public Instruction, Dr. Avellaneda. The Government assumed the expense of the instruments and equipments already bespoken, and authorised the engagement of the requisite assistants.

In 1874 Dr. Avellaneda succeeded Sarmiento in the presidency, and in 1880 he was himself succeeded by Gen. Roca. Thus, four successive administrations have encouraged and sustained the undertaking; and, notwithstanding the high political excitement which often prevails, and might easily have disinclined the members of any one party to give cordial aid to institutions established or fostered by its opponents, there has never been wanting a spirit of decided friendliness to the Observatory and to the scientific interests which have been developed under its auspices. No president of the nation, and no minister of the department under which the Observatory is placed, has failed to give strong practical evidence of his good will; there has been none of them to whom I do not owe a debt of gratitude; I have never made an official request which has not been granted, and almost always in such a way as to enhance the favour. And, just as the official founders of the Observatory met us with a cordial welcome on our arrival, so the Government of to-day has overwhelmed me with kindness and tokens of regard on my departure. On the very last evening before embarking—when it was my privilege to receive the farewells of a crowded assemblage in the halls of the Argentine Geographical Institute, and to hear words of sympathy and commendation from the lips of Gen. Sarmiento, my earliest Argentine friend, speaking in behalf of that Society—I replied, in the few words which alone were possible at the time, but with all sincerity and truthfulness, as follows:—

"It was you, sir, who provided the opportunity for which I was yearning; it was the Argentine Republic which made it easy for me to avail myself of it; it has been the National Government which, in its various phases, and under so many different administrations, always provided all needful means and resources; it is the Argentine people which has accompanied me in my tasks, giving support by their sympathy and incentive by their kindness."

The original purpose of the expedition was to make a thorough survey of the southern heavens by means of observations in zones between the parallel of 30° and the polar circle; but the plan grew under the influence of circumstances, until the scrutiny comprised the whole region from the tropic to within 10° of the pole—somewhat more than 57° in width, instead of 37°. Although it was no part of the original design to perform all the numerical computations, and still less to bring the results into the form of a finished catalogue, it has been my exceptional privilege, unique in astronomical history so far as I am aware, to enjoy the means and opportunity for personally supervising all that vast labour, and to see the results published in their definite, permanent form. Of course this has required time. The three years which I had purposed devoting to the less complete work have been drawn out to nearly fifteen; and you will comprehend what that implies for one who loves the friends of his youth, his kindred, and his country. Yet even here there has been consolation. For, while the work has demanded all that period, it did not absorb the whole time, and opportunity was left for other studies. Among the astronomical ones it has been possible to examine all the stars as bright as the seventh magnitude, up to 10° of north declination, for careful estimates of their respective brilliancy, and to reform the arrangement and boundaries of the southern constellations. Also to carry out the observations and computations for another stellar catalogue, more precise than that of the zones, and extending over the whole southern hemisphere. The total number of stars in this catalogue is less than in the other; but that of the observations is greater, since each star has been observed several times, as well as with greater precision. This catalogue, too, is at last finished and in the hands of the printer, and thus it is that I am once more at home with you, my cherished friends.

I am hopeful that the data now collected may throw some additional light upon the great problem of the distribution of the stars in space. Yet, even should these prove insufficient, there is reason to believe that the new labours, already begun by my successor, Dr. Thome, who has been connected with the observatory from the very first, will provide whatever additional information may be needful for the purpose. Among the other researches which have gone forward, while the preparation of the zone-catalogue dragged its slow length along, has been a study of the meteorology of the country. The absolute lack of information on the subject had forced itself unpleasantly upon my notice when endeavouring to select the most suitable place for the observatory; and, as it would have been disgraceful for any scientific inquirer to reside in the country without trying to supply the want in some degree, I succeeded in enlisting the aid of various educated men and women in different parts of the country and adjacent ones. The Government and Congress acceded to my recommendation that a modest sum should be annually appropriated for the purchase of barometers, thermometers, rain-gauges, &c., to be lent to volunteer observers, and for arranging, computing, and publishing the results. In this way was organised, in 1872, the Argentine Meteorological Office, which has established no less than fifty-two stations, scattered from the Andes to the Atlantic, and from Bolivia to Tierra del Fuego. At the end of the year 1884 there were already twenty-three points at which the observations had been continuously made, three times a day, for at least four years, and sixteen others at which they had already been continued for more than two years. These have provided the necessary data for constructing the isothermal lines, with tolerable precision, for all of South America from the torrid zone to Cape Horn. Some little has also been accomplished in determining local constants of terrestrial magnetism; and our determinations of geographical position have nearly kept pace with the extension of the telegraph wires. The beats of the Cordoba clock have been heard and automatically recorded amid the plash both of Atlantic and Pacific waves. And the series of longitude determinations made by the United States naval expeditions, between Buenos Aires and Europe on the one side, under Capt. Green, and between the United States and Valparaiso under Capt. Davis on the other, give, when combined with the two South American measurements, values for the longitude of Cordoba, which differ only by one-sixth of a second—this being the total amount of the aggregate errors of the several determinations in a series which, passing through Brazil, the Cape Verde Islands, Madeira, Portugal, England, Ireland, Newfoundland, the United States, Central America, and down the coasts of Ecuador, Peru, and Chile, completes the full circuit at Cordoba again.

But I will not descant upon collateral matters, nor convert this gathering of friends into an astronomical lecture-room. There are but two points more that I wish to mention.

One is, that I cherish a hope that our sojourn at Cordoba may hereafter be considered as marking an epoch in a new method of astronomical observation, namely, the photographic. The inception and introduction of this method belongs to our countryman, Mr. Rutherfurd; and it was only through his friendly aid in several ways that I was enabled to give it a larger scope, in spite of many obstacles. Now I can report that every important cluster of stars in the southern hemisphere has been repeatedly photographed at Cordoba with a precision of definition in the stellar images which permits accurate microscopic measurement; that these measurements are at present actively going on, and that the Argentine Government has undertaken to provide the means for their continuance under my supervision. It may be that I over-estimate the importance of this new method; but I confess that my expectations are very high. Another year ought to show us whether they are exaggerated or not.

The other point is, that a very large share of the merit which you so liberally attribute to me belongs to the faithful staff of fellow workers, with whose assistance I have been singularly favoured. Their unselfish devotion to the great undertakings in which they took part, their loyalty, trustworthiness and ability, have, in the great majority of cases, been beyond all praise. Happily, their faithful and inestimable services to science are placed on durable record; and yet unborn astronomers will know, at least in part, how great have been their deserts. The senior of them, Dr. John M. Thome, whose services began in 1870, before we started southward, is now director of the Observatory, where he has begun a new and important work, which will do honour to him and to the institution. Another, Mr. Walter G. Davis, who has laboured most earnestly and efficiently for eight and a half years, is now director of the Meteorological Office, which is assuming large proportions, and under which he is now organising at Cordoba a meteorological station of the highest class. One noble young man, Mr. Stevens, was summoned, without an instant's warning, to a higher reward than earth could give, leaving no memories behind him other than of affection, admiration, and respect. It was a sore loss for us, and for the bereaved parents in New Hampshire, to whom he was their only earthly stay and staff. Had he lived, his friends and country would have had abundant cause for pride in him. As it is, the number of those who love and honour his memory may perhaps be smaller, but their pride and admiration are no less, than had they seen the full harvest instead of the rich promise only. Mr. Bachmann, a native of Austria, who laboured with us for more than ten years, is now at the head of the Argentine Naval Academy in Buenos Aires, with more than three hundred pupils and an elegant little observatory, where he finds repose from administrative cares, in astronomical work analogous to that to which he gave his energies at Cordoba. He has already undertaken some longitude-determinations and arranged a time-ball, which is probably by this time giving daily signals by which the shipping in the outer roads, twelve miles away, may correct and rate their chronometers.

I have spoken longer than I intended, but will make no apologies, for I know your friendly indulgence. It only remains to say, for these Argentine scientific institutions, that I believe their success is now assured. They will enter upon new and enlarged fields of usefulness, as indeed they ought, for the world moves. And for myself, that the remembrance of this occasion and of your goodness will be a source of pride to me through life, and to my children afterwards.

Hardly had the sound of Dr. Gould's voice died away when he was the recipient of a splendid ovation, the guests of the evening seeming to vie with each other in a generous rivalry as to which should outdo the other in rendering honour to the distinguished guest of the evening.

The chairman, in introducing Dr. Oliver Wendell Holmes, pleasantly referred to him as not a small star, but one of the first magnitude. Dr. Holmes received just such a welcome as he is entitled to, and which is always accorded him, and in response thereto read the following poem, which was received with round after round of applause:—

A Welcome to Dr. Benjamin Apthorp Gould

Once more Orion and the sister Seven
Look on thee from the skies that hailed thy birth—
How shall we welcome thee, whose home was Heaven,
From thy celestial wanderings back to earth?

Science has kept her midnight taper burning
To greet thy coming with its vestal flame:
Friendship has murmured, "When art thou returning?"
"Not yet! Not yet!" the answering message came.

Thine was unstinted zeal, unchilled devotion,
While the blue realm had kingdoms to explore—
Patience, like his who ploughed the unfurrowed ocean,
Till o'er its margin loomed San Salvador.

Through the long nights I see thee ever waking,
Thy footstool earth, thy roof the hemisphere,
While with thy griefs our weaker hearts are aching,
Firm as thine equatorial's rock-based pier.

The souls that voyaged the azure depths before thee
Watch with thy tireless vigils, all unseen—
Tycho and Kepler bend benignant o'er thee,
And with his toy-like tube the Florentine—

He at whose word the orb that bore him shivered
To find her central sovereignty disowned,
While the wan lips of priest and pontiff quivered,
Their jargon stilled, their Baal disenthroned.

Flamsteed and Newton look with brows unclouded,
Their strife forgotten with its faded scars—
(Titans, who found the world of space too crowded
To walk in peace among its myriad stars).

All cluster round thee—seers of earliest ages,
Persians, Ionians, Mizraim's learned kings,
From the dim days of Shinar's hoary sages
To his who weighed the planet's fluid rings.

And we, for whom the northern heavens are lighted,
For whom the storm has passed, the sun has smiled,
Our clouds all scattered, all our stars united,
We claim thee, clasp thee, like a long-lost child.

Fresh from the spangled vault's o'erarching splendour,
Thy lonely pillar, thy revolving dome,
In heartfelt accents, proud, rejoicing, tender,
We bid thee welcome to thine earthly home.

The Rev. James Freeman Clarke in saying a word in honour of "our friend, the eminent astronomer, who is our guest to-night," remarked that—

"We are on the verge of still greater discoveries than any yet made, and our own country is prepared to do its full part in the work. When the Russian Government wishes for a better telescope than any now in Europe, it sends to Cambridgeport to get it. Mr. Rutherfurd invents an instrument which gives us the best photographs of the moon ever made. The Washington Observatory discovers the two satellites of Mars. Prof. Langley, in the midst of Pittsburg smoke, has made observations with instruments of his own invention, with an account of which he is now arousing great interest among the men of science of England. Dr. Peters, of Clinton, N.Y., and Prof. Watson, of Ann Arbor, have been the chief discoverers of the asteroids. Prof. Young and Harkness first gave, in 1869, the true theory of the solar corona. The two Bonds, at the Cambridge Observatory, have taken rank among the chief astronomers of our time. Our friend, Prof. Pickering, amid all his other labours, has invented instruments of precision by which the light of the stars can be measured with accuracy. And now we welcome home Dr. Gould, who has given long years of labour in a far-off land, away from home and friends, to complete his great work of a catalogue of the southern stars. To him and to his noble wife who shared his labours, sustained his courage, was his companion in his sacrifices, we give our thanks and our love to-night. We sympathise with him in that great loss, and we thank God with him that he and she had this great opportunity, and that they were able to share together, side by side, the consciousness of doing a work which will never be forgotten."

