THURSDAY, AUGUST, 19, 1880

## COLOURS IN ART

*A Handbook for Painters and Art Students on the Character and Use of Colours, their Permanent and Fugitive Qualities, and the Vehicles proper to Employ. Also Short Remarks on the Practice of Painting in Oil and Water-Colours.* By W. J. Muckley. (London: Baillière, Tindall, and Cox, 1880.)

THAT a book for the instruction of artists as to the composition and purity of their pigments is much needed can hardly be denied. The difficulty, however, in writing such a book is very great; for it must either be very incomplete or contain a large amount of matter which but very few artists can understand. And no one is competent to write such a book but he who has some knowledge of painters' manipulations and a very good knowledge of chemistry; to drop the chemistry and take upon faith what has been written about the purity and nature of pigments, is hardly the method which should be adopted, and the person who does it is not likely to be a very safe guide to the artist, although he may give very many useful hints, and state much that is true. To treat of colours properly their composition must be described and the adulterations to which they are liable should be explained, which cannot be done without a certain amount of chemistry and chemical terms, and if the persons who read a book on pigments know nothing about chemistry, how can they be benefited by it? And this is difficulty number two. How is it to be overcome? Why, simply by artists learning something of chemistry? There is no other way for it. A book so incomplete as that under consideration is very misleading, because a person after reading it will know but little more about pigments than when he began. Of what use is it to know that cadmium yellow is a "sulphide of the metal cadmium," and that "emerald green is a preparation of copper," unless it be known that the elements which compose each have a decided liking for changing places, and that if these pigments are brought into contact the change will assuredly take place to the entire destruction of the tint of both of them? The real truth of the matter is that until artists will consent to become, to a certain extent, students of science, they will never get out of their difficulties, and if they will consent to this, to some of them we fear derogatory task, they will find that there is more help for them from science than they imagined: chemistry will lead to physics, and then for the first time perhaps many of them will learn what colour is, and what light and shade *really* are, and new views will burst upon them, and new methods of using their pigments will become necessary, and then pictures will be resplendent with nature's tints, and transparency will replace opacity, and nature will have some chance of being fairly represented. There are many artists who are scientific men, and there are others to whom nature has given special powers; and these show by their works that they understand or appreciate the true nature of colour and of light and shade. Look at Mr. Brett's sea-pieces (he is a scientific man of note), they are bright, luminous, and true to nature, although they may not please painters of the old school, one of whom once, when asked what he thought of one of this artist's pictures, was heard to say he did not like rocks. As an illustration of one who lays no claim to be a scientific man, take Mr. Herbert's painting of *Moses* in the House of Lords, where bodies of the colour nearly of the sandy back ground stand out from it without any tricks, with all the vivid distinctness of a stereoscopic picture.

To those who know nothing of chemistry what directions can be given for the use of paints which in themselves are stable, but which cannot be mixed with certain others? It would take a huge volume to record all the cases in which they could be used, and to note all the contingencies which might arise to influence them, and yet a little sound chemical knowledge would make the matter easy and brief. Good champagne is a good and wholesome wine, and good old port is a nectar fit for the gods, and hock and claret are cooling drinks which, with their fragrant bouquets, appeal to the imagination: all are good and wholesome; but mix them all in the same stomach at a great feast, and what will be the result, at least in most cases? Vermilion is a good and safe pigment, so is cadmium yellow, and so is emerald green; but mix them all together, and what will happen? Keep the emerald green and the cadmium apart by some hard and quick-drying vehicle, and all will be well; allow a day's interval to elapse between taking the champagne and hock, and port and claret, and no inconvenience will be experienced.

It is very refreshing to read from the pen of Mr. Muckley the warning which he gives to artists to restrict the number of colours which they employ. It is to the use of bright and new tints with which the French colourmakers tempt our artists that much of the evil complained of is due, and moreover the adulteration practised abroad, but rarely in this country, has added to it. Mr. Muckley has divided pigments into "permanent colours" and "useless pigments." Speaking of "whites," he very justly recommends zinc white as being permanent, but then he speaks of "flake white" as permanent, but confesses that it loses "its opacity by age," and that "impure air and sulphuretted hydrogen turn white lead" (*i.e.* flake white) "to a dirty brown in a short time." One would hardly rank this among permanent colours. Amongst yellows he mentions "lemon yellow" as not altogether trustworthy. Now lemon yellow is chromate of baryta, and, like all other chromates, is liable to reduction by organic matter, and then, as it becomes reduced, its tint changes to green. Although he ranks this pigment among "permanent colours" he does so with a caution; why then place it in this list? "Aureolin" is also included in it; but very grave doubts are entertained of its stability in oil by many artists. It certainly resists the action of alkalies fairly well.

"Naples yellow," a pigment which portrait and figure painters have a great affection for, is now a compound made in imitation of the old paint, which consisted of antimony and lead; it was usually some time ago made with white lead tinted with some yellow pigments. If made with zinc white and cadmium, as Mr. Muckley asserts, there is not much danger in using it.

Amongst the "useless pigments" which are said to be "stable" it should be remarked that the whites, "Blanc d'Argent or silver white," "London and Nottingham white," are both white lead, and therefore subject to the same influences as "flake white." "Scheele's green," which is an arsenite of copper, can hardly be called a "stable" colour, "but unnecessary."

"Semi-transparent colours." Amongst these is placed "cremintz white." Why this should be it is difficult to understand, if flake white is to be ranked among permanent colours, for cremintz white is white lead produced by precipitation.

"Prussian blue" is spoken of as not being durable; it is quite certain that it stands well sometimes, but that its hue does often fade. This must surely cause a reflecting mind to ask himself how this can be? The colour is so beautiful and useful to the artist that some effort should be made to prevent its total expulsion from his palette, and here we have an instance of the importance of chemical knowledge to the artist. It is impossible in this place to go into the question; it is however manifest if a pigment stands well at one time but not at another that it must be mixed, in the latter case, with something which does not agree with it. Now this is true; from its composition prussian blue is affected by anything which will change the state of oxidation in which part of its constituent iron is held. Terra verte, for example, is, or ought to be, an earth tinted with the protoxide of iron; if this is mixed with prussian blue it will in time change the condition of the oxide of iron in the prussian blue, and therefore its colour. In concluding these remarks on pigments treated of in Mr. Muckley's book one feels great pleasure in being able to state that with the few exceptions noticed there is nothing incorrect, only one feels how terribly wanting it is in completeness when a thoroughly scientific treatment of the subject is required. One of the points which artists have to guard against is adulteration of pigments; now this is a thing of constant occurrence, where cheap colours are bought, but in this work nothing is said about this important matter. However well an artist may select his paints, impurities in one or two of them may upset all his calculations and render of no value a work which might, if sound, represent a considerable sum of money. From the present position of art in this country this is probably the most touching way of putting it. It would be well, in a future edition, if Mr. Muckley would attend to this, and give some simple methods by which the impurities could be detected.

It is as important to the artist that he should understand the nature of the vehicles with which he paints as the composition of his pigments, and here one wishes that Mr. Muckley had gone more into detail, and that he had given reasons why such substances as maguilps, mastic, sugar of lead, &c., are so very objectionable. The reason why pictures crack is because two or more media are used which dry differently; if the vehicle employed is homogeneous there is no fear of cracking. Maguilp is made by mixing linseed oil with mastic varnish, and mastic varnish is gum mastic dissolved in turpentine. When these are mixed together the turpentine goes to the oil and leaves the mastic in a jelly-like condition; the whole mass is then rubbed up together, and in proportion as the mixture is more or less complete so will the vehicle be more or less liable to crack, because it is made up of substances which take different times in drying. All maguilps are bad; here Mr. Muckley is right, and he is also right in advising the use of amber varnish and of good copal varnish tempered with nut (better with poppy) oil. No better media can be used than these, but the picture must be painted from first to last with one of them, whichever the artist selects, but the amber is the best. Six years ago the then Professor of Chemistry at the Royal Academy urged Messrs. Winsor and Newton to get amber varnish made, and that firm did so, therefore amber varnish has been to be had for that space of time, and several artists of distinction, viz., Mr. Brett, Mr. Vicat Cole, R.A., and others, have painted with it to their entire satisfaction; nor have they complained that it is too dark to mix with their lighter colours. When a picture is perfectly hard which has been painted with this vehicle, no better varnish can be used, when required, than amber varnish properly applied, that is, in as thin a coat as possible. Mr. Muckley speaks of mastic varnish blooming, but he does not tell us why it does so. It is because the substance is hygroscopic, and taking up moisture is the cause of blooming, therefore it should never be used. All driers, as he says, are unnecessary, they are all ruinous to pictures; under certain conditions crystallisable driers crystallise out and make the picture spotty. It would have been much more satisfactory if Mr. Muckley had treated this part of his subject at greater length and with greater minuteness; it is evident that he is quite competent to do so. Copal is a name used by varnish makers for several kinds of gum, and some of the cheap varnishes do not contain any of the better or harder gum. The kind used for artists' varnishes is what is termed a fossil gum, and is found largely at Zanzibar; it is almost, if not quite, as hard as amber, and almost intractable. The best copal varnishes sold by the best artist colourmen are, as a rule, made from this gum, and can be obtained from them with confidence. It is however pleasing to learn that so conscientious and respectable a firm as Messrs. Mander Brothers of Wolverhampton have undertaken to manufacture vehicles "in accordance with the old formulæ supplied by the author." There is no need whatever to use sandrac, it is very brittle and unmanageable.

In the work before us "turpentine" is spoken of as being, in conjunction with colours, "detrimental to their permanence." Turpentine, which is distilled with water from coniferous trees, oxidises and forms a resin, this it does most readily in the presence of moisture and sunlight. If then turpentine be kept free from moisture, in a well-corked bottle, in the dark, this will not happen, and the way to keep it free from moisture is to put into it lumps of quicklime or fused chloride of calcium; when so treated it may be used with safety. One does not like to have so old a friend banished without saying a word in his defence. The suggestion made to use oil of lavender is a very good one, but it need not displace turpentine, but both must not be used together.

"The conditions under which a painter commenced his education in former times were totally different from what they are now." It would be better for art if they were the same, though perhaps not better for art regarded as a trade. The paintings of the old masters certainly beat most of the modern works in this country, both in merit and durability. Mr. Muckley's remarks on this point are very good; one only wishes that he had treated this part of his subject more fully.

The chapter on "Mixing and Nature of Colours" is not as complete as it should be, from the almost entire absence of chemical illustrations, which on such a subject are invaluable. One remark, however, which often occurs in this book is most admirable. "The painter should always make an effort to use as few colours as possible, and they should be of the most permanent kind."

On damage to oil-paintings by gas and damp, it is stated that painter's canvas is usually prepared by first covering one side of it with a coat of whiting, to which glue size has been added. This is hardly a correct statement of the method employed by the best firms. The canvas is treated with size rubbed in with long knives, in the jelly form, it is then scraped off as bare as possible. This is done to protect the canvas from the disintegrating effects of the oil used in the preparation of the surface, for oil oxidises and speedily rots canvas, and therefore a coat of oil paint would not be, as stated, a protection to the back of prepared canvas: better use paraffin, which does not oxidise. Space will not allow a further notice of the concluding chapters of this work. One or two points, however, seem to require remark. "If darkening of a picture is due to some chemical action in the colours themselves, which is not unfrequently the case, the original condition of the work cannot be restored." If the darkening be due to the action of sulphuretted hydrogen or white lead, the whiteness can be restored by washing with peroxide of hydrogen.

In the directions given for painting the walls of the painting-room it is advised to use prussian blue, and the vehicle to be employed is spoken of as distemper colour. prussian blue is immediately decomposed by lime or chalk, and therefore cannot be used with these materials.

On the whole, one feels great pleasure in recommending this book as useful to art students. As has been before stated, it is matter for regret that parts of it have not been more fully treated, and at the same time it must be observed that, as regards scientific questions involved in the composition of pigments and on their action on one another, as well as the adulterations with which they are contaminated, the subject is almost wholly untouched, and we must look for some further treatise to illustrate and explain these points, either from Mr. Muckley or from some other author.

## *A VISIT TO ETNA*

*Un Viaggio all' Etna.* Del Prof. Orazio Silvestri, di Firenze, Presidente del Club Alpino Italiano a Catania. (Torino: Ermanno Loescher, 1879.)

THE Italian Alpine Club has branches in all the principal cities of the kingdom, and a good deal of useful work is done every year by its members. The work before us is designed not only for the benefit of the Club, but to foment and foster a greater taste among Italians for exploration, by setting before them a history of their most famous mountain, and detailing the very varied incidents to be met with in a journey to its summit. The book is divided into eight chapters, and is furnished with an appendix, which contains a list of the principal monticules on the slopes of Etna, with their altitude and position; the altitude of the principal towns on and around the mountain; and (to prevent imposition) the tariff established by the Catanian branch of the Alpine Club for the ascent of the mountain, and for visiting points of interest on its flanks.

The population of the mountain is rapidly increasing. In 1871 it amounted to 314,092, divided between thirty-nine cities, towns, and villages. The largest of these—Catania—contains 84,397 inhabitants; the smallest—S. Agata di Battiati—507.

The first chapter of the "Viaggio" carries the traveller from Turin to Naples, from Naples to Messina, and from Messina to Catania. The passing glimpses of Vesuvius and Stromboli are described, and the beautiful coast scenery between Messina and Catania, which embraces the Capo di Taormina, one of the most picturesque spots in Europe. The second chapter describes the ascent as far as Nicolosi, the last village on the route to the summit. In its immediate neighbourhood are the Monti Rossi, formed during the eruption of 1669, which is described at some length.

Starting from Nicolosi (Chapter III.), the traveller passes over the lava of 1537, and presently enters the *Regione Selvosa;* he notes the numerous groups of monticules scattered in various directions, rests at the Casa del Bosco, 235 metres higher than Vesuvius; and later on continues his journey through a region in which the vegetation becomes more and more sparse until he arrives at the Casa Inglese, near the foot of the great cone. Here the author bursts out into an "Inno alla Natura" improvised by the poet Mario Rapisardi on the occasion of his visit to the summit, and of which the following is a specimen:—

"Sorridi a noi, sorridi,
O Dea! sia che de l'Etna
T'amiamo oggi invocar,
O dai pietrosi lidi,
Ove fuggente e pavido
Scagliossi il poveretto Aci nel mar."

About two o'clock in the morning the traveller leaves the Casa Inglese for the summit (Chapter IV.). The severe climb up the cone of cinders (angle from 32° to 35°) is attended by some difficulty of respiration, both from the rarity of the atmosphere, and the presence of volcanic exhalations. The phenomena preceding sunrise are described, the gradual illumination of the scene, and the projection of the shadow of the mountain over Sicily. An account of the appearance of the great crater concludes this chapter. A description of the eastern flank of Etna and the Val del Bove furnishes the matter for the two succeeding chapters. The geology of the mountain is herein discussed; specially the theory of two axes of eruption, warmly supported by Lyell and other geologists.

After resting a night at Giarre, the traveller visits the eruptive craters of 1865, passing by the villages of S. Giovani and S. Alfio, and through the wood of Carpinetto, which contains the celebrated *Castagno del Cento Cavalli.* A detailed account of the eruption of 1865 which was minutely studied by Prof. Silvestri, is given in this part of the book (Chapter VII.). The last chapter is a very comprehensive one. It takes the reader completely round the northern, western, and southern flanks of the mountain, by way of Randazzo, Bronte, Adernò, Paterno, and Monte Ste. Anastasia, and so back to Catania. Reflections on the results of the journey are concluded by a perfervid peroration, in which the author reminds us that from the top of Etna we may see nearly the whole of that beautiful island which the ancient poets symbolised as "La bionda e leggiadra figlia di Cerere e del sole," and the moderns yet more happily as "la fulgida perla dell' Italico diadema circondata da tre puri zaffiri; il Tirreno, il Jonio, l'Africano" . . .

The book is not illustrated, but it contains a clear and very accurate map of Etna, reduced from that of von Waltershausen, and with the addition of the eruptions subsequent to 1843. Prof. Silvestri's style, while it is accurate and precise from the scientific standpoint, is never dull or lagging. He carries his reader with him, and excites a genuine enthusiasm, which all who know him can well understand. G. F. RODWELL

## *OUR BOOK SHELF*

*Methods and Theories for the Solution of Problems of Geometrical Construction, Applied to* 410 *Problems.* By Julius Petersen.

*Text-book of Elementary Plane Geometry.* By the same. (London: Sampson Low, 1880.)

SOME months since we noticed Prof. Petersen's "Theorie der algebraischen Gleichungen," and now we desire to draw attention to two more works by the same writer. The former, in its Danish garb, appeared so long ago as the year 1866, and having been tried and found to be a successful text-book, the author naturally desired to offer his work to a wider circle of geometers and students. The "Methods" has been rendered also into French; it is "an attempt to teach the student how to attack a problem of construction." Solutions in most cases are merely indicated, the following up the author's remarks being left to the student or teacher. The first chapter treats of "Loci" (method of similitude and inverse figures); the second of "Transformation of the Figures" (parallel translation, replacing, and revolution around an axis); the third of "The Theory of Revolution," with an appendix on systems of circles and on the possibility of solving a given problem by the straight edge and pair of compasses. It is a work of considerable merit. The "Text-book" we do not value so highly, though there are points of interest and novelty about it also; it contains besides 228 geometrical exercises. We hail Prof. Petersen as a valuable coadjutor in the work of improving geometrical teaching, and shall be glad if his little books meet with a fair measure of acceptance in this country. We could point out what we consider blemishes, but in the main commend both books. The respective translators (both, we presume, Danish students) have done their part intelligently, and English students will have no difficulty in understanding the language, though they may not be able to master the matter.

*Practical Chemistry. The Principles of Qualitative Analysis.* By W. A. Tilden, D.Sc. (Longmans and Co., 1880).

OF making books on practical chemistry there is no end. If it were necessary that another should be added to the list, the publication of this little book by Dr. Tilden has surely removed the necessity.

There is no special feature to be noted in this book: it is clearly and accurately written, and proceeds on the well-beaten paths. The adoption of a general table printed on strong paper and protected by cloth backing is to be commended.

It is, we think, doubtful whether anything is to be gained by attempting to teach mere outlines of the methods for analysis of mixtures; a more thorough grounding in qualitative analysis may, as a rule, be given by limiting the student's work for some time to simple salts—which is not such an extremely easy branch of analysis as may at first sight appear; then proceeding to mixtures of metals with one metal only in each group; then to mixtures of various metals of the same group; and lastly to complex mixtures.

The detection of acids—even of a simple acid—is made, as is usual in elementary text-books, to appear a much less difficult undertaking than it really is.

## *LETTERS TO THE EDITOR*

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

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

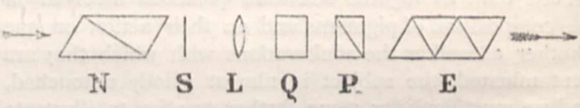
### A Rotatory Polarisation Spectroscope of Great Dispersion

I HAVE just had an opportunity of trying, on a fine aurora, an instrument for measuring the wave-length of monochromatic light in terms of quartz-rotation of its plane of polarisation. My apparatus is, as yet, very roughly put together, so that I got no measurements of any value, but to-night's experience has shown me that the method, while simple in application, is capable of very great accuracy.

The construction of the instrument will be easily understood from the anexed rough sketch. The course of the light is with the arrows. N is a Nicol, S an adjustable slit, L a lens at its focal distance from S, Q a plate of quartz cut perpendicularly to the axis, P a double-image prism, and E a small direct-vision spectroscope, which may be dispensed with when absolutely monochromatic light is to be examined.

