THURSDAY, JUNE 3, 1880

SIGN LANGUAGE AMONG THE AMERICAN INDIANS

Introduction to the Study of Sign-Language among the North American Indians, as Illustrating the Gesture-Speech of Mankind. By Garrick Mallery. (Washington : Government Printing Office, 1880.)

UNDER this modest title another of those valuable contributions, which we owe to the Smithsonian Institution, has been made to science. Researches into the ethnography of the North American Indians have been going on for the last eleven years under the superintendence of Mr. J. W. Powell, and a series of compact and beautifully-printed monographs has lately been started for the purpose of aiding and directing them. The monograph just issued forms the second of the series hitherto published, and in spite of its title is full of new and interesting matter. It will be appreciated not only by those who are actually engaged in observing the life and manners of barbarous tribes, but also by every student of language and anthropology.

The evidence that has been accumulating for some time past makes it probable that the most important part of language, its grammatical machinery, originated in gestures and signs. These were the means whereby sense and meaning were imported into spoken words. As Col. Mallery remarks : "A child employs intelligent gestures long in advance of speech, although very early and persistent attempts are made to give it instruction in the latter but none in the former; it learns language only through the medium of signs; and long after familiarity with speech, consults the gestures and facial expressions of its parents and nurses as if to translate or explain their words." An examination of the sign-language or languages of mankind consequently becomes of high importance, and it is strange that no thorough and scientific attempt to undertake it has hitherto been made. Leibnitz indeed, with the instinct of genius, pointed out the need and importance of such an investigation (in his "Collectanea Etymologica," ch. 9), but his words met with no response. It is therefore all the more satisfactory to find that the subject has at last been taken up in America, where special opportunities still exist for collecting materials, notwithstanding the rapid decrease in the native population that seems to have been going on of late years. North America has always been the country where a language of signs was pre-eminently in vogue. Col. Mallery says with justice that "the words of an Indian tongue, being synthetic or undifferentiated parts of speech, are in this respect strictly analogous to the gesture elements which enter into a sign-language." Just as a single idea or mental picture is represented by a connected group of individual gestures, so too it is expressed in the polysynthetic speech of the Red Indian by a group of individual syllables which form but one word.

The first question we have to ask ourselves is whether sign-languages are the same all over the world, whether each idea or group of ideas has a fixed and natural gesture or sign corresponding to it everywhere. To this question the researches made among the American Indians furnish a conclusive reply. "The alleged existence of *one* universal and absolute sign-language is, in its terms of general assertion, one of the many popular errors prevailing about our aborigines." Many signs are purely conventional, while many ideas or objects may be denoted by more than one sign. The signs used by the different Indian tribes to indicate the same ideas by no means agree together, nor do they always agree, so far as I know, with the signs employed for the same ideas in the Old World, whether by savages or by deaf-mutes. The curious language of signs employed in monasteries where the rule of silence was strictly observed, which is given by Leibnitz, if compared with the lists of signs furnished by American explorers, is a good example of the fact.

At the same time no signs can be so arbitrary and conventional as spoken words, nor can an idea be expressed by so many different signs as it can be by different sounds. Col. Mallery observes that "further evidence of the unconscious survival of gesture-language is afforded by the ready and involuntary response made in signs to signs when a man with the speech and habits of civilisation is brought into close contact with Indians or deaf-mutes. Without having ever seen or made one of their signs, he will soon not only catch the meaning of theirs, but produce his own, which they will likewise comprehend, the power seemingly remaining latent in him until called forth by necessity. The signs used by uninstructed congenital deaf-mutes and the facial expressions and gestures of the congenitally blind also present considerations under the heads of 'heredity' and 'atavism,' of some weight when the subjects are descended from and dwell among people who had disused gestures for generations, but of less consequence in cases such as that mentioned by Cardinal Wiseman of an Italian blind man who, curiously enough, used the precise signs made by his neighbours."

But care must be taken to distinguish between two things which are frequently confused together. Gestures and signs are wholly different, gestures being natural signs more or less conventional. A gesticulation is a gesture which has become a sign, and the nearer signs approach to gesticulations the more readily and instinctively they will be understood.

Those who wish to know what the Indian sign-language is will find plenty of interesting and suggestive examples in Col. Mallery's *Introduction*. He has added a list of his authorities as well as a speech in signs addressed by a medicine-man of the Wichitas to Mr. A. J. Holt, and a story in signs told by Natshes, the Pah-Ute chief, to Dr. W. J. Hoffman. These curious specimens of sign-language will show what it is more effectually than any description could do, and will justify the analysis and classification of the signs proposed by Col. Mallery.

In conclusion, aid and suggestions are asked from all interested in the subject, or who are in actual contact with savage and barbarous tribes. A list of words is appended for which the corresponding signs are wanted, those of chief importance being marked by an asterisk. We hope that the ethnographical department of the Smithsonian Institution will meet with all the assistance in this undertaking to which it is entitled. There must be many observers among the uncivilised races of the Old World

or in schools for deaf-mutes who have many facts of interest and value to contribute. It is only when these facts have all been gathered in that it will be possible to reconstruct that primitive speech of mankind which preceded articulate utterance, which formed the bridge to spoken language and expressed the earliest thought of the human race.

A. H. SAYCE

TESTING TELEGRAPH LINES

Instructions for Testing Telegraph Lines and the Technical Arrangement of Offices. By Louis Schwendler. Vol. ii. Second Edition. (London: Trübner and Co., 1880.)

THE second volume of this useful work is free from the defects which disfigured the first volume, and which we were bound to find fault with (NATURE, vol. xix. p. 192). This is doubtless due to the watchful eye and careful hand of Prof. M'Leod, who has nursed it through the press and added some useful notes. It contains a very full and clear description of Mr. Schwendler's modification of the tangent galvanometer, by which quantitative electrical measurements of batteries, lines, and apparatus are more rapidly though more roughly made than with bridges and coils. Such an instrument is very extensively employed in England and America, but Mr. Schwendler has certainly improved its efficiency by combining certain resistances with it and making it more portable. It is remarkable what a handy and useful instrument this becomes, and what a valuable help it is to the telegraph engineer. Mr. Preece mentioned at the Society of Telegraph Engineers the other evening that it frequently happened over the extensive system of the Post Office—120,000 miles of wire and 12,000 instruments—that the daily bill of health showed not one single fault existing, and this he attributed principally to that accurate system of testing which has been in use in England for nearly twenty years. Mr. Varley introduced this system in England and in America also, where it is very extensively employed. It is a pity that Mr. Schwendler has not made himself better acquainted with the systems in use in other countries, for the perusal of his book leaves the impression that he thinks he has inaugurated a new system in India, whereas he has only modified existing systems to suit the requirements of the Indian service. Again this desire to be individual is shown by the adoption of that most unnecessary nomenclature of unit current, the "Oersted." Unit current is now universally known as the "Weber," and though some confusion has occurred as to whether unit current should be "webers per second," or simply "weber," nevertheless "webers" and that useful sub-multiple "milliwebers" are now used all over the world, except in India. Custom only has forced the terms *volt*, *ohm*, *farad*, *weber* into use. He would be a bold man who would attempt to convert "Ohm" into "Schwend," yet Mr. Schwendler would convert "Weber" into "Oersted." There is no doubt that Mr. Latimer Clark, who is the author of the recognised nomenclature, proposed the term "weber" for unit quantity, but as any term applied to unit quantity, excepting that based on unit capacity or "farad," is not wanted, and unit current is unit quantity per unit time, "webers per second" has rapidly, by the silent linguistic process of abbreviation, subsided into "webers," and webers it will remain. This strange habit of ignoring existing terms is shown in the definition of "intensity" (p. 40) as applied to a battery which is said to be the maximum current which a battery produces on short circuit. Now there is scarcely an English-speaking country where this property is not known as "quantity," though this term is carefully excluded from all books from its eminently unscientific character. Nevertheless it is so rooted in telegraphic circles that there is scarcely a lineman in all England that does not use it. Again, those currents which every one knows as "earth currents" are called in India "natural currents" (p. 53). Moreover we have the strange anomaly that sometimes the author uses *Siemen's units*, sometimes *ohms*, sometimes *S.U.*, and sometimes *B.A.U.*, to designate units of resistance.

The battery used in India is the Minotto form of Daniell—a very wasteful cell, and giving for line purposes an internal resistance of 30 ohms! In dry climates where the circuits are long such a battery may be useful, but in damp climates, like England, where the circuits are comparatively short, such a battery is impossible. The Minotto cell is, however, very constant in its electromotive force; and Mr. Schwendler's instructions for its maintenance are very clear and complete.

The principal portion of the book is devoted to a description and mode of construction and examination of the instruments in use in India and their connections. Mr. Schwendler has introduced a useful test called the "range test," by which those currents are recorded between which the instrument will work without any readjustment. Thus the range test of a Siemen's relay is 25. In other words, whether the current used be ·001 or ·025 weber, or any current of intermediate strength, the relay will equally work. An instrument that will stand such a test must be quite free from friction in its points or from residual magnetism in its iron core. The working currents in India never exceed 8 milliwebers nor fall below 2 milliwebers. Hence if a relay fulfil the above test it never wants adjustment. This is certainly "a consummation devoutly to be wished" by all telegraphists.

We observe the following interesting instruction: "On no account are relays to be exposed to the direct rays of an Indian sun. The permanent magnet is sure to lose its magnetism perceptibly, and consequently the relay will become unsensitive." Is this due to the light or to the heat of the sun? His notions of the efficiency of lightning protectors are rather heterodox. "All," says he (p. 195), "that can be said of them at present is, that if they are kept clean they do no harm;" yet he gives a very clear description of those in use. He attributes to Steinheil, in 1846, the first lightning discharger; but Highton, on the London and North-Western Railway, before this, rapt the wire for eight inches on each side of the instrument in bibulous paper and surrounded it with a mass of metallic filings placed in a tin lined box in connection with the earth.

Very excellent descriptions are given of different forms of relays and of various plans devised for reducing the effects of induction, notably Mr. W. P. Johnston's electromagnetic shunt. Indeed the work is an admirable description of telegraphy in India, and it is one which should be in every electrician's library. There are

many telegraph administrations which would be benefited by its clear practical character. But it is not immaculate. The chief defect of the book is the absence of recognition of what has been done elsewhere and the negation of existing literature dealing with the same subject. Mr. Latimer Clark's book on "Electrical Measurement" (published in 1868) was written especially for use in India. His "Electrical Tables and Formulæ," written in conjunction with Mr. Sabine and published in 1871, contains nearly all that is known of testing. Culley's "Handbook," first published in 1866, has run through six editions. Hoskiær's "Guide to Electric Testing" was published in 1873, and has reached a second edition. Preece and Sivewright's "Text-book of Telegraphy" was published in 1876, and has also reached a second edition. Kempe's "Handbook of Electric Testing" (a most useful and valuable little work) was also published in 1876. Papers by Fleeming Jenkin, Siemens, F. C. Webb, Hockin, Heaviside, &c., are scattered everywhere; yet the impression left on the mind after perusing Mr. Schwendler's book is that, according to him, there is but one system of testing, and that is to be found in India; and there is but one book on the subject, and here it is!

OUR BOOK SHELF

A Physical, Historical, Political, and Descriptive Geography. By Keith Johnston, F.R.G.S. Maps and Illustrations. (London: Stanford, 1880.)

THIS work is in every way creditable to its unfortunate young author, who, our readers may remember, succumbed some months ago to the hardships of African travel while leading an expedition from the West Coast towards Lake Tanganyika. Mr. Johnston has not sought to enter into that minute and often painful detail with which we are familiar in most text-books of geography. His object has been to record in each of the great departments of geography the results of the latest research, leaving it to the teacher or to special text-books to fill up with details. After a brief sketch of some of the main points in mathematical geography, a clear and sufficiently full sketch of historical geography is given, treating not merely of the progress of discovery, but of the various movements of peoples and nations which have led up to the political divisions of the earth as they are at present; this we think a useful introduction of scientific method into history. Then follows a section on physical geography, in which the most trustworthy results of research in the various departments of this subject are stated with clearness and accuracy. The remaining two-thirds of the work is devoted to the special geography of the various continents and countries—their physical features, natural history, products, industries, peoples, and political and social conditions. The same method is followed throughout of dwelling only upon the important features. The work is amply illustrated by useful and beautifully executed maps, and is one of the best general handbooks of geography that we know.

Zeitschrift für das chemische Grossgewerbe. iv. Jahrgang. Von Jul. Post. Fortgesetzt von Arthur Lehmann. (Berlin: Oppenheim, 1880.)

WE have already had occasion to draw attention to the merits of this publication, and the present issue of the work is in no way inferior to its predecessors. It constitutes a complete compendium of the progress of chemical technology during the past year, and as such must be of great service to our manufacturers. The various articles are contributed by acknowledged authorities, and the whole is preceded by a short review indicating the more striking improvements which have been introduced into the chemical arts since the publication of the last issue of the work.

LETTERS TO THE EDITOR

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

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

The Lesser Spotted Woodpecker

I HAVE had an opportunity lately of observing closely the habits of the Lesser Spotted Woodpecker (*Picus minor*) as regards the very peculiar sound which it makes upon trees by the action of its bill.

It is quite certain that this habit has nothing whatever to do with the quest for food. The bird selects one particular spot upon the trunk or bough of a tree, which spot is naturally sonorous from the wood being more or less hollowed by decay. The bird returns to this precise spot continually during the day and produces the sound by striking the wood on the spot with its bill, the stroke being repeated with a rapidity which is really incomprehensible; for it quite eludes the eye. It is effected by a vibratory motion of the head; but the vibrations are so quick that the action looks like a single stroke. After short pauses this stroke is again and again renewed, sometimes for several minutes together. During each interval the woodpecker looks round it and below it with evident delight and with an apparent challenge of admiration. The beautiful crimson crest is more or less erected.