Other tributes were paid to the work of Dr. Gould by Prof. Lovering, of Harvard, Prof. Pickering, of Harvard Observatory, Dr. William Everett, Prof. W. A. Rogers, of Harvard. The last-named said that there is no exaggeration in the statement that the work which Dr. Gould has accomplished during the past thirteen years is without a parallel in the annals of astronomy.

"First of all it needs to be said that in 1870 there was no Cordoba Observatory. I suspect, also, that it must be said that astronomers had at that time little faith in the fulfilment of plans which required that the Government of a South American Republic should persistently pursue, for a series of years, that wise, enlightened and liberal policy which has made the Argentine Republic a conspicuous example of the way in which a government may foster learning and research with the most encouraging results. I do not know of a better way to give a clear idea of the magnitude of this work than by comparing it with similar work done previous to 1872. There are in the northern heavens, between the north pole and a little distance below the equator, about 4500 stars visible to the naked eye. These stars have been observed with more or less regularity at various observatories since about 1750. Within the same limits there are about 95,000 stars as bright or brighter than the ninth magnitude, which are usually observed in narrow belts or zones, and such stars are usually referred to as zone stars. The bright stars are common to nearly all general catalogues, but the positions of the fainter stars depend for the most part on two or three separate observations. Dr. Gould has formed two catalogues since 1872—a general catalogue of stars extending to the south pole, containing 34,000 stars, and a catalogue of zone stars, numbering 73,000. These two catalogues represent about 250,000 separate observations. It is stated in one of the printed volumes that the chronographic register of the transits, the pointing of the telescope for declination, and the estimation of the magnitude have all been done by Dr. Gould personally. The distinct and separate observations involved in this work must certainly exceed 1,000,000. I suppose there must be several gentlemen present who have a realising sense of what a million really means, but for myself I commonly say that it seems to me to be a very large number. Having made less than 50,000 observations during the time covered by Dr. Gould's observations, can you wonder that this work, which seems so far beyond the limit of human endurance, is at once my amazement, my admiration, and—I must add—my despair? The whole number of stars in the two Cordoba catalogues is nearly three times as great as in any single catalogue thus far constructed; and it must be remembered in this connection, that the great catalogues of Lalande, of Bessel, of Argelander, and of Schjellerup, represent the labours of a life-time. The total number of stars in all catalogues formed previous to 1870, is about 260,000 as against the 105,000 stars in the Cordoba catalogues. But there is another comparison which may be made, which will reveal yet more clearly, not only the magnitude of the work which Dr. Gould has now finished, but the intense energy with which it has been pushed to completion. Since 1869 a confederation of fourteen observatories, situated in different parts of the world, has been engaged in the accurate determinations of the positions of the 100,000 stars to the ninth magnitude, in the northern heavens. Up to 1882 a total of about 346,000 observations had been made. Considerable progress had been made in this work before Dr. Gould left this country for South America. His work, involving two-thirds as many observations as all others combined, is completed, and is all in the hands of the printer, while the actual formation of the catalogue to be issued under the direction of the Astronomische Gesellschaft can hardly be said to have been begun."

TELPHERAGE

On Saturday, October 17, a special train from Victoria conveyed a party of about 200 guests, among whom were many leading electricians, engineers, and other well-known men of science, to Glynde, in Sussex, to witness the ceremony of the opening of the first telpher line erected in this country. The ceremony was performed by the Viscountess Hampden, and was of an exceedingly simple character; on lifting a small box containing a present which the Chairman of the Company invited her ladyship to accept, electric communication was instantly established between the dynamo in the engine-house and the telpher line, and a train loaded with clay at once began to move up an incline towards the Glynde Railway Station, amidst the applause of the assembled spectators. Whether this ceremony, which brought so many distinguished visitors down to Lord Hampden's estate on Saturday, is the inauguration of a great commercial enterprise is beyond our province to inquire; but it is unquestionable that the slight flash seen when Lady Hampden lifted the little box lying on the table in front of the engine-house marked the beginning of a new departure in electro-technology.

Telpherage has been defined as the transmission of goods and passengers by means of electricity without driver, guard, signalmen, or attendants. The conception of propelling electrically a continuous stream of light trains along an elevated *single* rail or rope was due to the late Prof. Fleeming Jenkin, but, as stated by him in his introductory address at the University of Edinburgh, he did not see his way to carry this conception into practice until he read the account of the electrical railway exhibited by Professors Ayrton and Perry at the Royal Institution in 1882, when the idea of subdividing the rubbed conductor into sections and providing an *absolute block* for automatically preventing electric trains running into one another was first publicly described. A combination between these three gentlemen was then effected, which led ultimately to the formation of the Telpherage

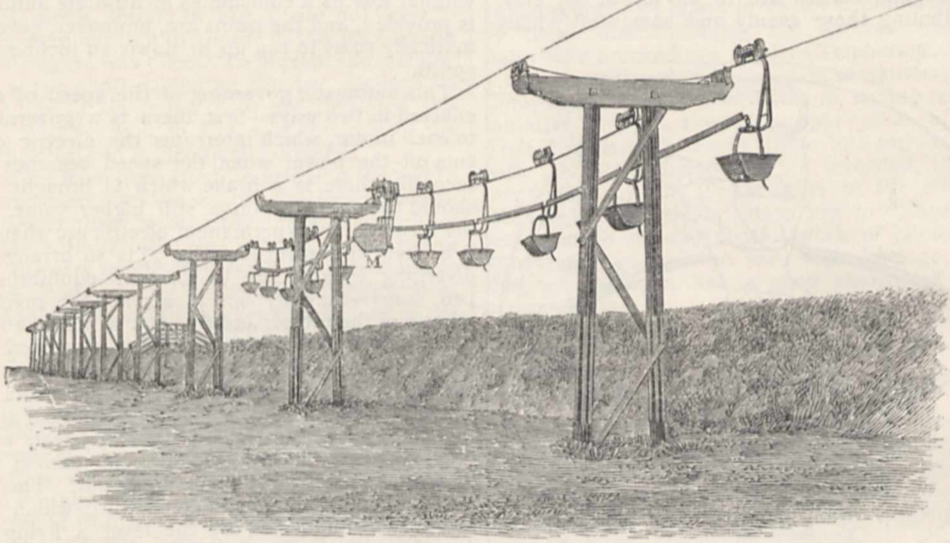


FIG. 1.

Company and to the series of experiments, lasting for over two years, on actual telpher lines erected at Weston in Hertfordshire, on the estate of Mr. Pryor, the chairman of the company. Various devices were worked out forming the subject of patents, which, together with the other patents of Professors Fleeming Jenkin, Ayrton, and Perry in telpherage, previously taken out, are possessed by the present Telpherage Company. At the commencement of this year matters had sufficiently advanced for the erection of commercial telpher lines, and as a tramway or road would have much interfered with the grazing and hay growing carried on in the fields at Glynde, and, as in addition these fields are under water during the winter, telpherage appeared to furnish the cheapest and most suitable mode of carrying the clay from the clay pits to the London, Brighton, and South Coast Railway. Consequently the Sussex Portland Cement Company decided to adopt this method of transport.

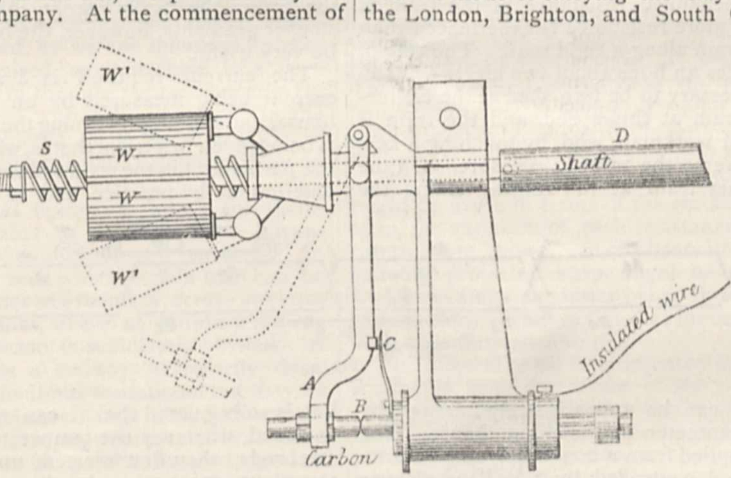


FIG. 2.

The line now opened is nearly a mile long, and composed of a double set of steel rods each 66 feet long, three-quarters of an inch in diameter, and 8 feet apart, supported on wooden posts standing about 18 feet above the ground, as seen in our illustration (Fig. 1), which is from a photograph taken of the line just before it crosses the stream. On the death of the late lamented Prof. Jenkin the construction of the Glynde telpher line was left for completion in the hands of Prof. Perry, who was then appointed the engineer to the company. The new line, it must be understood, is more than a mere experimental attempt. Although, as scientific men will appreciate, a new undertaking must necessarily involve much tentative experience, the programme carried out on Saturday marked the final result of the experiences gained by the constructors under the direction of Prof. Perry, and the Company are now regularly delivering clay at the Glynde Railway Station for the use of the Newhaven Cement Company at a price, as we are informed, of $7\frac{1}{2}d.$ per ton.

The garlanded train which passed along the steel rod-way on Saturday consisted of an electric locomotive, seen in Fig. 1 at about the middle of the train and propelled by the electromotor M, and ten skeps, or buckets, which hang by their travelling wheels from the steel line. Each skep weighs 101 lbs., and carries 250 to 300 lbs. of dry clay, and, by distributing these evenly and somewhat widely apart, the strain on the steel line is small although the total weight of the train and clay is about two tons, also as equal weights are simultaneously ascending and descending similar inclines on the several spans the effect of the sag on the mechanical resistance of the train is neutralised, and little more resistance is experienced than in hauling a similar train along a rigid road. The rate of travelling is 4 to 5 miles an hour about two electric horse-power only being necessary to be furnished at the engine-house to propel the train at this speed, and the train is under the control of a workman, who, by touching a key, can start, stop, or reverse the train at pleasure. On the arrival of each telpher train at the railway siding the clay is emptied into the railway waggons by the skeps being tipped over, this being effected either by a man touching with a pole the handles which are seen in Fig. 1 hanging down from the skeps, or automatically by these handles coming successively into contact with a wooden arm padded with india-rubber which is made to stand out from the post where it is desired the clay is to be emptied. One train will deliver the minimum amount of clay (150 tons per week) required by the Cement Company, but, if necessary, twenty trains can be run on the line without fear of a collision as an absolute automatic block is provided, and the trains are, moreover, governed automatically so as to run up or down an incline at the same speed.

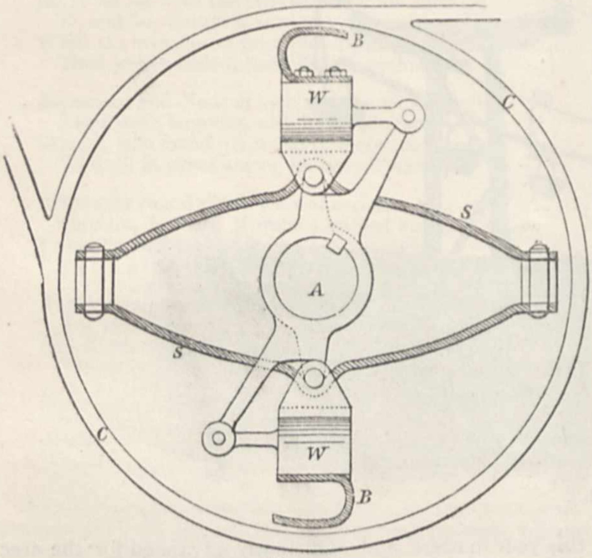


FIG. 3.