When the instrument is properly adjusted by daylight the two images of S formed by P are parts of a straight line, so that E gives two spectra side by side. These are crossed by dark bands, which are numerous in proportion to the thickness of Q, and which move along the spectra as N is made to rotate.

In observing a bright-line spectrum the slit is to be made as wide as possible, subject to the condition that no two of the




differently-coloured images shall overlap. We have thus a pair of juxtaposited rectangles for each of the bright lines, and the angular positions of N, when the members of the several pairs are *equally bright*, are read off on a divided head. I find by trial that a division to 2° is quite sufficient.

A *first* set of readings is taken with a plate Q (permanently fixed in the instrument) 5 or 6 millimetres thick. Then an additional plate of quartz 100 millimetres or more thick is introduced between Q and L, and a *second* set of readings is taken. From the readings with the thin plate we find approximately the positions of the spectral lines, and the more exact determination is obtained from the readings with the thick plate.

This is the chief feature of the instrument. The actual error of any one reading is not more than 2°, but when a thick plate is used the whole rotation may be from ten to twenty or even thirty circumferences. By thus increasing the thickness of the quartz plate *very* little additional loss of light is incurred, while the inevitable error forms a smaller and smaller fraction of the whole quantity to be measured.

The graduation of the instrument is to be effected by very careful measurements upon a hydrogen Geissler tube, and comparison with the known wave-lengths of the hydrogen lines.

An observer furnished with this instrument (which is not much larger than a pocket spectroscope) and with a long rod of quartz, will be able to make measurements of any required degree of accuracy. P. G. TAIT

The Club House, St. Andrews, N.B., August 12

### Dimorphism of "Nature" on June 17

WITH reference to the statement in an editorial note in NATURE, vol. xxii. p. 317, that one statement of mine "does not accord well" with another, I must request to be allowed to show that this observation is incorrect.

I was told by a friend on July 27 (five weeks after the event) that there had been apparently two issues of NATURE of June 17, and that Prof. Allman was intending to write to NATURE quoting the uncorrected issue (which was unfortunately the one which had been supplied to him) in support of his statement, in NATURE, vol. xxii. p. 218, which I had declared to be a misconception (NATURE, vol. xxii. p. 241), viz., that I differed from him as to the existence of a marginal canal in the new medusa. Accordingly I wrote on July 28 to the editor, requesting him to state, "if necessary," that there had been two issues, and expecting that this explanation would be inserted immediately after Prof. Allman's letter, published in NATURE, vol. xxii. p. 290. The explanation was not, however, given, and it was left to me to write my letter of two days later date (July 30), which was published in NATURE, vol. xxii. p. 316. I had in that two days interval "ascertained" by further evidence that there were actually two issues of No. 555 of NATURE, and my "great surprise" was due to the fact that the editor of NATURE should have allowed Prof. Allman's letter to appear without offering any explanation of the direct opposition between his quotation and mine—the cause of which was well known at the printing office of NATURE.

It is thus clear that my letter of July 30 is consistent with my letter of July 28. E. RAY LANKESTER

[We willingly give space to the above letter, and, accepting the interpretation of the former one which Prof. Lankester now gives us, we regret having made the observation to which Prof. Lankester alludes. We may further add that the insertion of the reference to the letter in question was due to an oversight.—ED.]

### Magnetic and Earth-Current Disturbance

IT may be of interest to point out that a magnetic disturbance has just been experienced at the Royal Observatory greater in magnitude than any that has occurred for some years.

On August 11, at 10.30 a.m., active disturbance suddenly commenced, and continued until midnight, accompanied, as usual, by the exhibition of earth currents. The magnets were then generally quiet until about noon of August 12, when disturbances of still greater magnitude began to be shown, continuing till 6 a.m. of August 13. During the latter period the variations in the magnetic declination and horizontal force were frequent and large, especially between noon and 4 p.m., and between 7 and 9 p.m. Between noon and 4 p.m. there was also a considerable increase of vertical magnetic force. During the whole period, from noon of August 12 to 6 a.m. of August 13, earth-currents were continuous and strong, and especially strong at those times at which the magnets were most disturbed.

It seems well at the present time to warn telegraph engineers, and especially those concerned in the laying of submarine cables, that disturbances of the character of that described above may now become not unfrequent as compared with the quietness of recent years. I may perhaps be permitted here to refer to a short paper, "Note on Earth-Currents," to be found at p. 214 of vol. viii. of the *Journal* of the Society of Telegraph Engineers, as containing information on the question of magnetic disturbances and earth-currents, probably not without interest at this time.

WILLIAM ELLIS

Royal Observatory, Greenwich, August 14

P.S.—During the evening and night of August 13–14 large magnetic disturbances again occurred, accompanied as before by strong earth-currents.

### Aurora Borealis and Magnetic Storms

THE epoch of grand auroras and magnetic storms has again returned, as was evident from the fine displays seen here on the evenings of the 11th and 12th, and these are as usual accompanied by an increase in the number and size of the sun-spots, and in the development of the solar prominences. The aurora on the 11th was grand, but that which followed it on the 12th recalled vividly the magnificent displays of 1869, 70, and 71.

On the 12th my attention was first called to the phenomenon at 10h. 25m. p.m., when the northern horizon was skirted by a bright white haze terminating in an ill-defined arch, from which sprang a large number of broad streamers stretching towards the zenith. The bank of white light on the horizon extended from about 15° E. of N. to 45° W. of N., and some of the streamers attained an altitude of fully 60° or 70°. The brilliancy of the individual streamers was varying rapidly, but there was little variety in the character of the phenomenon.

At 10h. 30m. the brightest streamer was 3° W. of N. Ten minutes later this brilliant white band of light had moved gradually westward, and was some 25° W. of N., when it faded away. Some streamers were still more W. of N., and others again were slightly E. of N.

At 10h. 46m. there was nothing remaining of the aurora except a cloudy whiteness in the north, the rest of the heavens being a deep blue. A minute later streamers were again appearing.

At 10h. 56m. a very bright streamer formed 2° E. of N., and then a similar band of light appeared 5° W. of N., followed in rapid succession by other streamers 10°, 20°, and 45° W. of N., each streamer fading away before the succeeding one became very bright.

At 11h. 0m. a single narrow band of intense white light stretched from the horizon towards the zenith, passing through Cor Caroli.

At 11h. 7m. the light in the N. and N.N.W. again brightened up, but there was no further appearance of streamers.

The magnetic storm that accompanied the aurora of the 12th was one of the most violent ever recorded at this observatory, and was very similar in character to the magnificent storm of 1869.

On the evening of the 11th the magnetic needle was very irregular in its movements, but it was only towards midday of the 12th that the storm really began. The oscillations from the beginning were very rapid and extensive. The first great movement began at 11h. 34m. a.m., and between 12h. 18m. and 12h. 24m. the declination magnet moved 1° 6′ 45″ eastward. It then returned westward, and at 1h. 4m. the reading had increased by 1° 18′ 13″. Between 7h. 9m. and 7h. 29m. p.m. the needle moved 59′ 18″ eastward, when it attained its minimum; it then returned quickly towards the west, and after a double sweep it reached its maximum at 8h. 13m., the change of declination in 46m. being 1° 27′ 23″.

The oscillations of the V.F. magnet were as great as those of the declination. The chief maximum occurred at 3h. 40m. p.m., and there were three decided minima at about 10 p.m. midnight and 2 a.m., the two latter of which were lost from the oscillation being too great to be recorded on the photographic cylinder, and the first showing a change of 1·9 inch of ordinate in 5m.

The variation of the H.F. magnet was very large, but not so remarkable as that of the V.F.

On the 13th the magnetic storm continued greatly to disturb all the magnets, but it was less violent than on the preceding day.

Stonyhurst Observatory, August 15 S. J. PERRY

THERE was a beautiful display of the aurora here last night. Between ten and eleven o'clock the streaks extended from the horizon to the zenith. The colour was principally pale blue, but a reddish tinge was occasionally discernible. I observed what I thought was a lateral movement of some of the streaks. A bright spot suddenly made its appearance to the westward of a small black cloud, seemed to move slowly eastward and disappear. There was a slight breeze from the east at the time, but I do not think that the clouds were moving sufficiently rapidly to account entirely for the phenomenon. J. A. B. OLIVER

Springburn, Glasgow, August 13

A FINE display of aurora was visible here on the night of Thursday, August 12, about 10.30. White streamers, stretching vertically from the horizon nearly to the zenith, occupied the north-west segment of the heavens from the pole to Arcturus. There was a narrow bank of cloud along the horizon, and I thought at first that the streamers might be shadow-phenomena from the sun; but the hour was too late, and the rapid variations of form and intensity were characteristic of aurora, which is not very common at this season of the year, I think. F. T. MOTT

Birstal Hill, Leicester, August 13

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WE had a fine aurora here last night (11th). There was a bright bank of uniform glow till 11 p.m., when it suddenly broke into streamers, some of which reached 40° or 45° in height, the glow extending along 100° or 120° of the horizon. There was no colour, and by midnight it had all faded out.

Whitby, August 12 B. W. S.

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### Height of the Aurora

I SHALL be glad if you will allow me the use of your columns to point out that there is really less uncertainty about this element than is usually supposed, and that there are two methods of measuring auroral heights which give accordant results. The first is that based upon the measurements of the altitude and amplitude of auroral arches, and which gives the results mentioned by Mr. Rand Capron. That these results should have so wide a range is probably owing to the fact that they proceed upon an assumption which may or may not be correct, viz., that the arch is part of a circle having the magnetic pole for its centre. Still the mean result from this method would seem to be reliable, especially if care were taken to exclude doubtful measurements from the list. Possibly we may assume that this method gives a height not far from 100 miles for the ordinary arch. I speak particularly of the white auroral arch with or without uncoloured streamers that forms, I suppose, 95 per cent. of the auroral phenomena visible in this country. These arches are formed for the most part over a portion of the earth considerably to the (magnetic) north of these islands, but occasionally they would seem to be formed over our heads. Mr. Capron in his work on "Auroræ and their Spectra" mentions one such instance, though he appends no explanation of the phenomenon, but in the course of ten years' observations I have myself seen three such arches. Indeed they are perfectly well known to observers in Scotland and the north of England, though I have never seen them in the south. As early as the year 1843 the height of these zenithal arches had been trigonometrically computed from observations made in different localities in Britain, with the result of proving them to be at an uniform height of 70 to 74 miles above the earth.[1] There is much less liability to error in these results than in the determination of the height of a meteor, and a single pair of satisfactory observations will yield a value within one or two miles of the actual elevation.

That auroral arches are ever formed much below this limit I beg leave to doubt. I am aware of the accounts which would place them between the eye and natural objects, but such assertions are far from having the weight of accurate measurements, and I have yet to find a case of a supposed low aurora, the evidence of which is above criticism.

I do not wish to assert that the streamers at right angles to these arches may not be frequently visible at a *less* height, just as they undoubtedly reach to a much *greater* elevation in the region where the auroral crown is formed. But to fix either the superior or inferior limit is precisely one of those questions which we can have no hope of solving by direct measurement, since the length of the streamer varies with the force of electric discharge. This is shown by the fact that in an active aurora some streamers extend only a short distance from the arch, while others will climb up to the vanishing point, or crown.

To carry these remarks so as to include the question of coloured auroræ would oblige me to trespass more upon your space than I am willing to do on this occasion.

Orwell Park Observatory, Ipswich JOHN I. PLUMMER

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### Fire-Ball

ON the evening of the 12th a very brilliant fire-ball fell at 8h. 30m. G.M.T. It was first observed at an elevation of about 25° above the E.S.E. horizon, and its path was inclined at an angle of about 35° to the horizon. It was lost in the mist near the south horizon. There was no explosion or noise of any kind. The daylight was still fairly strong, and yet the light of the meteor was very dazzling. S. J. PERRY

Stonyhurst Observatory, August 15

[1] I give these figures from memory, as I have no library at hand to which to refer, but I have no doubt that they are strictly correct. Mr. Capron may perhaps find some information on the point in the published works of the late Prof. Phillips, who was one of the observers engaged in these investigations about the date I have named, or they may be verified upon the first appearance of a zenithal arch.

### Atmospheric Phenomenon

A CURIOUS phenomenon was observed here after sunset the night before last, and again in a less degree last night.

Looking across from this point to the position of the sun at and after setting, the line of sight crosses about three miles of sea, then about the same distance or rather less of projecting high ground, and beyond that many miles of sea again. On Tuesday (10th) the sun set in a hot haze, and half an hour after there appeared on the edge of the projecting land what looked like tongues of flame fifteen to thirty minutes in height, lasting from two to four seconds each, and then disappearing in different places, sometimes half a dozen at a time. At the same time there was more or less of a flickering light along the whole line of projecting land.

My first impression was that it was an optical illusion, and the second that a moor was on fire behind the ridge, and that these were points of flame. The first was negatived by the fact that four others beside myself (two of them with very keen sight) saw the lights independently in the same places; and the second by the gradual fading of the light as the evening became darker, the "tongues" retaining pretty much their relative brightness to the general glow until both faded out.

The day had been extremely hot, and the evening was sultry, with motionless air. I imagine the appearance was due to irregular refraction, arising from heated currents of air from the cooling land, and that the circumstance of the *slice* of land with its currents occurring between the two stretches of homogeneous air over the sea allowed the effect to be seen without being masked, as it would have been had there been intervening land. But I never saw it before, and don't remember to have seen it described. B. W. S.

Whitby, August 12

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### Intellect in Brutes

INSTINCT apart, cases of intelligence in animals are very numerous, of the affections still more numerous. Comte was of opinion that the affections were even more highly developed in animals than in men. The dog will lay down life for the man he loves, the horse will do so likewise. We have all heard of Greyfriars Bobby, if that be the creature's name. But instances crowd on the memory. A few years back, during a heavy gale, a sweep of the spanker-boom drove the master of a Leith and London smack into the sea. Instantly the ship's dog bounded in after, and, sustaining the drowning man, both passed grandly into the eternities together. I have known cats who let themselves into the dwelling-house at pleasure, and at least three dogs who were wont to deposit the pennies given them on the counter of some baker or pastry-cook in return for values received. I used to meet on the highway a dog who rode behind his master's groom. The hardest trot never seemed to discompose his seat. Even birds—not merely trained birds—sometimes display singular attainments. I knew a lady who had a singing duck, but being one day at a loss for a couple, she sacrificed the songstress to make up a pair. One wishes that she had displayed a little more humanity; as also a clergyman, not a hundred miles from where I sit, who ordered a goose that had evinced the warmest attachment to be slain by reason of the poor bird having followed him on the occasion of paying a visit into a friend's drawing-room.

When a boy I used to spend many a holiday at a farmer's house in the County Armagh. I there experienced great kindness, enjoying myself as much as was well possible in the open air, the garden, and the stubble fields. Besides human beings, I had numerous playmates too in the kine, swine, dogs, fowl, horned cattle, and horses about the place, and indeed was never tired in observing their modes of living and acting. The great house-dog used often to play with a large hog. They alternately chased and faced one another till the hog's chaps would froth again actually with the excitement of the sport. At first I supposed that the pig did not like it, but in this I was mistaken. One day a strange dog, an immense brute, made his appearance, and attacked the house-dog, who was evidently getting the worst of it, when who should come to the rescue but the hog, who instantly jumped on the strange dog's back, assailing him at the same time with hoof and tooth. Placed thus between two fires, the stranger beat a speedy retreat, leaving the friends complete masters of the situation.

I think I was about ten years old when my parents went to reside at a place called Fairlawn, situated on a gentle eminence a few miles from the mutually contiguous towns of Moy and

Charlemont. Facing the house, a stone's throw or two in front of the lawn, was a river called the Tall, which ran into the close-at-hand Callan, which again ran into the Black Water, which, in turn, emptied itself into that immense puddle which bears the name of Lough Neagh. The waters of Lough Neagh, unable, by reason of the obstructions in the Lower Bann, to escape rapidly enough into the sea, swell up and cause backwater in the rivers I have named, and others as well. The result is the periodic flooding of thousands and tens of thousands of acres of valuable land, to the immense prejudice of the occupants and country at large. The Tall, I should observe, was banked or dyked up on both sides. In some places, however, the dyke had given way, so that at flood-time—and it was flood-time at the period I speak of—the waters of the Tall were awash with those of the flooded meads on both sides. There was further a rapid current in the Tall, and before it merged into the Callan the stream had to pass under the arch of a bridge which it filled to the crown. In fact the battlements themselves were nearly covered, and the country, as far as the eye could reach from the position which I at the moment occupied at the foot of the lawn, wore the aspect of a sea. At this precise juncture two horses, whilom occupants, I presume, of the then flooded meads, were to be seen slowly wading in the direction of the Tall. The green summit of the dyke was for the most part visible, and upon this the poor brutes mounted, in quest, I suppose, of some outlet. They had not gone very far when, owing to the treacherous footing, one of the horses lost his balance and fell, rolling over and over into the Tall. He swam on bravely, the other horse stretching down at intervals a sympathising muzzle, making indeed repeated efforts to escape, but falling back each time into the surging current. I was alone, surveying the transaction, from which I never removed my eyes, with the deepest interest. All at once the horse that was on the dyke, keeping pace at a sort of half-trot with the other, burst into a hand-gallop, and when he had got sufficiently beyond his struggling comrade, bounded himself into the Tall. Swimming briskly onwards for a few fathoms, he then made his way out through what he must have seen beforehand was a practicable breach in the dyke, followed on the instant by his friend, evading, not a moment too soon, the submerged bridge, where they would have otherwise inevitably gone under. So long as my eyes could follow them they dashed onwards at a gallop, throwing up their exultant heels and flourishing their tails across the flooded meadows. It is now many years since I beheld this astonishing spectacle, which my memory recalls as freshly as if it had happened yesterday, awakening, as I think it is well calculated to do, serious reflections in regard of our mysterious associates and the wondrous Power which has called them into being, and now sustains them and ourselves alike in this transitory state which we term life. HENRY MACCORMAC

Belfast, August

## Radiation.—A Query

IN Baily's experiments with the torsion-rod and two leaden balls weighing 380½ pounds each, it was found that the radiation of heat from the leaden masses affected the vibrations of the torsion-rod. These masses were thereupon gilded, and the torsion-rod protected by a gilt box covered with thick flannel, and the disturbing influence overcome. How did radiation affect the motion of the torsion-rod? F. G. S.

## "On a Mode of Explaining the Transverse Vibrations of Light"—The Expression "Radiant Matter"

WITHOUT wishing at all to underrate the apparent difficulty noticed by your New Zealand correspondent, Mr. J. W. Frankland (NATURE, vol. xxii. p. 317) in regard to my paper under the above heading (NATURE, vol. xxi. p. 256), as it would be against the interests of truth to do so; I may nevertheless call his attention to a letter of mine (NATURE, vol. xxi. p. 369), where an attempt is made to meet the difficulty in question. The point is to account for the circumstance (admitting that it is rendered necessary by physical evidence) that the velocity of propagation of gravity must, at least, be very much greater than that of light. I will merely confine myself here to recapitulating one of the main conclusions in a somewhat different form, viz., it appears to be necessary to look to a separate medium for gravity, or (more accurately) to *one* medium with particles of two grades of dimensions; the one set of particles having very minute mass, and consequently enormous velocity, and concerned in the effects of gravity; the other set, of much greater mass and slower velocity, concerned in the phenomena of light. It will, I think, be so far tolerably evident that if the *number* of the more minute set of particles be comparatively very great, the pressure produced by them would be correspondingly great, and therefore these particles would be mainly (*i.e.*, almost exclusively, if their number were sufficiently great)[1] concerned in producing gravity. On the other hand, on account of the extreme velocity of these particles, they could not apparently be appreciably concerned in the phenomena of light, since the molecules of gross matter would vibrate among them without appreciable resistance. For it is a well-known dynamical fact that the resistance opposed to the motion of a body in a medium *diminishes* as the velocity of the particles of the medium increases. It may be worth observing perhaps that this idea of three grades of dimensions in matter (viz. gross matter, light-carrying matter, and gravific matter) appears to be an old one. Thus a book was published in 1827 by Dr. Blair, formerly Regius Professor of Astronomy in the University of Edinburgh, entitled "Scientific Aphorisms" (to which my attention was called by Prof. Tait), where the idea of three grades of dimensions in matter is set forth, and a theory of gravity very similar to that of Le Sage expounded. Also M. Prevost ("Deux Traités de Physique mécanique") expresses, I believe, the view that matter exists fundamentally in three grades of magnitude.