The whole performance evidently takes the place of the vernal song in other birds; and so far as I know it is the only case among the feathered tribes in which vocal is replaced by instrumental music.

The nest does not appear to be in the same tree; but similar spots are selected on several trees in the neighbourhood, and as the sound is very loud and is heard a long way off, the hen bird when sitting is serenaded from different directions.

I have not seen or heard any attempt to vary the note produced by variations either in the strength or in the rapidity of the stroke, or by changing the point of percussion; but I have observed that the note varies more or less with the tree on which it is produced.

During about six weeks the performance has been frequent every day, and early in the mornings during part of this time it was almost constant. Of late it has been discontinued. In all probability this is parallel to the well-known fact that singing birds cease to sing after the eggs are hatched.

This instrumental substitute for singing among the woodpeckers is extremely curious. ARGYLL

May 29

Mr. Preston on Vortex Atoms

SOME passages in an article in NATURE, vol. xxii. p. 56, on Sir William Thomson's theory of vortex atoms, seem to show that the author, Mr. Preston, has not perfectly apprehended the nature of vortex motion. On p. 57 he says that "the rotating portion" of the liquid "therefore glides smoothly over the incompressible liquid that surrounds it like a pipe." From this it appears that the vortically-moving fluid is conceived by him as slipping with reference to the rest of the fluid. This is, however, an incorrect view of the nature of the motion. If there be an infinite mass of fluid, then the stable existence of a vortex filament at any part necessitates motion throughout the whole, and there is, at the surface bounding the filament, no discontinuity of the kind apparently conceived by Mr. Preston.

Two vortices exercise very remarkable influences on one another, which are due to the irrotational motion of the parts of the fluid outside the vortices.

The existence of surfaces of finite slip in the hydrodynamics of an ideal perfect fluid is not precluded by any quality attributed to the fluid, but I do not think that the behaviour of vortices bounded by surfaces of slipping has been hitherto treated by any mathematician

It does not seem likely, however, that the investigation would lead to interesting physical results, because this kind of motion is essentially dynamically unstable.

Towards the end of the same article there occurs the following passage:—

"The old idea that a ship (or more correctly a totally immersed body, such as a fish) encountered a mysterious resistance in addition to the mere friction of the molecules on its sides, is now known to have been a pure delusion."

This statement appears to me either erroneous or very misleading. The resistances to the motion of a ship have been classified under three heads, viz., wave-making resistance, eddy-making resistance, and surface-friction.[1] For a totally-immersed body the wave-making resistance is non-existent, but Mr. Preston would appear only to take notice of the last of the three. Now whilst for a body with "fair lines," such as a fish, the eddy-making resistance may be small, yet if the lines are not fair it may be very large. Thus a fish leaves scarcely any wake, whilst an oar leaves a very great amount of disturbance.

Helmholtz, Kirchhoff,[2] and Lord Rayleigh[3] have made some interesting hydrodynamical investigations on the resistance suffered by a vane exposed to a current, on the hypothesis that in the wake of the vane there is dead water, separated from the moving water by surfaces of finite slip.

It has been already noticed that such a motion is dynamically unstable, but there is in many respects a remarkable accordance between the resistance as determined by this theory and that found experimentally,[4] so that it seems probable that the actual stable motion of flow, with eddies in the wake, does not differ very much from the theoretically unstable motion, with dead water in the wake. It will be noticed that this theory of resistance, which gives approximate results for bodies with very bad lines, such as flat vanes, actually entirely neglects surface-friction, to which Mr. Preston's statement would seem to refer the whole resistance.

G. H. DARWIN

Trinity College, Cambridge, May 27

The Inevitable Test for Aurora

IN reference to Prof. Piazzi Smyth's courteous criticism of our communication to the Royal Society on the aurora borealis, we regret that we are unable to say whether the critical citron line, to which he directs attention, was present or not in the spectra of the electric discharges in atmospheric air from which we deduced the probable heights of auroral displays. The experiments quoted were made without reference to the aurora, and this particular line was consequently not sought for, nor indeed have many measurements been made of the spectra of discharges in atmospheric air, on account of the time required and consequent great consumption of the life of the battery which such observations entail.

WARREN DE LA RUE

73, Portland Place, W., May 29 HUGO MÜLLER

Cloud Classification

THERE is a proverbial objection to "looking a gift-horse in the mouth," and M. Poëy's Cloud Book is such a valuable addition to the scanty literature on the subject that it would be highly ungracious to make captious objections to his views. On the other hand, M. Poëy, when he differs from others, puts forward his views with such fairness and courtesy that I believe he would be the last man to deprecate full discussion.

Allow me then to put in a plea for certain old public servants, that they should neither be cashiered altogether, nor transported to strange regions, without full examination into their character and their merits.

First, then, for the *stratus*.

M. Poëy—happy man!—has carried on his observations under tropical skies and in the clear atmosphere of Paris. Had his lot been cast on the clays and gravels of the London basin I venture to think that he would have regarded the "stratus" with more respect, if with no increase of affection. He would have had frequent opportunities of observing it—at times resting entirely on the ground,[5] at others rising with a clearly defined lower and upper surface, a few feet (or even inches) from the earth, cutting the taller trees in a horizontal line, leaving their tops and bottoms free, and then being gradually dissipated, to be absorbed in the warmer air or to form *cumuli* at a higher elvation. He could hardly have failed to recognise it as a clear and distinct variety of *cloud*, the lowest in altitude of all the family, but none the less a member of it. If every cloud which has contact with our baser earth is to be cashiered on that account, what will become of M. Poëy's own cumulus on Plate XV.? Every mountaineer knows to his cost that if he happens to be on the mountain where such a cumulus is resting, he will be enveloped in a fog undistinguishable from what he finds on the Thames marshes.

Whether, on the other hand, it is desirable to use the term "stratus" for clouds in a totally different sky-region, which differ both in their origin and their nature from the true "stratus," is a question too long to be fully discussed here.

Next with regard to the *nimbus*.

M. Poëy's view appears to be that Howard's term applies to an isolated shower-cloud, and is unsuitable for a rain-cloud overspreading the sky. After careful reading of M. Poëy's remarks on the "pallium," and comparing them with Howard's description of the "nimbus," I entirely fail to see where lies sufficient difference to consign the "nimbus" to oblivion; and I can only imagine that M. Poëy has taken his idea[1] of what Howard meant almost entirely from the illustration, without noticing that Howard first describes the forming and behaviour of the cloud overhead in words curiously similar to those which Poëy himself uses for his "pallium," and then says, "But we see the nature of this process more perfectly in viewing a distant shower in profile." This clearly shows that the illustration was only chosen as the easiest form in which the cloud, *vel nubium congeries*, could be depicted, while the context guards completely against the name being limited to an isolated shower-cloud.

It would occupy to much space to place the descriptions of the two *savants* side by side, but I think that any one who will take the trouble to read the two together can hardly fail to see that Howard's "nimbus" fulfils all that Poëy describes as the rain-discharging cloud, including the upper "veil,"[2] or pallium of cirrus, the lower "sheet,"[3] or "pallium" of cumulus, and the "lower clouds arriving from the windward," which "move under this sheet and are successively lost in it" (Howard, p. 11; compare Poëy, Plate XII.). In fact, to use an expression frequently employed in the discussion of patents, you can take the description of the one inventor and "read it on to" the drawing of the other, or *vice versâ*.

M. Poëy's term "pallium" is certainly expressive, and will probably make itself a home in cloud terminology; but it appears after all only to mean that a certain modification overspreads the whole or a large part of the sky (compare Howard, p. 11), and does not by any means cover that combination of clouds which produces rain ("nimbus.")

I must leave it to a future time or to other pens to discuss the merits of the "cumulo-stratus," and pass on to examine shortly M. Poëy's views about the "cumulus." The Rev. W. C. Ley, in his review of M. Poëy's work, in your pages, has already pointed out the illogical nature of the author's repeated remark that the "cumulus" only exists in the horizon, forgetting that a cloud which is on the horizon of one place must be in the zenith of another. Now I venture to suggest that this curiously-distorted mental view affects M. Poëy's classification far more than appears at first sight. If clouds are considered not objectively according to their whole form and structure, but subjectively as they present themselves to an individual observer, we naturally need new modifications as the clouds are viewed in different positions. Are not many of the clouds which M. Poëy calls "fracto-cumulus" simply "cumuli" viewed from beneath? Just as (to borrow a simile from Mr. Ley) an elm-tree seen from beneath presents a spreading, ragged edge, and shows the blue sky through its interstices, whereas on the horizon it appears compact, rounded, and sharply defined.

May I add a practical suggestion as to the popular terms proposed by M. Poëy on p. 39? These terms are put forward as an alternative to the scientific Latin names, for the use of *non-scientific observers*, who may be of great service in collecting information at out-stations where no trained meteorologist is at hand. It is therefore all-important that they should be as short,

[1] Froude, *Proc. of Roy. Inst.*, December, 1876.

[2] "Math. Vorlesungen," 21st and 22nd lectures.

[3] *Phil. Mag.*, December, 1876.

[4] In particular Lord Rayleigh's investigation throws light on the theory of the balanced rudder.

[5] Howard's Essay says, "its inferior surface *commonly*" (not "invariably" or "necessarily") "rests on the earth or water." P. 7, Edit. 1868.

[1] See Poëy, p. 33.

[2] "At a greater altitude a thin light veil," &c., Howard, p. 11, and again, "superne cirrata," p. 4.

[3] "The lower clouds . . . . form one uniform sheet," p. 11.

plain, and simple as possible, conforming as nearly as may be to the popular terms in use, and above all that there should be nothing to mislead an ignorant person. Now I would ask what idea is conveyed to an ordinary unscientific mind by the term "snow-sheet"? The name is perfectly correct if read in the light of M. Poëy's explanation; but to an average lighthouse-keeper or coastguard it would certainly convey the idea of a so-called "pallio cumulus," *ready to discharge snow*, and would be used accordingly.

"Wind cloud" appears also distinctly misleading. To most minds it would, I believe, imply a cirrus or cirro-cumulus, as being the harbinger of wind. We have two excellent names in common use—"scud" and "rack,"—either of which would serve.

"Stratified cloud" is a very vague term, applicable to many varieties besides "cirro-stratus."[1]

Objections might also fairly be raised against "Belt cloud," as compared with the familiar "Noah's ark" which Poëy himself quotes elsewhere, and to the "Globular tempestuous cloud," as a very cumbrous term, although a correct one.

It is to be hoped that all these details will be fully discussed before M. Poëy's suggestions are either admitted into general use, or, on the other hand, too readily rejected. E. H.

Walthamstow, Essex

NOTE.—The references are to Howard's *Essay on the Modifications of Clouds*, third edition, Churchill, 1865, and to Poëy's *Comment on observe les Nuages*, Paris, 1879.

"Chipped Arrow heads"

IN a number of NATURE (vol. xx. p. 483) which only lately reached us here I read an interesting account of Mr. Cushing's researches into the manufacture of flint weapons as practised by aboriginal tribes; and as I have had many opportunities of observing the method by which the Fuegians of Magellan's Straits fashion their glass arrow-heads, a few words on the matter may not be without interest to some of your readers.

One of the indications of the increase of traffic through these Straits which has of late years taken place is that empty bottles are now to be found about the shores of those anchorages which are used by passing vessels as stopping-places for the night; and bottle-glass is consequently the material used by the Fuegians of the present day, to the exclusion of obsidian, quartz, or flint. The following is the process:—A fragment somewhat approaching to the shape of the intended arrow-head is grasped firmly in the left hand, while in the right hand is held an old iron nail stuck into a short wooden handle. The fingers of the closed right hand are turned upwards, and the point of the nail is directed towards the operator's breast. He then presses with great force the blunt point of the nail obliquely against the edge of the piece of glass, when a thin scale flies off towards him. One side of the edge having been bevelled in this way, the glass is turned round, and the opposite edge flaked off in a similar manner. Working the edges alternately in this way, the glass is readily brought to the required shape. The fashioning of the point is the most difficult part of the process, the formation of the barbs being easily effected.

I have seen a native thus make a large arrow-head out of a piece of broken pickle bottle in about half an hour. The glass is never struck, but is fashioned entirely by pressure. After a little practice I succeeded in making fair imitations.

I find, moreover, that the iron tool above mentioned can be dispensed with, and that the flaking may be effected by pressing with an angular flint or with a piece of *bone*, which were probably the methods used by the Fuegians before they possessed any iron implements. R. W. COPPINGER

H.M. Surveying Ship *Alert*, Swallow Bay, Straits of Magellan, March 21

Cup and Ring Stones

IN reply to Mr. Middleton's letter I beg to say that the Ilkley cup and ring stones have been carefully described and illustrated in a paper read by me before the Brit. Archæolog. Assoc. (see *Journal* B. A. A. for 1879, p. 93).

Further information will be found in Sir Jas. Simpson's work on the subject, which forms the appendix to vol. vi. of the *Proc.* Soc. Ant. Scot., and in Prof. Boyd Dawkins' "Early Man," p. 338.