This automatic governing of the speed of the train is effected in two ways—first, there is a governor attached to each motor, which interrupts the electric circuit, and cuts off the power when the speed becomes too high; secondly, there is a brake which is brought into action should the speed attain a still higher value. To avoid the formation of a permanent electric arc when the circuit is broken, the governor (Fig. 2) is so arranged that the diverging weights are in *unstable* equilibrium between two stops—they fly out at about 1700 revolutions per minute of the motor, and fly back at about 1600. When the circuit is closed the current is conveyed across the metallic contact at C. When the weights W W fly out this contact is first broken, but no spark occurs because a connection of small resistance is continued at B between the piece of carbon and a piece of steel, which being pressed out by a spring follows the carbon for a short distance as the arm A begins to fly out. This contact is next broken, producing an electric arc, which however is instantly extinguished by the lever A flying out to the dotted position. The brake is shown on Fig. 3, and consists simply of a pair of weights, W W, which at a limiting speed greater than 1700 revolutions per minute of the motor press the brake blocks B B against the rim C C, and introduce the necessary amount of retarding friction. In practice, however, with the gradients such as exist at Glynde, and which do not exceed 1 in 13, the economic method of automatically cutting off the power with the governor is all that is necessary to control the speed of the train; the brake rarely coming into action. With steeper gradients, however, the brake would undoubtedly be very useful.

The current required is 8 amperes per train, this current being measured by an ammeter in the engine-house, and by roughly timing the intervals when no current is being given to a train, that is, when the governor is acting, the particular hill the train is descending can be electrically determined by practice, and so the progress of a train

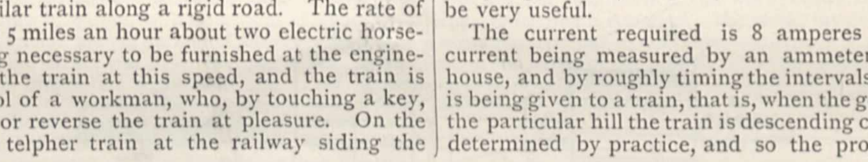


FIG. 4.

along the telpher line can be approximately followed by simply watching the ammeter in the engine-house. The electric current is supplied from a 200-volt dynamo driven by a steam-engine, and controlled by a Willans electric governor which automatically varies the speed of the engine and dynamo so as always to keep the electro-motive force at 200 volts whatever be the number of trains running; hence the starting or stopping of one telpher train in no way affects the speed of the remainder. It is obvious that water-power or any other source of power can be used where available, even when the source of power is at a considerable distance from the line. By means of compensating gear the tension of the line is so regulated that it can never exceed $2\frac{1}{4}$ tons on each rod, whatever the temperature, and for straining the steel rods, when first erected, up to the right tension an ingenious arrangement has been devised during the construction of the line of vibrating them and determining the strain on a rod from the number of vibrations it makes per minute.

The way in which a single wheel track is made to serve for one train, or rather two wheel tracks for two trains, instead of the necessity of having four wheel tracks for two trains, as in the ordinary electric railways, is seen from Fig. 4. D is the dynamo maintaining two long conductors permanently at different potentials indicated by the signs + and − of each section. The wheels L and T of one train, and L_1 and T_1 of the other, are insulated from their trucks and joined by a conductor attached respectively to the terminals of the motor M and M_1. A current consequently is always passing from a + section to a − section through each motor. Mechanically then each train is supported by what is practically one continuous steel rod, but in reality at the tops of the posts the rods are electrically subdivided into sections and joined across by insulated wires, one of which may be seen at the top of the posts in Fig. 1. The wires connecting the two skeps with the motor, shown in Fig. 4, are not seen in Fig. 1, as they were too thin to appear in the photograph from which this figure was taken. To prevent the metallic wheels of the skeps short circuiting the two sections as they cross the tops of the posts, there are insulated gap pieces, which may be seen in Fig. 1, at the tops of the posts where the steel rod is electrically divided.

Various devices have been tried for gripping the rod to obtain the hold necessary to enable the locomotive to haul the train, and these, with many ingenious plans of *nest gearing* for economically communicating the power given out by the very quickly revolving electro-motor to the much more slowly moving wheels of the telpher locomotive, formed the subject of Prof. Jenkin's lecture at the Society of Arts in the spring of 1884. Practically, however, it is found that for moderate inclines direct driving, with pitch chains, of two wheels with india-rubber treads gives a gravitation grip sufficiently large for satisfactory haulage; hence the expense of the locomotive, the complexity and wear and tear of its parts combined with the risk of its getting out of order have been all most materially reduced during the last twelve months.

As the result of the experience gained in the construction of the Glynde line, it is estimated that a similar line could now be erected at short notice for a total cost of 1200*l*., including engine, dynamo, permanent way, and five trains, with locomotives to carry 100 tons daily; the working expenses, including coal, attendance, and depreciation, being less than 3*d*. per ton per mile upon the material carried. A double line like that at Glynde, ten miles long, worked heavily, would carry material at a cost of 2*d*. per ton per mile, the skeps being empty on their return journey. The larger part of the original cost of the Telpher line is due to dynamos and rolling stock. This plant can be increased, as we are informed, in proportion to the work required, so that there is a very moderate increase of cost in the rate per ton per mile for a small traffic, as compared with a larger one. On the other hand, a line constructed for a small traffic will accommodate a much larger one with no fresh outlay on the line itself.

Leaving these facts and figures to speak for themselves, it now only remains to point out the advantages claimed for this system of electric carriage. In the first place the facility with which such a line can be run up and carried over uneven ground or across streams, high fences, and deep ditches, where an ordinary railway would involve serious expense, is sufficiently obvious. A Telpher line need not, as a railway necessarily does, impede the ordinary agricultural operations, but may be carried over fields and pasture lands with little inconvenience. The Telpher line is, moreover, in itself a source of power which can be simultaneously tapped at any desired points and made to assist in the work of agriculture, as the visitors on Saturday had an opportunity of witnessing when, by means of a motor connected with the line, a turnip-cutter was put into operation. The possibility of utilising natural sources of power like falling water, and of working the line at great distances from such sources will, as already stated, be evident to our readers. A special advantage claimed for the new system is the ease with which the trains can go round sharp curves without loss of power, since electricity, having no momentum, experiences no loss in going round a corner, whereas, with the overhead wire haulage system, as used in Spain and elsewhere, there is both considerable friction and great wear and tear of the running wire ropes where they go round sharp curves.

The constructors of the Glynde Line are careful to point out that the present line is far from perfect; unnecessary gradients have been introduced in order to show how the system can be carried over uneven land, and many other improvements have suggested themselves in the course of their experience, of which advantage would be taken in future undertakings. In face of these disadvantages, the success which marked Saturday's proceedings renders Telpherage, as a system, a very hopeful and cheap method of transference, and the Company is to be congratulated in having taken the first initiative step in this new application of electricity. That Telpherage will ever come into serious competition with the large railways is not intended, for the statement made by the Company is to the effect that the function of the Telpher line is not to compete with railways, but to do cheaply the work of horses and carts, light tramways, and the wire rope haulage system, and this, we think, it has a good chance of successfully accomplishing.

THE MELDOMETER

THE apparatus which I propose to call by the above name (μέλδω, to melt) consists of an adjunct to the mineralogical microscope, whereby the melting points of minerals may be compared or approximately determined and their behaviour watched at high temperatures either alone or in the presence of reagents.

As I now use it it consists of a narrow ribbon of platinum (2mm. wide) arranged to traverse the field of the microscope. The ribbon, clamped in two brass clamps so as to be readily renewable, passes bridgewise over a little scooped-out hollow in a disk of ebony (4 cm. diam.). The clamps also take wires from a battery (3 Groves cells), and an adjustable resistance being placed in circuit the strip can be thus raised in temperature up to the melting point of platinum.

The disk being placed on the stage of the microscope the platinum strip is brought into the field of a 1″ objective, protected by a glass slip from the radiant heat. The observer is sheltered from the intense light at high temperatures by a wedge of tinted glass, which further can be used in photometrically estimating the temperature by using it to obtain extinction of the field. Once for all approximate estimations of the temperature of the field might be made in terms of the resistance of the platinum strip, the variation of such resistance with rise of temperature being known. Such observations being made on a suitably protected strip might be compared with the wedge readings, the latter being then used for ready determinations. Want of time has hindered me from making such observation up to this.

The mineral to be experimented on is placed in small fragments near the centre of the platinum ribbon, and closely watched while the current is increased, till the melting point of the substance is apparent. Up to the present I have only used it comparatively, laying fragments of different fusibilities near the specimen. In this way I have melted beryl, orthoclase, and quartz. I was much surprised to find the last mineral melt below the melting-point of platinum. I have, however, by me as I write, a fragment, formerly clear rock-crystal, so completely fused that between crossed Nicols it behaves as if an amorphous body, save in the very centre where a speck of flashing colour reveals the remains of molecular symmetry. Bubbles have formed in the surrounding glass.

Orthoclase becomes a clear glass filled with bubbles:—at a lower temperature beryl behaves in the same way.

Topaz whitens to a milky glass—apparently decomposing, throwing out filmy threads of clear glass and bubbles of glass which break, liberating a gas (fluorine?) which, attacking the white-hot platinum, causes rings of colour to appear round the specimen. I have now been using the apparatus for nearly a month, and in its earliest days it led me right in the diagnosis of a microscopical mineral, iolite, not before found in our Irish granite, I think. The unlooked-for characters of the mineral, coupled with the extreme minuteness of the crystals, led me previously astray, until my meldometer fixed its fusibility for me as far above the suspected bodies.

Carbon slips were at first used, as I was unaware of the capabilities of platinum.

A form of the apparatus adapted, at Prof. Fitzgerald's suggestion, to fit into the lantern for projection on the screen has been made for me by Yeates. In this form the heated conductor passes both below and above the specimen, which is regarded from a horizontal direction.

J. JOLY

Physical Laboratory, Trinity College, Dublin, November 1

NOTES

OUR readers will hear with regret that Prof. Huxley has placed in the hands of the Council of the Royal Society his resignation of the office of President, and that the Council have felt it their duty to accept that resignation. It would appear that Prof. Huxley had wished to resign so long ago as November last, when he had decided to winter abroad, and again, last summer, he definitely placed his resignation in the hands of the Council. On both these former occasions Prof. Huxley was induced to continue in office, in the hopes that he would soon regain complete health. On the present occasion we gather that the resignation was accepted, because, though Prof. Huxley is rapidly improving in health, the cares of the presidential chair seemed likely to prove a hindrance to his complete recovery being so rapid as could be desired. We feel sure that the whole scientific world will share the regret of the Council of the Royal Society at the necessity of such a step, but we also feel that every one must recognise the wisdom of the decision. We may add that every one hopes that freedom from the responsibilities of office may soon convert the marked improvement in Prof. Huxley's health, visible to all his friends, into complete and perfect restoration.

WE understand that Prof. Stokes has consented to allow himself to be nominated as Prof. Huxley's successor in the presidential chair. We believe that this choice of the Council will give universal satisfaction to the Fellows of the Society; while it makes Prof. Stokes doubly the successor of Newton, it does honour to the Society.

A CONSIDERABLE portion of the "Zoological Record" for 1884 has already been issued to subscribers; the Reports on Coleoptera, Lepidoptera, and Hymenoptera, by Mr. W. F. Kirby, were issued in September, and those on Reptiles, Fishes, Mollusca, Tunicata, Polyzoa, and Brachiopoda last week. The remaining parts are in a very forward state, Mr. W. L. Sclater, B.A., having undertaken the Mammalia in the place of Dr. Murie.

THE French Government has just created a certain number of travelling-juries. This is a modified form of an institution established by the first Republic. In the organic law of the Institut it was ordained that the Institut was to select yearly ten citizens to travel abroad and collect information useful to science, commerce, and agriculture. These scientific travellers will not be appointed by the Academy of Sciences or the whole Institut, but by a special administrative commission on the basis of a competitive examination.