It may be rather a curious fact to notice that if the theory, that the æther consists merely of finely sub-divided matter in the ultra-gaseous state, light being regarded as a vector property carried off by the atoms in their passage through the open structure of the vibrating molecules of gross matter, as suggested by the late Prof. Clerk Maxwell, article "Æther," new edition of the "Encyclopædia Britannica" (*i.e.*, with range of free path greater than planetary distance, NATURE, vol. xxi. p. 256),[2] should ultimately turn out to be substantially true; then the term "radiant matter," employed by Mr. Crookes in connection with his experimental researches, would have its practical application in nature on a large scale—or light would be actually propagated by "radiant matter." If, on an examination of the theory in that spirit of good-humoured impartiality representing entire freedom from the predilections of any school of thought (the best guarantee of truth)—the difficulties attaching to it should not be considered insurmountable; then it may be worth remarking that the theory, without violating in the least the essential principles of the firmly-established undulatory theory, contains nevertheless (in its corpuscular essence) *one* of the ideas of Newton; so that it would appear that the latter might not have been entirely wrong, nor the upholders of the opposite view completely right, but that a partial reconciliation of their rival ideas might be possible. S. TOLVER PRESTON

London, August 10

## Earthquake in Smyrna

ACCOUNTS are freely coming forward, but they are of popular interest, seismological details being scanty. I must premise that in in 1862 I took great interest in promoting Abyssinian wells in Smyrna, and that large numbers were put down. When the French Company built the quay the new works there were similarly supplied, and the result has been that for some years the surface and pipe-wells in the parallel Marina and Frank Streets have been wanting in water.

Within a few hours after the earthquake it was noticed that both classes of wells, say 600 feet from the sea, were freely supplied with water. This fact appears to me deserving of record.

It is said that the earthquake was most felt near the Greek Cathedral of St. Photius, at the Three Corners in Frank Street. It was here the ground opened in the last century earthquake and swallowed up two men, as I heard by tradition; and I always walked across the churchyard in full remembrance.

Of late years some kind of a landslip took place on Mount Pagus, or the Castle Hill, where Alexander the Great fell asleep.

[1] It may be worth noting in connection with this that (according to a principle developed by Sir W. Thomson, *Phil. Mag.*, May, 1873) it appears that if the "elastic rigidity" of the *larger* particles were such that they suffered no appreciable diminution of velocity at rebound from gross matter, they would not be appreciably concerned in the effects of gravity (even if their number were comparable to that of the smaller set of particles).

[2] Also previous papers by the present writer (on the same subject)—*Phil. Mag.*, September and November, 1877, February, 1878, April and May, 1880.

In this new earthquake springs are said to have burst out on the side of Mount Sipylus. HYDE CLARKE

32, St. George's Square, S.W., August 9

### New Biological Term

IN writing certain parts of a book on water-beetles, I find myself frequently desirous of indicating briefly but emphatically that some particular genus I may be mentioning consists of only a single species. If we take a rational or theoretical view of classification rather than an empirical one, it must be admitted that a genus consisting of only one species is almost as great an anomaly as a species that should consist of a single individual; and a special term to indicate the fact would be desirable. Mr. Pascoe has suggested to me that the expression "monotypical genus" meets the want: but I am not satisfied with this, for in the first place it is a phrase, not a word; and in the second place the use of the "typical" interferes with concentration of thought by the introduction of an alien suggestion. I therefore propose to use either the word "autogenus" or the word "monogenus" for the purpose, and on the whole prefer the former. Perhaps some one else may be able to suggest a better term, and I shall be very glad of an expression of opinion on the point.

Thornhill, Dumfriesshire D. SHARP

### Depraved Taste in Animals

YOUR correspondent, Mr. Nicols, draws attention this week to what he terms the "depraved taste" for tobacco exhibited by several individuals of that species of Phalangistidæ known as the koala.

Whilst in Australia some years ago I myself remarked the same propensity amongst numerous *wild* specimens of the *Pharcolarctos cinereus*, in an abandoned tobacco-clearing not far from my residence, and, like Mr. Nicols, I also observed that no ill effects seemed to follow the consumption of the tobacco by the Koalæ. Now since the Phalangistidæ I had the opportunity of observing were perfectly wild, I cannot agree with Mr. Nicols that their taste for tobacco is a depraved one, although the desire for spirits which he mentions is of course decidedly unnatural.

These observations induced me to make several analyses of the Victorian tobacco, with the result of isolating an hitherto undiscovered vegetable alkaloid. A detailed account of my various experiments is contained in a paper read by me before the Melbourne Medical and Chemical Society, and printed in the fourteenth volume of the Society's *Transactions*.

F. R. GREENWOOD

St. Bartholomew's Hospital, E.C., August 14

### Firing a Tallow Candle through a Deal Board

WILL the writer of "Physics without Apparatus" be good enough to specify the conditions of success for the above experiment? C. J. WOODWARD

Birmingham and Midland Institute, August 9

[Set up a ½-inch or ¾-inch plank of deal in the ground. It should be 6–8 inches wide. Ram small charge of gunpowder into gun with wad. Select a *dip* candle just fitting bore; cut down to about 5 inches long, with flat end. Be very particular to ram it down well; for if there is air space between it and the wad there is risk of bursting gun. Take care that the rest of barrel is cleared of bits of tallow. Fire at say 3 yards from plank. If you don't miss aim, there will be a hole *torn*, about 2 inches in diameter.—The WRITER of "Physics without Apparatus."]

$\sqrt{-1}$ must send his name and address.

## *THUNDERSTORMS*[1]

II.

BEFORE I can go farther with this subject it is necessary that I should give some simple facts and illustrations connected with ordinary machine electricity. These will enable you to follow easily the slightly more difficult steps in this part of our subject which remain to be taken.

Since we are dealing mainly with *motion* of electricity, it is necessary to consider to what that motion is due. You all know that winds, *i.e.* motions of the air, are due to differences of pressure. If the pressure were everywhere the same at the same level we should have no winds. Similarly the cause of the motion of heat in a body is difference of temperature. When all parts of a body are at the same temperature there is no change of distribution of heat. Now electricity presents a precisely analogous case. It moves in consequence of difference of *potential*. Potential, in fact, plays, with regard to electricity, a part precisely analogous to the *rôle* of pressure, or of temperature, in the case of motions of fluids and of conducted heat. Now the power of an electrical machine may be measured by the utmost potential it can give to a conductor. The greater the *capacity* of the conductor the longer time will be required for the machine to charge it; but no electricity passes between two conductors charged to the same potential. Hence the power of a machine is to be measured by using the simplest form of conductor, a sphere, and finding the utmost potential the machine can give it. It is easily shown that the potential of a solitary sphere is directly as the quantity of electricity, and inversely as the radius. Hence electricity is in equilibrium on two spheres connected by a long thin wire when the quantities of electricity on them are proportional—not to their surfaces, nor to their volumes, as you might imagine—to their radii. In other words, the capacity is proportional to the radius. This, however, is only true when there are no other conductors within a finite distance. When a sphere is surrounded by another concentric sphere, which is kept in metallic connection with the ground, its capacity is notably increased, and when the radii of the spheres are nearly equal the capacity of the inner one is directly as its surface, and inversely as the distance between the two spheres. Thus the capacity is increased in the ratio of the radius of one sphere to the difference of the radii of the two, and this ratio may easily be made very large. This is the principle upon which the Leyden jar depends.

It is found that the work required to put in a charge is proportional to the square of the charge. Conversely, the damage which can be done by the discharge, being equal to the work required to produce the charge, is proportional to the square of the charge, and inversely to the capacity of the receiver. Or, what comes to the same thing, it is proportional to the square of the potential and to the capacity of the conductor directly. Thus a given quantity of electricity gives a greater shock the smaller the capacity of the conductor which contains it. And two conductors, charged to the same potential, give shocks proportional to their capacities. But in every case, a doubling of the charge, or a doubling of the potential, in any conductor, produces a fourfold shock.

The only other point I need notice is the nature of the distribution of electricity on a conductor. I say *on* a conductor, because it is entirely confined to the surface. Its attractions or repulsions in various directions exactly balance one another at every point in the *substance* of the conductor. It is a most remarkable fact that this is always possible, and in every case in one way only. When the conductor is a single sphere the distribution is uniform. When it is elongated the quantity of electricity per square inch of its surface is greater at the ends than in the middle; and this disproprotion is greater the greater is the ratio of the length to the transverse diameter. Hence on a very elongated body, terminating in a point, for instance, the electric density—that is, the quantity per square inch of surface—may be exceedingly great at the point while small everywhere else. Now in proportion to the square of the electric density is the outward pressure of the electricity tending to escape by forcing a passage

[1] Abstract of a lecture, delivered in the City Hall, Glasgow, by Prof. Tait. Continued from p. 341.

through the surrounding air. It appears from experiments on the small scale which we can make with an electrical machine, that the electric density requisite to force a passage through the air increases under given circumstances, at first approximately as the square root of the distance which has to be traversed, but afterwards much more slowly, so that it is probable that the potential required to give a mile-long flash of lightning may not be of an order very much higher than that producible in our laboratories.

But from what I have said you will see at once that under similar circumstances an elongated body must have a great advantage over a rounded one in effecting a discharge of electricity. This is easily proved by trial. [The electric machine being in vigorous action, and giving a rapid series of sparks, a pointed rod connected with the ground was brought into the neighbourhood, and the sparks ceased at once.] In this simple experiment you see the whole theory and practical importance of a lightning conductor. But, as a warning, and by no means an unnecessary one, I shall vary the conditions a little and try again. [The pointed rod was now insulated, and produced no observable effect.] Thus you see the difference between a proper lightning-rod and one which is worse than useless, positively dangerous. There is another simple way in which I can destroy its usefulness, namely, by putting a little glass cap on the most important part of it, its point, and thus rendering impossible all the benefits it was originally calculated to bestow. [The pointed rod was again connected with the ground, but furnished with a little glass cap. It produced no effect till it was brought within four or five inches of one of the conductors of the machine, and then *sparks* passed to it.] You must be strangely well acquainted with the phases of human perversity if you can anticipate what I am now going to tell you, namely, that this massive glass cap, or *repeller*, as it was fondly called, was only a year or two ago taken off from the top of the lightning-rod employed to protect an important public building. [The repeller was exhibited. It resembled a very large soda-water bottle with a neck much wider than the usual form.] From the experiments you have just seen it must be evident to you that the two main requisites of an effective lightning-rod are that it should have a sharp point (or, better, a number of such points, lest one should be injured), and that it should be in excellent communication with the ground. When it possesses these, it does not require to be made of exceptionally great section; for its proper function is *not*, as is too commonly supposed, to parry a dangerous flash of lightning: it ought rather, by silent but continuous draining, to prevent any serious accumulation of electricity in a cloud near it. That it may effectually do this it must be thoroughly connected with the ground, or (if on a ship or lighthouse) with the sea. In towns this is easily done by connecting it with the water mains, at sea by using the copper sheathing of the ship, or a metal plate of large surface fully immersed. Not long ago a protected tower was struck by lightning. No damage was done in the interior, but some cottages near its base were seriously injured. From a report on the subject of this accident it appears that the lower end of the lightning rod was "jumped" several feet into the solid rock! Thus we see, in the words of Arago, how "False science is no less dangerous than complete ignorance, and that it *infallibly* leads to consequences which there is nothing to justify."

That the lightning-rod acts as a constant drain upon the charge of neighbouring clouds is at once proved when there is, accidentally or purposely, a slight gap in its continuity. This sometimes happens in ships, where the rod consists of separate strips of metal inlaid in each portion of the mast. If they are not accurately fitted together, a perfect torrent of sparks, almost resembling a continuous arc of light, is seen to pass between them whenever a thunderstorm is in the neighbourhood.

I cannot pass from this subject without a remark upon the public as well as private duty of having lightning-rods in far greater abundance than we anywhere see them in this country. When of proper conducting power, properly pointed, properly connected with the ground and with every large mass of metal in a building, they afford absolute protection against ordinary lightning—every single case of apparent failure I have met with having been immediately traceable to the absence of one or other of these conditions. How great is their beneficial effect you may gather at once from what is recorded of Pietermaritzburg, viz., that till lightning-rods became common in that town it was constantly visited by thunderstorms at certain seasons. They still come as frequently as ever, but they cease to give lightning-flashes whenever they reach the town, and they begin again to do so as soon as they have passed over it.

A knight of the olden time in full armour was probably as safe from the effects of a thunderstorm as if he had had a lightning-rod continually beside him; and one of the Roman emperors devised a perfectly secure retreat in a thunderstorm in the form of a subterraneous vault of iron. He was probably led to this by thinking of a mode of keeping out missiles, having no notion that a thin shell of soft copper would have been quite as effective as massive iron. But those emperors who, as Suetonius tells us, wore laurel crowns or sealskin robes, or descended into underground caves or cellars on the appearance of a thunderstorm, were not protected at all. Even in France, where special attention is paid to the protection of buildings from lightning, dangerous accidents have occurred where all proper precautions seemed to have been taken. But on more careful examination it was usually found that some one essential element was wanting. The most common danger seems to lie in fancying that a lightning-rod is necessarily properly connected with the earth if it dips into a mass of water. Far from it. A well-constructed reservoir full of water is *not* a good "earth" for a lightning-rod. The better the stonework and cement the less are they fitted for this special purpose, and great mischief has been done by forgetting this.

A few years ago the internal fittings of the lighthouse at Skerryvore were considerably damaged by lightning, although an excellent lightning-rod extended along the whole height of the tower.

The real difficulty in these situations, exposed to tremendous waves, lies in effecting a permanent communication between the lightning-rod and the sea. But when this is done the sea makes far the best of "earths."

When a lightning-rod discharges its function imperfectly, either from insufficient conducting power or because of some abnormally rapid production of electricity, a luminous brush or glow is seen near its point. This is what the sailors call St. Elmo's Fire, or Castor and Pollux. In the records of mountain climbing there are many instances of such discharges to the ends of the alpenstocks or other prominent pointed objects. One very remarkable case was observed a few months ago in Switzerland, where at dusk, during a thunderstorm, a whole forest was seen to become luminous just *before* each flash of lightning, and to become dark again at the instant of the discharge.

Perhaps the most striking of such narratives is one in the memoirs of the Physical and Literary Society of Edinburgh, on Thunder and Electricity, by Ebenezer McFait, M.D.

The destructive effects of lightning are familiar to all of you. All the more ordinary effects can easily be reproduced by the help of Leyden jars on a small scale. How small you may easily conceive when I tell you that a three-foot spark is considered a long one, even from our most powerful machines, while it is quite certain that lightning flashes often exceed a mile in length, and sometimes extend to four and five miles. One recorded observation, by a trustworthy observer, seems to imply a discharge over a total length of nearly ten miles.

When a tree is struck by a violent discharge it is usually split up laterally into mere fibres. A more moderate discharge may rupture the channels through which the sap flows, and thus the tree may be killed without suffering any apparent external damage. These results are usually assigned to the sudden vaporisation of moisture, and the idea is probably accurate, for it is easy to burst a very strong glass tube if we fill it with water and discharge a jar by means of two wires whose extremities are placed in the water at a short distance from one another. The tube bursts even if one end be left open, thus showing that the extreme suddenness of the explosion makes it act in all directions, and not solely in that of least resistance. When we think of the danger of leaving even a few drops of water in a mould into which melted iron is to be poured, we shall find no difficulty in thus accounting for the violent disruptive effects produced by lightning.

Heated air is found to conduct better than cold air, probably on account of the diminution of density only. Hence we can easily see how it is that animals are often killed in great numbers by a single discharge, as they crowd together in a storm, and a column of warm air rises from the group.

*Inside* a thundercloud the danger seems to be much less than outside. There are several instances on record of travellers having passed *through* clouds from which, both before and after their passage, fierce flashes were seen to escape. Many remarkable instances are to be found in Alpine travel, and specially in the reports of the officers engaged in the survey of the Pyrenees. Several times it is recorded that such violent thunderstorms were seen to form round the mountain on which they were encamped, that the neighbouring inhabitants were surprised to see them return alive.

Before the use of lightning-rods on ships became general great damage was often done to them by lightning. The number of British ships of war thus wholly destroyed or much injured during the long wars towards the end of the last and the beginning of the present century is quite comparable with that of those lost or injured by gales, or even in battle. In some of these cases, however, the damage was only indirectly due to lightning, as the powder magazines were blown up. In the powder magazine of Brescia, in 1769, lightning set fire to over 2,000,000 lbs. of gunpowder, producing one of the most disastrous explosions on record.

A powerful discharge of lightning can fuse not only bell wires, but even stout rods of iron. It often permanently magnetises steel, and in this way has been the cause of the loss of many a good ship; for the magnetism of the compass-needles has been sometimes destroyed, sometimes reversed, sometimes so altered that the compass pointed east and west. And by the magnetisation of their steel parts the chronometers have had their rates seriously altered. Thus two of the sailor's most important aids to navigation have been simultaneously rendered useless or, what is worse, misleading; and this, too, at a time when, because of clouds, astronomical observations were generally impossible. All these dangers are now, however, easily and all but completely avoidable.

A very singular effect of lightning sometimes observed is the piercing of a hole in a conducting-plate of metal, such as the lead-covering of a roof. In such a case it is invariably found that a good conductor well connected with the ground approaches near to the metal sheet at the part perforated.

(*To be continued.*)

## HUMAN HYBERNATION

DR. TANNER is scarcely off the field when another physiological wonder breaks out in the form of a sleeping girl of Grambke, near to Bremen. This young lady lies, it is said, in a profound slumber night and day, resting on her left side and never asking for food, but swallowing liquid food when it is put into her mouth. The trance lasts an average of fifty days, during which time she is pale, but does not lose in weight. Her sleep is not cataleptic in the proper sense of the term, inasmuch as she is sufficiently conscious to swallow, and presents none of the indications of death. She merely sleeps. Instances of this kind are not so uncommon as those of true catalepsy, though some of them are sufficiently remarkable. In the *Transactions* of the Royal Society Dr. W. Oliver has recorded the history of an extraordinary sleeping person named Samuel Chilton of Tinsbury, near Bath, who, on May 13, 1694, being then "of robust habit of body, not fat, but fleshy, and a dark brown hair," happened, without any visible cause or evident sign, to fall into a very profound sleep, out of which no art used by those who were near him could rouse him until after a month's time; then he rose of himself, put on his clothes, and went about his business of husbandry as usual; slept, could eat and drink as before, but spoke not one word till about a month after. In 1696, on the 9th of April, this youth fell off to sleep again, and although a heroic apothecary, Mr. Gibbs, bled him, blistered him, cupped him, and scarified him, he slept on for seventeen weeks, waking up on August 7, not knowing he had slept above a night, and unable to be persuaded he had lain so long, until going out into the fields he found everybody busy getting in the harvest, and then remembered very well that when he fell asleep they were sowing of the barley and oats which he now saw ripe and ready to be cut down. For six weeks of this sleep he had fasted, but after he awoke he went to work in his ordinary way, and continued to work until August 17, 1697, when, after complaining of shivering and cold in his back, and vomiting once or twice, he fell into one of his long sleeps once more, and being visited by Dr. Oliver and many others, was subjected to further bleeding and extremely sharp treatment indeed, but without being roused. So he lay sleeping until November 19, when he awoke, said he "felt very well, thank God," ate some bread and cheese, and dropping off still another time, slept on until the end of January, 1698, and "then waked perfectly well, not remembering anything that happened all this while." He was observed to have lost flesh, but only complained of being pinched by the cold, and presently fell to husbandry as at other times. The known phenomenon that is nearest to this is hybernation in some of the inferior animals; but it is worthy of remark that the persons affected take food unconsciously when it is offered them, the lower nervous centres seeming to remain in a continued state of activity.