In a large number of instances cup and ring marks have been found on the stones of cists, stone circles, and menhirs. It would therefore appear that they are connected with sepulchral rites. Cup marks are found in Scotland, Ireland, Wales, Northumberland, Yorkshire, Cumberland, Lancashire, Switzerland, Sweden, and India (see Rivett Carnac's papers in *Journal* of Asiatic Society of Bengal, 1878-9). I should be glad of evidence of their existence in Derbyshire and elsewhere in the South of England. J. ROMILLY ALLEN

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Songs of Birds

CAN any musical reader of NATURE transcribe for me the notes of the king lorry (*Aprosinectus scapulatus*)? May not the *major* and *minor* keys of the cuckoos noticed by John Birmingham be sexual characteristics? The males are believed to exceed the females in number in the proportion of four or five to one, and, if this be so, the male note must be heard more often than the female. The "jerkiness of style" in the *major* cuckoo, as described, suggests that the performer is a female. A. N.

C. W. HARDING.—The teeth belong to a young horse—not yet "in mark" (*Equus caballus*). Their geological horizon appears uncertain, and they are as likely to be historic or prehistoric as pleistocene.

COMPARATIVE ANATOMY OF MAN[1]

III.

Modifications of the Negro type.—At several parts of the equatorial region of Africa, from the Gulf of Guinea to the White Nile, indications have been met with of a small race of negroes, sometimes so small that the name of pygmy may truly be applied to them, differing from the ordinary negro in the short rounded form of the head. These bear some resemblance to the diminutive members of the oceanic black races who inhabit some parts of the East Indian Archipelago, especially the Andaman Islands, and to whom the name *Negrito* is now generally applied, and Dr. Hamy, who has collected together all the evidence at present accessible as to their existence, has proposed to distinguish them by the term *Negrillo*. The Akkas of Schweinfurth appear to belong to this race. In many districts they are more or less mixed with the ordinary negroes, and their physical characters are therefore obscured, but some skulls from the West Coast of Africa in the collection of Dr. Barnard Davis bear a striking resemblance to those of the Andamanese, and have a cephalic index of 80 or upwards.

The greater part of Africa, between the equator and the most southern parts, where the Hottentots and Bushmen dwell, is inhabited by negroes, who for linguistic reasons are grouped together, and separated from the more northern tribes, and are now generally known to ethnologists by the name of *Bantu*. Their range seems to have extended southwards in comparatively recent times, encroaching upon that of the original inhabitants. They are a pastoral people, warlike, energetic, and intelligent, owning large herds of cattle, and living in villages composed of a number of beehive-like huts. The southern Bantu, who at present are the best known, from their vicinity to the British and Dutch settlements of South Africa, are divided by Fritsch into 1. The Ama-Xosa, who inhabit at present the south-east portions of the Bantu territory, adjoining the sea, between the Cape Colony and Natal. To these the name *Kafir*, derived from an Arabic word applied to them as unbelievers or heathens, is commonly given, but the name is sometimes used in a wider sense for the Bantu negroes generally. The Ama-Xosa include the well-known tribes of Gaikas and Galeikas, with whom we were at war in 1877. 2. The Ama-Zulu,

[1] I am not aware whether *Geschichtete Wolken* is an accepted term in Germany. In the Bernese Oberland a very expressive name is used, *Gestreifte Wolken*, only too well known to mountaineers.

[1] Abstract Report of Prof. Flower's lectures at the Royal College of Surgeons, March 1 to March 19, on the Comparative Anatomy of Man.

Continued from p. 80.

situated to the north of these, in Natal and Zululand. 3. The Bechuanas, occupying the central or inland country; and 4. The Ova-hereros, or Damaras, of the western coast-lands. Each of these divisions is composed of numerous small tribes, frequently at war with each other, and constantly changing in relative importance and even locality. The growth of the Zulu nation is a striking example of the mutable character of native African political combinations. At the commencement of the present century they were an extremely insignificant tribe, but by the military and political genius of their chief, Chaka, who conquered and absorbed all the neighbouring tribes, a powerful kingdom was formed, which was consolidated by his successors, Dingaan, Panda, and Ketchwhyo, under whom, however, it has been destroyed by the superiority of European weapons and organisation, at what cost we know too well. Five crania of Zulus who were killed in the fatal battle of Isandthlwana, on January 22 of last year, have already reached the museum, through the kindness of Mr. Fynn, a magistrate in Natal, Col. Mitchell, the Colonial Secretary, and Dr. R. J. Mann, and their uniformity of characters is such that they probably are very fair average specimens of the race. They are the skulls of large, powerful men in the prime of life. The capacity of their cranial cavity is remarkable, far above that of the ordinary negro, even above that of the lower class of Englishmen, the average of the five being 1,580 cubic centimetres. One measures as much as 1,745. Their average latitudinal index is 75·1, their altitudinal index 76·6. Their orbits are remarkably small and low; index 81·7. The form of the nasal bones and nasal index (60·7) is characteristically negroid, but they differ from ordinary negroes in two important points. They are not truly prognathous, but mesognathous, the alveolar index (100·4) being intermediate between that of the negro and the European, and their teeth are small, the index being only 40·7. The crania of other Zulu and Kafir tribes previously examined give similar results, especially a larger cranial capacity and a less degree of prognathism than is found in the equatorial negro.

Another great division of South African people comprises those popularly known as Hottentots and Bushmen, or in their own language Koi-Koin. They formerly inhabited a much larger district than at present; but, encroached upon by the Bantu from the north and by the Dutch and English from the south, they are greatly reduced in numbers, and indeed threatened with speedy extinction. The Hottentots are at present divided into three principal groups—the Namaquas, Korannas, and the Griquas. The latter especially are much mixed up with other races, and, under the influence of a civilisation which has done little to improve their moral condition, they have lost most of their distinctive peculiarities. The pure-bred Hottentot is of moderate stature, has a yellowish-brown complexion, very frizzly hair, which, being less abundant than that of the ordinary negro, has the appearance of growing in separate tufts. The forehead and chin are narrow and the cheek-bones wide, giving a lozenge-shaped visage. The nose is very flat and the lips prominent. The women are often remarkable for immense accumulation of fat upon the nates, called *steatopygy*, and also of great elongation of the nymphæ and of the *preputium clitoridis*. In these anatomical peculiarities, and in almost everything else except size, the Bushmen agree with the Hottentots. In fact they appear to be a stunted, outcast branch of the same race living the life of the most degraded of savages among the rocky caves and mountains of the lands where the comparatively civilised and pastoral Hottentots dwelt in the plains. Their usual appellation is derived from the Dutch Bosjesman, or "man of the woods," and they have been regarded both by Kafirs and Boers as something only half human, and have been treated accordingly, and nearly exterminated. Notwithstanding their generally low condition of culture, they show remarkable pictorial power, drawing animals especially with life-like accuracy. The osteological characters of the Bushmen are tolerably well illustrated in the museum both by skeletons and crania. Their average height would appear to be from 4 feet 6 to 4 feet 8 inches, and there is very little, if any, difference between the men and women in this respect. The form of the skull is extremely characteristic, and could scarcely be mistaken for that of any other race. It has generally a very feminine, almost infantile appearance; though the capacity of the cranial cavity is not the smallest, exceeding that of the Andamanese and the Veddahs of Ceylon. In general form the cranium is rather oblong than oval, having straight sides, a flat top, and especially a vertical forehead, which rises straight up from the root of the nose. The lower occipital region is greatly developed, in marked contrast to that of the Andaman islanders. They are moderately dolichocephalic or mesaticephalic, the average of ten specimens being 75·4. The height is in all considerably less than the breadth, the average index being 71·1, so that they are decidedly low skulls. The zygomata are little developed, the malars project forwards about as much as in the Mongolian races, giving a nasi-malar angle of 140°. The glabella and supra-orbital ridges are little developed except in the oldest males. The orbits are elongated and low (average index 81·4), the space between the orbits very wide and flat, there being no depression at the root of the nose. A large portion of the ascending process of the maxilla is visible on each side of the nasals. The nasal bones are extremely small and flat, and the aperture wide; the average nasal index being 60·8, so that they are the most platyrhine of all races. On the other hand they are rarely prognathous. In this, and some other characters, there is much that recalls the infantine condition of the true negro.

Inhabitants of North Africa.—The whole of the various populations inhabiting the portion of Africa north of the Sahara Desert, from the Atlantic coasts as far south as the River Senegal on the west to the Red Sea on the east, belong to a completely different type of mankind from that which we have been last considering, and, as before mentioned, the boundaries between the two types coincide remarkably with those of zoological regions, as indicated by distinct characters of the fauna. As must naturally have happened during the vast length of time during which the people of Northern Africa and the negroes have occupied contiguous regions since the drying up of the Sahara Sea, with absolutely no physical barrier between them, considerable intermixture has taken place along the frontier line, and even for some distance into the territories of each at certain points. In the east, especially, the superior northern race has encroached far southwards, and the practice, which has existed from the most ancient times down to our own, of importing the negroes into the northern country as slaves and soldiers, has given rise to a considerable modification of the type in certain districts.

Besides the negro element which has thus partially and locally modified the characters of the inhabitants of Northern Africa, at least two other adventitious elements, although with differences small compared with those last named, appear to have come into the district and assisted to diversify the physical type. The evidence on which the first of these rests is rather shadowy; but to account for the considerable number of individuals, especially in Marocco, who depart at least in colour from the prevailing North African type, and have fair complexions, eyes, and hair, an immigration of a northern race is supposed; and as all such immigrations within the strictly historic period, such as that of the Vandals (A.D. 500) have been on too small a scale or too temporary to effect such a permanent change in a considerable portion of the

population, and as there is evidence from Egyptian monuments of fair people (the Tamahou) inhabiting North Africa, to the west of Egypt, at least 1500 years B.C., this race has been associated with the builders of the megalithic monuments found scattered over the west of Europe and the north-west of Africa, who are supposed to have invaded Africa by way of Spain and Tangiers. The invasion of the country by Semitic races from the East, the Phœnicians and Carthaginians, and more recently the Arabs, who overspread North Africa by way of the Isthmus of Suez in the seventh and tenth centuries, and impressed the Mohammedan religion upon all these regions, rests upon surer historical evidence. The basis of the population of Marocco, Algiers, and Tunis are the Berbers, descendants of the Libyans or *Lebou* of the ancient Egyptians. An important section of them are the Kabyles of the French. They are mostly a settled and pastoral people. The Moors are mixed descendants of Arabs and Berbers, residing in towns. The Bedouins are the Arabs who still lead a nomadic life in the desert. There is much in common in the physical characters of all these people, and indeed with those of the South of Europe and South-West of Asia. They belong mainly to the group called *Melanochroi* by Prof. Huxley.

The Berber type, which perhaps forms the basis of the population of North Africa, is thus described by Topinard, by whom it has been carefully studied. The height is slightly above the mean, 1·68m. *i.e.*, 5 feet 6·1 inches. The skin, white in infancy, quickly becomes brown by contact with the air; hair black, straight, and abundant; eyes dark brown; skull dolichocephalic (index 74·4), leptorhine (44·3), and moderately orthognathous. The face is less elongated and of a less regular oval contour than in the Arab. The straight forehead presents at the base a transverse depression; the superciliary crests are well developed; the nose is sunken at the base, often arched without being aquiline. The moral and social qualities of the Berbers are contrasted with those of the Arabs, considerably to the disadvantage of the latter.

The enterprising and commercial spirit of the Arabs has led to their extension over a very considerable part of Africa, along the north as far as Marocco, and down the east coast beyond Zanzibar, and once, in association with Berbers, and under the name of Moors, they effected a lodgment for a considerable period in Spain and the south of France. Physically they are a fine race. Their skull, seen from above, forms a perfectly regular oval. Their face, long and thin, forms another oval, with a not less regular contour, pointed below. Their colour is perfectly white until subjected to the action of the air, when it bronzes with facility. The hair and beard are smooth, and black as jet, the limits of their implantation are clearly marked: eyes black, the palpebral openings elongated, almond-shaped, and bordered with long black eyelashes; forehead not much elevated. The curve of the nose and retreating chin give to the profile a form rather rounded than straight. The superciliary arches and glabella little developed; the root of the nose is little hollowed, so that the forehead and the dorsum of the nose are almost in a straight line. The nose is aquiline, and its point detaches itself from the alæ and descends downwards, recurved like the beak of an eagle. The cheek-bones do not project; the mouth is small, the teeth white and vertical, the ears well made and rather small, and close to the head. The skull is subdolichocephalic (index 74·0), and the nose leptorhine, 45·5.

A branch of the North African people which has received much attention from anthropologists is that called Guanche, which formerly inhabited the Canary Islands, and which previous to the discovery and conquest of the islands by the Spaniards in the fourteenth century had long been isolated from all other people, and had attained to a peculiar civilisation of its own, preserving somewhat of the purity of type generally found under such circumstances. The custom of embalming their dead in a mummified condition in rock sepulchres has permitted us to become acquainted with their physical characters. They were of small stature, and rather resembled the Berbers of the adjoining coast than any of the negro races. Their skull was of the mesaticephalic form, having an average cephalic index of 76·5, and was considerably lower than it was broad. The face was not prognathous, the nose was leptorhine, and at least those inhabiting the island of Teneriffe, who are best known to us, are remarkable for the low and elongated orbits, having, according to Broca, the lowest orbital index (77) of any race. In this respect and some others they resemble the ancient skulls of the reindeer period found in the cave of Cro-Magnon in the South of France, and it has been thought that they may be related to that race. It should be mentioned, however, that the Guanche skulls from Teneriffe in the collection of Dr. Barnard Davis do not altogether bear out this view, as they have a considerably higher orbital index than those measured at Paris.