WHILE so much public attention is attracted by the second part of the Greville "Memoirs," it will interest our readers to learn that the acute and observant Clerk to the Council, who, on the whole, had a very low idea of the great men with whom he came in contact, possessed a great respect for the men of science of his generation. Under March 17, 1838, we find the following interesting entry ("Memoirs," vol. i. p. 78):—"Went to the Royal Institution last night in hopes of hearing Faraday lecture, but the lecture was given by Mr. Pereira upon crystals, a subject of which he appeared to be master, to judge by his facility and fluency; but the whole of it was unintelligible to me. Met Dr. Buckland and talked to him for an hour, and he introduced me to Mr. Wheatstone, the inventor of the electric telegraph, of the progress of which he gave us an account. I wish I had turned my attention to these things and sought occupation and amusement in them long ago. I am satisfied that, apart from all considerations of utility, or even of profit, they afford a very pregnant source of pleasure and gratification. There is a cheerfulness, an activity, an appearance of satisfaction in the conversation and demeanour of scientific men that conveys a lively notion of the *pleasure* they derive from their pursuits. I feel ashamed to go among such people when I compare their lives with my own, their knowledge with my ignorance, their brisk and active intellects with my dull and sluggish mind, become sluggish and feeble for want of exercise and care."

THE first volume of "Geology, Chemical, Physical, and Stratigraphical," by Prof. Joseph Prestwich, F.R.S., will be ready for publication immediately by the Clarendon Press. This work is a general treatise on Geology adapted both for elementary and advanced students. Vol. I. treats of questions in chemical and physical geology, and special attention is paid to such subjects, among others, as Hydro-Geology, the geological bearings of the recent deep-sea explorations, volcanic action, joints, mineral veins, the age of mountain ranges, and metamorphism. Vol. II., which is far advanced, treats of stratigraphy and palæontology, and touches upon various theoretical questions. The author advocates the *non-uniformitarian* views of geology. The book is copiously illustrated with woodcuts, maps, and plates.

FATHER DENZA, according to the *Times* Rome correspondent, writing from the Observatory of Moncalieri, gives interesting particulars of a remarkable shower of dust which fell in various parts of Italy in the night of October 14–15. This dust-shower accompanied the violent gale of wind which occurred at the time, and seems to have fallen thickest in places situated more or less in the latitude of Rome. Father Denza regards the dust as meteoric. Mr. Abercromby writes to the *Times* to point out that this is probably premature, if by meteoric Father Denza means the product of meteors. But is it not probable that by meteoric sand he simply means sand which falls as "a meteor" or meteorological phenomenon? As Mr. Abercromby points out, this dust probably came from the Sahara.

AN interesting series of papers, copiously illustrated by charts, and comparative tables, is appearing in *Naturen*, on the climate of Norway. The author, Dr. Hesselberg, enters fully into the various causes on which depend the great differences between the inland and littoral climates, and notes in detail the varying relations of temperature for each month in the interior, and on the coast. From these tables it would appear that while in Norway, generally, the five months, from November to March inclusive, exhibit a purely winter temperature, no single month presents throughout a complete summer temperature. The remaining four months pass through the various stages of temperature between winter and summer. In the more northern and more elevated parts of the interior not a single month of the year is free from the risk of night-frost, while in such localities frost occurs on from 225 to 230 days in the year. On the coast-lands, on the other hand, the mean winter temperature is generally from 2° to 3° Cels. above the freezing point, and here the greatest cold occurs in February, while in the interior December and January are the coldest months.

WE learn, from a recent report by Herr Reusch, of the condition of the Bommelö gold-mines worked by Messrs. Oscar and Daw, that gold to the value of 8000 kroner has been obtained during the three months in which these works have been in operation. The writer believes the mines may be made remunerative, but only moderately so, and provided they are worked with care and economy, and he emphatically warns his countrymen not to waste time and money, as has frequently been done in Norway, in seeking for gold in localities where the existence of any appreciable quantity of quartz is not well attested beforehand. He, moreover, points out the fallacy of believing that any large proportion of the auriferous quartz deposits of Norway are capable of yielding more than the mere fragmentary traces which are so constantly met with. Quite recently, indeed, the presence of gold has been shown in new localities, Herr Hansen having obtained in the quartz at Haugesund a number of microscopically small granules of the precious metal with titanic iron, while at Mæland, in Bommelö, about four miles from the spot where the first finds were made, he extracted gold after crushing and washing the white quartz which occurs in large lumps, accumulated on a hillock about 5 feet high, by 36 in length, and 13 in breadth.

PÈRE DECHEVRENS, the head of the Zi-ka-wei Observatory near Shanghai, has published a pamphlet entitled, "The Meteorological Elements of the Climate of Shanghai: Twelve Years of Observations made at Zi-ka-wei by the Missionaries of the Society of Jesus." It is a series of tables containing "all the information that meteorology can supply concerning the climate of Shanghai." A complete meteorological period in China is said to be about eleven years, and consequently this pamphlet embraces one such period. The tables show maximum and minimum, mean and normal readings of the barometer and thermometer, intensity of solar radiation, relative and absolute humidity, nebulosity, rainfall, and direction and velocity of the wind for every month throughout the twelve years, conveniently tabulated for comparison. There is also a table of eight years' observations of ozone, and a special section is devoted to terrestrial magnetism. Explanations are given in most cases of the methods of taking the various observations, and the objects which they serve. The readings are all given according to English methods of computation; but for the convenience of those who are more familiar with the metric barometer scale and the centigrade degrees of temperature, tables for the conversion of the English into the Continental systems are given.

AMONGST the anthropological papers recently issued by the Smithsonian Institution, special interest attaches to the memoir by Lieut. C. E. Vreeland and Dr. J. F. Brandsford on the antiquities recently discovered on the Pantaleon estate, near Santa Lucia, Guatemala. This place, which lies about thirty miles north-west of Escuintla on the railway from San José to the city of Guatemala, was visited in 1884 by the authors for the purpose of photographing the objects, which had here been observed two years previously by Dr. Brandsford, and earlier by Dr. Habel. Several of the finest specimens had been removed to Berlin, where an account of them was published by Dr. Adolph Bastian. Those here described and figured from the photographs form a group of remarkable sculptures, all of black basalt or hard lava mounted on a low wall round the fountain of the Pantaleon courtyard, and disposed in front of a grand central piece raised on a pedestal. This figure, which is in an excellent state of preservation, the nose alone being injured, is a new revelation in native American art, characterised by great strength and simplicity of outline. It is well formed, the lines simple and clearly cut, without a trace of the usual conventional style. Majesty is so plainly stamped on the countenance, that it was known to the Indians by the name of El Rey—the king. The brow, the eyes, and the nose, as far as can be judged, are in good shape and well proportioned; the mouth hard, the chin firm and full of character. Near it stands the head of an old person whose venerable appearance is heightened by the deep lines on brow and cheek. In contrast to this is another head of an old person, where calmness of expression is replaced by the inexpressible sadness of age with blindness. As in the case of some other figures, the eyes are here represented as hanging from the sockets, the balls resting on the cheeks. The chin and lower lip protrude, while the upper lip has fallen in as from the loss of teeth. To the long ears are appended large pear-shaped ornaments, and the turban-like headdress is surmounted with a little Tam O'Shanter cap. All the figures show real artistic skill, far beyond the elaborate but fantastic style of the conventional sculptures found at Copan and other parts of Central America.

A BORE-HOLE made about two years ago to a depth of 52 metres into the older Devonian strata near Burgbrohl on the Rhine, yields a large and steady supply of carbonic acid gas (with water) which is variously utilised. In a recent paper to the Niederrheinische Gesellschaft in Bonn, Herr Heusler says the normal quantity of gas amounts to about 2160 cubic metres in twenty-four hours. The supply having proved constant, a compressing apparatus was set up last autumn; the gas being taken directly over the bore hole. The present system produces per minute from 500 litres of gaseous $C.O_2$., 1 litre of liquid, weighing 1 kilogram. As the liquefaction depends on the external air-temperature, and is impossible at a temperature over 30·9 C. (the critical point), it is necessary in high temperatures to cool the apparatus, and the water of the spring (which keeps at 12°) serves for this. The pressure employed ranges from about 50 to 70 atmospheres. The wrought-iron vessels for despatch of the liquid contained about 8 litres, or 8 kilograms, and are tested to about 250 atmospheres; they very rarely explode. The enormous expansion of carbonic acid with rise of temperature yields a pressure which is utilised, it is known, for compression of steel and other casts, and Messrs. Krupp at Essen have thus got, *e.g.* a pressure of 1200 atmospheres for a temperature rise of 200° C. Among other rises are pressure of beer, impregnation of natural water, apparatus for fire extinction, motor force for torpedoes, &c. Solid carbonic acid is to a large extent produced from liquid by opening the cock of the vessel into a canvass bag tied over the mouth.

IN his recent investigation of pile-dwellings of the Lake of Bienne, Dr. Studer has met with two extreme types of human skulls—the brachycephalic and the dolichocephalic; the former (at Schaffis and Lüschery) belonging to the pure Stone period, and the latter (found at Vinelz and Sutz) to the Bronze period. The facts point to an invasion by the bronze men, involving a complete transformation of the group of domestic animals; the horse appears for the first time, and new races of sheep and dogs drive out the old forms of the Stone period. The occurrence of mesocephalic, and even much shortened, skulls in the Bronze period shows that there was no extinction of the brachycephalic race, but that the two races mixed. This mixture of races in prehistoric times increases the difficuity of tracing back the skull-forms of the present population. Dr. Studer suggests that the Rhaetian short-headed type may be referred to the old dwellers of the Stone period, in which case the prevalent dark hair, eyes, and skin of the present natives of Graübünden may recall the aspect of the older prehistoric race. There is also a large dark population about the lakes in Canton Berne.

M. VERNET has recently made a number of physiological observations on himself during eighteen ascents of high Alpine summits (between 1680 and 4638 metres in height). He finds that the strong muscular efforts made both in mounting and descending caused a rise of temperature of about 1·64° to 1·70° C. on an average; a rise in the pulse from about 75 to 83 in a minute, and an increase in the respiratory acts from about 21 to 25 in a minute. A few hours' rest after the effort ceased brought back the temperature to its normal value. Other muscular efforts, such as riding, wood-sawing or chopping, &c., had quite the same effect. The author's observations are detailed in the *Archives des Sciences*.

THE School of Anthropology, created a few years ago under the auspices of the city of Paris, has opened its 1885–86 session. The course of lectures delivered by M. de Mortillet on prehistoric anthropology will be illustrated for the first time by a series of projections. English anthropologists will learn with pleasure that M. Gabriel de Mortillet, who was one of the companions of Agassiz, has been elected representative of the Seine et Oise Department.

THE engineers of the French Service are establishing a telephonic communication between Paris and Rheims, 160 kilometres from Paris. The Paris terminus of this line will be the Exchange. A sum of one franc for each five minutes will be charged for conversation. As soon as this line is finished the work will begin of connecting Rouen with Paris (126 kilometres). Rouen has been already connected with Havre, 78 kilometres distant, by a telephonic line. Conversation between these two cities is very easily held. It is the success of this system which led to further extension on larger distances.

ON October 9, between 9 and 10 a.m., two severe shocks of earthquake were felt on the Lis Island, in the parish of Sorunda, in Sweden. In the school-house, while teaching was going on, two severe shocks were felt like two blows from an enormous hammer in the north-western corner of the building. In this corner the windows rattled, the floor swayed, and rumbling like that of distant thunder was heard. Simultaneously a great thunderstorm passed over the district, accompanied by heavy rain. It has, however, been ascertained beyond doubt that the shocks were not due to the former, as the shocks were felt by many persons out of doors. The earthquake went from west to east.

SINCE 1880, when diggings for amber were commenced under the Smaland Peninsula in East Prussia, the yield of the veins here has greatly increased. In 1864 the revenue was 1700*l.* against 25,000*l.* in 1883.