## PHYSICS WITHOUT APPARATUS[1]

### III.

THE laws of the behaviour of liquids, their pressure and their flow, are very readily demonstrated without special apparatus by the aid of simple articles of everyday use. First amongst the laws of liquid pressure comes the all-important principle that the pressure exerted by a liquid at any point is proportional to the depth, below the surface, of the point under consideration. This pressure is exerted upwards or downwards according to circumstances. We can show first a case of pressure exerted in an upward direction. Take the glass chimney of a lamp, that of a paraffin-lamp will answer, though the straighter form of chimney used in an Argand or a Silber lamp is preferable. Cut out with a pair of scissors a circular disk of stout cardboard, and attach a thread to it by means of a drop of sealing-wax. Provide yourself also with a deep dish of water. Such a glass trough as is

[1] Continued from p. 345.

used for a drawing-room aquarium will answer capitally for this purpose; but if no deep glass vessel is available, a pan or tub of stone-ware or of tin-ware will serve the purpose. The disk of card should be pressed against the lower end of the lamp-chimney (as in Fig. 8) by pulling up the thread through the glass tube. If it is then lowered into the water in the glass trough, the upward force of the water outside pressing up against the card disk will keep it against the end of the lamp-glass. The deeper it is plunged the more tightly is it pressed up against the end of the tube, for the pressure of the liquid becomes greater and greater as the depth of the disk below the surface is increased. A case of downward pressure is even more simply shown. Take the lamp-chimney in your hand and hold it vertical as before, and fix to the lower end another disk of card, this time fixing it to the bottom of the glass by means of soft bees'-wax or of a little stiff tallow. Now pour in some water from above. At first the disk is held on by the wax, and you may pour in water until the chimney is perhaps half full. But as you go on pouring in water the

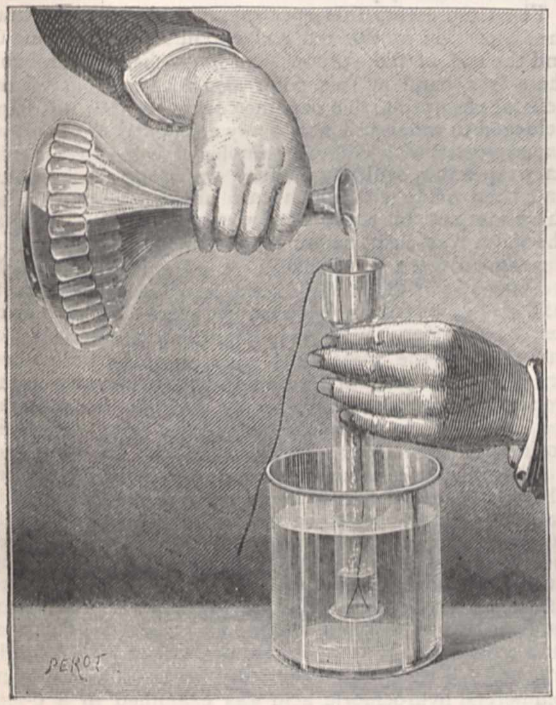



Fig. 8.

depth of the water inside gets greater and greater, and the pressure exerted by the column of liquid becomes also greater, until the adhesive force of the wax is overcome, and the water bursts off the card and rushes out. This second experiment may be combined with the first one, as is shown in Fig. 8. After having lowered the empty lamp-chimney closed by the card disk into the rough of water, slowly pour in water into the inside. As long as the level of the water *outside* is higher than that of the water inside, the outer pressure upwards will be greater than the inner pressure downwards; but as soon as enough water has been poured in to raise the inner level to that outside, the internal and external pressures will be equal, and when a few more drops are added inside the card will be forced away. The fact that liquid pressure depends upon the height of the column of liquid that is pressing, is made familiar to us in the arrangements for supplying our houses with water; for when the cistern is at the top of the house we find that on opening a tap in a lower storey the water rushes out with very great force, so great, perhaps, that we cannot


Fig. 9.

possibly stop it with our hand, however tightly we press it against the mouth of the tap.

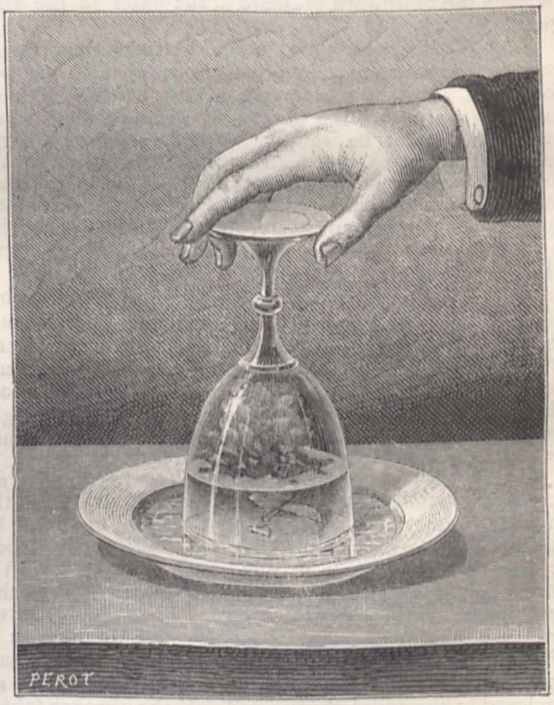



Fig. 10.

Another important law of liquid pressure, not so easy of illustration without apparatus, is the famous principle of Pascal, that when a liquid is put into a closed vessel, and then subjected at any point to a pressure, this pressure is transmitted equally in all directions. If the vessel be a strong one and provided with two movable pistons, a large and a small one, the area of the large piston being many times as great as that of the small one, any pressure exerted upon the small piston to the liquid will be transmitted equally over equal amounts of surface, and hence the total pressure on the large piston will be many times as great as the original force, just in proportion as its area is greater than that of the small piston. This is, in fact, the principle applied in the hydraulic press of Bramah and in the hydraulic machinery of Sir W. Armstrong, by which heavy bridges, dock-gates, and elevators are set in motion. The writer of this article, when sore-pressed to devise an experimental illustration of the principle of the hydraulic press, contrived the following arrangement. The lid of a coffee-pot was removed and a piece of sheet-indiarubber was tied tightly over the open top. Into the spout a piece of lead-pipe about six feet long was inserted, firmly fixed with sealing-wax, and then turned up vertically. The pot was filled with water, and a heavy book placed upon the top. Water was poured into the lead tube until it was filled up to the top. A column of water six feet high affords a pressure of nearly three pounds per square inch, and this, exerted over the whole area of the rubber-covered top, gave a sufficient total pressure to raise the heavy book.

The air also possesses weight, and exerts a pressure which may be upwards or downwards according to circumstances. Let a wine-glass or a tumbler be filled full of water and a thin card laid upon the top of it, so that bubbles of air are excluded. Now invert the whole, pressing the card lightly on to the glass during the operation, to prevent accidents, and it will be found (see Fig. 9) that the water will remain in the wine-glass, and will not fall out. In fact the pressure of the air upwards against the card is much more than sufficient to counterbalance the downward pressure of the water in the wine-glass.

Most of the experiments upon the pressure of the air require, however, the aid of an air-pump for their performance. With the air-pump a large variety of interesting properties of the air can be demonstrated, which otherwise cannot be shown. A few, however, do not require the aid of this instrument. The effect of the external pressure of the air in raising the level of a liquid in a tube from which the air has been partially exhausted, thereby reducing its pressure, can be shown by sucking with the mouth at the top of a glass tube, the lower end of which dips into the liquid in question. Thus it is possible to suck up mercury to a height of fifteen inches into a tube; for the lungs are strong enough to reduce the air in the tube to about half the ordinary pressure. If a glass tube of sufficient length were available it would be possible to suck up water in it to a height of about sixteen or seventeen feet; for a column of that height would be sufficient to counterbalance the difference between the inside and outside pressures.

The rising of a liquid into a space from which the air has been partially removed may also be illustrated in the following pretty way. Take a small bit of card and let it float upon the surface of water in a shallow dish. Upon it place a few shavings of wood and light them with a match; or place a small red-hot coal upon it, and on this sprinkle a little brimstone to burn. Then quickly invert over the blazing mass a wine-glass or a tumbler, as in Fig. 10. As the shavings or the brimstone, as the case may be, burn away, they withdraw the oxygen of the air inclosed in the space above, until only the nitrogen (about four-fifths of the whole) remains. The gases inside, therefore, will not exert so great a pressure as before, and consequently the pressure of the air outside will force the water to rise in the glass as the remaining gases cool down to the temperature at which they were at first.

(*To be continued.*)

## ON THE ABSORPTION BANDS IN CERTAIN COLOURLESS LIQUIDS

[Preliminary Notice]

HAVING occasion to examine the absorption spectra produced by considerable thicknesses of alcoholic solutions of certain cobalt salts, we were led accidentally to observe that alcohol alone gave a very distinct band, and afterwards, on examining water, found that it also, when a column of six feet was used, gave a very distinct absorption band in the orange, a little on the less refrangible side of D. By graphical interpolation we find the centre of this band to be about 600, and that the band extends from 607 to 596. This position corresponds very closely, if it be not identical, with Piazzi Smyth's rain band,[1] and also with the band seen in 330 feet of high-pressure steam by Janssen.[2]

Fig. 1 represents this spectrum. It will be seen that the absorption at the red end extends up to the line C, and the end of the shadow is so sharp that it is probable there is a band at this point also, but masked by the general absorption. To convince ourselves that this band belonged to water and not to any accidental impurity, we experimented with different samples of water, using ordinary tap-water, ordinary distilled water, also water which had been made with much care absolutely pure; in all these samples this same band was visible, and as long as the water was clear, as far as we could judge, it was of the same degree of intensity. A column of water eight feet long shows the band clearer than one only six feet; still greater lengths we have not yet tried. We next tried the effect of increase of temperature on the water. For this purpose the glass tube containing the water was fitted into an air-bath, and the temperature was raised from 20° to 60° without removing the tube from before the spectroscope; no change in the band, either in position or intensity, as far as we could see, occurred. Further, it seemed to us that it would be interesting to try whether, on dissolving different colourless substances in water, the band would be affected. We consequently examined saturated solutions of the following substances in a tube 8 feet long:—Ammonium chloride, ammonium nitrate, ammonium carbonate, potassium nitrate, lead nitrate, sodium chloride, and sugar. In all these cases the band was as visible as in pure water, and no additional band was seen. With a mixture of 1 volume of sulphuric acid and 5 of water the band was unaffected, but if pure commercial hydrochloric acid was examined in a 6-feet tube the band was invisible, but with 8 feet a faint indication of it was seen.

This absorption with water being so marked, we naturally went on to try whether other so-called colourless liquids gave, when depths of 6 or 8 feet of them were examined, absorption bands, and at first really our difficulty was to find any liquid which did not show clearly one or more bands.

The ordinary solution of ammonia gave a very clear and marked spectrum (Fig. 2). It consists of four bands, the centres of which are at 650, 630, 610, and 556. The band at 650 is much the darkest, and the band at 630 is remarkably sharp. Then with regard to the 610 band, it is characterised by sharpness only on the least refrangible side, but shades off gradually on the other side, the shade extending as far as 596; this shade is probably due to the water band; and lastly, the band at 556 is by far the

[1] Piazzi Smyth, "Edinburgh Astronomical Observations," vol. xiv.

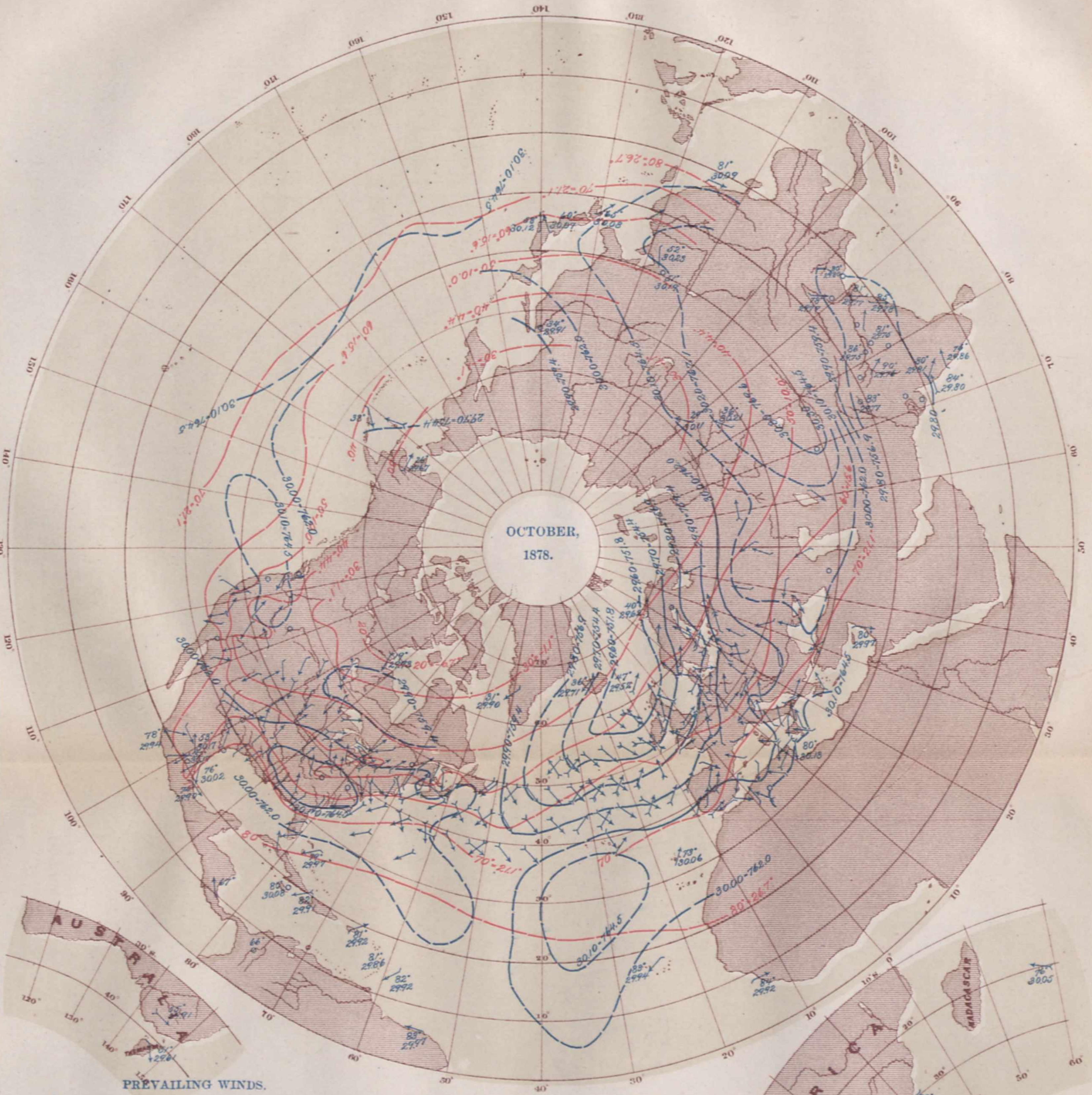
[2] In this and the following experiments a Desaga's spectroscope with a single heavy glass prism was used, and the source of light was an Argand gas-burner. The measurements are expressed in the millionths of a metre.

# Office of the Chief Signal Officer,

*UNITED STATES ARMY.*

No. V.

**Charted from Actual Observations taken Simultaneously. Series commencing October, 1877.**




### PREVAILING WINDS.

Arrows show the direction of, and fly with, the wind
Force is shown as follows:

| Symbols. | Force. | Velocity. | |
|---|---|---|---|
| | | Miles per hour. | Metres per second. |
| | 1, 2 | 0 to 9 | 0 to 4.0 |
| | 3, 4 | 9.1 to 22.5 | 4.1 to 10.1 |
| | 5, 6 | 22.6 to 40.5 | 10.1 to 18.1 |
| | 7, 8 | 40.6 to 67.5 | 18.1 to 30.2 |
| | 9, 10 | 67.6 up. | 30.2 & over. |

PUBLISHED BY ORDER OF THE SECRETARY OF WAR.

Albert J. Myer

BRIG. GEN. (BVT ASSG'D) CHIEF SIGNAL OFFICER, U. S. A.

### INTERNATIONAL MONTHLY CHART.

Showing mean pressure, mean temperature, mean force and prevailing direction of winds at 7:35 A. M., Washington mean time, for the month of October, 1878, based on the daily charts of the International Bulletin.

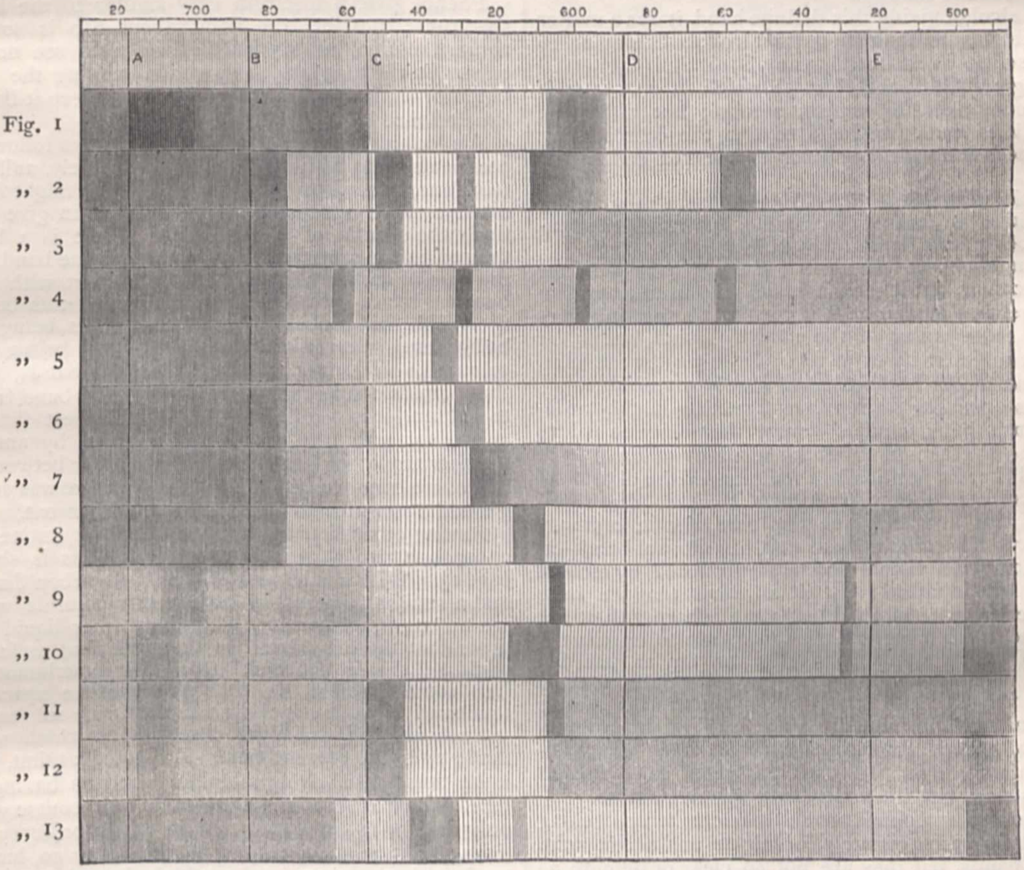
### ISOBARS AND ISOTHERMS.