Of all the people of North Africa the Egyptians are undoubtedly the most interesting. "When history begins to dawn, the first object the light strikes upon, and which for a long time alone rears its form above the general gloom, is the civilisation of ancient Egypt. On inquiry we find this thoroughly organised civilisation, fully supplied with all the necessaries and many of the embellishments of life, and which is alone visible in the dawning light, must have existed through ages long prior to the dawn. It recedes into the unfathomable depth of time far beyond the monuments and traditions." The valley of the Nile has been for thousands of years the scene of many events which have affected the ethnological characters of its population. Invasions and conquests more or less complete from the east, the north, the west, and the south; importation to its interior from all the regions around of prisoners and slaves in enormous numbers, many of whom have become permanent settlers and integral parts of the population: yet through all the lapse of years since the period from which the first evidence of the condition of man in that region has come down to us to the present day the mass of the population, through all the political vicissitudes which they have undergone, have presented the same general physical type. Notwithstanding the mixture of Semitic or Syro-Arabian nations, as in the Hyksos, who ruled in the Delta for nearly 500 years, and the Arabs of later times, the less important Phœnician, Jewish, and Greek immigration in the north, that of the Persians from the east, and Lybians from the west, and the Ethiopians from the south, the Copts and Fellahs of modern Egypt are the little changed lineal descendants of the subjects of the Pharaohs of the early empire. The physical characters of these are preserved to us fortunately by artistic representations, graphic and sculptural, and the still more trustworthy evidence of mummified bodies. Although there are considerable signs, as might be expected, of admixture with other races here and there, the general uniformity is striking, especially as it extends through so long a period of time. If variations appear at particular epochs the original type constantly reasserts itself, almost, if not quite, in its primitive purity.

In size the ancient Egyptians were not large, and rather delicately built; their hair was long, soft, straight, or wavy, and black; their cranium oval in form, and the average cephalic index is on the borders between mesaticephaly and dolichocephaly, and tolerably uniform in different series, collected and measured by different observers. Thus Morton gives the average of 43 specimens in American museums as nearly 75; Broca that of 81 crania at Paris as 75·58; while the average of 33 in the College museum is 75·4. Of the latter but one is as high as 80·7, and one as low as 69·6. Of the others, 20 are

above 75·0, or belonging to the mesaticephalic class, and 11 below 75·0, or dolichocephalic. The average altitudinal index is below that of the latitudinal, viz., 73·1. The average cranial capacity of the males is 1,454 cubic centimetres. They are almost as orthognathous as Europeans, and have teeth of the same comparatively small size, the dental index being in 7 male skulls 40·8, and in 8 females 41·2. The nasal index of 81 measured by Broca was 47·88, and this was found to be tolerably constant in mummies of different historical periods. The average nasal index of 25 in the College collection is rather higher, viz., 48·7. The orbital index of the same crania is 86·2. Of modern Copts unfortunately but few crania have been hitherto available for examination; but Broca gives the latitudinal index of 12 at 76·39, and the nasal index at 47·15.

The cranial and other characters of the Egyptians correspond in the main with those of the Berbers and other inhabitants of North Africa, and they must be placed in the same general category in any classification of the human race founded on anatomical characters. They have no affinities with the negroes, except such as may easily be accounted for by the occasional admixture of negro blood. Indeed it is almost remarkable that there are not more signs of this having taken place. Some authors have supposed a Turanian origin for the Egyptians, but if this term is to be taken in any sense as equivalent to Mongolians, there is absolutely no support for it in their osteological characters; all the characteristics of the Mongolian races are entirely absent in the Egyptian skull. Still less can any resemblance be seen to the Australian, whose skull, compared with that of an Egyptian, presents almost as great a contrast as can be found within the limits of variation of the human cranium. The angular form, limited capacity, wide zygomata, projecting supraorbital ridges, short flattened nasals, wide nasal aperture with rounded inferior border, great alveolar prognathism, retreating chin, and immense teeth, characteristic of the Australian, are all wanting in the Egyptian. In fact: the Egyptian belongs by all his anatomical characters to the type called by Blumenbach Caucasian. The much vexed questions, Who were the Egyptians? and Where did they come from? receive no answer from anatomical investigations, beyond the very simple one that they are one of several modifications of the great group of races which inhabit all the lands surrounding the Mediterranean Sea; that they here lived in their own land far beyond all periods of time measured by historical events, and that in all probability it was there that they gradually developed that marvellous civilisation which has exercised such a powerful influence over the arts, the sciences, and the religion of the whole of the Western world.

THE UNITED STATES WEATHER MAPS, SEPTEMBER, 1877

IN Canada and the United States during September, 1877, atmospheric pressure was everywhere above the normal except over a small triangular patch bounded by the Gulf of Fundy, Chesapeake Bay, and the entrance to Lake Superior. The deficiency was greatest in the North-Western States from Leavenworth to Lake Winnipeg, where it amounted to nearly the tenth of an inch, and on the coasts of the Gulf of Mexico, the deficiency at Mobile being 0·074 inch. Pressure was also under the normal over Greenland, the Atlantic, the Spanish Peninsula, Italy, nearly all Austria and Prussia, the whole of Russia and Siberia, except a patch stretching in a N.N.E. and S.S.W. direction about Lake Baikal. The centres of greatest depression were in the Atlantic between Greenland and the Azores, over a rather broad region extending eastwards from Moscow to the Obi, and from Pekin northwards to Nertschinsk, the greatest depressions below the normals of these regions for September being respectively 0·112 inch, 0·130 inch, and 0·051 inch.

Pressures were above the normal over the whole of North-Western Europe, including Iceland, Sweden, Norway, Denmark, the Netherlands, France, and Germany as far as Pressburg, the greatest excess, 0·303 inch, occurring in the extreme north-west of the British Islands. But the most extensive region of unusually high pressure embraced the whole of Southern Asia, including Japan, China, except the extreme north, India, Syria, and also Egypt; and the whole of Australia, Tasmania, and New Zealand was also above the normal, and very considerably so, the excess at Deviliquin, on the Murray River, reaching 0·265 inch.

The most remarkable disturbance in the temperature arising out of this abnormal distribution of pressure and the winds necessarily resulting therefrom, occurred over the whole of Europe, except Italy and the Spanish Peninsula. If the Weather Map be examined, it will be seen that from the west of the British Islands pressures steadily diminished on proceeding eastward over Europe, and along with this diminution of pressure pretty strong northerly winds prevailed, except in the two peninsulas already referred to, where winds were southerly and the temperatures consequently above the normal. Under the influence of these northerly winds the temperature of Europe from the North Cape southwards fell greatly below the average, a deficiency of 5°·0 or upwards being experienced at the North Cape, Christiania, Memel, Gulynki, Warsaw, and Prague. In Siberia, to the east of this cold region, southerly winds prevailed and high temperatures consequently ruled, the excess above the normal temperature being 6°·3 at Taschkent, 4°·0 at Semipalatinsk, and 2°·5 at Jenisseisk and Irkutsk. Southerly winds also prevailed over Iceland and Greenland, raising the temperature above the normal, the excess on the west of Greenland being about 4°·0, and in the north-west of Iceland 5°·0. The Weather Map shows strong southerly winds also over Canada and the northern half of the United States, where consequently the temperature was high for the season, the excess being from 2°·0 to 3°·0, rising even at some places to nearly 4°·0. Further south the excess was much less; and in some cases there was even a deficiency, as about Cape Hatteras, where northerly winds will be seen from the Map to have swept over that coast, and the temperature fell a degree and a half below the average; and along the upper reaches of the Arkansas and Red rivers, or to westward of the region of lowest pressure, where, winds being north-westerly, the temperature fell nearly a degree below the normal.

In India, pressure was unusually and continuously high from the beginning of the year, except in August, when it fell below the average over the region of the Lower Ganges and Assam. In September, however, pressure again became unusually high over all India, the excess being greatest along the northern coasts of the Bay of Bengal and the central districts from Visagapatam to Ajmere. In Assam the excess was considerable and the rainfall exceeded the average, whereas in Orissa, Western Bengal, and Berhar the rainfall was scanty. The excess above the normal pressure was also considerably less over Southern India and Ceylon than it was to northward; and with this distribution of the pressure occurred the memorable feature of the meteorology of India for the month, viz., an unusual strength of the south-west monsoon over the west of India from Goa southward, accompanied with an abnormally heavy rainfall on that coast, which extended eastward over the Deccan and the greater part of the Madras Presidency, and thus terminated the disastrous famine which had wasted Mysore and a large portion of the Madras Presidency during the previous two years.

CONTRIBUTIONS TO MOLECULAR PHYSICS IN HIGH VACUA[1]

THIS paper is a continuation of the Bakerian Lecture "On the Illumination of Lines of Molecular Pressure and the Trajectory of Molecules," read before the Royal Society, December 5, 1878. Phenomena there briefly referred to have since been more fully examined; new facts have been observed, and their theoretical bearings discussed; and numerous experiments suggested by Prof. Stokes and others have been tried, with the result of acquiring much information which cannot fail to be of value in assisting to evolve a theory capable of embracing all the phenomena under discussion.

Experiments previously described have shown that the molecular stream hypothesis is the correct one. According to this, the molecules of the residual gas, coming in contact with the negative pole, acquire a negative charge, and immediately fly off by reason of the mutual repulsion exerted by similarly electrified bodies. Were the individual molecules solely acted on by the initial impulse from the negative pole, they would take a direction accurately normal to the surface repelling them, and would start with their full velocity. But the molecules, being all negatively electrified, exert mutual repulsion, and therefore diverge laterally. The negative pole, likewise, not only gives an initial impulse to the molecules, but it also continues to act on them by repulsion, the result being that the molecules move with an accelerating velocity the further they get from the pole. The lateral divergence of the molecules, owing to their negative electricity, will naturally increase with the amount of charge they carry; the greater the number of collisions the more the molecules lose negative charge, and the less divergent the stream becomes. This hypothesis is borne out by facts. When the vacuum is just good enough to allow the shadow to be seen, it is very faint (owing to few molecular rays), but is quite sharp (owing to the divergence of the molecules laterally). The variation in mutual repulsion is shown by the fact that the focus projected from a concave pole falls beyond the centre of curvature, and varies in position with the exhaustion, being longer at high than at low exhaustions.

Assuming that the phosphorescence is due, either directly or indirectly, to the impact of the molecules on the phosphorescent surface, it is reasonable to suppose that a certain velocity is required to produce the effect. Within the dark space, at a moderate exhaustion, the velocity does not accumulate to a sufficient extent to produce phosphorescence; but at higher exhaustions the mean free path is long enough to allow the molecules to get up speed sufficient to cause phosphorescence. At a very high exhaustion the phosphorescence takes place nearer the negative pole than at lower exhaustions; this I consider results from the initial velocity of the molecules being sufficient to produce phosphorescence, their greater speed being due to the fewer collisions near the negative pole.

The luminous boundary to the dark space round the negative pole is probably due to the impact of molecule against molecule, producing phosphorescence of the gas in the same way as the impact of molecules against German glass produces phosphorescence of the glass.

The following experiments were commenced at the suggestion of Prof. Maxwell:—

A tube was made as shown in Fig. 1. The terminal *a*

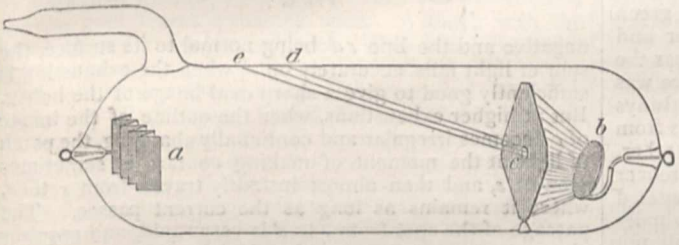

FIG. 1.

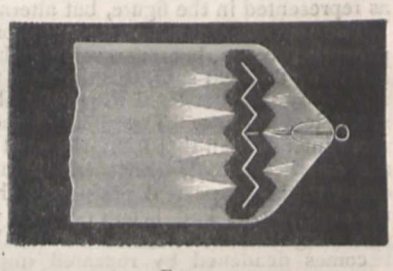

FIG. 2.

is a rectangular plate of aluminium, folded as shown in section Fig. 2; the other terminal *b* is a flat disk of aluminium set obliquely to the axis of the tube. In front of the pole *b* is fixed a screen of mica, with a small hole in it, as shown at *c*; this hole is not in the axis of the tube, but a little to one side of it, so that rays starting normally from the centre of the pole *b* may pass through it and strike the glass at *d*, whilst at the same time rays passing direct between the poles *a* and *b* can also pass through the hole.

The questions which this apparatus was to answer are: (1) Will there be molecular projections from the negative pole, *a*, in two series of plane strata normal to the sides of the individual furrows, or will the projection be perpendicular to the electrode as a whole, *i.e.*, along the axis of the tube? and (2), Will the molecular rays from the pole *b*, when it is made negative, issue through the aperture of the screen, along the axis of the tube, *i.e.*, direct to the positive pole, or will they leave the pole normal to its surface and strike the glass as shown at *d*?