MR. WILLIAM CAMERON, F.G.S., the Singapore papers state, has been appointed *Honorary* Explorer and Geologist to the Straits Settlements. "Honorary Explorer" is a curious office, and we cannot recollect ever having heard of one before; but as Mr. Cameron, it is to be presumed, has accepted these two honorary offices, they must be of some assistance to him in his explorations in the Malay Peninsula. One so rarely hears of an Honorary Colonial governor, secretary, treasurer, or other official, that an "Honorary Colonial Explorer" is something of a *rara avis*, and as such deserves to be specially chronicled.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂), a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. C. E. McCheane; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. C. Canfor; a Mexican Deer (*Cariacus mexicanus* ♂) from Florida, presented by Mr. G. B. H. Marton; two Spotted-tailed Dasyures (*Dasyurus maculatus* ♂ ♀), three Short-headed Phalangers (*Belideus breviceps* ♂ ♂ ♀) from South Australia, presented by Sir W. C. F. Robinson, K.C.M.G.; an Osprey (*Pandion haliætus*), captured at sea, presented by Capt. Morgan; an Alexandrine Parrakeet (*Palæornis alexandri*) from India, presented by Mr. Chas. Williams; a Black-eyebrowed Albatross (*Diomedea melanophrys*) from False Bay, South Africa, a Vulturine Eagle (*Aquila verreauxi*) from South Africa, a Sharp-headed Lizard (*Lacerta oxycephala*) from Madeira, presented by Mr. W. Ayshford Sandford, F.Z.S.; a Black-crested Eagle (*Lophoætus occipitalis*) from South Africa, presented by the Lady Robinson: a Rufescent Snake (*Leptodira rufescens*), a Hoary Snake (*Coronella cana*), a Keeled Euprepes (*Euprepes carinatus*), five Rough-scaled Zonures (*Zonurus corydlus*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; three Grey-breasted Parrakeets (*Bolborhynchus monachus*) from South America, a Pale-headed Broadtail (*Platycercus pallidiceps*) from North-East Australia, deposited; two Lesser Vasa Parrakeets (*Coracopsis nigra*) from Madagascar, purchased.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *NOVEMBER* 8–14

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 8

Sun rises, 7h. 8m.; souths, 11h. 43m. 54·1s.; sets, 16h. 20m.; decl. on meridian, 16° 43′ S.: Sidereal Time at Sunset, 19h. 32m.

Moon (two days after New) rises, 8h. 28m.; souths, 13h. 9m.; sets, 17h. 46m.; decl. on meridian, 16° 33′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	8 34	12 38	16 42	21 42 S.
Venus	11 22	14 54	18 26	26 12 S.
Mars	23 48*	7 0	14 12	13 11 N.
Jupiter	2 34	8 46	14 58	1 33 N.
Saturn	19 17*	3 25	11 33	22 18 N.

* Indicates that the rising is that of the preceding day.

Phenomena of Jupiter's Satellites

Nov.	h. m.		Nov.	h. m.	
8	4 54	II. ecl. disap.	13	4 59	I. tr. ing.
9	5 40	III. occ. reap.	13	7 16	I. tr. egr.
10	4 42	II. tr. egr.	14	4 37	I. occ. reap.
12	6 54	I. ecl. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Nov.	h.	
10	20	Venus in conjunction with and 7° 49′ south of the Moon.

OPTICAL THEORIES[1]

THE last general report on Optics which was laid before the Association was read at Dublin by the late Dr. Lloyd in the year 1834, fifty-one years ago. Since then, in 1862, Prof. Stokes dealt very completely with double refraction so far as the elastic-solid theory is concerned, and there is little to add to what he said then. In all branches of his subject the fifty-one years since Dr. Lloyd's report have been most fruitful, and in consequence the mass of papers to be dealt with has been very large.

The report is divided into four sections: the first, which is introductory, deals with the work of Green, MacCullagh, Cauchy, and Neumann, the founders of the elastic-solid theory.

In the second section the more modern writers on the elastic-

[1] Report presented to the British Association by R. T. Glazebrook, M.A., F.R.S.

solid theory are considered—De St. Venant, Sarrau, Lorenz, Stokes, Lord Rayleigh, Kirchhoff, and others.

The third section is devoted to theories in which the mutual action between the matter molecules of the transparent body and the ether is considered as the main cause of refraction, dispersion, and other phenomena.

The chief workers in this field seem to be Boussinesq, Sellmeier, Helmholtz, Lommel, Ketteler, Voigt, and, in his lectures at Baltimore, Sir W. Thomson.

The fourth and last section deals with the electro-magnetic theory of Maxwell, and the developments it has received from the hands of Helmholtz, H. A. Lorentz, Fitzgerald, J. J. Thomson, Rowland, and Glazebrook.

The report is devoted strictly to *general optical theories*. This has been required by the necessities of both space and time, and, as a consequence, the optical papers of many most distinguished workers, such as Fizeau, Jamin, and Quincke, are hardly noticed, except in so far as the results at which they have arrived bear on some point or other of the general theory. There is ample room for a report dealing with optics from an experimental standpoint which should arrange and compare the conclusions of various experimenters on debated points.

Turning, then, to the sections in order: in the second section, which deals with the elastic-solid theory, the optical properties of media are considered on the hypothesis that they arise entirely from differences in the rigidity or in the density of the ether in these media.

While the development of this theory has taught us much, we are driven to conclude that the fundamental hypothesis will not account for all the optical phenomena.

The papers of Stokes on diffraction, of L. Lorenz and Lord Rayleigh on refraction and the scattering of light by small particles, have proved conclusively that we must look to difference of density, or of apparent density, in the media to explain the phenomena, and not, as was suggested by MacCullagh and Neumann, to difference of rigidity.

With this conclusion Fresnel's hypothesis that the direction of vibration in polarised light is normal to the plane of polarisation is necessarily connected.

On the other hand, the only strict elastic-solid theory of double refraction is that of Green, and according to it, if we suppose the medium initially free from stress, the direction of vibration lies in the plane of polarisation, and even this conclusion is only arrived at by supposing certain arbitrary relations between the coefficients.

These two conclusions, then, of the elastic-solid theory are hopelessly at variance. It is true that, by supposing the medium initially to be in a state of stress, Green arrived at a second theory in agreement with his theory of reflection, but this agreement is gained by the introduction of a second set of arbitrary relations.

In connection with this point I should mention that it seems to me that Green's theory of reflection can be reconciled with experiment by adopting the suggestions of Lord Rayleigh as to the refractive index of the media for the normal waves.

The elastic-solid theory also fails to explain anomalous dispersion and metallic reflection. Cauchy's expressions for the mathematical analysis of the latter agree with experiment; but then they require that μ^2 should be complex quantity with its real part negative, and this involves the instability of the medium as regards the problem of ordinary dispersion. Cauchy's theory has been advanced by the writings of Sarrau; while the investigations of Ketteler have shown that a formula of the form—

$$\mu^2 = A + B\lambda^2 + \frac{C}{\lambda^2} + \frac{D}{\lambda^4}$$

agrees very closely with experiment.

Stokes has given us an explanation of aberration by showing us that we may suppose the earth to move through space and carry the surrounding ether with it, the ether at some distance from it being at rest; provided that the motion thus produced in the ether be irrotational, all the known phenomena of aberration will follow. And he has further shown us that any small tendency to variation from such irrotational motion will call into action the rigidity of the ether, and be propagated into space with the velocity of light. According to the views developed in these papers of Prof. Stokes, the ether may be treated as a perfect fluid for the large motions produced in it by the motion of the earth; while at the same time it has rigidity, and obeys the equations of an elastic-solid for such small motions as are involved in the passage of a wave of light.

According to the views dealt with in the second section, the ether is of the same density and rigidity in all transparent media. For such media, however, its motions are affected by the presence of the molecules of the medium. Some of the energy of the incident light may be used up in setting these matter-molecules into motion. The amount required for this depends on the nature and properties of the matter-molecules, and hence is different for different media and for waves of different length. This gives rise to reflection and refraction.

There are indications in the writings of Fresnel that he looked to some explanation himself, but it seems to be to Boussinesq that we owe the first real development of the theory.

He forms the equation of motion of the ether and matter combined on the supposition that the forces on the matter arising from the direct action of surrounding matter are owing to the smallness of the displacements negligible. He then supposes that the matter displacement U may be expanded in terms of the ether displacements u and its differential coefficients, and finally arrives at equations of the form

$$(\rho + A\rho')\frac{d^2 u}{dt^2} = B\Delta^2 u + C\frac{d\delta}{dx}, \text{ \&c.}$$

where

$$\delta = \frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz}.$$

B and C involve the period, ρ is the density of the ether, and ρ' of the matter; and hence dispersion is accounted for. Double refraction is explained by supposing A to be a function of the direction, while B and C remain constant; and for this reasons are given, and it is shown that on certain other hypotheses this leads to Fresnel's theory. This theory deals also with the phenomena of elliptic polarisation in quartz, and of aberration.

In Boussinesq's theory the motions of the matter particles are neglected, except in so far as they act on the ether and modify its motion. Sellmeier was the first to see that reflection and refraction would be profoundly modified in the cases in which the free period of the matter particles agrees with that of the incident light, and when, therefore, the energy in that light is absorbed in setting the matter into motion. His work was continued by Helmholtz, Lommel, Ketteler, Voigt, and Sir W. Thomson.

The equations of motion employed by all these writers are the following:

$$\rho\frac{d^2 u}{dt^2} = X + A + X',$$

$$\rho'\frac{d^2 U}{dt^2} = \mathfrak{X} + A + \mathfrak{X}'.$$

In these equations X represents the force on the ether, in the element of volume considered, arising from the surrounding ether; X', from any external impressed forces; and $\bar{A}$, from the matter; while $\mathfrak{X}$, $\mathfrak{X}'$, and A, are the same for the matter. According to all $X = X' = 0$. We must also have $\bar{A} + A = 0$. The difference in the theories consists in the different forms given to A.

Sellmeier, Thomson, and Helmholtz put $A = \beta^2(u - U)$. Lommel puts $A = \beta^2\frac{d}{dt}(u - U)$. The results of Ketteler's theory are, except in one small and, I venture to think, non-essential point, identical with those found by putting $A = \beta^2\frac{d^2}{dt^2}(u - U)$ (Ketteler obtains his equations in a different form from the above). Voigt investigates the general form possible for A consistent with the propagation of a plane wave and the conservation of energy. He finds

$$A = \left(\alpha^2 + \beta^2\frac{d^2}{dt^2} + \gamma^2\frac{d^2}{dz^2} + \delta^2\frac{d^4}{dt^2\,dz^2}\right)(u - U).$$

For the value of X all the authors put—taking waves travelling parallel to z—

$$X = e\frac{d^2 u}{dz^2};$$

while Voigt adds the term $\frac{dp}{dz}$. For $\mathfrak{X}$ all but Voigt and Thomson write—

$$\mathfrak{X} = aU + b\frac{dU}{dt}.$$

Thomson objects to the term $\frac{dU}{dt}$ as involving a viscous expenditure of energy. Voigt argues, with Boussinesq that in ordinary transparent media U is so small compared with u that it may be neglected, and puts it zero everywhere.

The results of the various theories differ in the form they give for the dispersion formula. Lommel's theory has been shown by Voigt to be untenable. The theories of Helmholtz, Thomson, and Sellmeier lead, when b is small, to the same result, and give

$$\mu^2 = 1 + \frac{\beta^2 \tau^2}{\rho} \left\{ 1 + \Sigma \frac{q \tau^2}{\tau^2 - \kappa^2} \right\},$$

which Ketteler's gives

$$\mu^2 = 1 + \frac{\beta^2}{\rho} + \Sigma \frac{D}{\tau^2 - \kappa^2}.$$

τ is the period of the ether vibration, κ of the matter vibration, and q, D, &c., are functions of the constants.

Voigt's formula, since he does not consider the matter motion, is different and not so general.

With regard to these formulæ, I am not aware that Helmholtz's has been tested by comparison with experiment. Ketteler's has, and agrees excellently over a long range of values of τ.

Double refraction is generally explained by supposing β^2 to be a function of the direction; but, as Sir W. Thomson has pointed out, this involves for Helmholtz's theory—he did not, however, apply his formulæ to crystals—dispersion with double refraction. For Ketteler's theory this is not the case. μ can be a function of the direction independently of τ.