Isobars in *blue*; detached barometer means in English inches.

Isotherms in *red*; detached temperature means in degrees Fahrenheit.

Broken lines are doubtful.

faintest, and is only visible in a column of 8 feet. With the exception of the 556 band, the other bands are so distinct that in a nearly saturated solution $4\frac{1}{2}$ feet in depth, they are clearly seen. This spectrum was so marked and intense that at first we were sceptical with regard to its belonging really to ammonia, thinking that possibly some coal-tar product might be still clinging to the commercial ammonia solution which in the first instance we used. To satisfy ourselves that this was not the case, first we added lime, and distilled the ammonia gas into pure water; this acted in exactly the same way as the former solution; then we obtained from Messrs. Hopkins and Williams what they guaranteed to be volcanic ammonia. A solution of this gave exactly the same spectrum as the former solutions. And lastly we prepared pure ammonia by Stas' method, by the action of caustic potash and zinc—free from carbon—on potassic nitrite; this also gave precisely the same bands as the other ammonia solutions; there could therefore be no doubt that this spectrum belonged to the ammonia solution. Thirty-six feet of ammonia gas did not give us any indication of bands. Obviously this is only a mere trace of gas as compared with the amount held in the solutions before examined. To have as gas the same amount as there was of solution in our 6-feet tube, we should require a tube nearly a mile long. If absolute alcohol instead of water be saturated with ammonia, a spectrum (Fig. 3) still sharper than that with water is obtained, but similar to it, excepting that the band at 610 is wanting and the two bands at 650 and 630 now are of equal intensity, instead of the 650 band being decidedly and constantly the darker of the two. Ammonia giving so definite a spectrum it was evidently




1, Water; 2, Ammonia; 3, Ammonia in Alcohol; 4, Ethylamine; 5, Amyl Alcohol; 6, Ethyl Alcohol; 7, Aldehyd; 8, Acetic Acid; 9, Benzene; 10, Toluene; 11, Aniline; 12, Toluidine; 13, Turpentine.

of much interest to ascertain what spectra would be given by bodies of allied chemical constitution. Ethylamine was the next substance we tried. Using a 33 per cent. solution, this gave a spectrum (Fig. 4) similar in character to that of ammonia, but the dominant band, as far as we could ascertain, has clearly moved towards the red. It was now at 665 to 656. The next band is also somewhat nearer the red than the corresponding ammonia band. The position of the third band is very nearly identical with that of the water-band, but instead of being a wide band shading off on both sides, is now narrow and perfectly sharp. It will be noticed that in the alcoholic ammonia solution it is this band and the next more refrangible one that are absent.

For lack of material we have not yet examined the spectra of other organic ammonias, but intend doing so.

A solution of peroxide of hydrogen was also examined, using the commercial 20-volume solution. The liquid was not absolutely free from colour, and consequently there was a very appreciable amount of absorption over the whole spectrum. The water band was not visible, and in fact no sharp band could be seen; there was however a decidedly marked absorption commencing about 674, then the absorption is both dark and sharp; it extends, diminishing gradually, to 638; very probably this absorption may prove to be a band, but the experiment was not altogether satisfactory.

We naturally returned to alcohol and other typical organic liquids. Alcohol gives in the six-feet tube a very visible and fairly-defined band, more sharply defined than the water band and nearer the red. It extends from 632 to 624. The spectrum is given in Fig. 6. It will be seen that a faint absorption extends as far as 650, and very likely the termination of this shade is a band. Fig. 6 represents the spectrum of a sample of pure absolute alcohol. Ordinary methylated spirit gives a very similar spectrum, differing only in the presence of some general absorption, and with a mixture of equal parts of methylated spirit and water the alcohol band was still clearly visible, and only a faint indication of the water band.

On referring now to the alcoholic solution of ammonia (Fig. 3), it will be seen that the probable explanation of the darkening of the 630 band is owing to the coincidence of the alcohol band with that of the ammonia, so that really the marked difference of the two ammonia spectra is in the absence of the 610 band, and this, we have seen, may be accounted for by one being an aqueous and the other an alcoholic solution.

Ethylic alcohol giving this definite band, it was a matter of much interest to examine other alcohols belonging to the same series. We found that amylic alcohol ($C_5H_{11}HO$) gave a single visible band (Fig. 5), which in character is like the one given by ethylic alcohol, but differs in position; it extends from 638 to 630, the centre being 634, so that it is decidedly nearer to the red end of the spectrum.

A sample of amylene ($C_5H_{12}$) gave also a band in the same position as that of the alcohol, but it differs apparently in being broader and less defined at the edges.

The sample of methylic alcohol was not quite pure nor free from colour, but it gave a band quite similar to that of the other two alcohols. Its position is certainly very nearly the same as that of the ethylic alcohol, but as far as our measurements went it was a little nearer the blue, but with our method of measuring hardly discernible.

It seems—pending further investigations—highly probable that this band—and of course there may be others not visible—is common to all the alcohols of the ethylic series, and that its position is a function of the density of the particular alcohol. Apparently however the significance of this line does not stop here, for in ordinary ether there is a band coincident with this alcohol-band—in fact practically the visible spectrum produced by alcohol and ether are identical; but in all cases that we have seen the ether spectrum is clearer and sharper than the alcohol one. We thought it of importance to examine a sample of ether which should be as far as possible rendered pure by ordinary means, especially that it should be free from all traces of moisture: this sample gave a band precisely similar to the band in the ordinary commercial ether. Another sample of ether was saturated with water: in this case the ether band was as marked as ever, but the water-band was not visible.

We have also examined two other bodies which belong to the ethylic series, namely, aldehyde and acetic acid. Both give bands, but they are not so clear or definite as the alcohol or ether bands. Figs. 8 and 9 show these bands. The aldehyde band commences sharply at 628, but on the other side it shades gradually off and ceases at 620. The band in acetic acid is very faint, in fact at first, when using the 6-feet tube, we were led to think there was no visible band.

We also tried a few of the saline ethers, and, as far as our investigations have gone, the ethyl compounds give a band coincident with the alcohol- and ether-band. And the band of the amyl compounds is coincident with that of amylic alcohol. There appears, however, to be this general difference between the bands in the alcohols and those in the corresponding saline ethers, namely, that in the latter the bands are always broader and less distinct; the saline ethers we have examined are ethyl oxalate, amyl acetate, amyl iodide, and amyl nitrate.

Passing now to the aromatic series, we find that they give very marked absorption bands. Fig. 9 represents the bands given by benzene; the spectrum is remarkably sharp and clear, quite as clear as the ether spectrum; the figure is drawn from the spectrum produced by 8 feet of the liquid. The absorption extends as far as 656; the first band is from 707 to 698, the second from 609 to 605; both are very dark and distinct. The third band extends from 531 to 528, and is very much fainter.

Toluene, the next higher member of this series, gave also a similar spectrum, and it is equally sharp (Fig. 10). As in the case of the alcohols, with increase of density the bands have moved nearer the red. It will be seen that the band in the red differs in position from the corresponding benzene band more than either of the other two bands do.

Cresol, unfortunately at present, we have not been able to examine for want of a sufficient quantity of the pure substance.

Phenol gives a spectrum very similar to the benzene spectrum; possibly the band about 610 is somewhat nearer the blue, but beyond this we could see no difference. In the first instance we tried melting the phenol, but afterwards found it far preferable to keep it liquid by the presence of a mere trace of water.

We looked with much interest to the two following experiments, with bodies of this series, namely, aniline and toluidene, to see how far their constitution might be indicated by their spectrum. Figs. 11 and 12 give respectively the spectra of these bodies. There is a band in the red in the same position as the toluene band, and in the case of aniline a band agreeing in part with the 606 benzene band. With toluidene, however, this band was not visible, but probably this arose from its being hidden by general absorption, the liquid used being slightly coloured. However, besides these two bands, both of these amido compounds gave a very clear band from 656 to 645, and it is certainly not without interest that this is coincident with one of the bands given by ammonia; whether any other band coincidences occur between these bodies we cannot say, as in both cases there was sufficient general absorption to hide them even if present.

Among other liquids we have tried turpentine, which appears to give a definite spectrum. This is shown at Fig. 13. With a thickness of 8 feet of carbon disulphide and a similar thickness of carbon tetrachloride, we could see no bands. However, with the former liquid it may prove that there is a band in the green, but as far as we could tell this is doubtful. One other experiment, which has some interest, is that the benzene spectrum is unaltered when the liquid is saturated with sulphur.

Such are the principal observations which we have made up to the present time. As stated at first, we look upon these results as preliminary, and as having to be repeated with more accurate means. Of course we have only dealt with the bands visible under ordinary conditions; still, the above results, as far as they go, have been made with much care, and we think show that most interesting relations exist between the chemical composition and constitution of a body and its absorption spectrum. Obviously a far more extended series of observations must be made before any general conclusions of value can be deduced.

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WILLIAM LAPRAIK
Chemical Laboratory,
St. Bartholomew's Hospital

## CELLULOID

THE product of the action of strong nitric acid upon cellulose has of late years met with many applications in the arts.

When cotton wool, linen, paper, or other substance largely consisting of cellulose, is immersed in strong nitric acid, a mixture of two or more nitro-celluloses is produced; a solution of this mixture in alcohol and ether has been long known as collodion.

About three or four years ago it was shown that this product may be dissolved under pressure and at moderately high temperatures in camphor, and that on cooling a hard, compact mass closely resembling ivory is produced. This observation furnished the starting-point in the manufacture of "Celluloid," a substance which has already been put to many and varied uses, and promises to be of much importance in the future.

In the process of Tribouillet and Besaucèle—patented in January, 1879—the raw material, consisting of paper, linen, cotton wool, hemp, or white wood, is dried at 100°, and is then nitrated in vessels of glass, clay, or glazed sheet-iron, furnished with a double bottom, between the parts of which water is constantly flowing. The nitrating acid consists of a mixture of 3 parts concentrated sulphuric acid (sp. gr. = 1·834) and 2 parts concentrated nitric acid, containing nitrous acid. The dry and finely-divided material is first treated with acid which has been already once used for nitrating; the materials are mixed for ten or fifteen minutes by the help of a kind of trowel; the mass is pressed in a glazed iron cylinder with perforated sides and bottom, through which the acid runs out. The material is again treated with a fresh mixture of acids in the proportions already mentioned; it is then washed with water in a series of wooden vessels with perforated bottoms placed one beneath the other on an inclined plane. The last particles of acid are removed by washing with very dilute soda or ammonia, and again with water. The material is then dissolved in appropriate solvents, from which it is again recovered in a paste-like form, by distilling off the solvent.

For making artificial ivory and similar opaque substances, about 100 parts of the prepared nitro-cellulose are intimately mixed with from 42 to 50 parts of very finely-divided camphor, and the mixture pressed in a warm press, into which steam is conducted, and which is connected with a moist chamber wherein the fumes from the press are condensed. After being for some time in a warmer press, the material is dried in a chamber containing calcium chloride or sulphuric acid, and connected with an air-pump.

Other manufacturers appear to mix ivory-dust, nitrocellulose, and camphor, and to press the mixture when moist, heat it with ethyl nitrite in a closed vessel until perfectly homogeneous, and distil off the nitrite.

Celluloid is a hard, perfectly homogeneous substance, which is not attacked by ordinary reagents (it dissolves slowly in cold concentrated sulphuric acid), cannot be easily broken, and becomes plastic at about 125°. It may be obtained in thin layers 0·5 millims. in thickness, which may be encrusted on wood, marble, &c. At about 140° celluloid suddenly decomposes, emitting a reddish vapour; this liability to complete decomposition may be prevented by washing the celluloid with sodium silicate solution and then immersing it in a solution of sodium or ammonium phosphate; thus treated, the material is non-inflammable.

If colouring materials be mixed with the celluloid during the manufacture, artificial coral, amber, malachite, and *lapis lazuli* may be prepared.

Celluloid is an admirable material for forming the backs of brushes, handles of knives or umbrellas, combs, playthings for children, &c.; it is also employed in America as a substitute for linen in the manufacture of collars, scarves for the neck, &c. Articles made of it may be washed with soap and a brush, and are practically indestructible. M. M. P. M.

## L. F. DE POURTALES

[OUR readers will be glad to have the following further notice of the late Count Pourtales from his intimate friend and colleague, Prof. A. Agassiz.—ED.]

Louis François de Pourtales died at Beverly Farms, Massachusetts, in the fifty-seventh year of his age, on July 17, 1880. Spite of a magnificent constitution and a manly vigour of body and mind which seemed to defy disease and to promise years of activity, he sank, after a severe illness, under an internal malady.

Educated as an engineer, he showed from boyhood a predilection for natural history. He was a favourite student of Prof. Agassiz, and when his friend and teacher came to America in 1847, he accompanied him, and remained for some time with the little band of naturalists who, first at East Boston, and subsequently at Cambridge, shared his labours.

In 1848 Pourtales entered the U.S. Coast Survey, where his ability and indefatigable industry were at once recognised, and he remained attached to that branch of our public service for many years. He then became deeply interested in everything relating to the study of the bed of the ocean. Thanks to the enlightened support of the then Superintendent of the Coast Survey, Prof. Bache, and of his successors, Prof. Peirce and Capt. Patterson, he was enabled to devote his talents and industry to the comparatively new field of "thalassography" and the biological investigations related to it. The large collections of specimens from the sea-bottom accumulated by the different hydrographic expeditions of the U.S. Coast Survey were carefully examined by him, and the results were published, in advance of their appearance in the Coast Survey Reports, in *Petermann's Mittheilungen*, accompanied by a chart of the sea-bottom on the east coast of the United States.

So interesting and valuable were the results obtained, not only as an aid to navigation, but in their wider bearing on the history of the Gulf Stream and on the distribution of animal life at great depths, that in 1866 he was sent out by Prof. Peirce, then superintendent of the Coast Survey, to continue these investigations on a larger scale. During 1866, 1867, and 1868 he was in charge of the extensive dredging operations carried on by the U.S. Coast Survey Steamer *Bibb*, acting-master Platt, along the whole line of the Florida reefs and across the Straits of Florida to Cuba, Salt Key, and the Bahama Banks. The results of these expeditions, published in the *Bulletin* of the Museum of Comparative Zoology, excited great interest among zoologists and geologists. M. Pourtales was indeed the pioneer of deep-sea dredging in America, and he lived long enough to see that these expeditions had paved the way not only for similar English, French, and Scandinavian researches, but had led in this country to the *Hassler*, and finally to the *Blake* expeditions, under the auspices of the Hon. Carlile P. Patterson, the present Superintendent of our Coast Survey. On the *Hassler* expedition from Massachusetts through the Straits of Magellan to California, he had entire charge of the dredging operations; owing to circumstances beyond his control, the deep-sea explorations of that expedition were not as successful as he anticipated.

At the death of his father M. Pourtales was left in an independent position, which allowed him to devote himself more completely than ever to his zoological studies. He resigned his official connection with the Coast Survey and returned to Cambridge, where he became thenceforth identified with the progress of the Museum of Comparative Zoology. To Prof. Agassiz his presence there was invaluable. In youth one of his favourite pupils, throughout life his friend and colleague, he now became the support of his failing strength.

The materials of the different deep-sea dredging expeditions above-mentioned had been chiefly deposited at the Museum in Cambridge, and were thence distributed to specialists in this country and in Europe. A large part of the special reports upon them have already appeared. M. Pourtales reserved to himself the Corals, Halcyonarians, Holothurians, and Crinoids. A number of his papers on the deep-sea corals of Florida, of the

Caribbean Sea, and of the Gulf of Mexico have appeared in the Museum publications. He had begun to work at the magnificent collection of Halcyonarians made by the *Blake* in the Caribbean Sea, and had already made good progress with his final report on the Holothurians. The Crinoid memoirs published by him relate to a few new species of Comatula and to the interesting genera Rhizocrinus and Holopus.

The titles of his memoirs indicate the range of his learning and his untiring industry. His devotion to science was boundless. A model worker, so quiet that his enthusiasm was known only to those who watched his steadfast labour, he toiled on year after year without a thought of self, wholly engrossed in his search after truth. He never entered into a single scientific controversy, nor ever asserted or defended his claims to discoveries of his own which had escaped attention. But while modest to a fault and absolutely careless of his own position, he could rebuke in a peculiarly effective, though always courteous, manner ignorant pretensions or an assumption of infallibility.

Appointed keeper of the Museum of Comparative Zoology after the death of Prof. Agassiz, he devoted a large part of his time to the administration of the museum affairs. Always at his post, he passed from his original investigations to practical details, carrying out plans which he had himself helped to initiate for the growth of the institution. As he had been the devoted friend of Prof. Agassiz' father, he became to his son a wise and affectionate counsellor, without whose help in the last ten years the Museum could not have taken the place it now occupies.

If he did not live to see the realisation of his scientific hopes, he lived at least long enough to feel that their fulfilment is only a matter of time. He has followed Wyman and Agassiz, and like them has left his fairest monument in the work he has accomplished and the example he leaves to his successors.

Cambridge, Mass., August 2 ALEXANDER AGASSIZ

## NOTES

THE honour of a Knight-Commandership of the Bath has been conferred upon Mr. E. J. Reed, C.B., F.R.S., late Chief Constructor of the Navy.

WE give this week, by the continued kindness of General Myer, the International Monthly Chart for October, 1878, showing mean pressure, temperature, force and prevailing direction of wind at 7.35 a.m. Washington mean time, for that month. The lessons which it teaches may be learned by comparison with the chart for the previous month; any remarks we may have to make upon it we reserve for the issue of the next chart.

WE are happy to state that the Worshipful Company of Drapers have intimated their intention of continuing, at all events for the present, their annual subscription of one hundred guineas to the Research Fund of the Chemical Society.

THE eighth session of the French Association for the Advancement of Science was opened on August 11 at Rheims, under the presidency of M. Krantz, senator and ex-director of the Universal Exhibition of 1878. In his opening speech M. Krantz paid a tribute to the memory of Paul Broca, and spoke of the late Universal Exhibition as well as the construction of the Trocadéro Palace. The General Secretary, M. Mercadier, according to the routine of the French Association, reviewed the work done last year at Montpellier. Addresses were also delivered by M. Diancourt, Mayor of Rheims, and M. Paulane, ex-Mayor, President of the Local Committee. The report read by M. Georges Masson, the treasurer, shows that the French Association is very prosperous, numbering 3,000 members, with a capital of 300,000 francs. The income is 60,000 francs. The attendance is considered to be very good, the local attractions being really unexceptionable in a city whose wines are famous in the whole world, and which is the centre of interesting excursions. On the 12th M. Perrier delivered, in the General Session, an address on the law of selection.