The tube was exhausted and connected with an induction coil; the following results were obtained:—At a moderate exhaustion, the corrugated pole being made negative, the dark space entirely surrounds it, slight indentations being visible opposite each hollow, where there also is a linear concentration of blue light. The appearance is in section as shown in Fig. 2. At higher exhaustions the luminous margin disappears and the rays which previously formed the blue foci are now projected on the inner surface of the tube, where they make themselves evident in green phosphorescent light as portions of ellipses formed by the intersection of the several sheets

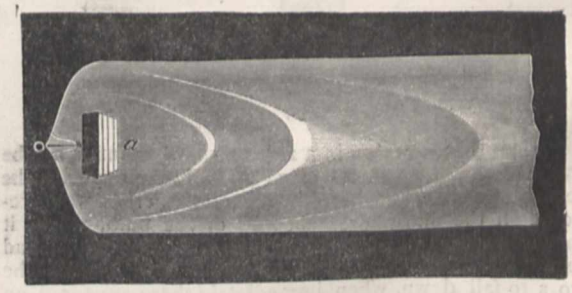

FIG. 3.

of molecular rays with the cylindrical tube. Fig. 3 shows this appearance.

When the other pole was made negative, and the

[1] "Contributions to Molecular Physics in High Vacua. Magnetic Deflection of Molecular Trajectory; Laws of Magnetic Rotation in High and Low Vacua; Phosphorogenic Properties of Molecular Discharge." By William Crookes, F.R.S. (Extracts from a paper in the *Philosophical Transactions* of the Royal Society, Part 2, 1879.)

exhaustion was such that the dark space extended about 8 millims. from the pole, the first appearance noticed was that of a ray of dark blue light issuing through the hole in the mica screen, and shooting upwards towards the side of the tube, but not reaching it. Fig. 4 shows the

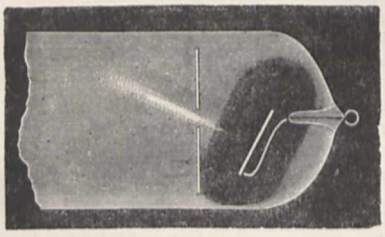

FIG. 4.

dark space round the pole, and the ray of blue light. On increasing the exhaustion this blue line of light, and the luminous boundary to the dark space, disappeared, and presently a green oval spot appeared on the side of the tube, exactly on the place previously marked where the rays issuing normal from the surface of the pole should fall.

It happened that this oval spot fell on a portion of the tube where one of the elliptical projections from the opposite (corrugated) pole also fell when that was made negative. Thus by reversing the commutator I could get a narrow band of green phosphorescent light from one pole, or a wider oval of green light from the other pole, to fall alternately on the same portion of the glass. Fig. 5 shows these effects, which, however, did not occur together as represented in the figure, but alternately.

The narrow band shone very brightly with green phosphorescence, but on reversing the commutator and obtaining the oval spot, this was seen to be cut across the middle by a darker band where the phosphorescence was much less intense. The light of the band was always more intense than that from the spot; the impacts from the one being more concentrated than from the other, owing to the shape and position of the poles; moreover the experiments had been first tried with the corrugated pole negative. The glass along the band gradually becomes deadened by repeated impacts, and will not readily phosphoresce in reply to the weaker blows from the flat plate, although it still responds to the more energetic bombardment from the corrugated pole. This phenomenon almost disappears at very high exhaustions, or if the tube is allowed to rest for some time. The tired glass then recovers its phosphorescent power to some extent, but not completely.

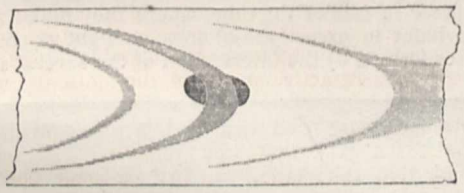

FIG. 5.

To obtain this action in a more striking manner, a tube was made having a metal cross on a hinge opposite the negative pole. The sharp image of the cross was projected on the phosphorescent end of the bulb, where it appeared black on a green ground. After the coil had been playing for some time a sudden blow caused the cross to fall down, when immediately there appeared on the glass a bright green cross on a darker background. The part of the glass formerly occupied by the shadow, having been protected from bombardment, now shone out with full intensity, whilst the adjacent parts of the glass had lost some of their sensitiveness, owing to previous bombardment.

This effect of deadening produced on glass by long-continued phosphorescence was shown in a very striking manner at a lecture delivered at the Royal Institution on April 4, 1879, when the image of a cross was stencilled on the end of a large pear-shaped bulb.

I subsequently experimented further with this bulb, and found that the image of the cross remained firmly stencilled on the glass. The bulb was then opened and the wide end heated in the blowpipe flame till it was quite soft and melted out of shape. It was then blown out again into its original shape, and re-exhausted; on connecting it with the induction coil, the metal cross being down out of the line of discharge, the original ghost of the cross was seen to be still there, showing that the deadening of the phosphorescing powers the glass produced by the first experiment at the Royal Institution had survived the melting-up and re-blowing out of the bulb.

When experimenting with this apparatus a shifting of the line of molecular discharge was noticed when the current was first turned on. The flat pole *b* (Fig. 6) being

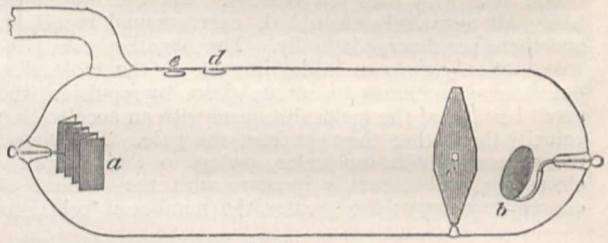

FIG. 6.

negative and the line *c d* being normal to its surface, the spot of light falls accurately on *d*, when the exhaustion is sufficiently good to give a sharp oval image of the hole *c*. But at higher exhaustions, when the outline of the image of *c* becomes irregular and continually changing, the patch of light at the moment of making contact is sometimes seen at *e*, and then almost instantly travels from *e* to *d*, where it remains as long as the current passes. The passage of the spot from *e* to *d* is very rapid, and requires close attention to observe it. If the coil is now stopped for a longer or shorter time, and contact is again made *the same way as before* (*b* being negative), the spot does not now start from position *e*, but falls on *d*, in the first instance. This can be repeated any number of times.

If now the pole *b* be made positive even for the shortest possible interval, and it then be made negative, the original phenomenon occurs, and the spot of light starts from *e* and rapidly travels to *d*. After this it again falls on *d*, *ab initio*, each time contact is made, so long as *b* is kept the negative pole. There seems no limit to the number of times these experiments can be repeated. The explanation of this result appears to depend on a temporary change in the condition of the wall of the glass tube when positively electrified molecules beat against it, a change which is undone by subsequent impact from negative molecules. This phenomenon is closely connected with some shadow and penumbra experiments described further on, and as the same explanation will apply to both I will defer any theoretical remarks for the present.

A suggestion was made by Prof. Maxwell that I should introduce a third, idle, electrode in a tube between the positive and negative electrodes so that the molecular stream might beat upon it, so as to see if the molecules gave up any electrical charge when impinging on an obstacle. A tube was therefore made as shown in Fig. 7; *a* and *b* are the ordinary terminals; *c* and *d* are large aluminium disks nearly the diameter of the tube, con-

nected with outer terminals. The poles *a* and *b* were connected with the induction coil, an earth wire was brought near the idle pole *c*, and a gold leaf electroscope was brought near *d*.

On passing the current at inferior exhaustions, when the dark space is about 8 millims. from the negative pole,

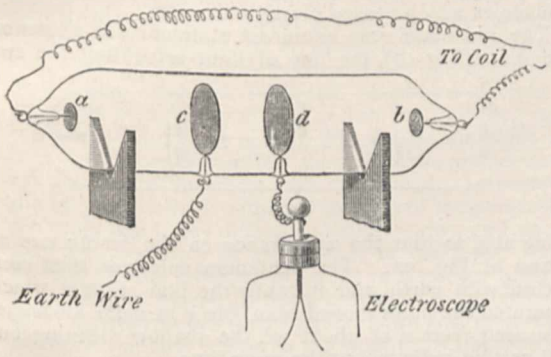

FIG. 7.

no movement of the gold leaves takes place whether *a* or *b* is negative, and whether *c* is connected with earth or is insulated.

At a good exhaustion, when the green phosphorescence of the glass is strong, the gold leaves are only slightly affected whichever way the current passes.

On increasing the exhaustion to a very high point, so that the green phosphorescence gets weaker and the spark has a difficulty in passing, the gold leaves are violently affected. When the pole *a* is negative and *b* positive, the leaves diverge to their fullest extent. On examining their potential it is found to be positive. The coil was stopped and the gold leaves remained open. A touch with the finger caused them to collapse. They then gradually opened again, but not to the original extent. The finger again discharged them, when they reopened slightly a third time. Experiment showed that the electrical excitement took many minutes to recover equilibrium. A Leyden jar put to the idle pole *d* was charged positively.

The earth wire and electroscope remaining, as shown in the figure, the direction of current was reversed so as to make *a* positive and *b* negative. The gold leaves were now less strongly affected; they opened a little, and remained quivering, as if under the influence of rapidly-alternating currents.

The wires were rearranged as shown in Fig. 8, *b* and *d*

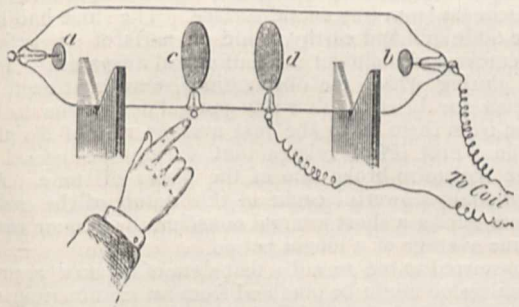

FIG. 8.

being connected with the coil. When *d* was made negative, faint sparks about 1 millim. long could be drawn by the finger from *c*; but when *d* was made positive the sparks from *c* were 10 millims. long. The same results are obtained when the finger is brought near *a*, so long as *c* remains insulated. If, however, *c* be connected with earth by a wire, no sparks can be got from *a*, whichever way the current passes between *b* and *d*. Connecting *a* with earth diminishes the length of the sparks, which can be drawn from *c* by about one-half.

The poles *a* and *b* being connected with the coil and the idle poles *c* and *d* having loose wires hanging from them, the wires were strongly repelled from each other.

The above experiments show that an idle pole in the direct line between the positive and the negative poles, and consequently receiving the full impact of the molecules driven from the negative pole, has a strong positive charge.

It now became of interest to ascertain whether the trajectory of the molecules suffered any deflection in passing an idle pole when it was suddenly uninsulated by an earth contact. For this purpose I used the tube described in a former paper,[1] where the shadow of an aluminium star was projected on a plate of phosphorescent glass. So long as the aluminium star is insulated, the shadow is sharp, as already described; but on touching the star to earth, the shadow widens out, forming a tolerably well-defined penumbra outside the original shadow, which can still be seen unchanged in size and intensity. On removing the earth connection, the penumbra disappears, the umbra remaining as before. The same penumbra is produced by connecting the idle pole with the negative pole through a very high resistance, such as a piece of wet string, instead of connecting it with earth. On bringing a magnet near the negative pole, the shadow of the (insulated) star is much increased in definition, the adjacent luminous parts of the screen becoming more luminous. Touching the star now brings a large, somewhat blurred, penumbra round the original image. The penumbra obeys the magnet the same as the umbra.

The aluminium star was now made the positive pole, the other pole remaining unchanged. The shadow of the star was projected on the phosphorescent plate of the same sharpness and almost the same intensity of light and shade as if the positive pole had been the one ordinarily used as such. The image obeyed the magnet as usual. With this arrangement the penumbral action could not be tested.

This, therefore, confirms the above-described results—that the idle pole, the shadow of which is cast by the negative pole, has strong positive charge. Now the stream of molecules must be assumed to carry negative electricity; when they actually strike the idle pole they are arrested, but those which graze the edge are attracted inwards by the positive electricity, and form the shadow. When the idle pole is connected with earth its potential would become zero were the discharge to cease; but, inasmuch as a constant positive charge is kept up from the passage of the current through the tube, we must assume that the potential of the uninsulated idle pole is still sufficiently positive to neutralise the negative charge which the impinging molecules would give it, and leave some surplus of positive. The effect of alternately uninsulating and insulating the idle pole is therefore to vary its positive electricity between considerable limits, and consequently its attractive action on the molecules which graze its edge.[2]

Experiments were tried with an idle pole and shadow tube whilst the exhaustion was going on. At such a rarefaction that the shadow can just be made out, it is quite sharp; touching the idle pole causes a small penumbra to appear round its shadow. When the exhaustion is at the best point for obtaining the green phosphorescence on the glass, the shadow is very sharp and well defined; and connecting the idle pole with earth gives a much wider penumbra, the width of the penumbra increasing with the degree of rarefaction. When the

[1] *Phil. Trans.*, 1879, vol. 170, p. 147.

[2] I am aware that the theory which makes these effects of deflection depend on electrostatic attractions and repulsions is open to some grave objections; still it was that which in a great measure guided me in my experiments, and it could not well be omitted without reducing the description of them to a dry record of apparently unconnected facts.

vacuum is so high that the spark has difficulty in passing, the penumbra (which becomes visible on insulating the idle pole) is much wider than before, and apparently eight or ten times as wide as it was at the lowest exhaustion at which observations were taken.

If the object whose shadow is cast on the screen is a non-conductor (such as a piece of glass rod), its shadow remains constant at all exhaustions, no penumbra being visible, as it cannot be uninsulated.

Prof. Stokes, whose suggestions throughout the course of this research have been most valuable, considered that much information might be gained by experimenting with an apparatus constructed in the following manner: the two poles of the tube (Fig. 9) are at *a* and *b*. At *c* is a

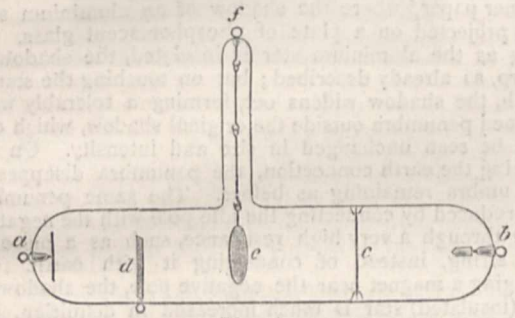

FIG. 9.