The mechanism which would make the action between the matter and ether in each element of volume a function of the acceleration is perhaps not so easy to conceive as that supposed by Helmholtz and Thomson; but still Ketteler's theory seems to overcome some of the difficulties inherent in the latter.

Either of these theories can be shown to lead to Fresnel's wave-surface, provided we do not consider it necessary that the vibrations should lie in the wave-front. The vibration, as indeed Ketteler and Boussinesq have pointed out, will be normal to the ray. In all other respects Fresnel's construction will hold.

Ketteler and Voigt have tried, without much success, to apply their theories to reflection and refraction.

Thomson, in that most valuable appendix to his Baltimore lectures, has given a complete theory. This can be readily adapted to Ketteler's theory, and the results in many points agree in a striking manner with experiments both for transparent and opaque bodies. The occurrence of a real negative value for μ^2 is explained by the supposition that the period of the incident light is higher than the highest possible mode of vibration for the matter-molecules in the medium.

The last section deals with Maxwell's electro-magnetic theory of light.

Electro-magnetic disturbance travels in air with a velocity equal to that of light; and in a double refracting medium obeys Fresnel's laws. The difficulty lies in giving a physical explanation of light motions, and of accounting for the mechanical structure of the ether required by the theory. No complete theory of dispersion has yet been given. The work of Willard Gibbs does not explain why there is no dispersion in a vacuum. The objection made to Cauchy's theory holds good. It is probable that some theory such as is developed in the third section may be successfully applied to the electro-magnetic disturbance.

The theory has the great advantage of connecting naturally with the theory of light the important electro and magneto-optical discoveries of Faraday, Kerr, Kundt, and Quincke, and to the development of this much is due to Prof. Fitzgerald. The theory of reflection and refraction as at present developed is only approximate.

ELECTROLYSIS

PROF. LODGE opened the discussion at the Aberdeen meeting of the British Association on Electrolysis by reading a paper, the notes of which have already appeared in NATURE.

Sir W. Thomson referred, in his remarks on Prof. Lodge's paper, to a matter of importance in electro-plating—viz. the selection which takes place in the electrolysis of solutions containing several salts, as, for instance, in the electrolysis of copper sulphate containing ferrous sulphate, which, when decomposed by a strong current gives a deposit containing impurities, whereas a slower decomposition yields a very pure deposit. Sir W. Thomson spoke also of the necessity for the careful investigation of those cases in which the formation of deposits between the electrodes had been observed, and it would be important to know whether deposits could be formed in the line of conduction without a nucleus at all. Such matters are of importance to physiology, indicating a possible danger in the passing of long continued currents through the human body.

Prof. Schuster explained the views propounded by Von Helmholtz in his recent papers on this subject. Helmholtz explains the phenomena of electrolysis by assuming a different attraction of different chemical elements for electricity. If this be admitted, most of the difficulties connected with the phenomena of contact electricity disappear. In electrolysis the element (say hydrogen) charged with positive electricity travels to the negative electrode and forms a coating over it. Any electromotive force, however small, is sufficient to produce this effect, as no work is done. The hydrogen does not appear as free hydrogen, however. It is only liberated when the electromotive force is sufficient to produce a transfer of the positive electricity from the hydrogen molecule to the electrode. When the dissociated elements appear in a neutral state an interchange of the electricities of the elements must have occurred before dissociation. In this way we may explain the conversion of stannic in stannous chloride, which was mentioned by Prof. Armstrong in his address. Prof. Schuster did not think that Prof. Lodge had laid sufficient stress on the fact that in very dilute solutions an ion has the same rate of transference, no matter with what element it was combined. This fact affords strong evidence in favour of the above views, from which it follows as a necessary result. Prof. Schuster also explained his own views of the discharge of electricity in gases. He believes that the phenomena present some analogy to those exhibited in electrolysis of liquids. The phenomena exhibited at the negative pole are, he thinks, due to dissociation of the compound molecule. They do not appear in the case of monatomic mercury vapour. Experiments which he hopes to conclude in the next few months will decide whether or not the law of the constancy of molecular charge holds.

The next contribution to the discussion was a paper by Dr. C. R. Alder Wright, containing an account of the nature of his investigations, conducted with the view of measuring Chemical Affinity in terms of E.M.F.

On the Sensitiveness to Light of Selenium and Sulphur Cells, by Shelford Bidwell, M.A., LL.B.—The author suggests that the operation of annealing in the making of selenium cells increases the sensitiveness to light by promoting the combination of the selenium with the metal of the electrodes, forming a selenide which completely surrounds the electrodes, and is, perhaps, diffused throughout the selenium when in a liquid condition; further, that the apparently improved conductivity of the selenium, together with the electrolytic phenomena which it exhibits, are to be accounted for by the existence of this selenide. This view finds considerable support in the fact that cells, constructed with sulphur, replacing the selenium and containing a proportion of silver sulphide, are all more or less sensitive to light, and exhibit properties of annealed selenium. The author also read a paper *On the Generation of a Voltaic Current by a Sulphur Cell with a Solid Electrolyte*, a short account of which has already appeared in NATURE (vol. xxxii. p. 345).

MOLECULAR WEIGHTS

THE discussion on the Molecular Weights of Liquids and solids was opened in Section B of the British Association by the reading of a paper by Prof. A. W. Reinold, F.R.S., the subject of which was the *Size of Molecules*. In this paper an account was given of the different lines of argument by which Sir W. Thomson has been led to form an estimate of the size of molecules. The estimate is based upon four lines of argument—the first, from the refractive dispersion of light; the second, from the phenomena of contact electricity; the third, from liquid films; and the fourth, from the kinetic theory of gases. All four agree in showing that in liquids and transparent solids the mean distance between the centre of contiguous molecules is something between 1/10th and 1/200th of a millionth of a millimetre. Recently Exner (*Monatschrift für Chemie*, vi. 244–278) has proposed another method for estimating the diameter of gaseous molecules, the results obtained by this method being slightly smaller than those deduced from the above. The author gave an account of his experiments on soap-films, conducted conjointly with Prof. Rucker (NATURE, vol. xxxii. p. 210), the results of which are not out of accord with Sir W. Thomson's estimate of the size of molecules.

On Macro-molecules, with the Determinations of the Form of some of them, by Prof. G. Johnstone Stoney, D.Sc., F.R.S.—The author suggested that the molecule of a crystal, which in all probability, consists of several chemical molecules, should be termed a macro-molecule. He then went on to show that it is possible to deduce the form of the macro-molecule from the composition of the chemical molecule; this he illustrated by the cases of iron pyrites, boracite, and quartz.

An Approximate Determination of the Absolute Amount of the Weight of Chemical Atoms, by Prof. G. Johnstone Stoney, D.Sc., F.R.S.—The author showed that the mass of a molecule of hydrogen is a quantity of the same order as a decigramme divided by 10^{24}—*i.e.* a twenty-fourth decigrammet, which is the same as the twenty-fifth grammet. (The grammets are the decimal sub-divisions of the gramme, of which the first is the decigramme, the second the centigramme, &c.) The mass of the chemical atom of hydrogen may be taken to be half the twenty-fifth of the grammet. This value is based on the conclusion arrived at by several physicists—that the number of molecules in a cubic millimetre of a gas at ordinary temperature and pressure is somewhere about a unit eighteen (10^{18}), from which it can be shown that the number of molecules per litre must be about a unit twenty-four (10^{24}). From this, together with a knowledge of the weight of a litre of hydrogen, the above value for the mass of a molecule of hydrogen has been deduced. The mass of a molecule of hydrogen being known, it is possible now to determine approximately the masses of all other simple substances and of compounds also.

Prof. Osborne Reynolds then made a communication to the Section on the subject of *Dilatancy*, which was also read before Section A (see NATURE, vol. xxxii. p. 535).

On Physical Molecular Equivalents, by Prof. F. Guthrie, F.R.S.—The author pointed out that the *cryohydrates* are solid compounds of water and salts possessing very low melting-points, in which the mass ratios, whilst definite, are other than those of the ordinary chemical mass ratios. Another class of somewhat similar compounds has been discovered, which are quite analogous to the ordinary hydrates, and to these the name *sub cryohydrates* has been given. Metallic alloys are true homologues of the cryohydrates; the ratios in which metals unite to form the alloy possessing the lowest melting-point are never atomic ratios, and when metals do unite in atomic ratios the alloy produced is never *eutectic*, *i.e.*, having a minimum solidifying point. Thus pure cast-iron is not a carbide of iron, but an *eutectic* alloy of carbon and iron. Similar hyperchemical mass ratios are found to exist amongst anhydrous salts; when one salt fused *per se* acts as a solvent to another salt, forming *eutectic* salt alloys, similar to *eutectic* metallic alloys and the cryohydrates. The study of solution affords other instances of masses of unlike matter dealing critically with one another when not in any integral ratio of their molecular masses. Liquids, unsuspected of having chemical or physical relationships, are found, when mixed with one another, either to get warm and finally lose volume, or get cool and gain volume. In the first place chemical union is supposed to take place, and it appears certain that chloroform unites chemically with alcohol, ether with amylene, and benzene with ether, forming bodies analogous to the *sub-cryohydrates* and their prototype the *sub-cryohydrate* $C_2H_6O + 4H_2O$. The examination of those cases in which expansion and cooling results from admixture, shows that the maximum effects are produced when the admixture takes place in certain simple molecular weight ratios. This the author proposes to call the maximum molecular repulsion, which, in the case of carbon disulphide and chloroform, is attained with a mixture in which the molecular ratios are as 1 : 1. Mixtures in these proportions are found to show abnormally high vapour-tensions. And the author has made experiments which appear to show that, when carbonic acid and hydrogen are mixed, the joint volume is measurably greater than the sum.

On the Evidence Deducible from the Study of Salts, by Spencer Umfreville Pickering, M.A.—In this paper the author deals with the evidence as to the molecular weights of salts, derived from a study of the composition (1) of hydrated salts; (2) of basic salts; (3) of double salts. He also criticises the evidence deducible from experiments on hydration, dehydration, and the vapour tension of hydrated salts, and finally examines the conclusions drawn from the calorimetric investigations of such compounds. The conclusions arrived at by the author are that, although in a few isolated cases the molecular weights obtained would appear to be greater than the analytical results necessitate, still, in a vast majority of cases there are no grounds for multiplying these weights, and indeed there is a considerable mass of evidence in favour of adhering to the simplest possible formulæ. Such a conclusion may, at first sight, appear opposed to conclusions drawn from other sources. On the one hand the author considers it undeniable that if we succeed in determining the number of replaceable portions of the elements in any compound, we determine *ex hypothesi* the number of atoms in the molecule, that is, the molecular weight; and whilst the data at our disposal at present are of the most meagre description, nevertheless are such as seem to point to the simplicity of these molecules. On the other hand, considerations based on the crystalline form and other physical properties of bodies force on us the conclusion that liquid and solid molecules are in all probability of a very complicated nature, certainly more complicated than gaseous molecules. Both these conclusions the author considers to be reconcileable with one another and contends that because the smallest particle of a substance which enters into a chemical reaction may be simple, there can be no reason why many of these particles may not agglomerate and act in unison as regards certain physical forces. That this agglomerate does not act as a unit towards chemical forces would simply imply that the force which unites the individuals constituting it is not chemical force, or is chemical force of such a weak nature that, in presence of the strong chemical agents we make use of, it is inappreciable. The molecule of a chemist is not necessarily identical with the molecule of the physicist.