THE Cambridge meeting of the British Medical Association last week is considered to have been one of the most successful which the Association has held. The presidential address by Prof. Humphry traced the history of medical science in the English universities, and showed the causes of the gradual divorce between university and medical studies up to the last few years. He reiterated his advocacy of university residence for medical students, and of continual advance and expansion of good teaching and examining. He claimed that in no other branch of knowledge were true science and sound practice so perfectly conjoined; in no other was there so much that was calculated to give strength and balance to the thinking and the observing faculties; nor was there any in which mental and bodily effort were more required or more telling. What problems were harder of solution than those relating to the aberrations of the human organism? The very difficulty of the problems caused them to be overlooked. Clearer knowledge of physiology and pathology, of heredity, of the effects of social laws and climatic variations, would have a vast influence on the whole framework of civilisation; and thus he was led to conclude with Descartes that all great movements in the world of thought, of philosophy, or of morals, and of government, were to come out of medicine. Cambridge ought not to fail in doing its share in the great work, and renewed life would come to all its best interests from a wise encouragement of medicine. The British Medical Association brings together in one aim an enormous power, and ought to aid in wearing away false dogmas and false notions of conflicting interests. Dr. Humphry further urged on the vast mass of members of the Association a hearty participation in the collection of facts bearing on the effects of temperature, climate, soil, &c., on disease, under the guidance of a medical investigation committee. The latter proposal awakened a cordial response, and the Council were requested to see it carried out. The honorary degree of LL.D. was conferred on Doctors Brown-Séquard, Donders of Utrecht, Gross of Philadelphia, Sir W. Jenner, Sir W. Gull, Sir George Burrows, Prof. Haughton of Dublin, Mr. Wm. Bowman, Mr. Joseph Lister, Dr. Denis O'Connor of Cork (the retiring president of the British Medical Association), Mr. John Simon, C.B., and Dr. Andrew Wood. Dr. Chauveau of Lyons was unavoidably absent from the meeting, and consequently could not receive in person the degree which would otherwise have been conferred upon him; and Prof. Broca's lamented death caused another variation from the list as originally settled.

THE International Congress of Hygiene will meet at Turin on September 6 under the presidency of King Humbert, who will give the inaugural address. The general meeting will take place in the Carignan Palace. The Congress will end by an excursion to Milan, where a cremation will take place.

IN a brief report of the recent French scientific cruise in the *Travailleur*, in the Bay of Biscay, M. Alph. Milne-Edwards says the weather was very good, allowing them in the last fortnight of July to dredge twenty-four times, sometimes using two dredges at once. The bottom has a thick layer of greenish-grey ooze, which was apt to fill the dredges, so recourse was had largely to weighted rods with hemp or twig bundles, swabs, &c., attached, to sweep the bottom. Sir William Thomson's wire apparatus proved very serviceable in sounding. The greatest depth reached was 2,700 m., and the least exceeded 300 m. An important collection of marine organisms was obtained, including, besides most of the species described by English and Scandinavian naturalists, many new animals not previously known. Some large Gorgonians of the genus Isis, once brought up from 600 m., about midnight presented a curious sight: the whole of the sarcosoma between the zooids emitted a green phosphorescent light so strong that on agitating these animals they seemed to produce a shower of fire, and with the light emitted one could read the smallest type. The collections are distributed thus: M. Vaillant examines the fishes, nemertians, and sponges; M. Fischer, the molluscs; M. Marion, the annelids, echinoderms, and other zoophytes; M. de Folin, the foraminifera; M. A. Milne-Edwards, the crustacea; while M. Perier has made thermometric observations, and will analyse the samples of sea-bottom.

AMONG our letters this week are some referring to the recent remarkable displays of auroræ. Another correspondent writes that similar displays were seen from Caithness-shire on the evenings of Wednesday the 11th, and Thursday the 12th inst. The finer of the two displays was on the Thursday, lasting from about 10 p.m. to midnight. The outburst of streamers at 10.15 p.m. was very fine, the streamers appearing like wavy swaying curtains from the zenith to near the horizon, with a development of tints of the loveliest green near the zenith. The aurora of the 11th was to the north-west of Wick, but that of the 12th chiefly to the north-east. From Kirkwall also fine displays were seen on the 13th till past midnight. Reports in the daily papers also show that the phenomena have been seen from many parts of England as well as Scotland. Fine displays of this beautiful meteor may very confidently be looked for during the next three months, and if our spectroscopists bestir themselves a large extension of our knowledge of the aurora is close at hand.

PROF. SILVESTRI writes to the *Daily News* Naples correspondent that in a short time the Observatory on Etna will be an accomplished fact. The Italian Government contributes half of the expenses, the Province of Catania a fourth, and the Commune of Catania the remaining fourth. The object of the observatory is the study of vulcanology, and therefore it has been built at the base of the central cone, exactly on the former site of the well-known refuge called the "Casa degli Inglesi.' It will be in connection with several small sismic stations posted on the slopes of the mountain, and the whole will communicate telegraphically with another vulcanic station which he proposes to establish in Catania. In the central observatory, so favourably situated about 3,000 metres above the level of the sea on the isolated mountain, where the extent of view is unlimited, and the sky peculiarly transparent, meteorological observations most interesting to science will be carried on, and Prof. Tacchini, the astronomer, proposes to make there experiments in physical astronomy, particularly relating to the spectroscopical study of the fixed stars. The Observatory will therefore be divided into three scientific branches—vulcanology, astronomy, and meteorology, connected with the University of Catania, and dependent on the Minister of Public Instruction. It was intended that the inauguration should take place during the Congress of the Alpine Club at Catania, but unforeseen delays in the execution of the works will defer it to next year.

THE United States Government has taken prompt and vigorous action on the basis of the recent conclusions come to by scientific investigators as to the prevalence of colour-blindness. Both in the army and the navy, and in the case of pilots, systems of examination have been devised and are enforced to secure the detection of colour-blindness in all cases in which such a defect would be likely to lead to inefficient discharge of duty. As we formerly intimated, also, the State of Connecticut insists that all railway *employés* within its borders be tested for the same purpose, and doubtless in time a similar law will be passed in all the other States. The following are the rules for conducting the examinations in the State of Connecticut:—Rule 1.—For the qualitative estimation of colour-blindness the following tests are to be employed: Holmgren's worsteds, the tables of Stilling, Donders' colour-test patterns, Pflüger's letters with tissue papers. Däae tests and Woinow's revolving cards may also be used. For the quantitative test for colour-blindness, Donders' reflected spots, Donders' method with transmitted light, Holmgren's shadow-tests shall be employed. Rule 2.—The following are the requirements for a certificate in the first class: 1. Healthy eyes and eyelids without habitual congestion or inflammation. 2. Unobstructed visual field. 3. Normal visual acuteness. 4. Freedom from colour-blindness. 5. Entire absence of cataract or other progresssive disease of the eyes. The second class shall have:—1. Healthy eyes and eyelids without habitual congestion or inflammation. 2. Unobstructed visual field. 3. Visual acuteness at least equal to three-fifths without glasses and normal with glasses in one eye, and at least one-half in the other eye with glasses. 4. Freedom from colour-blindness in one eye, colour-perception at least equal to three-fourths in the other eye. Rule 3.—In the case of *employés* who have held their positions five years or more, the standards required in each class shall be determined under special instructions from the Board of Health.

THE third instalment of Dr. Elliott Coues's "Ornithological Bibliography" is, we learn from the New York *Nation*, still in the press, having been delayed by its unexpected extent. Meantime, extracted from the *Proceedings* of the United States National Museum, we have the fourth instalment, being a "List of Faunal Publications relating to British Birds." Such a list, of course, could not possibly be made complete out of England, and the compiler himself points out its inadequacy. Nevertheless, it embraces something like a thousand titles, only in a comparatively few cases taken at second-hand, and is so accurate and punctilious as far as it goes that to call it a "published proof-sheet" is almost an excess of modesty. The titles are given in full, and even, as in the first two (different editions of the same book), with the typographic errors and inconsistencies of the originals. Further, they are arranged chronologically, and copiously annotated, not seldom with the aid of Prof. Alfred Newton, of Magdalene College, Cambridge.

"PALÆONTOLOGISTS and naturalists generally," the *Nation* states, "will learn with satisfaction of the appearance in connected form of the results of a portion of Prof. Marsh's wonderful palæontological discoveries in the Western Territories. The series of explorations so successfully carried on by this distinguished naturalist in the Rocky Mountain region since 1868, undertaken at no inconsiderable personal risk and no less considerable outlay of private capital, has resulted in the acquisition by Yale College of the most extensive collection of fossil vertebrate remains in the world. Huxley's visit to this country in 1876 was largely, if not mainly, brought about by his desire to examine personally this collection. Some notion of its extent may be gleaned from the fact that of Pterodactyls (flying reptiles) alone it embraces fragments belonging to at least 600 individuals, and of Mesozoic birds—a class of remains which, as far as number is concerned, has thus far yielded the most barren results in extra-American countries—fragments representing more than 100 individuals. The work before us, which is intended to form vol. vii. of the geological reports of the Fortieth Parallel Survey, deals with the *Odontornithes*, or extinct toothed birds of North America. These, belonging to the middle-cretaceous period, are the oldest ornithic remains as yet discovered on this continent, and, with the exception of the three specimens of the *Archæopteryx* unearthed from the Jurassic lithographic limestone of Solenhofen, Bavaria, represent the oldest known form of birds altogether, for the footprints in the Triassic sandstone of the Connecticut valley are now generally referred to Dinosaurian reptiles. Despite their strongly reptilian characters—among others, the presence of teeth in the beaks—which point to a position low down in the avian branch of the Sauropsida, Prof. Marsh argues, from the structural differences existing between such forms as *Hesperornis* and *Ichthyornis*, and between these and *Archæopteryx*, which appear greater than those presented by any two living birds, that they represent comparatively highly specialised types, and that we must look for the earliest appearance of birds in strata possibly as old as the Permian (Palæozoic). The magnificent engravings which accompany the work render it a *livre de luxe*, and place it in the category of recent American scientific works next to Leidy's 'Rhizopods,' to which we lately had occasion to call attention. We are informed that another important work on the extinct vertebrata of the West is shortly to appear, from the pen of Prof. Cope."

MR. THOMAS BOLTON of Birmingham has sent us No. 3 of his "Portfolio of Drawings and Descriptions of Living Organisms (Animal and Vegetable) Illustrative of Freshwater and Marine Life," which have been sent out by him with the living specimens.

AN interesting paper by Mr. G. M. Dawson on the distribution of some of the more important trees of British Columbia is reprinted from the *Canadian Naturalist*. In connection with this subject we learn from the *Gardener's Chronicle* that three of the most distinguished botanists of America—Dr. C. C. Parry, Dr. George Engelmann, and Prof. C. S. Sargent—are now on their way to Vancouver's Island; thence they propose to return and ascend the Columbia River as far as it is necessary to settle vexed tree questions in the extensive forest region along its shores; they will thence journey southward *viâ* Portland through the centre of Oregon to the great Fir forests of Shasta. We may hope that much "clearing-up" in the nomenclature of certain Conifers will accrue from the visit.

WE have received the five Annual Reports of the Little Miami Natural History Society, which was founded in 1875 at Antioch College, Yellow Springs, Ohio. The objects of this Society are:—(1) To develop among the students a habit of accurate observation and patient investigation rather than mere acquisition in studying the natural sciences, and thus to accustom them to the methods and rules of scientific study; and (2) to work out the natural history of the district in which the college is situated, especially the valley of the Little Miami and its tributary streams. The membership of the Society is open to all students of the College who wish to join for the purpose of doing actual work in furtherance of this purpose. Each of the Reports covers only one side of a sheet of paper, but from the catalogue of papers and reports contributed to the Society, it is evidently doing good work in the natural history of its district.

DR. R. F. HUTCHINSON of Mussoorie, N.W.P., India, writes with reference to NATURE, vol. xxii. p. 119, that he has frequently seen Mercury with the naked eye out there, especially in the cold weather when the atmosphere is clear and dry. He has also twice seen two of Jupiter's satellites under the same circumstances.

SEVERAL important changes have been made in the method of conducting the technological examinations in connection with the City and Guilds of London Institute; those interested should apply for a programme of the changes to the Secretary, Gresham College, E.C.

TELEPHONE experiments with a new apparatus by Dr. Herz have been made with the French Atlantic cable between Brest and Penzance, and are said to have yielded satisfactory results.

ON Sunday, August 8, a young man named Brest ascended at Marseilles in a balloon he had constructed himself. He was lost to view in the direction of the sea, and his aërial craft was found by fishermen close to Bastia, in Corsica. It is feared that the unfortunate aëronaut was drowned.

THE lady who took so high a place in the London University B.Sc. examination, referred to last week, was not Miss, but Mrs. Bryant, the well-known teacher at the North London Collegiate School for Girls.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. J. E. Kincaid; a Black-handed Spider Monkey (*Ateles geoffroyi*) from South America, presented by Capt. Woolward; a Common Squirrel (*Sciurus vulgaris*), British, presented by Capt. Tholandir; a Spotted Ichneumon (*Herpestes auropunctatus*) from India, presented by the Hon. L. S. Jackson; four Richardson's Skuas (*Lestris crepidatus*), Shetland Isles, presented by Mr. Robt. T. C. Scott; three Abyssinian Guinea Fowls (*Numida ptilorhyncha*) from Abyssinia, presented by Mr. Gerald Waller; two Common Nightjars (*Caprimulgus europæus*), British, presented by Mr. E. Ockenden; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Percy Howard; an Areolated Tortoise (*Homopus areolatus*), a Geometric Tortoise (*Testudo geometrica*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; three Richardson's Skuas (*Lestris crepidatus*), Shetland Isles, four Glass Snakes (*Pseudopus pallasi*) from Dalmatia, deposited; a Yellow-collared Parrakeet (*Platycercus semitorquatus*) from West Australia, received in exchange.

## *OUR ASTRONOMICAL COLUMN*

THE AUGUST METEORS.—The meteors annually encountered by the earth on arriving at the descending node of the third comet of 1862, in the orbit of which they are found to travel, are reported to have been less numerous this month than in most recent years. The earth arrived in the longitude of the node about midnight on the 9th inst., and in this position is only 430,000 miles, or less than twice the moon's distance from the comet's track. Even if less frequent than in several past years, a considerable number was observed on August 9, 10, and 11, and on the latter night a conspicuous Aurora Borealis, which phenomenon has so often accompanied meteoric displays, was witnessed in the north of England. Early on the evening of August 12 the meteors were sufficiently frequent and bright to attract the attention of persons in the suburbs of London who were not looking for them, but there were very few later in the evening.

It has been frequently remarked that the August meteors, or, to call them by their astronomical designation, the *Perseids*, must be much more widely distributed along the cometary orbit than are those of the November period—the *Leonids*—moving in the track of the first comet of 1866. The comet which appears to generate the August meteors, or at any rate to be followed by them, has now receded beyond the orbit of Neptune, and will continue to recede until about the year 1923. It was last in aphelion, according to Prof. Oppölzer's investigation, about 1801 or 1802, and, notwithstanding the great distance of the comet, there was a remarkable meteoric display. Herrick reports a letter from Dr. Joseph Priestley describing the phenomenon as he witnessed it on August 8, 1801, amongst the meteors being "a prodigious number of fire-balls." He compared the whole to a brilliant display of fire-works.

It is rather singular that in the history of comets we should not have been able to recognise any previous appearance of the body connected with the *Perseids*, notwithstanding its close approach to the earth's orbit when the perihelion passage takes place in the summer. Perhaps for many past centuries the perihelion may have fallen in the winter, when the comet would have greater chance of escaping notice.

CAPE OBSERVATIONS OF COMET 1880 (I).—Mr. Gill sends us the fully reduced observations of the great comet of the present year made at the Royal Observatory, Cape of Good

Hope. A ring-micrometer was used, the aperture of the telescope and the unsatisfactory illuminating arrangements not permitting the use of the parallel-wire micrometer. The stars of comparison have been observed in the early morning with the meridian circle; also the 7½ mag. star used by Mr. Ellery on February 14. Mr. Gill expresses himself as by no means proud of his observations, the comet's nucleus being an object which could not be satisfactorily observed, but he did his best with the available means. He also writes disparagingly of the ring-micrometer, a tool which we incline to agree with him has been very much over-lauded. As Mr. Gill will no doubt communicate the details of his observations and reductions to the Royal Astronomical Society or the *Astronomische Nachrichten*, we shall confine ourselves to appending his final results:—

| | Cape M.T. | App. R.A. | App. N.P.D. |
|---|---|---|---|
| | h. m. s. | h. m. s. | ° ′ ″ |
| Feb. 10 | 8 50 2 | 0 3 58·59 | |
| — | 8 52 49 | — | 123 43 15·53 |
| 11 | 8 33 4 | 0 20 22·16 | — |
| — | 8 45 42 | 0 20 31·53 | 123 31 30·78 |
| 12 | 8 42 18 | 0 36 28·06 | 123 11 33·93 |
| — | 8 42 18 | 0 36 28·29 | — 23·44 |
| 13 | 8 30 57 | 0 51 39·32 | 122 44 20·93 |
| 14 | 8 23 5 | 1 6 7·89 | 122 11 17·23 |
| — | 8 42 51 | 1 6 19·25 | 122 10 52·86 |
| — | 8 42 51 | 1 6 19·79 | — 57·19 |
| 15 | 8 24 31 | 1 19 54·92 | 121 32 52·17 |

On February 12 two, and on February 14 three, comparison stars were employed. The observations are not yet corrected for parallax.

## PHYSICAL NOTES

PROF. O. N. ROOD claims to have produced a *new* improvement into the Sprengel pump, by which he says he can easily exhaust to $\frac{1}{900000000}$ or $\frac{1}{1000000000}$. The alleged improvement is in two parts; the first being an arrangement whereby "the mercury, instead of being at once introduced into the pump, passes beforehand through an exhausted bulb"; the second being a "theoretically perfect fluid valve," formed by bending the fall-tube into a crenellated form at one point. It is hardly necessary to point out that neither of these improvements is new. The first has been adopted in the Sprengel pumps sold by instrument makers in London for the last ten years, and the second, in a form superior even to that of Prof. Rood (since the fall-tube was furnished with more than one fluid valve of a form identical with that devised by Prof. Rood), was to be seen in one of the improved Sprengel pumps exhibited in the Loan Collection at South Kensington in 1876.

M. TROUVÉ has suggested a new improvement in the old and simple longitudinal armature employed by Siemens in his earlier magneto-electric machines, and lately revived by M. Marcel Deprez in his little motors. M. Trouvé's improvement consists in constructing the armature, not with parallel sides, but with sides forming part of a skew-cylinder. Thus one part of the armature is ready to leave the poles of the field magnets when the other is approaching it, and the currents produced are therefore much more nearly continuous than with the parallel form. This will probably be a considerable advantage in the case where the armature is employed in a small motor, which will be driven much more steadily than has hitherto been possible. With three cells of Reynier's new battery this little motor will drive a sewing-machine.

M. J. PLATEAU proposes a method of estimating approximately the apparent distance at which the moon seems to different people to be in the sky. This means consists in looking at the moon steadily until the retina is sufficiently fatigued to produce an "accidental" image or ghost. The observer must then turn his gaze to a blank wall, on which he will see the accidental image projected as a tinted patch of the same shape as the moon. He is then to retreat from, or advance to, the wall until this image appears to him to be of the same size as the moon itself did. The distance measured off between the observer and the wall will be the same as that at which he unconsciously takes the moon to be. One of the sons of the author having made this experiment, found the distance to be in his case about fifty metres. This seems a small distance, but it was the result of a single experiment under circumstances which were not very favourable. M. Plateau concludes the brief memoir on the subject, presented by him to the Belgian Académie, by cautioning all persons who may be interested in the subject to take care in repeating the experiment lest the great brilliance of the luminary should damage their sight.

M. REYNIER recommends as a powerful and constant battery for electric light work a modified Daniells' cell, in which the zinc is immersed in a solution of caustic soda placed in a rectangular porous cell of parchment paper. The electromotive force of this combination varies from 1·47 to 1·35 volts, and the resistance may be less a Thomson's tray battery. The actual energy which a cell of this battery would furnish is calculated to be twice that of the ordinary round Bunsen cell.