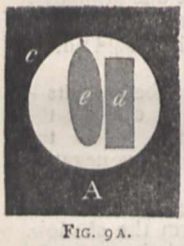

FIG. 9A.

FIG. 9B.

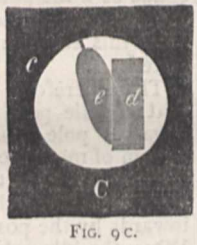

FIG. 9C.

fluorescent screen; *d* is a fixed bar of aluminium, and *e* is another aluminium bar hanging from a platinum pole *f*, by a metal chain. The bar and pendulum are on opposite sides of the horizontal axis of the tube, as shown in the plan, so that when properly exhausted and the pole *a* made negative, the shadows of bar and pendulum shall fall side by side on the screen, as shown in Fig. 9A. On swinging the pendulum, the shadow alternately overlaps and recedes from the shadow of the bar (Figs. 9B and 9C).

This apparatus was tried many times with an induction coil, and also with a Holtz machine; but the results were not sufficiently definite to render it safe to draw any inference from them. By the kindness of Mr. De La Rue I have lately had the opportunity of experimenting with his large chloride of silver battery, and the results now come out with great sharpness and with none of the flickering and indecision met with when working with an induction-coil.

The tube was so adjusted that the pendulum hung free, and a narrow line of molecular discharge passed between the edges of the bar and the pendulum, forming a line of light between the two shadows on the screen (Fig. 9A). When the pendulum was set swinging, and the idle pole *f* connected with it was kept insulated, the regular appearance of the moving and fixed shadows was very slightly interfered with. That is to say, the shadows followed the successive positions between those shown in Figs. 9B and 9C almost as if they had been cast by a luminous point in place of the negative pole. As the shadow of the swinging pendulum came very near that of the bar, the latter shadow seemed to shrink away, showing that the pendulum itself exerted slight repulsion on the molecules which passed close to its edge.

The pendulum was again set stationary, as shown on the plan (Fig 10), the line of light separating the two

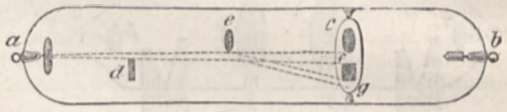

FIG. 10.

being at *f*, so that the appearance on the screen was as shown at Fig. 9A. The pendulum pole was then connected with earth, and instantly the line of light which separated the poles moved from *f* to *g* through an angle, measured from *e*, of about 30°, the shadow widening out and getting indistinct at the same time.

When the pole *a* was negative and *b* positive, the bar *d* and pendulum *e* were each found to be positively electrified. The outside of the glass tube, both near the negative pole and near the positive pole, was also positively electrified.

The above experiments were tried with 6300 cells, a resistance equal to 800,000 ohms being interposed. The current through the tube was 0·00383 weber. These measurements were taken by Mr. De La Rue, to whom I am greatly indebted for permission to experiment with his magnificent battery, and who himself kindly assisted me in making the arrangements. WILLIAM CROOKES

(*To be continued.*)

ROCK-WEATHERING, AS ILLUSTRATED IN CHURCHYARDS[1]

COMPARATIVELY little has yet been done in the way of precise measurement of the rate at which the exposed surfaces of different kinds of rock are removed in the processes of weathering. A few years ago some experiments were instituted by Prof. Pfaff of Erlangen to obtain more definite information on this subject. He exposed to ordinary atmospheric influences carefully measured and weighed pieces of Solenhofen limestone, syenite, granite (both rough and polished), and bone. At the end of three years he found that the loss from the limestone was equivalent to the removal of a uniform layer 0·04 mm in thickness from its general surface. The stone had become quite dull and earthy, while on parts of its surface fine cracks and incipient exfoliation had appeared.[2] The time during which the observations were continued is however too brief to allow any general deductions to be drawn from them as to the real average rate of disintegration. Prof. Pfaff relates that during the period a severe hailstorm broke one of the plates of stone. An exceptionally powerful cause of this nature might make the loss during a short interval considerably greater than the true average of a longer period.

It occurred to me recently that data of at least a provisional value might be obtained from an examination of tombstones freely exposed to the air in graveyards in cases where their dates remained still legible or might be otherwise ascertained. I have accordingly paid attention to the older burial-grounds in Edinburgh, and have gathered together some facts which have perhaps sufficient interest and novelty to be communicated to the Society.

At the outset it is of course obvious that in seeking for

[1] A Paper read to the Royal Society of Edinburgh, on April 19, by Prof. Geikie, F.R.S.

[2] "Allgemeine Geologie als exacte Wissenschaft," p. 317.

data bearing on the general question of rock-weathering we must admit the kind and amount of such weathering visible in a town to be in some measure different from what is normal in nature. So far as the disintegration of rock-surfaces is effected by mineral acids, for example, there must be a good deal more of such chemical change where sulphuric acid is copiously evolved into the atmosphere from thousands of chimneys than in the pure air of country districts. In these respects we may regard the disintegration in towns as an exaggeration of the normal rate. Still the difference between town and country may be less than might be supposed. Surfaces of stone are apt to get begrimed with dust and smoke, and the crust of organic and inorganic matter deposited upon them may in no small measure protect them from the greater chemical activity of the more acid town rain. In regard to the effect of daily or seasonal changes of temperature, on the other hand, any difference between town and country may not impossibly be on the side of the town. Owing probably to the influence of smoke in retarding radiation, thermometers placed in open spaces in town commonly mark an extreme nocturnal temperature not quite so low as those similarly placed in the suburbs, while they show a maximum day temperature not quite so high.

The illustrations of rock-weathering presented by city graveyards are necessarily limited to the few kinds of rock employed for monumental purposes. In this district the materials used are of three kinds: 1st, Calcareous, including marbles and limestones; 2nd, Sandstones and flagstones; 3rd, Granites.

I. Calcareous.—With extremely rare exceptions, the calcareous tombstones in our graveyards are constructed of ordinary white saccharoid Italian marble. I have also observed a pink Italian shell-marble and a finely fossiliferous limestone containing fragments of shells, foraminifera, &c.

In a few cases the white marble has been employed by itself as a monolith in the shape of an obelisk, urn, or other device; but most commonly it occurs in slabs which have been tightly fixed in a framework of sandstone. These slabs, from less than one to fully two inches thick, are generally placed vertically; in one or two examples they have been inserted in large horizontal sandstone slabs or "through-stanes." The form into which it has been cut and the position in which it has been erected have had considerable influence on the weathering of the stone.

A specimen of the common white marble employed for monumental purposes was obtained from one of the marble works of the city, and examined microscopically. It presented the well-known granular character of true saccharoid marble, consisting of rounded granules of clear transparent calcite, averaging about $\frac{1}{100}$ inch in diameter. Each granule has its own system of twin lamellations, and not unfrequently gives interference colours. The fundamental rhombohedral cleavage is everywhere well developed. Not a trace exists of any amorphous granular matrix or base holding the crystalline grains together. These seem moulded into each other, but have evidently no extraordinary cohesion. A small fragment placed in dilute acid was entirely dissolved. There can be no doubt that this marble must be very nearly pure carbonate of lime.

The process of weathering in the case of this white marble presents three phases, sometimes to be observed on the same slab, viz., Superficial Solution, Internal Disintegration, and Curvature with Fracture.

(1) *Superficial solution* is effected by the carbonic acid and partly by the sulphuric acid of town rain. When the marble is first erected it possesses a well-polished surface capable of affording a distinct reflection of objects placed in front of it. Exposure for not more than a year or two to our prevalent westerly rains suffices to remove this polish, and to give the surface a rough granular character. The granules which have been cut across or bruised in the cutting and polishing process are first attacked, and removed in solution or drop out of the stone. An obelisk in Greyfriars churchyard erected in memory of a lady who died in 1864 has so rough and granular a surface that it might readily be taken for a sandstone. So loosely are the grains held together that a slight motion of the finger will rub them off. In the course of solution and removal the internal structure of the marble begins to reveal itself. Its harder nests and veinings of calcite and other minerals project above the surrounding surface, and may be traced as prominent ribs and excrescences running across the faint or illegible inscriptions. On the other hand some portions of the marble are more rapidly removed than others. Irregular channels, dependent partly on the direction given to trickling rain by the form of the monumental carving, but chiefly on original differences in the internal structure of the stone, are gradually hollowed out. In this way the former artificial surface of the marble disappears, and is changed into one that rather recalls the bare, bleached rocks of some mountain side.

The rate at which this transformation takes place seems to depend primarily on the extent to which the marble is exposed to rain. Slabs which have been placed facing to north-east, and with a sufficiently projecting architrave to keep off much of the rainfall, retain their inscriptions legible for a century or longer. But even in these cases the progress of internal disintegration is distinctly visible. Where the marble has been less screened from rain the rapidity of waste has been sometimes very marked. A good illustration is supplied by the tablet of G—— G——, on the south side of Greyfriars Churchyard, who died in 1785.[1] This monument had become so far decayed as to require restoration in 1803. It is now, and has been for some years, for the most part utterly illegible. The marble has been dissolved away over the centre of the slab to a depth of about a quarter of an inch. Yet this monument is by no means in an exposed situation. It faces eastward in a rather sheltered corner, where, however, the wind eddies in such a way as to throw the rain against the part of the stone which has been most corroded.

In the majority of cases superficial solution has been retarded by the formation of a peculiar grey or begrimed crust, to be immediately described. The marble employed here for monumental slabs appears to be peculiarly liable to the development of this crust. Another kind of white marble, sometimes employed for sculptured ornaments on tombstones, dissolves without crust. It is snowy white, and more translucent than the ordinary marble. So far as the few weathered specimens I have seen enable me to judge, it appears to be either Carrara marble or one of the strongly saccharoid, somewhat translucent varieties employed instead of it. This stone, however, though it forms no crust, suffers marked superficial solution. But it escapes the internal disintegration which, so far as I have observed, is always an accompaniment of the crust. But the few examples of it I have met with hardly suffice for any comparison between the varieties.

(2) *Internal Disintegration.*—Many of the marble monuments in our older churchyards are covered with a dirty crust, beneath which the stone is found on examination to be merely a loose crumbling sand. This crust seems to form chiefly where superficial solution is feeble. It may be observed to crack into a polygonal network, the individual polygons occasionally curling up so as to reveal the yellowish white crumbling material underneath. It also rises in blisters, which, when they break, expose the interior to rapid disintegration.

So long as this begrimed film lasts unbroken the smooth face of the marble slab remains with apparently little modification. The inscription may be perfectly

[1] For obvious reasons I withhold the names carved on the tombstones referred to in this communication.

legible; the moment the crust is broken up, however, the decay of the stone is rapid. For we then see that the cohesion of the individual crystalline granules of the marble has already been destroyed, and that the merest touch causes them to crumble into a loose sand.

It appears therefore that two changes take place in upright marble slabs freely exposed to rain in our burial-grounds—a superficial, more or less firm crust is formed, and the cohesion of the particles beneath is destroyed.

The crust varies in colour from a dirty grey to a deep brown black, and in thickness from that of writing-paper up to sometimes at least a millimetre. One of the most characteristic examples of it was obtained from an utterly decayed tomb (erected in the year 1792), on the east side of Canongate Churchyard. No one would suppose that the pieces of flat dark stone lying there on the sandstone plinth were once portions of white marble. Yet a mere touch suffices to break the black crust, and the stone at once crumbles to powder. Nevertheless the two opposite faces of the original polished slab have been preserved, and I even found the sharply-chiselled socket-hole of one of the retaining nails. The specimen was carefully removed and soaked in a solution of gum, so as to preserve it from disintegration. On submitting the crust of the marble to microscopic investigation, I found it to consist of particles of coal, grains of quartz sand, angular pieces of broken glass, fragments of red brick or tile, and organic fibres. This miscellaneous collection of town dust was held together by some amorphous cement which was not dissolved by hydrochloric acid. At my request my friend Mr. B. N. Peach tested it with soda on charcoal, and at once obtained a strong sulphur reaction. There can be little doubt that it is mainly sulphate of lime. The crust which forms upon our marble tombstones is thus a product of the reaction of the sulphuric acid of the town rain upon the carbonate of lime. A pellicle of amorphous gypsum is deposited upon the marble and incloses the particles of dust which give the characteristic sooty aspect to the stone. This pellicle, of course, when once formed, is comparatively little affected by the chemical activity of rain-water. Hence the conservation of the even surface of the marble. It is liable, however, to be cracked by an internal expansion of the stone to which I shall immediately refer, and also to rise in small blisters, and as I have said, its rupture leads at once to the rapid disintegration of the monument.