On the Molecular Weights of Solids and Salts in Solution, by Prof. W. A. Tilden, D.Sc., F.R.S.—Accepting the conclusion that bodies in the solid state consist of units or molecules of a very complex character, and made up of a number of such smaller aggregates as compose the molecules of gases, the author is inclined to go further, and sees no reason for limiting the number of small molecules, which may thus be bound together to form a physical unit. From the law of Dulong and Petit, and of Neumann's law, it would appear that in solid elementary bodies, and in salts, &c., there is no difference between molecule and mass, and that the physical unit is the atom. The facts known concerning specific volumes and refraction equivalents support such a conclusion. According to this view solid bodies are composed of atoms, which are only distributed into molecules capable of independent existence; when the body becomes a fluid. Such a view implies that chemical combination between atoms and the combination of molecules which ensues when a gas or liquid returns to the state of a solid are phenomena of the same nature, which agrees with the commonly recognised resemblance between the process of dissociation and those processes of fusion and evaporation. Another consequence of this view is that the idea of limited valency must be confined to gaseous substances. With regard to solutions, many facts are known, which indicate that the molecules of dissolved substances are smaller than those of solids. With regard to the question of water of crystallisation, the author does not altogether agree with the views of Dr. Nicol (see *Report on Solution*, NATURE, vol. xxxii. p. 529), but considers that the composition of the salt molecule in solution is dependent chiefly upon temperature, and in such a way that the dissolved molecule retains the same amount of water as the crystals formed at the same temperature. As the temperature rises these molecules undergo a gradual dissociation, and at a certain temperature the salt molecules lose this water and become anhydrous.

On the Molecular Constitution of a Solution of Cobaltous Chloride, by Prof. W. J. Russell, Ph.D., F.R.S.—A thin layer of cobaltous chloride gives an absorption spectrum consisting of two broad, ill-defined bands. If the chloride be mixed with potassium, sodium, or calcium chlorides, the spectrum of these mixtures, both in the solid and fused state, is different from that of cobaltous chloride, and consists essentially of four bands, two of which are marked and characteristic. This same spectrum is obtained with solutions of cobaltous chloride in absolute alcohol, in amyl alcohol, in hydrochloric acid, or in glacial acetic acid. This spectrum would, therefore, appear to be that of cobaltous chloride in an altered molecular state. The spectrum of an aqueous solution is again different, and consists of one broad band nearer to the blue end than the other bands, but the addition of cobaltous chloride to such a solution, or of such bodies as possess an affinity for water, causes a reversion of the spectrum to that of the anhydrous cobaltous chloride. Heat also produces the same effect, and it would appear from these results that the anhydrous chloride can exist in aqueous solutions. The changes in the character of the spectrum of an aqueous solution produced by heat may be explained as arising from a dissociation of some of the hydrates existing in the solution, and the production of anhydrous cobaltous chloride. Further, the fact that those solutions containing the anhydrous salt more readily transmit the blue rays and absorb the red rays, whilst those containing hydrates in solution more readity transmit the red rays, would indicate that the molecule of the hydrate is smaller than that of the anhydrous salt. The action of water on the anhydrous salt, therefore, is not to form an additive compound, but to split the molecule of the anhydrous salt and form one in which water replaces cobaltous chloride.

In the discussion which followed the reading of these papers Prof. Ramsay said that the density of a saturated vapour afforded a clue to the molecular complicity. Now while a liquid such as water or alcohol gave a saturated vapour, which at a sufficiently low temperature and corresponding low pressure had normal density, the saturated vapour of acetic acid, on the contrary, had an increasing density with fall of temperature, this density showing that the molecule has passed the stage $C_4H_8O_4$ and is on its way to $C_6H_{12}O_6$, if the results are to be explained by agglomeration of simple molecules at all.

Dr. Gladstone remarked that from the evidence of coloured salts in solution such as the sulphocyanides of cobalt, he believed that a dissolved salt might be in an anhydrous condition and might become more and more hydrated as the mass of water in its presence is increased or its temperature lowered. Evidence of other changes might also be obtained from the colour of solutions. He did not think that the refraction of light by a body is often likely to tell anything about its molecular volume; but in the case of the polymeric olefines, C_nH_{2n}, the specific refraction and dispersion will probably decrease considerably as the value of n becomes greater, on account of the increasing proportion o carbon in the normal condition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following have been appointed examiners for the ensuing year:—Physics and Chemistry: Prof. Schuster, F.R.S., and Mr. R. T. Glazebrook, F.R.S.; Chemistry: Messrs. A. Scott and W. J. Sell; Mineralogy: Prof. Liveing; Geology: Messrs. J. J. H. Teall and J. E. Marr; Botany: Messrs. W. Gardiner and H. M. Ward; Human Anatomy: Profs. A. Macalister, F.R.S., and G. D. Thane; Comparative Anatomy: Mr. A. Sedgwick; Physiology: Prof. Michael Foster, Sec. R.S., and Mr. A. S. Lea; Pharmacy and Pharmaceutical Chemistry: Prof. Wyndham Dunstan.

Mr. F. H. Neville, Sidney Sussex College, is appointed as teacher of chemistry with reference to certificates for M.B.

In the late Higher Local Examinations the arithmetic and Euclid were fairly well done.

In Algebra and Trigonometry the cases of gross failure were fewer, while the work of the better candidates was not so good as last year.

Considerable care had been taken to apprehend the facts of Mechanics, but some candidates merely stated a result when asked to "prove" or "establish" it; and when asked to draw inferences by means of the laws of motion, they drew inferences from quite other considerations. A certain amount of knowledge of Descriptive Astronomy was shown by some of the candidates: two of the twenty-two obtained more than half marks.

Only four candidates took the paper in Differential and Integral Calculus. Two of them showed a sound knowledge of the early definitions and rules for differentiation; the other two (who alone attempted the last eight questions) were less successful on the whole, and had confused ideas on the elementary parts of the subject. No marks were obtained in Integral Calculus.

In the Elementary Natural Science paper the work was as a whole extremely poor, notably in Chemistry.

In Physics the candidates seemed to possess very little power of giving concise and definite answers. The attempts to describe experiments and experimental proofs of physical laws were remarkably weak, and might be described as a mere echo of experimental lectures only partially understood; they showed none of the results that might fairly be expected from a careful consideration of those facts and principles which were clearly within the candidates' reading.

In Physical Geography and Geology most of the papers were good, but none excellent.

In Physiology the answers were on the whole satisfactory, while three or four papers showed that the writers had gained a very creditable acquaintance with the subject.

In Zoology most of the papers were far from creditable, and exhibited but little real or intelligent knowledge. The answers to the practical questions were uniformly bad.

In Botany the candidates displayed but little knowledge of what is meant by the terms "growth," and "collateral," and no one gave a good description of the method of measuring growth. The plant given for description was fairly well described, but the floral diagram was in many cases imperfect. The germination of a seed was not well described. Several students described *Penicillium*, *Mucor*, and *Agaricus*, as parasites.

At Gonville and Caius College an examination will be held on December 8 for open scholarships and exhibitions. Natural Science candidates, who must be under nineteen years of age, will be examined in Physics, Chemistry, Biology, and Animal Physiology; proficiency will be expected in at least two of these subjects, of which chemistry must be one. Further information will be given by the tutors.

At the annual election on November 2 at St. John's College, the following were elected to Fellowships:—A. Harker, M.A., Eighth Wrangler 1882, First Class Nat. Sciences Tripos (Physics) 1883, Woodwardian Demonstrator in Geology; D. W. Samways, M.A. (D.Sc. London), First Class (with distinction in Physics) Nat. Sciences Tripos, 1881, University Extension Lectures in Physics and Physiology; W. H. Bennett, M.A. (M.A. London, Mathematics), First Class Theological Tripos 1882, Tyrwhitt Hebrew Scholar; W. Bateson, B.A., First Class Nat. Sciences Tripos (Zoology) 1883, Assistant Demonstrator of Animal Morphology; R. W. Hogg, B.A., Sixth Wrangler 1883, First Class, Part III., Mathematical Tripos, 1884.

THE annual election of Fellows of St. John's College, Cambridge, took place on Monday, when the five vacancies were filled up by the election of the following graduates of the College:—

(1) A. Harker, M.A., 8th Wrangler, 1882—First-class Natural Sciences Tripos, Part I., June, 1882, First-class Natural Sciences Tripos, Part II., June, 1883, for Physics, Woodwardian Demonstrator in Geology.

(2) D. W. Samways, M.A., D.Sc. London—First-class Natural Sciences Tripos, 1881, distinguished in Physics.

(3) W. H. Bennett, M.A.

(4) W. Bateson, B.A.—First-class Natural Sciences Tripos, Part I., June, 1882, and First-class Natural Sciences Tripos, Part II., June, 1883, for Zoology and Comparative Anatomy, Assistant Demonstrator in Animal Morphology.

(5) R. W. Hogg, B.A., 6th Wrangler, June, 1883, and in the first division Mathematical Tripos, Part III., January, 1884.

PRELIMINARY SCIENTIFIC EXAMINATION OF THE UNIVERSITY OF LONDON.—The following statistics of the Preliminary Scientific Examination for the degree in Medicine of the University of London are of importance as conclusively proving that those members of the medical profession who so urgently declare this examination to be too severe are entirely misinformed. At the examination in last July there passed from all parts of the United Kingdom 159 candidates. Nearly an equal number were rejected; but that this is owing to the fact that the candidates had not sought the usual and proper methods of preparation, and not to the fact that the examination is a specially difficult one, is proved by the following important facts:—63 candidates entered for this examination, stating that they had prepared for the examination wholly or in part at University College, London. Of these 63 candidates 52 passed, and several took honours. Thus less than one-fifth were rejected of those candidates who attended the carefully-organised teaching of University College. This is an exceedingly small proportion of failures for any pass examination. From other London colleges a much smaller number of successful candidates is recorded. The largest number after the University College list is that of St. Bartholomew's Medical School. Instead of 52 we fine here, however, 16. Then come Guy's, St. Thomas's, and King's College, each with 11, London Hospital with 5, St. Mary's with 3, and St. George's, Middlesex, and Charing Cross, each with 1. These figures lend strong support to the suggestion which has so often been made, that the Hospital schools would do well to cease the attempt to teach purely scientific subjects, and should recognise the Faculty of Science of University College as the common preliminary scientific school for all London hospitals. The students themselves, it is obvious, already take this view. Of the 52 successful candidates belonging to the Faculty of Science of University College only 12 have entered the Faculty of Medicine of that institution. The remaining 40 have selected their hospitals without prejudice. Several have obtained entrance scholarships at the large London hospitals.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale de Belgique, July.—Observations on the planets Jupiter and Venus, made at the Astronomic Institute of Ongrée, by M. L. de Ball.—On the eurites, or older rhyolithic formations of Grand-Manil, by M. Ch. de la Vallée Poussin.—On the pretended bacterian origin of diastase, by M. Emile Laurent.—On the organic structure and growth of *Phycomyces nitens*, by the same author.—On the Devonian limestones of coral origin and their distribution throughout the palæozoic formations of Belgium, by M. E. Dupont.—Theory of elliptic functions: Hermite's equation, by M. J. A. Martins da Silva.—The philosophic system of the Bhagavadgîta, by M. Le Roy.—An unpublished Latin inscription referring to T. Desticius Severus, Procurator of Gallia Belgica, by M. Bartolini.—Origin of the Flemish inhabitants of Belgium, with preliminary remarks on the Suevi of Flanders, by M. Alph. Wauters.

August.—Fresh researches on the apparent enlargement of the sun, moon, and stars at the horizon, by M. Paul Stroobant.—Reaction of the sulphate of barium and the carbonate of sodium under the influence of pressure, by M. W. Spring.—Note on the lower Devonian rocks of Belgium: the pudding system of Weris and its transformation, by M. E. Dupont.—Experimental researches on the sense of sight in insects: Do insects distinguish the outlines of objects? by M. F. Plateau.—Determination of an empirical relation connecting the tension of vapour with the coefficient of internal friction in fluids, by M. P. De Heen.—The eurites of Grand-Manil (continued), by M. Ch. de la Vallée Poussin.—Biographical notices of Mathieu de Morgues and Philippe Chifflet, by M. Auguste Castan.—On the old Persian, Hindu, and Chinese literatures, by M. Ch. de Harlez.—Note on the domain of the Aduaticæ, and on some other questions of ancient Belgian geography, by M. L. Vanderkindere.