A FEW months ago Prof. Boltzmann of Vienna published a calculation of the velocity of the electric current in a conductor based upon the discovery of Mr. E. H. Hall that a magnet acts upon a current in a conductor, tending to alter its path in the substance of the conductor. In the July number of the *American Journal of Science* Mr. Hall combats Boltzmann's calculation, and shows that by parallel reasoning a current should tend to urge forward with considerable force the conductor through which it flows; which mechanical effect is certainly non-existent. Mr. Hall now gives us the very interesting additional piece of information that the displacing force exercised by the magnet upon the current in the conductor is in an opposite direction in gold to what it is in iron—which is also quite irreconcilable with Boltzmann's theory.

AN improved centrifugal machine for schools is described in the *Nachrichten* of the Göttingen Society of Sciences (No. 9), by Herr W. Holtz. The driving-wheel runs in a vertical plane, and the quick axis may (with one and the same length of cord) be set either in a horizontal or a vertical plane, and higher or lower, also at varied distance from the frame of the machine; further, it can be so rotated that an object to be rotated with it can be suspended from it. On the same axis and of equal size with the large driving-wheel, but independent of it, runs another grooved wheel. The endless cord passes under these and round two smaller wheels higher up, one of which is on the axis to be quickly rotated (which is set in a movable support). The machine has been patented in Germany.

IN a communication to the Göttingen Society of Sciences (*Nachr.*, No. 13), Herr Wöhler states that with aluminium *alone* and with very few elements, a galvanic battery may be formed of strength sufficient to deflect a magnetic needle strongly, decompose water, and raise a thin platinum wire to glow. In a cylindrical glass vessel holding very dilute muriatic acid or dilute soda lye, is placed a roll of sheet aluminium, and within this a porous cell containing concentrated nitric acid and a smaller roll of aluminium. A projecting piece of the metal from each roll is inserted in a circular cover of ebonite.

DURING a recent thunderstorm at Hamburg the British Consul, Mr. Pogson, observed the phenomenon of St. Elmo's fire playing above the tip of the spire of a church three-quarters of a mile away. Twenty times within one hour a pale bluish ball of light resembling in tint the flame of burning potassium was seen. It appeared to be spherical in form, and from three to six feet in diameter. It seemed to hover above the spire without touching it, and lasting about forty seconds at each time of appearance.

*Apropos* of the approaching meeting of the British Association at Swansea, we may note that on the occasion of the last meeting at Swansea of the Association, in 1848, a paper was read by Mr. F. Wishaw "On the Telekouphon, or Speaking Telegraph." This antedates Philip Reis's "Telephon" by several years.

ANOTHER improved bichromate battery is announced, this time by the Silvertown Company. In no essential respect does this battery differ from the form known as "Fuller's battery," save in the addition of certain "exciting powders" to the liquids, a "grey compound" being dissolved in the inner cell in which the amalgamated zinc is placed, and a "red compound" in the outer cell with the carbon-rod. The use of dilute sulphuric acid is avoided by employing the "grey compound;" the avowed aim of this change is the increase of internal conductivity. The result is certainly an increase of cost.

SPEAKING of bichromate batteries, it appears to us that the true function of the porous cell now usually employed with them is entirely misunderstood. The bichromate solution, as reduced by the zinc in the cell on standing, is a colloidal substance. The porous cell prevents this from mixing with the fresher strong solution outside, and thus enables the operator to remove the exhausted portion.

An adaptation of the telephone to the needs of deaf persons has been brought out by one H. G. Fiske of Springfield (Massachusetts). To the centre of the disk of the receiving telephone is attached a short rod of wood, ebonite, or other elastic hard material which can be held between the teeth. The sonorous vibrations imparted to the disk by the magnet are thus transmitted mechanically to the auditory nerves through the teeth and the bones of the skull. The advantages are probably limited, since, as experiments with the audiphone have shown, only a small percentage of truly deaf persons retain the power of hearing through the teeth. In the greater majority of cases it is the auditory nerve itself, not the mechanical adjustments and auditory apparatus of the ear, that is the cause of deafness.

## GEOGRAPHICAL NOTES

Some modifications have been made in the composition of the fifth International Expedition to Central Africa. Lieut. Harou, who was to have formed part of the expedition, will only join his companions at a later period on the Upper Congo. He is charged, meantime, with a secret mission to Africa, for the accomplishment of which about ten months are necessary. After the termination of this mission he will join the expedition. M. Harou will embark about the 23rd for his new destination. We learn that Dr. Dutrieux, who had to return from Africa to Belgium to recruit his health, is about to return to Africa to take part in the service for the abolition of slavery, at the head of which is Col. Sala. He had begun when in Africa a dictionary of the Suaheli language, so common all over Central Africa. Although incomplete, the Executive Committee of the Association have decided to print the dictionary as it is, and put it in the hands of travellers for correction and completion.

The *Bereg* states that next autumn Baron Nordenskjöld will visit St. Petersburg to make preparations for his proposed expedition to the New Siberian Islands in 1882, the expenses of which will be borne by the Russian merchant, M. Sibiriakoff. Nordenskjöld will go to the mouth of the Lena overland, and thence embark for his destination.

The Congress of French Societies of Geography was held this year at Nancy during the first week of August. M. Levasseur, honorary president, gave an address, in which he reviewed the progress realised by the creation of so many geographical societies. In the evening the members were invited to the Town Hall, where they were entertained by M. Volland, the mayor. A number of toasts were delivered by his Worship, as well as by M. Levasseur and others.

A letter from Dr. Matteucci, written in May last, intimates the arrival of the expedition under Prince Borghese at El Fasher, the capital of Darfur, and the approaching departure for Wadai. Dr. Matteucci remarks on the almost absolute want of water in Darfur, and the consequent recent cultivation of water-melons by the natives as far as the arid soil will permit. They also utilise the Baobab tree in a curious manner. Hollowing out the huge trunk of the older trees by fire, they by some prehistoric primitive method get the hollow trunk filled with water during the rainy season, the water keeping sweet for eight months. The people of Darfur, Dr. Matteucci says, are still in a primitive uncorrupted condition, a contrast to the Egyptianised natives of Kordofan.

M. Bischoffsheim pays the expenses of M. G. Capu, a young geologist and botanist, who will accompany M. de Ujfalvy on his new mission to Central Asia, referred to last week; M. Gabriel Bovalt, as topographer and naturalist, will also accompany the mission.

## THE ALGÆ OF THE SIBERIAN POLAR SEA[1]

Before the voyage of the *Vega* our knowledge of the algæ of the Siberian Polar Sea outside the Kara Sea was limited to the fact of their existence in Tschaun Bay and along the coast between that bay and the mouth of the Kolyma. This information was obtained by Baron Maydell, the leader of a scientific expedition sent out in 1869, under the auspices of the Russian Geographical Society, to explore the Tchuktchi Peninsula. A statement previously made by Matiuschin, one of Wrangel's companions during his Siberian journey, that algæ exist at Tschaun Bay, was thereby confirmed. Maydell brought home with him only three incomplete specimens of algæ, which he obtained from a native living at Cape Schelagskoj. From the description given by him they appear to belong to the genera Alaria and Laminaria.

From observations made during the voyage of the *Vega* it appears that algæ exist at several places along the whole coast of the Siberian Polar Sea. They occur almost exclusively within the sublittoral region. In the elittoral area, which was the best and most completely examined during the expedition, Dr. Kjellman found only at two places, viz., between Port Dickson and Tajmur Island, an exceedingly scanty flora consisting of three species, two Florideæ—*Lithothamnion polymorphum* and *Phyllophora interrupta*—and a Phæozoosporacea—*Lithoderma fatiscens*. The littoral region along the north coast of Siberia is, like that of the coasts of Novaya Zemlya and clearly for the same reasons, nearly everywhere devoid of algæ. Only at two places did Dr. Kjellman find traces of a strand vegetation. They consisted of two small green algæ, *Enteromorpha compressa* and *Urospora penicilliformis*, both known from the same region in other parts of the North Polar Sea. Fucaceæ occur nowhere within the littoral region, not a single individual of this group having been found at any of the places visited between Port Dickson and Koljuschin Fjord near Behring's Straits. To the east of this fjord there was found in the sublittoral region in limited quantity *Fucus evanescens*, which is extensively distributed in the North Polar Sea. In the sublittoral belt of the bottom, too, the vegetation in the Siberian Polar Sea is very scanty. Dr. Kjellman had not an opportunity of examining any region where the flora was not considerably poorer in individuals than in those places on the coasts of Spitzbergen and Novaya Zemlya where algæ are pretty abundant. The eastern portion of the sea appears to be somewhat less poor in algæ than the western. The places where they most abounded were Cape Irkajpij—Cook's North Cape (N. L. 68° 55′ W. L. 179° 25′), and the mouth of Koljuschin Fjord. From the natives settled between this fjord and Cape Serdze, situated about fifty miles to the east of it, Dr. Kjellman repeatedly obtained during the first half of 1879 very large masses of algæ, which appears to show that a pretty abundant vegetation of algæ is to be found at certain places along this part of the coast. There are not wanting, however, in the western part of the Siberian Sea some comparatively very good places for algæ. One such at least was found, viz., the region round Tajmur Island, between Port Dickson and Cape Chelyuskin.

The species that occurred most frequently were *Polysiphonia arctica*, *Rhodomela tenuissima*, a variety of *Rhodomela subfusca*, *Sarcophyllis arctica*, *Phyllophora interrupta*, species belonging to the family Laminarieæ, *Sphacelaria arctica*, and *Phloeospora tortilis*. The Laminarieæ give in general their stamp to the vegetation; at one place however *Phyllophora interrupta*, at another the above-mentioned variety of *Rhodomela subfusca* occurred in quantity surpassing that of the Laminarieæ.

Of this family six species were found, viz., four species of Laminaria: *L. Agardhii*, *L. cuneifolia*, *L. solidungula*, and one belonging to the digitata group, in which Dr. Kjellman believed that he recognised the *L. atro-fulva* of J. G. Agardh, and two species of Alaria, one standing near to *A. esculenta*, the other corresponding in much to *A. musæfolia*, but probably belonging each to species allied to these, and yet incompletely known, which occur in the north part of the Pacific. The distribution of the Laminaria along the north Siberian coast is different. *Laminaria solidungula* occurs both east and west of Cape Chelyuskin. *Laminaria Agardhii* was found only at that promontory and at a couple of places west, but nowhere east of it. Eastward it is replaced by *L. cuneifolia*, found first at Irkajpij and afterwards east of it in comparatively large quantities. Both the two species of Alaria and *Laminaria atro-fulva* appear also to be confined to the eastern portion of the Siberian Polar Sea. None of them were seen west of Irkajpij. Some of the species already mentioned as occurring most frequently enter into the composition of the vegetation in different proportions east and west of Cape Chelyuskin. *Polysiphonia arctica* and *Phyllophora interrupta* were more common west; *Rhodomela tenuissima* again more numerous east of the northernmost point of Asia. *Phloeospora tortilis* was nowhere seen east of Tajmur Island, nor *Sarcophyllis arctica* and the variety of *Rhodomela subfusca* west

[1] Abstract of preliminary communication by Dr. F. R. Kjellman in "Ofvers. af Kongl. Vet. Akad. Förhandl.," 1879.

of Irkajpij. Hence it follows that the algal flora differs in its composition in a noteworthy degree in the eastern and western portions of the Siberian Polar Sea.

It has been stated that an abundance of large-sized luxuriant plants is a characteristic of the Arctic algæ. In this respect the vegetation of the Siberian Sea is considerably behind that in other parts of the North Polar Sea. The largest alga seen by Dr. Kjellman was a *Laminaria Agardhii*, whose length was 210 and greatest breadth 37 centimetres. Among the many specimens of *L. cuneifolia* examined there was none more than half so large as this. *L. solidungula* is about as large as middle-sized specimens of this plant from the coasts of Spitzbergen and Novaya Zemlya, about 90 centimetres long and 15 to 20 broad. The two species of Alaria, when they are largest, are about a metre in length. Other algæ almost without exception are stunted in comparison with plants of the same species from other portions of the North Polar Sea.

The collections of algæ made by Dr. Kjellman, according to the examination to which it has been possible to subject them, consist only of thirty-five species, of which there belong to the

| | |
|---|---|
| Florideæ ... ... ... ... ... ... ... | 12 |
| Fucoideæ ... ... ... ... ... ... ... | 16 |
| Chlorophyllophyceæ ... ... ... ... | 6 |
| Phycochromophyceæ ... ... ... ... | 1 |

These are not more than half as many as are known from the Murman and Spitzbergen Seas. With the exception of two, or possibly three, species, all also occur in other parts of the North Polar Sea.

The western part of the Siberian Polar Sea, at least to Cape Chelyuskin, must doubtless be considered to belong to the territory of the Spitzbergen marine flora, though poorer in individuals and species and more stunted than it. The algæ in the eastern part of the same sea also in a considerable degree correspond with those on the coasts of Spitzbergen and Novaya Zemlya, but in the composition of its Laminaria vegetation it has a trait foreign to the latter, and indicating a connection with the algæ in the north part of the Pacific.

## ON THE COMPRESSIBILITY OF GLASS [1]

THE following experiments were undertaken with a view to determine by actual observation the effect produced on solids by hydraulic pressure. The instrument was constructed according to my directions by Mr. Milne, of Milton House, about two years ago, but it is only now that I have been able to devote myself to its application to the purposes for which it was designed. It consists of a hydraulic pump, which communicates with a steel receiver capable of holding instruments of considerable size, and also with a second receiver of peculiar form. This receiver consists essentially of a steel tube terminated at each end by thick glass tubes fitted tightly. It is tapped at the centre with two holes, the one to establish connection with the pump, and the other to admit a pressure-gauge or manometer. The steel tube may be of any length, being limited only by the extent of laboratory accommodation at disposal. The tube which I am using at present has a length of a little over six feet, and an internal diameter of about three-tenths of an inch. The solid to be experimented on must be in the form of rod or wire, and must, at the ends at least, be sufficiently small to be able to enter the terminal glass tubes, which have a bore of 0·08 inch, and an external diameter of 0·42 inch. The length of the solid is such that when it rests in the steel tube its ends are visible in the glass terminations.

When the joints have all been made tight the experiment is conducted as follows:—

A microscope with micrometer eyepiece is brought to bear on each end of the rod or wire. These microscopes stand on substantial platforms altogether independent of the hydraulic apparatus. The pressure is now raised to the desired height, as indicated by the manometer, and the ends of the rod are observed and their position with reference to the micrometer noted. The pressure is then carefully relieved and a displacement of both ends is seen to take place, and its amplitude noted. The sum of the displacements of the ends, regard being had to their signs, gives the absolute expansion in the direction of its length, of the glass rod, when the pressure at its surface is reduced by the observed amount, and consequently also by the compression when the process is reversed. As in the case of non-crystalline bodies, like glass, there is no reason why a given pressure should produce a greater effect in one direction more than in another, we may, without sensible error, put the cubical compression at three times the linear contraction for the same pressure.

As yet I have only experimented on glass, and only on one sort, namely, that made by Messrs. Ford and Co. of Edinburgh. It contains lead, and is very suitable for glass-blowing purposes. I have not yet analysed it. I have observed its compressibility up to a pressure of 240 atmospheres, and before proceeding to higher pressures I intend to determine the compressibilities of other solids, especially metals at pressures up to 240 atmospheres. The reason for taking this course is that having got two glass tubes to stand this pressure I am anxious to utilise them as far as possible before risking them at higher pressures.

The pressure in these experiments was measured by a manometer, which consists simply of a mercurial thermometer with a stout bulb, which is immersed in the water under pressure, whilst its stem projects outside.

The values of the readings of this instrument were determined by comparing it with a piezometer containing distilled water. This piezometer had been compared with others which had been subjected to the pressure of very considerable and measured columns of water on the sounding-line.

The mean apparent compressibility of water in glass was thus found [1] to be 0·00004868, or, multiplying by 1,000, to reduce the number of figures 0·04868 per atmosphere at temperatures from 1° to 4° C.

The manometer (No. 2) was compared with this piezometer. The temperature of the manometer was 12°·5 C., while the piezometer was enveloped in ice in the receiver. The ice was thus melting under the same pressure as the instrument was undergoing, consequently the piezometer was not exposed really to precisely the same temperature at each succeeding experiment.

For our present purpose the effect of the possible variation in volume due to this thermic cause is negligable, and we assume that the indications of our piezometer are comparable with those obtained in deep ocean waters. In a future communication I hope to return to this point.

In Table I. we have in the first column the number of observations meaned for each pressure from which the average values of the manometer-reading under A, and of the piezometer-indication under H are computed.

Manometer No. 2, when treated simply as a thermometer, showed at atmospheric pressure a rise of one division for a rise of 0·233° C. in temperature. Piezometer K, No. 4, was filled with distilled water, and contained 7·74 cubic centimetres at 0° and atmospheric pressure. It is made of Ford's glass, though not drawn at the same date as the experimental rod.

TABLE I.—*Comparison of Manometer No. 2 at 12·5° C. with Piezometer K, No. 4, in ice melting under pressure*

| Piezometer K, No. 4, contains at 0° and atmospheric pressure 7·74 cub. cent. of water. | Number of observations meaned. | Pressure in divisions of manometer No. 2. | Apparent contraction of water per thousand, K, No. 4. |
|---|---|---|---|
| | | A. | H. |
| Temperature of manometer 12·5° C. | 4 | 26·08 | 4·0228 |
| Piezometer immersed in ice ... ... | 4 | 30·28 | 4·6534 |
| Melting under pressure A ... ... | 1 | 36·20 | 5·5972 |
| Probable temperature between − 1° and 0° C. ... ... ... ... ... | 5 | 40·08 | 6·1045 |
| | 3 | 50·08 | 7·6043 |
| | 3 | 60·20 | 9·1057 |
| | 3 | 70·08 | 10·5163 |
| Total number of observations ... | 23 | | |
| Mean reading of manometer ... | ... ... | 43·61 | |
| Mean apparent contraction of water in piezometer ... ... ... ... | ... ... | ... ... | 6·6495 |

Dividing the mean apparent contraction of the water in the piezometer by the apparent compressibility of water in glass (0·04868), we have for the pressure corresponding to a rise of 43·61 divisions on manometer No. 2 at 12·5° C.

$$P = \frac{H}{0·04868} = \frac{6·6495}{0·04868} = 136·6 \text{ atmospheres.}$$

[1] Substance of a paper read before the Royal Society of Edinburgh, June 21, by J. Y. Buchanan.

[1] *Proc.* Royal Society of London, 1876. p. 162.

But this pressure produces a rise of 43·61 divisions on manometer No. 2. We have then for the value of one division on the manometer—

$$a = \frac{136·6}{43·61} = 3·132.$$

Hence to convert readings of manometer No. 2 into atmospheres we have to multiply by 3·132 the difference between the manometer reading under pressure and that at atmospheric pressure.

In another series of experiments piezometer K, No. 4, was compared with manometer No. 2, both being at a temperature of 12·5° C., and the following results were obtained as the mean of nineteen observations :—

| | | |
|---|---|---|
| Mean rise of manometer No. 2 ... | (A) | 41·35 divisions. |
| Mean apparent contraction per thousand of water in piezometer K, No. 4 ... ... ... ... ... | (H) | 5·8782 |

But from the results in Table I. we have for the pressure in atmospheres—

$$P = 3·132 \times A = 3·132 \times 41·35 = 129·5 \text{ atmospheres.}$$

And the apparent compressibility of water in glass at this temperature (12·5° C.) in volumes per thousand per atmosphere is—

$$M = \frac{H}{P} = \frac{5·8782}{129·5} = 0·04539.$$

We see then that at pressures up to 240 atmospheres the property peculiar to water of diminishing in compressibility with rise of temperature is preserved unimpaired, and the amount of change corresponds closely with that found at low pressures in the experiments of Regnault and Grassi.