The cause of this disintegration is the next point for consideration. Chemical examination revealed the presence of a slight amount of sulphate in the heart of the crumbling marble; but the quantity appeared to me to be too small seriously to affect the cohesion of the stone. I submitted to microscopic examination a portion of a crumbling urn of white marble in Canongate Churchyard. The tomb bears a perfectly fresh date of "1792" cut in sandstone over the top; but the marble portions are crumbling into sand, though the structure faces the east, and is protected from vertical rain by arching mason-work. A small portion of the marble retaining its crust was boiled in Canada balsam, and was then sliced at right angles to its original polished surface. By this means a section of the crumbled marble was obtained which could be compared with one of the perfectly fresh stone. From the dark outer amorphous crust with the carbonaceous and other miscellaneous particles fine rifts could be seen passing down between the separated calcite granules, which in many cases were quite isolated. The black crust descends into these rifts, and likewise passes along the cleavage planes of the granules. Towards the outer surface of the stone immediately beneath the crust the fissures are chiefly filled with a yellowish, structureless substance, which gave a feeble glimmering reaction with polarised light, and inclosed minute amorphous aggregates like portions of the crust. It probably consists chiefly of sulphate of lime. But the most remarkable feature in the slide was the way in which the calcite granules had been corroded. Seen with reflected light, they resembled those surfaces of spar which have been placed in weak hydrochloric acid to lay bare inclosed crystals and zeolites. The solution had taken place partly along the outer surfaces, so as to produce the fine passage or rifts, and partly along the cleavage. Deep cavities, defined by intersecting cleavage planes, appeared to descend into the heart of some of the granules. In no case did I observe any white pellicle such as might indicate a redeposit of lime from the dissolved carbonate. Except for the veining of probable sulphate just referred to, the lime when once dissolved had apparently been wholly removed in solution. There was further to be observed a certain dirtiness, so to speak, which at the first glance distinguished the section of crumbled marble from the fresh stone. This was due partly to corrosion, but chiefly to the introduction of particles of soot and dust, which could be traced among the interstices and cleavage lamellæ of the crystalline granules, for some distance back from the crust.

It may be inferred, therefore, that the disintegration of the marble is mainly due to the action of carbonic acid in the permeating rain-water, whereby the component crystalline granules of the stone are partially dissolved and their mutual adhesion is destroyed. This process goes on in all exposures, and with every variety in the thickness of the outer crust. It is distinctly traceable in tombstones that have not been erected for more than twenty years. In those which have been standing for a century it is, save in exceptionally sheltered positions, so far advanced that a very slight pressure suffices to crumble the stone into powder. But with this internal disintegration we have to take into consideration the third phase of weathering to which I have alluded. In the upright marble slabs it is the union of the two kinds of decay which leads to so rapid an effacement of the monuments.

3. *Curvature and Fracture.*—This most remarkable phase of rock-weathering is only to be observed in the slabs of marble which have been firmly inserted into a solid framework of sandstone and placed in an erect or horizontal position. It consists in the bulging out of the marble, accompanied with a series of fractures. The change cannot be explained as mere sagging by gravitation, for it usually appears as a swelling up of the centre of the slab, which continues until the large, blister-like expansion is disrupted. Nor is it by any means exceptional; it occurs as a rule on all the older upright marble tablets, and is only found to be wanting in those cases where the marble has evidently not been fitted tightly into its sandstone frame. Wherever there has been little or no room for expansion, protuberance of the marble may be observed. Successive stages may be seen, from the first gentle uprise to an unsightly swelling of the whole stone. This change is accompanied by fracture of the marble. The rents in some cases proceed from the margin inwards, more particularly from the upper and under edges of the stone, pointing unmistakably to an increase in volume as the cause of fracture. In other cases the rents appear in the central part of the swelling, where the tension from curvature has been greatest.

Some exceedingly interesting examples of this singular process of weathering are to be seen in Greyfriars Churchyard. On the south wall, in the inclosure of a well-known county family, there is an oblong upright marble slab measuring 30¼ inches in height by 22⅜ inches in breadth, and ¾ inch in thickness, facing west. The last inscription on it bears the date 1838, at which time it was no doubt still smooth and upright. Since then, however, it has escaped from its fastenings on either side, though still held firmly at the top and bottom. It consequently projects from the wall like a well-filled sail. The axis of curvature is of course parallel to the upper and lower margins, and the

amount of curvature from the original vertical line is fully 2½ inches, so that the hand and arm can be inserted between the curved marble and the perfectly vertical and undisturbed wall to which it was fixed. At the lower end of this slab a minor curvature, to the extent of ⅛ inch, is observable coincident with the longer axes of the stone. In both cases the direction of the bending has been determined by the position of the inclosing solid frame of sandstone which resisted the internal expansion of the marble. Freed from its fastenings at either side, the stone has assumed a simple wave-like curve. But the tension has become so great that a series of rents has appeared along the crest of the fold. One of these has a breadth of $\frac{1}{10}$ inch at its opening.[1] Not only has the slab been ruptured, but its crust has likewise yielded to the strain, and has broken up into a network of cracks, and some of the isolated portions are beginning to curl up at the edges, exposing the crumbling, decayed marble below. I should add that such has been the expansive force of the marble that the part of the sandstone block in the upper part of the frame exposed to the direct pressure has begun to exfoliate, though elsewhere the stone is quite sound.

More advanced stages of curvature and fracture may be noticed on many other tombstones in the same burying-place. One of the most conspicuous of these has a peculiar interest from the fact that it occurs on the tablet erected to the memory of one of the most illustrious dead whose dust lies within the precincts of the Greyfriars—the great Joseph Black. He died in 1799. In the centre of the sumptuous tomb raised over his grave is inserted a large upright slab of white marble, which, facing south, is protected from the weather partly by heavy over-hanging masonry, and partly by a high stone wall immediately to the west. On this slab a Latin inscription records with pious reverence the genius and achievements of the discoverer of carbonic acid and latent heat, and adds that his friends wished to mark his resting-place by the marble whilst it should last. Less than eighty years, however, have sufficed to render the inscription already partly illegible. The stone, still firmly held all round its margin, has bulged out considerably in the centre, and on the blister-like expansion has been rent by numerous cracks which run on the whole in the direction of the length of the stone.

A further stage of decay is exhibited by a remarkable tomb on the west wall of the Greyfriars Churchyard. The marble slab, bearing a now almost wholly effaced inscription, on which the date 1779 can be seen, is still held tightly within its inclosing frame of sandstone slabs, which are firmly built into the wall. But it has swollen out into a ghastly protuberance in the centre, and is moreover seamed with rents which strike inwards from the margins. In this and in some other examples the marble seems to have undergone most change on the top of the swelling, partly from the system of fine fissures by which it is broken up, and partly from more direct and effective access of rain. Eventually the cohesion of the stone at that part is destroyed, and the crumbling marble falls out, leaving a hole in the middle of the slab. When this takes place disintegration proceeds rapidly. Three years ago I sketched a tomb in this stage on the east wall of Canongate Churchyard. In a recent visit to the place I found that the whole of the marble had since fallen out.

The first cause that naturally suggests itself in explanation of this remarkable change in the structure of a substance usually regarded as so inelastic is the action of frost. White statuary marble is naturally porous. It is rendered still more so by that internal solution which I have described. The marble tombstones in our graveyards are therefore capable of imbibing a relatively large amount of moisture. When this interstitial water is frozen its expansive force as it passes into the solid state must increase the isolation of the granules and augment the dimensions of a marble block. I am inclined to believe that this must be the principal cause of the change. Whatever may be the nature of the process, it is evidently one which acts from within the marble itself. Microscopic examination fails to discover any chemical transformation which would account for the expansion. Dr. Angus Smith has pointed out that in towns the mortar of walls may be observed to swell up and lose cohesion from a conversion of its lime into the condition of sulphate. I have already mentioned that sulphate does exist within the substance of the marble, but that its quantity so far as I have observed is too small to be taken into account in this question. The expansive power is exerted in such a way as not sensibly to affect the internal structure and composition of the stone, and this I imagine is most probably the work of frost.

The results of my observations among our burial grounds show that, save in exceptionally sheltered situations, slabs of marble exposed to the weather in such a climate and atmosphere as that of Edinburgh are entirely destroyed in less than a century. When this destruction takes place by simple comparatively rapid superficial solution and removal of the stone, the rate of lowering of the surface amounts sometimes to about a third of an inch (or roughly nine millimetres) in a century. Where it is effected by internal displacement, a curvature of two and a half inches with abundant rents, a partial effacement of the inscription and a reduction of the marble to a pulverulent condition may be produced in about forty years, and a total disruption and effacement of the stone within one hundred. It is evident that white marble is here utterly unsuited for out-of-door use, and that its employment for really fine works of art which are meant to stand in the open air in such a climate ought to be strenuously resisted. Of course I am now referring not to the durability of marble generally, but to its behaviour in a large town with a moist climate and plenty of coal smoke.

II. Sandstones and Flagstones.—These, being the common building materials of the country, are of most frequent occurrence as monumental stones. When properly selected, they are remarkably durable. By far the best varieties are those which consist of a nearly pure fine siliceous sand, with little or no iron or lime, and without trace of bedding structure. Some of our sandstones contain 98 per cent. of silica. A good illustration of their power of resisting the weather is supplied by Alexander Henderson's tomb in Greyfriars Churchyard. He died in 1646, and a few years afterwards the present tombstone, in the form of a solid square block of freestone, was erected at his grave. It was ordered to be defaced in 1662 by command of the Scottish Parliament, but after 1688 it was repaired. Certain bullet marks upon the stone are pointed out as those of the soldiery sent to execute the order. Be this as it may, the original chisel marks on the polished surface of the stone are still perfectly distinct, and the incised lettering remains quite sharp. Two hundred years have effected hardly any change upon the stone, save that on the west and south sides, which are those most exposed to wind and rain, the surface is somewhat roughened, and an internal fine parallel jointing begins to show itself.

Three obvious causes of decay in arenaceous rocks may be traced among our monuments. In the first place, the presence of a soluble or easily removable matrix in which the sand grains are embedded. The most common kinds of matrix are clay, carbonates of lime and iron, and the anhydrous and hydrous peroxides of iron. The presence of the iron reveals itself by its yellow, brown, or red colour. So rapid is disintegration from this cause, that the sharply-incised date of a monument

[1] It is a further curious fact that the slab measures half an inch more in breadth across the centre where it has had room to expand than at the top where it has been tightly jammed between the sandstone slabs.

erected in Greyfriars Church to an officer who died only in 1863 is no longer legible. At least $\frac{1}{8}$th of an inch of surface has here been removed from a portion of the slab in sixteen years, or at the rate of about $\frac{3}{4}$ inch in a century.

In the second place, where a sandstone is marked by distinct laminæ of stratification, it is nearly certain to split up along these lines under the action of the weather if the surface of the bedding planes is directly exposed. This is well known to builders, who are quite aware of the importance of "laying a stone on its bed." Examples may be observed in our churchyards, where sandstones of this character have been used for pilasters and ornamental work, and where the stone set on its edge has peeled off in successive layers. In flagstones, which are merely thinly-bedded sandstones, this minuter lamination is fatal to durability. These stones, from the large size in which slabs of them can be obtained and from the ease with which they can be worked, form a tempting material for monumental inscriptions. The melancholy result of trusting to their permanence is strikingly shown by a tombstone at the end of the South Burying Ground in Greyfriars Churchyard. The date inscribed on it is 1841, and the lettering that remains is as sharp as if cut only recently. The stone weathers very little by surface disintegration. It is a laminated flagstone set on edge, and large portions have scaled off, leaving a rough, raw surface where the inscription once ran. In this instance a thickness of about $\frac{1}{3}$ inch has been removed in forty years.

In the third place, where a sandstone contains concretionary masses of different composition or texture from the main portion of the stone, these are apt to weather at a different rate. Sometimes they resist destruction better than the surrounding sandstone, so as to be left as prominent excrescences. More commonly they present less resistance, and are therefore hollowed out into irregular and often exceedingly fantastic shapes. Examples of this kind of weathering abound in our neighbourhood. Perhaps the most curious to which a date can be assigned are to be found in the two sandstone pillars which until recently flanked the tomb of Principal Carstares in Greyfriars Churchyard. They were erected some time after the year 1715. Each of them is formed of a single block of stone about 8 feet long. Exposure to the air for about 150 years has allowed the original differences of texture or composition to make their influence apparent. Each is hollowed out for almost its entire length on the exposed side into a trough 4 to 6 inches deep and 6 to 8 inches broad. As they lean against the wall beneath the new pillars which have supplanted them, they suggest some rude form of canoe rather than portions of a sepulchral monument.

Where concretions are of a pyritous kind, their decomposition gives rise to sulphuric acid, some of which combines with the iron and gives rise to dark stains upon the corroded surface of the stone. Some of the sandstones of this district, full of such impurities, ought never to be employed for architectural purposes. Every block of stone in which they occur should be unhesitatingly condemned. Want of attention to this obvious rule has led to the unsightly disfigurement of public buildings.

III. GRANITES.—In Prof. Pfaff's experiments, to which I have already referred, he employed plates of syenite and granite, both rough and polished. He found that they had all lost slightly in weight at the end of a year. The annual rate of loss was estimated by him as equal to 0·0076 mm. from the unpolished and 0·0085 from the polished granite. That a polished surface of granite should weather more rapidly than a rough one is perhaps hardly what might have been expected. The same observer remarks that though the polished surface of syenite was still bright at the end of not more than three years, it was less so than at first, and in particular that some figures indicating the date which he had written on it with a diamond had become entirely effaced. Granite has been employed for too short a time as a monumental stone in our cemeteries to afford any ready means of measuring even approximately its rate of weathering. Traces of decay in some of its felspar crystals may be detected, yet in no case that I have seen is the decay of a polished granite surface sensibly apparent after exposure for fifteen or twenty years. That the polish will disappear, and the surface will gradually roughen as the individual component crystals are more or less easily attacked by the weather, is of course sufficiently evident. Even the most durable granite will probably be far surpassed in permanence by the best of our siliceous sandstones. But as yet the data do not exist for making any satisfactory comparison between them.