Schriften der Physikalisch-Okonomischen Gesellschaft zu Königsberg i. Pr., 25th year (1884).—1st and 2nd parts.—Memorial address on Oswald Heer (with list of works) by A. Jentzsch.—On the development of the oil-vessels in the fruits of Umbelliferæ, by J. Lange.—Festival address on the centenary of Bessel's birth, by I. Franz.—Correction of Sanio's memoir on the numerical relations of the flora of Prussia, by J. Abromeit.—Reports on local botany, museum collections, &c.

SOCIETIES AND ACADEMIES

London

Mineralogical Society, October 20.—The Rev. Prof. Bonney, President, in the chair.—Messrs. F. R. W. Daw, John Daw, Jun., G. F. Kung, and C. C. Ross, M.P., were elected members. The following were elected officers and Council for the ensuing year:—President: L. Fletcher, F.G.S.; Vice-Presidents: Rev. S. Haughton, F.R.S., Rev. Prof. T. G. Bonney, F.R.S.; Council: C. A. Burghardt, LL.D., A. Geikie, F.R.S., Rev. H. Gurney, M.A., Hugo Müller, F.R.S., Rev. W. W. Peyton; Treasurer: R. P. Greg, F.G.S.; General Secretary: R. H. Scott, F.R.S.; Foreign Secretary: T. Davies, F.G.S.; Auditors: B. Kitto, F.G.S., F. W. Rudler, F.G.S. The Secretary read the following Report of Council:—The balance-sheet for the year 1884, which appeared in No. 28 of the *Journal*, showed that the finances of the Society were in a healthy condition, the excess of assets over liabilities amounting to 215*l*. 12*s*. 4*d*. The number of Members and Associates elected during the year has been seven, and the number of resignations five, while the names of four Members and one Associate have been removed from the list for non-payment of subscriptions for three years. The Council regret that they have to report also the death of Alexander Murray, C.M.G., of St. John's, Newfoundland. Three meetings have taken place since the last anniversary: those in December and March were held in the Museum of Economic Geology, by kind permission of the Director-General of the Survey; the third was held in Glasgow in the month of June, in the rooms of the Philosophical Society. This, the second Scottish meeting, was, like its predecessor in 1884, a decided success. Three parts of the *Journal* have been issued during the year. Among their contents the Council would especially draw attention to Mr. Miers' contributions, including his careful index to the mineralogical literature of the year. Herr Sjögren's paper on graphite also deserves notice; it is a translation from the Swedish, as it originally appeared in the *Forhandlingar* of the Stockholm Academy. In conclusion the Council would only remind the members that it is very desirable that they should co-operate actively in the working of the Society by the contribution of papers to be read at its meetings and published in its *Journal*. It is by such co-operation alone that the Society can be maintained in a state of vigorous activity. The President then delivered his address, which will appear in the *Journal*. Prof. Bonney then vacated the chair, which was taken by the newly-elected President, Mr. Fletcher, and the following papers were read:—H. A. Miers, on a crystal of orthoclase.—R. H. Solly, notes from the Mineralogical Laboratory, Cambridge, being an account of the following minerals:—garnet, axinite, asbestus, and semiopal from the Mid-Devon Copper Mine, apatite or Francolite from the Levant Mine, and Fluor Spar from Holmbush.—Dr. Max Schuster, results of the crystallographic study of danburite.—W. E. Dawson, analysis of a supposed new chromate of lead from the Transvaal.—Prof. Lewis exhibited a fine crystal of colemanite; and Mr. Fletcher exhibited some Roman coins found near Chester and presenting crystals of cuprite.

Sydney

Linnean Society of New South Wales, August 26.—Prof. W. J. Stephens, M.A., F.G.S., President, in the chair.—The following papers were read:—List of plants in use by the natives of the Maclay Coast, New Guinea, by N. de Miklouho-Maclay, with botanical remarks by Baron Ferd. von Müller, K.C.M.G., &c. Baron Maclay in this paper gives (1) a list of the plants used as food, dividing them into those cultivated and those growing wild; (2) those cultivated as stimulants or for medicine; (3) those useful in various ways for household purposes; and (4) those introduced since 1871. An Appendix by Baron Müller gives an account of some of the plants mentioned by Baron Maclay and gives a description of a new species named *Bassia maclayana*.—Catalogue of the Coleoptera of Australia, by George Masters. This is the first of a series of papers intended by Mr. Masters to make a complete and perfect list of all the known species of Coleoptera in Australia. The present part comprises the Cicindelidæ and Carabidæ, and numbers 950 species.—Descriptions of three new Port Jackson fishes, by J. Douglas-Ogilby, Assistant Zoologist, Australian Museum. The three species here described are *Scyllium anale*, *Heliastes immaculatus*, and *Pempheris lineatus*.—Mr. Macleay exhibited a section of a branch of an orange tree completely perforated by the larva of a longicorn beetle. Also three specimens of a beetle found in the perforated wood. The exhibit had been sent by Mr. M. de Meyrick, a member of the Society, who stated that many orange trees had suffered in the same way in the neighbourhood of Penrith. Mr. Macleay said the injury was caused by the larva of *Monohammus fistulator*, a grub destructive to all kinds of fruit trees, but, as far as his experience went, its ravages were confined to old or decaying trees, and it would be interesting to know if in any instance it had been found to attack young and vigorous plants. The accompanying beetles were heteromerous insects of the genus *Amarygmus*, and were not in any way the cause of the injury to the tree.—Mr. A. Sidney Olliff exhibited specimens and sketches of *Cryptommatus jansoni*, Matt., a curious beetle which was found under the fur of the common rat in Tasmania, and said that he believed new and interesting species with similar habits might be found in Australia if the smaller mammals were examined when freshly killed. Two allied species were known from Peru, one of which was found in the fur, and also in the nests, of mice. The specimens exhibited were captured by Mr. A. Simson and had been obtained from Mr. Morton, of the Hobart Museum.

PARIS

Academy of Sciences, October 26.—M. Bouley, President, in the chair.—A means of preventing rabies from the bite of a mad dog, by M. L. Pasteur. After almost endless experiments the author announces that he has at last succeeded in obtaining a practical and prompt prophylactic remedy, which has already proved sufficiently efficacious in the case of dogs, to justify the belief in its general efficacy when applied to all animals, including man himself. A full account of the process will be found at p. 1 of this week's NATURE.—Direct fixation of free atmospheric nitrogen in plants through the agency of certain argillaceous clays, by M. Berthelot. Some years ago the author found that to atmospheric electricity was largely due the attraction of free nitrogen to the immediate elements of vegetable organisms. After fresh experiments conducted for two years at the Meudon station for vegetable chemistry, he has now discovered a new and perhaps a more general cause of this arrestation in the silent but incessant action of argillaceous clays and of the microscopic organisms contained in them. In this memoir he gives the results of over 500 analyses of four different clays constituting five distinct but simultaneous series of experiments in a closed chamber, in a field under shelter, on top of a tower 28 metres high without shelter, in hermetically sealed flasks, and lastly in soil artificially sterilised.—Note on the Cynthiadæ of the French seaboard, by MM. H. de Lacaze-Duthiers and Yves Delages. In the present paper the authors restrict their remarks to the typical *Cynthia morus*, a characteristic group of simple ascidians occurring in the English Channel, in the Atlantic, and in the Mediterranean. The several varieties are determined and the anatomy of the whole group described in detail.—Note respecting some recent communications on waterspouts, by M. Faye. The author's remarks refer to the report issued by the United States Army Signal Service on the thirteen tornadoes of May 29-30, 1879, the most complete and elaborate account of these phenomena hitherto published.—Experiments on the transmission of force by electricity between Paris and Creil, by M. Marcel Deprez. These costly experiments, begun on October 17, 1884, and carried out with the aid of MM. Rothschild, have so far proved very satisfactory. In a future communication complete tables are promised of all the electric and mechanical data of the experiments hitherto made both by the author and by M. Collignon.—On the propagation of motion in bodies, and especially in perfect gases, by M. Hugoniot.—Note on a new process for making hydrogen gas, by MM. Felix Hembert and Henry. By this simple and economic process hydrogen gas available for numerous combinations applicable to the arts and industries may be produced at the rate of 0·015 franc the cubic metre.—Discovery of a new planet (No. 25*a*, of 13th magnitude) at the Observatory of Nice, by M. Perrotin.—Remarks on the new star in the nebula of Andromeda, one illustration, by M. E. L. Trouvelot. This new star A, as well as the already discovered B, would appear to form part not of the nebula itself, but of the Milky Way. — Application of M. Lœwy's new methods for determining the absolute co-ordinates of the circumpolar stars, without the necessity of ascertaining the instrumental constants (polar distances), by M. Henri Renan.—Questions relating to a bundle of plane cubic figures (continued), by M. P. H. Shoute.—On birational plane geometrical transformations, by Mr. G. B. Guccia.—General differential equations reducible to quadratures, by M. Wladimir Maximowitch.—Note on a new absorption spectroscope, by M. Maurice de Thierry. This apparatus enables the observer to study fluids under a thickness of 3 to 10 metres, and to detect the presence of oxyhemoglobine in a liquid containing not more than 1-5,000,000th of that substance. It is an instrument of extreme precision, capable of rendering great services to forensic medicine, physics, and biological chemistry, by facilitating the study of the absorption spectra of fluids examined under a great thickness.—Note on a new neutral carbonate of magnesia, by M. R. Engel. This is an anhydrous carbonate absolutely different both from the natural neutral carbonate (CO_3Mg) and from the crystallised and anhydrous neutral carbonate artificially obtained by M. de Senarmont.—On the volatile property of the mixed organic compounds, by M. Louis Henry.—Note on the zymotic properties of four kinds of virus: those of the spleen, of puerperal septicemia, of gangrenous septicemia, and of the symptomatic charbon of the ox, by M. S. Arloing.—On the existence of two kinds of sensibility to light—the sense of colour and of form, by M. H. Parniaud.—On the physiological action of the sodic sulpho-conjugate of rocellic acid, by MM. P. Cazeneuve and R. Lépine.—On the circulation of the blood in the nerve-cells of the intervertebral ganglia, by M. A. Adamkiewicz.—On the method of distribution of certain sympathetic intra-cranial chords, and on the existence of a sympathetic root of the ciliary ganglion in the goose, by M. F. Rochas.—On the development of the nematodes (second note), by M. Paul Hallez.—Fresh researches on the influence of shocks on the egg-germ of the hen during the period between laying and hatching, by M. Dareste. Theoretical researches on the distribution of heat on the surface of the globe, by M. Alfred Angot.—On the varying dates of the vintage season in France since the year 1236, by M. Alfred Angot.—Application of thermo-chemistry to the explanation of geological phenomena: carbonate of zinc, by M. Dieulafait.—On the green luminous ray observed at sunset in the Indian Ocean, by M. Trève.—Remarks on M. G. Arth's recent note regarding the action of the nitrate of anhydrous ammoniacal ammonia on some metals, by M. Ed. Divers.

STOCKHOLM

Academy of Sciences, October 14.—The following papers were presented for insertion in the Society's *Journal*:—A monographic revision and synopsis of the Microceridæ and Protomantinidæ, by Prof. Aurivillius.—Lois de l'équilibre chimique dans l'état dilué, gazeux ou dissous, by M. T. H. vant Hoff.—On the distribution of the sexes in *Acer platanoides*, L., and in some other species of Acer, by Prof. V. Wittrock.—*Codiolum polyrhizum*, n.sp., a contribution to the knowledge of Codiolum A. Braun, by Herr G. Lagerheim.—Contributions to the knowledge of the specific warmth of some minerals, by Dr. W. Öberg.—On Petrus de Dacia, by Dr. G. Eneström.—The osteology and exterior conformation of Sowerby's whale (*Micropteron bidens*, Sow.), by Dr. Carl Aurivillius.—Researches on remains of the limbs in the Ophidians, by Miss Albertina Carlsson.—Investigations into some sources of error in measuring the amount of the rainfall, by Dr. S. A. Hjeltström.

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