In Table II. the results obtained are summarised. In the first column we have the number of the series, and in the second the number of observations which constitute the series. Under T we have the temperature of the receiver and therefore of the rod in it. The experiments were made at the temperature of the room, which varied very slightly. The arithmetical mean of the values of T is 12°·77 C. Under A we have the pressure in terms of the scale of the manometer; that is the difference between the readings of the manometer when the pressure was up and when it was equal to that of the atmosphere. Under P (3·132 × A) we have the pressure in atmospheres which is obtained by multiplying A by 3·132 (see Table I.) Under D we have the sum of the expansions observed at each end in terms of the micrometer, divisions which had identical values. Under F we have the values of D reduced to parts of an inch by multiplying them by 0·000417. Under Q we have the greatest deviations from the mean amongst the individual observations forming this particular series. R represents this deviation as a percentage of the total expansion (F). Under H we have the linear compression (in inches) of a rod one million inches long under a pressure of P atmospheres. K is the corresponding value for one atmosphere, and N = 3K is the cubical compression of the glass per million per atmosphere.

The total expansion on D was determined by observing the expansion at each end and adding them together. These partial expansions were not always, nor indeed often, of exactly the same extent; the excess was sometimes on the one side and sometimes on the other. The effect of the rise of pressure is to extend the containing tube and to compress the contained rod. On the relief of pressure the tube shortens again and the rod recovers its length, and there is necessarily a sliding of the one or the other, and it depends entirely on minute local circumstances whether the rod finds it easier to return to its original relative position or to another. In some experiments made previously to those quoted in Table II. the rod had greater freedom of motion longitudinally, and it happened several times that it crept bodily to the one end, necessitating the opening of the apparatus to replace it in a position suited to observation. Afterwards stops were placed in the tube, which, while setting limits to the crawling motion, did not in any way interfere with the expansion and contraction. The results of these previous experiments are not included in the table, because they were merely tentative with a view to learning the details of the kind of experimentation; and further, because in the microscope at the east end the power used was very low, and the micrometer insufficiently delicate.

The micrometers used were: at the east end a photographic copy of Hartnack's eyepiece micrometer, and at the west end one of Morz's. They were both compared, and the values of their divisions as used determined by comparison with a stage micrometer of Smith and Beck, obligingly lent me by my friend Dr. William Robertson, who had very carefully verified its graduations. It is remarkable as a coincidence that the values of the divisions turned out to be identical, namely, 0·000417".

In the observations recorded I made no attempts to subdivide the micrometer divisions further than to estimate a half. As the micrometer readings are not affected directly by the pressure, the deviation per cent. should be, as it is, the less the higher the pressure; and there is no doubt that the higher the pressure is the greater is the accuracy of the observation. The only way in which the pressure affects the reading of the micrometer is that when it is sufficiently high it produces a microscopic distortion of the tube which throws the point very slightly out of focus. This is remedied by a slight touch of the fine-adjustment screw of the microscope.

TABLE II.—*Summary of Experiments on the Compression produced on a Glass Rod by Pressures up to 240 Atmospheres*

| Series No. | Number of observations meaned. | Temperature. Cents. | Pressure. | | Compression of rod. | | Greatest deviation from mean. | | Linear compression per million. | Linear compression per million per atmosphere. | Cubical compression per million per atmosphere. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Manometer No. 2. | Atmospheres. | Micrometer divisions. | Inch. | Inch. | Per cent. | | | |
| | | T. | A. | P. (3·132×A). | D. | F. (0·000417×D). | Q. | R. 100. | H. $\left(\frac{10^6}{75·05}F.\right)$ | K. $\left(\frac{H}{P}\right)$ | N. (3 K). |
| 1 | 8 | 13·5 | 20·40 | 64 | 11·13 | 0·0047 | 0·00047 | 10·0 | 62·6 | 0·98 | 3·0 |
| 6 | 11 | 12·2 | 34·81 | 109 | 18·05 | 0·0075 | 0·00044 | 5·8 | 100 | 0·92 | 2·8 |
| 2 | 8 | 13·7 | 37·51 | 118 | 19·81 | 0·0083 | 0·00034 | 4·1 | 110 | 0·94 | 2·9 |
| 7 | 10 | 12·3 | 50·30 | 157 | 27·00 | 0·0113 | 0·00042 | 3·7 | 150 | 0·96 | 2·9 |
| 3 | 13 | 12·8 | 50·49 | 158 | 26·84 | 0·0112 | 0·00056 | 5·0 | 149 | 0·95 | 2·9 |
| 4 | 8 | 12·5 | 56·88 | 177 | 32·00 | 0·0133 | 0·00042 | 3·2 | 178 | 1·00 | 3·0 |
| 8 | 7 | 12·5 | 62·21 | 195 | 33·71 | 0·0140 | 0·00033 | 2·3 | 187 | 0·96 | 2·9 |
| 5 | 10 | 12·5 | 62·97 | 197 | 35·39 | 0·0148 | 0·00046 | 3·1 | 197 | 1·00 | 3·0 |
| 9 | 10 | 12·8 | 68·94 | 216 | 37·10 | 0·0155 | 0·00058 | 3·7 | 206 | 0·96 | 2·9 |
| 10 | 6 | 12·9 | 76·53 | 240 | 40·08 | 0·0167 | 0·00059 | 3·5 | 223 | 0·93 | 2·8 |
| | | | | | | | | | | 0·960 | 2·92 |

The micrometers used were eye-piece scale micrometers. The values of their divisions as used were identical. One division in the eye-piece corresponded to 0·000417 inch on the stage. Length of glass rod experimented on 75·05 inches. Diameter of ditto, 0·28 inches. Weight of rod 209·5 grammes. Date of experiments June 3, 4, and 7, 1880.

The general result of these experiments is that the linear compressibility of the glass experimented on is 0·96 and its cubical compressibility 2·92 per million.

Grassi[1] gives as the means of his observations at pressures up to ten atmospheres:

Glass ... 2·25 ... Crystal ... 2·804 and 2·8584

So that our results agree closely with those found by him for crystal.

[1] *Ann. Chim. Phys.*, (1851) [3], 31, p. 477.

| | | |
|---|---|---|
| We have then the apparent compressibility of water in glass at 2·5° C. ... ... ... | 0·04868 | |
| Add compressibility of glass ... ... ... | 0·00292 | |
| True compressibility of water at 2·5° C. ... | | 0·05160 |
| And the apparent compressibility of water at 12·5° C. is ... ... ... ... ... ... | 0·04539 | |
| Add compressibility of glass ... ... ... | 0·00292 | |
| True compressibility of water at 12·5° C. ... | | 0·04831 |

Grassi gives the following values for the true compressibility of water at various temperatures:—

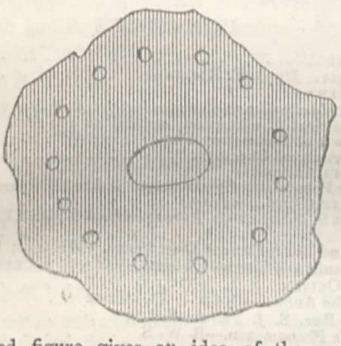
| | | |
|---|---|---|
| At 1·5° C. ... ... ... ... ... ... | 0·0515 | |
| At 4·1° C. ... ... ... ... ... ... | 0·0499 | |
| Mean ... ... ... ... ... | | 0·0507 |
| At 10·8° C. ... ... ... ... ... ... | 0·0480 | |
| At 13·4° C. ... ... ... ... ... ... | 0·0477 | |
| Mean ... ... ... ... ... | | 0·0478 |

My results agree very closely with these.

Before concluding I would call attention to a very curious phenomenon which I have never seen noticed, namely, the peculiar *noise* which accompanies the relief of pressure in a mixture of ice and water.

In comparing the Piezometer K No. 4, in melting ice with the manometer at 12·5° C., I proceeded gradually from lower to higher pressures. When the pressure which was relieved was 100 or 120 atmospheres, I thought I noticed a slight noise. On raising the pressure higher the noise became more and more distinct, until when the pressure relieved was over 200 atmospheres, it was distinctly audible at a distance of 5 feet or 6 feet. It resembles the noise produced by bending a piece of tin backwards and forwards, and is markedly intensified by accelerating the relief, just as the noise made by blowing off steam is intensified by enlarging the outlet. When the relief valve is opened very carefully it whispers gently but very distinctly, till the pressure is all down. If opened comparatively briskly, but still with great care, the noise is comparatively loud but more rapidly used up. I forbear making any reflections until I have been able to study this phenomenon more closely.

Pieces of clear ice which had been subjected to high pressure in the receiver were finely laminated in parallel planes. In each plane there was a central patch surrounded near the sides of the block by a ring of spherules.



The annexed figure gives an idea of the arrangement in a plane of lamination; the size of the spherules is greatly exaggerated.

The lamination of ice by pressure in one direction is well known. I am not aware that its production by pressure in all directions has been noticed. I hope to pursue my observations on this subject.

J. Y. Buchanan

## THE CONGRESS OF BOHEMIAN PHYSICIANS AND NATURALISTS

THE first Congress of Bohemian Naturalists and Physicians met at Prague on May 14 last. More than 400 members met under the presidency of M. Krejcí, M. Eiselt, M. Koristka, and M. Studnicka. The first general meeting was opened by M. Krejcí, Professor of Geology, who delivered an inaugural address "On the share of the Bohemian Nation in the Development of Natural Science." He showed that not only Bohemian workers in science were in the field up to the seventeenth century, but that when the Bohemian nation, after two centuries of political and national slavery, awoke to life again, it very soon took its part in the progress of natural science. The names of Purkyne, Rokytanský, Skoda, Bohdálek, Pitha, Blazina, Safarík, Celakovský, Fric, Krejcí, Helmhacker, and of many others, are known even beyond the boundaries of Bohemia. Many obstacles were placed in the way of these promoters of science; they were not assisted by Government, and even the ancient university of Prague was, and indeed is, almost exclusively German. But in spite of all difficulties scientific progress went on steadily, and at present the number of workers in science is very fair. Knowing the cosmopolitan character of science, the Bohemian nation values equally the progress made in England, France, Germany, Italy, and Russia; it wishes only that its own share—if proportionately small—may be recognised by others. The great languages of the world are like the sea, which carries the ships and steamers of all nations; but the languages and literature, of small nationalities—of the Danes, Swedes, Dutch, and Bohemians—resemble so many rivers irrigating and fertilising the continents by which the sea is surrounded.

On May 15 and 17 sectional meetings took place. On the 16th the members visited the village Chuchel, where Prof. Krejcí explained to them the very interesting distortions of the silurian strata on the left bank of the river Vltava (Moldau). In the evening of the same day the members assembled at a banquet, where especially the healths proposed by Prof. Safarík were heartily responded to. He spoke first of the progress of science in Bohemia and its relation to scientific investigation in England and France; he then proposed the health of the distinguished Russian naturalists, referring chiefly to Mendeleeff, Butleroff, Menshutkin, Chebysheff, Shecheneff, Mechnikoff, and Kowalewski; finally he drank to the Nestor of palæontological research, to Joaquin Barrande, who at Prague has carried out the chief part of his scientific work.

In the first section (medicine) papers were read on purely professional subjects.

The second section was devoted to mathematics. Besides several mathematical papers Prof. Augustin spoke on cyclones and anticyclones; M. Doubrava read a paper on electricity; M. Domalip explained the action of a magnet on a current of electricity traversing a rarified medium; Prof. Charles Zengef gave an account of his method of constructing achromatic lenses by means of a combination of crown-glass and certain liquids. Excellent microscopic photographs made by the aid of these lenses were shown. For astronomical purposes lenses with an opening of 2 inches and a focal distance of only 9 inches have been constructed according to this method with complete success.

In the third section (Natural Science) the following papers were read:—Prof. Borický, on the structure of the Bohemian porphyries. He showed that they frequently contain the mineral "cordierite," which hitherto had not been found in Bohemia. According to Prof. Borický a great part of the Bohemian porphyries must be classed as *siliceous porphyrites*. Prof. Fric demonstrated a new genus of the ganoids found at Kounová, near Rakovník. This fish resembles the genus Palæoniscus, but its scales are very different. He gave to the new genus the name of *Trissolepis kounoviensis*.

M. Bayer gave a report on the characters of the skulls of some batrachia. Comparing the skull of the genus Pelobates with that of other genera, he found that the skull of Pelobates differs essentially from all others, and that this genus does *not* form the connecting link between the Ranidæ and the Bufonidæ. M. Hellich read a report on the genital apparatus of the genus Cypris. He supplemented the data given by Zenker, and corroborated in a certain sense the new observations of Weissmann. A series of plates belonging to a new work on Bohemian cretaceous Echinodermata was shown by Dr. Ottomar Novák, and their peculiarities were explained. M. Ladislav Duda gave a preliminary account of the anatomy of the Bohemian hemiptera, especially of the section Scutata. He has discovered on the fore feet of these insects a comb-like apparatus, by means of which the insect cleans its tentacles. In Bohemia as yet 401 species of hemiptera have been found. Prof. Borický showed to the members many interesting novelties in mineralogy, as, *e.g.*, the Rösslerit, a mineral of which as yet only three specimens are known. Dr. Vejdovský exhibited the second part of his work on the comparative morphology of the annelids, containing a new system of the Oligochæta and their anatomical details, together with their affinities to the Turbellaria and vertebrata. Dr. Vejdovský proposes the following arrangement of the new families of the Oligochæta:—(1) Amedullata (Aeolosoma), (2) Chætogastrida, (3) Discodrilida (Branchiobdella), (4) Naidea, (5) Echytraeida, (6) Tubificida, (7) Lumbriculida, (8) Phreorzetida, (9) Criodrilida, (10) Lumbricida. M. V. Fric showed to the members a specimen of the body of a chimpanzee, four years old, which was prepared by the injection of Wickersheim's conserving fluid. He explained all methods hitherto known and used to preserve the bodies of animals, and he declared the method of Wickersheim to be the best of them.

In chemistry some interesting papers were read and an animated discussion took place on educational and scientific questions.

On the 17th the second general meeting took place, Prof. Albert, of the Innsbruck University, delivering an address "On Theory and Practice in University Education."

During the session of the Congress a journal was published containing the abstracts of the papers read before the Congress. The addresses of M. Krejcí and Dr. Albert, however, were printed *in extenso*, and of the former afterwards also a German translation appeared in print.

## SCIENTIFIC SERIALS

*Archives des Sciences Physiques et Naturelles*, July 15, No. 7.—Note on the equilibrium of solids of great dimensions, by M. Cellerier.—Geological description of the Canton of Geneva, by M. Favre.—Phytography, &c. (M. de Candolle), by M. Micheli.—A differential thermometer for demonstration, by M. Dufour.—On the casting of the beak of birds of the Mormonides family, by M. Bureau.

*Reale Istituto Lombardo di Scienze e Lettere Rendiconti*, vol. xiii. Fasc. xiii. June 17.—On some trigonometric series, by Prof. Beltrami.—Morphological studies on the human body, by Prof. De Giovanni.—On the part taken by the pneumogastric in death by hanging, by Prof. Tamassia.—Iconography of the Laplanders, by Prof. Mantegazza.—On reflex arthropathia of urethritis, by Prof. Scarenzio.—On a geological congress held at Rome, by Prof. Taramelli.

Fasc. xiv., July 1.—Ossiferous breccia and neolithic station in Corsica, by Dr. Major.—On the present geographical distribution of *Nyctinomus cestonii*, Gavi., by Dr. Beltoni.—On a shower of falling stars observed at Milan on June 22, 1880, by S. Fornioni and Prof. Schiaparelli.—On univocal plane transformations and particularly on involutory, by Prof. Bertini.—Notes on the fishes, and in particular on the male eels, observed at the Berlin Exhibition, by Prof. Pavesi.

## SOCIETIES AND ACADEMIES

### PARIS

**Academy of Sciences**, August 9.—M. Wurtz in the chair.—The following papers were read:—Summary report of a zoological exploration in the Bay of Biscay in the Government ship *Le Travailleur*, by M. A. Milne-Edwards.—Experiments tending to prove that fowls vaccinated for cholera are refractory for *charbon*, by M. Pasteur.—Results of observations of solar spots and faculæ during the first two quarters of 1880, by P. Tacchini. The numbers indicate rapid increase of solar activity. The days without spots form five groups separated by a mean interval of twenty-nine days, showing that in one hemisphere (which is that visible in the end of last December) the spots were formed with difficulty.—On a class of linear differential equations of the second order, by M. Brioschi.—Experiments on the discharge in rarefied gases, by M. Righi. *Inter alia*, the glass seems to become luminous at the point where it acts as positive electrode. During discharge the negative electrode is probably much more heated than the positive. The cause of mechanical action of the negative electrode is the same as in the radiometer.—On some properties of flames, by M. Meyreneuf. The gas which feeds a flame is subject to two opposing influences, one creating a draught outwards, the other (expansion through combustion) tending to drive the gas back. By diminishing the rate of outflow without modifying the combustion, one may regulate these movements so as to get vibrations of the nature of sound. Better sonorous effects are had by making a flame impinge on a round rod or on another flame.—Indices of refraction of aqueous solutions of acetic acid and of hyposulphite of soda, by M. Damien.—On an improvement of the Bunsen battery by M. Azapis, by M. Ducretet. For acidulated water is substituted a 15 per cent. solution of cyanide of potassium, caustic potash, marine salt, or ordinary sal ammoniac. The zincs need not be amalgamated. They are less consumed than in the Bunsen; the intensity of the current is no less, and its constancy is remarkable.—On the spectra of ytterbium and erbium, by M. Thalén.—On thulium, by M. Clève.—Researches on the heats of combustion of some substances of the fat-series, by M. Louguinine.—Secondary reaction between sulphuretted hydrogen and hyposulphite of soda, by M. Bel'amy.—On the acid obtained by M. Boutroux in the fermentation of glucose, by M. Maumené.—On a new process for producing malleable nickel of different degrees of hardness, by M. Garnier. This consists in incorporating phosphorus with the nickel (to take up oxygen); *e.g.*, adding to the bath of nickel a phosphide of nickel containing about 6 per cent. phosphorus. Very thin sheets of the material can be produced.—On propylnervine, by Mr. Morley.—Influence of light on transpiration of plants, by M. Comes. Plants transpire more in light than in darkness, and more the intenser the light. The more intense the colour of the organ, the greater the transpiration. The luminous rays absorbed alone favour the transpiration.—On the source of muscular work and on supposed respiratory combustions, by M. Sanson. The liberation of energy is due greatly, if not wholly, to phenomena of dissociation similar to those in fermentations; in presence of anatomical elements (blood-corpuscles specially) the immediate principles of the plasma are dissociated, give carbonic acid and doubtless other compounds which borrow oxygen from the hæmoglobin for their formation, and yield their energy to the muscular elements, which then manifest it by doing work in contracting, or to the blood for maintenance of animal heat.—On the use of nitrite of ethyl for rendering contaminated places healthy, by M. Peyrusson. It acts like ozone, but more powerfully.—Complement of the biological evolution of pucerons of galls of poplar (*Pemphigus bursarius*, Lin.), by M. Lichtenstein.—On the affinities of the genus *Polygordius* with annelides of the family of *Opheliidæ*, by M. Giard.—Discovery of new mammalia in the phosphate of lime deposits of Quercy (Upper Eocene), by M. Filhol.—On the structure and functions of the embryonal suspensor in some leguminous plants, by M. Guignard.—On deforming pilosism in some plants, by M. Heckel.—On a new instrument for pointing guns, by M. Arnoux.

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