GERHARD JOHANNES MULDER

IN the death of Prof. G. J. Mulder, to which we briefly alluded in our last number, Holland has been called upon to mourn the loss of her leading chemist. Gerhard Johannes Mulder was born at Utrecht, December 27, 1802. His studies were completed at the university of his native city, and embraced especially mathematics, the natural sciences, and medicine. In 1825 he established himself as physician at Amsterdam. His inclination towards a more purely scientific career caused him however in the year following to accept a position as teacher of physics at Rotterdam under the auspices of the Batavian Society. This proved but the stepping-stone to the Professorship of Botany and Chemistry at the Rotterdam Medical School, to which he was appointed in 1827. In 1841 he accepted a call to the Chair of Chemistry at Utrecht, and returned to the place of his birth, to add to its fame by making it the scene of a long-continued series of valuable chemical researches.

Mulder's tastes lay almost entirely in the department of organic chemistry, and more especially in those branches connected with the phenomena of vegetable and animal life. In mineral chemistry his researches were confined to careful studies on the chemical composition of white lead and red lead (1839)—two of the important technical products of Holland—and to the establishment of the atomic weight of tin (1849) by means of numerous analyses. He also modified or perfected a number of analytical methods, such as those for the determination of silver, phosphorus, carbonic acid, &c., and contributed a large variety of analytical data on various technical and scientific compounds. In 1864 he made an elaborate investigation on the phenomena of solution of salts in water, establishing several of the now generally accepted laws with regard to the solubility of mixtures of salts, among others the interesting fact that in saturated solutions of mixtures the relations between the respective quantities of the salts is expressed in multipla of their molecular weights. The varied experimental data resulting from his own researches were grouped, together with the contributions of other chemists on this subject, in the form of a monograph of over 300 pages, which forms the most important work extant on solubility.

In physiological chemistry Mulder has conducted a large variety of investigations. The most important are those connected with the study of the albuminoids, which were commenced in 1838 and extended over a period of twenty years. In the course of these investigations he exposed albumin, fibrine, caseïne, &c., to the action of a variety of chemical agents, obtaining the products of oxidation, chlorination, nitrification, &c. At an early date he obtained, by the action of alkaline solutions on the albuminoids, the so-called *proteïn*, which he regarded as the primary albuminoid matter, the various members of the group consisting of this radical in union with small quantities of sulphur, phosphorus, and oxygen. This

ingenious hypothesis, while being a fruitful cause of research, was ultimately found to be untenable. It involved the author in a somewhat bitter discussion with Liebig and his school, who finally proved proteïn to be by no means a homogeneous body, and to contain a notable quantity of sulphur, in opposition to Mulder's opinion. While failing to solve the problem of the constitution of this group of compounds, a problem which, even despite Schüztenberger's remarkable experiments during the past few years, is but half-way toward solution, Mulder vastly increased our knowledge of the proteïds by numerous analytical results and thorough studies of the chemical properties of the different members of the group and of their derivatives. As especially interesting papers in this connection should be mentioned his research on the nature of the albuminoid forming the crystalline lens of the eye (1839), and that on the natural and artificial formation of peptone from the albuminoids (1858). Closely allied to this subject were the important researches on chondrine and other gelatinous bodies carried out in 1839. From this same year dates also his extended investigation of the chemical properties of hematin, the colouring matter of the blood. The examination of blood enlisted his attention at various intervals, and led to numerous analytical tests, to one of which we owe the proof of the presence of carbonic acid as a normal constituent of the blood. In addition to the topics alluded to, Mulder has contributed to physiological chemistry a large variety of minor isolated observations and numerous analyses of various products of the animal economy.

In the chemistry of vegetable physiology he developed a scarcely less noteworthy activity and diversity. In 1839 and 1840 were published important papers on inulin and starch, and on pectin and pectic acid. At the same time appeared his analytical investigations on the composition of silk, of gum arabic and other gums, of the poison of the upas, of various sorts of tea and coffee, of tannic acid, of numerous ethereal oils, of the resinous matter in turf, of salicin and phlorizin, and of the compounds rufin and rutilene, derived from them, and of gluten. In 1839 he published an extensive research on cassia-oil and cinnamon-oil, and on benzone, in which numerous derivatives of these bodies are described. In the year following he completed an elaborate investigation on the ulmic bodies, which forms the chief basis of our knowledge in this still comparatively obscure field. This was followed by interesting researches on yeast (1844), on chlorophyll, on the presence of waxy constituents in many ordinary plants (1844), on the action of acids on woody fibre (1846), on chrysamonic acid and other derivatives from aloes. In 1865 he published a very complete and valuable study on drying oils and their chemical properties, based on a wide range of experimental observation. Mulder made two important contributions to the special chemistry of the aromatic compounds by his discovery in 1839 of meta-nitro-benzoic acid—one of the earliest representatives of the nitro acids—and by his study in 1858 on the formation of picric acid from indigo, in which he advanced the now generally accepted opinion of a transition, by means of isatin and nitro-salicylic acid, from one compound to the other. Organic chemistry is likewise indebted to him for several improvements in analytical methods, and he was one of the first to devise gas furnaces for use in organic combustions.

As an author and editor Prof. Mulder was scarcely less active than as an investigator. His principal works, which are better known in their German translations, are:—"Proeve eener allgemeene physiologische Scheikunde" (1843), translated into German by Prof. Kolbe, under the title of "Versuch einer allgemeinen physiologischen Chemie;" "Die Ernährung in ihrem Zusammenhang mit dem Volksgeist" (1847); "Die Chemie des Weins" (1856); "Die Chemie des Biers" (1858); "Die Silberprobirmethode" (1859); "Die Chemie der Ackerkrume," 3 vols. (1864); "Beiträge zur Geschichte des chemisch gebundenen Wassers" (1864); "Die Chemie der austrockenden Oele" (1867). As an editor he published, in connection with Van Hall and Vrolik, the "Bijdragen tot de natuurkundige wetenschappen" from 1826 to 1832. During the six years following he edited the "Natuur- en scheikundige Archief." After uniting for several years with Miquel and Wenckeback in the editorship of the "Bulletin des Sciences physiques et naturelles en Néerlande," he has issued since 1842 the "Scheikundige Verhandelingen en Onderzoekingen" (Rotterdam), the only chemical journal of Holland.

Prof. Mulder was frequently intrusted by his Government with important commissions, and has contributed greatly by his pen and speech to the cultivation of chemistry in Holland. In 1860 he was elected an honorary member of the London Chemical Society. T. H. N.

NOTES

A CONSIDERABLE number of the Fellows of the Royal Society have decided to add a portrait of Sir Joseph Hooker to the valuable collection of historical portraits belonging to the Society, and they invite others to join in the subscription. Cheques crossed "Barclay and Co., for the Sir J. Hooker Portrait Fund," to be paid to Messrs. Barclay and Co., 54, Lombard Street, E.C.

AT the last meeting of the Chemical Society it was announced that the Longstaff Medal had been awarded to Prof. Thorpe, of the Yorkshire College, Leeds. Prof. Thorpe is the first recipient of the medal.

ON Sunday, May 23, M. Dumas was presented by the Société d'Encouragement with a civic crown, in acknowledgment of the services rendered to science and to France during more than half a century.

THE Emperor of Germany has appointed Prof. Baron von Nordenskjöld a foreign Knight of the Ordre pour le Mérite for Arts and Sciences.

THE Visitation of the Royal Observatory takes place on Saturday.

THE funds for the erection of a monument in memory of the great philosopher, Leibnitz, at Leipzig, have now reached the sum considered necessary, and Prof. Hänel of Dresden is about to execute the monument. It will be erected on the southern side of the St. Thomas Churchyard. The statue of Leibnitz will be of bronze, and will measure 3½ metres in height. The pedestal will have the same height, and will be adorned by four bas reliefs.

WE have to record the death of Mr. Alfred Swaine Taylor, F.R.S., the physician and toxicologist. He was born at Northfleet, Kent, in December, 1806. He was a pupil of Sir Astley Cooper and Mr. J. H. Green at Guy's Hospital, and afterwards studied in the leading medical schools of France, Germany, and Italy. In 1830 he entered the Royal College of Surgeons, was admitted a Licentiate of the Royal College of Physicians in 1848, and was elected a Fellow of the same five years later. In 1845 he was chosen a Fellow of the Royal Society. He was the first holder of the chair of Medical Jurisprudence in Guy's Hospital, and was for many years joint-Professor, and subsequently sole Professor, of Chemistry. Dr. Swaine Taylor was the author of several professional treatises, more especially on the subjects of poisons and poisonings, chemistry, and medical jurisprudence; and he had received the honorary degree of M.D. from the University of St. Andrew's.

ON May 15 the Congress of Bohemian Naturalists was opened at Prague. Dr. Albert, of Innsbruck University, was elected

president. Prof. Krejczi, a geologist of repute, delivered an address in which he pointed out the importance of German natural science, rather a bold, and certainly commendable, thing to do in the somewhat narrow-minded Czech capital.

THE Swiss Natural History Society will hold its general meeting on September 12–15 next, in the small town of Brieg, in the canton Vaud, at the foot of the Simplon.

WE are pleased to hear that negotiations are in progress for the transfer of the Museum Godeffroy to the City of Hamburg. In it are to be found by far the finest series of the zoological and ethnographical products of the Pacific Islands yet assembled together, including, we believe, all the types of the new species described in the thirteen "Hefts" of the *Journal des Museum Godeffroy*. It would be a great misfortune to science if these were distributed all over the world by the auctioneer's hammer, so that it is much to be hoped that a satisfactory arrangement will be come to between the liquidators of the "Maison Godeffroi" and the citizens of Hamburg.

THE Emperor of Russia has conferred the Grand Cross of the Order of Stanislaus upon Dr. Hermann Obst, the director of the Ethnographical Museum of Leipzig.

WE would earnestly draw the attention of our readers to the fact that the Secretary of the Smithsonian Institution, Washington, U.S., of which Mr. James Smithson was the founder, is desirous of obtaining information respecting that gentleman to assist in the preparation of a memoir. James Smithson, F.R.S., was the son of Hugh, first Duke of Northumberland, and Elizabeth, heiress of the Hungerfords of Audley, and niece of Charles, Duke of Somerset. In 1826 he resided at Bentinck Street, Cavendish Square. He died in 1829. The following are some of the points on which information is desired:—"John Fitall, a trusted servant of Mr. James Smithson, died June 14, 1834, at Bush House, Wanstead, Essex, England. Have his heirs any relics or mementoes of Mr. Smithson—any notes, letters, &c.? Mr. Charles Drummond, a London banker, was the executor of Mr. Smithson. Can we procure originals or copies of any letters of Mr. Smithson from him? What do the records of the Royal Society say as to the election of James Lewis Macie as a Fellow? Perhaps a report was made to the Council as to his qualifications? What can be learned of the disagreement between Mr. Smithson and the Council of the Royal Society? Mr. Wheatstone knew of it. Do any of the surviving Members remember the circumstances? Information relative to Henry Louis Dickinson (half-brother of James Smithson), Colonel of the 84th Regiment of Foot. Information relative to the college life of James Lewis Macie, a graduate of May 26, 1786, of Pembroke College, Oxford University. Letters from James Smithson to Sir Humphrey Davy, Sir Davies Gilbert, Hon. Henry Cavendish, Dr. W. H. Wollaston, Mr. Smithson Tennant, Dr. Joseph Black, Dr. Hutton, M. Arago, M. Gay Lussac, M. Cordier, M. Haüy, M. Klaproth, M. A. C. Becquerel, M. Fanjas de St. Fond, Mr. Thornton, Mr. Maclaire, Mr. Wm. Thomson; or any original letters of Mr. Smithson. Can the original manuscripts be found of Mr. Smithson's communications to the Royal Society or to Thomson's "Annals of Philosophy"? Can Mr. Smithson's authorship of papers or articles in any scientific journals be identified? What can be learned of Mr. Smithson's mother, Mrs. Macie? or of Col. Henry Louis Dickinson's mother, Mrs. Mary Ann Coates? At what number in Bentinck Street did Mr. Smithson reside? (He held apartments, was not a householder.) Had he at any time any other residence; if so, where?" Any information on the above points should be addressed to Prof. Spencer F. Baird, care of William Wesley, 28, Essex Street, Strand, London, the agent of the Smithsonian Institution.

MR. STORY MASKELYNE put his maiden question in Parliament the other evening very appropriately in connection with the Natural History Museum. Mr. Adam, in reply, stated that the trustees of the British Museum had been informed that they may now proceed to remove their collections to the new Natural History Museum. The question of providing residences for the officers of the museum was considered by the late Government, who did not see their way to comply with the request. At present, therefore, it is not contemplated that any such residences should be erected.

A DIFFICULTY has supervened in the St. Gothard tunnel, which, according to the *Times* correspondent, threatens seriously to retard the completion of the undertaking. In a part of it where the formation is a porous white stone the vaulting has already given way two or three times, and it has required the greatest care and constant staying with timber to prevent the passage thereabouts from completely collapsing. It was thought, however, that a granite wall 6 feet thick would be sufficiently strong to support the superincumbent mass of white stone and keep the tunnel permanently open. A wall of this thickness has just been finished, but it too has begun to give way, and the engineers are at their wits' end how to overcome the difficulty. In the opinion of Dr. Stapf, the geologist of the tunnel, it can be overcome only by making a wide curve so as to get round the white stone instead of going through it. This would involve the entire reconstruction of that part of the tunnel, in which case it will probably not be ready for traffic before the time fixed for the completion of the lines of approach, two years hence.

MR. SETH GREEN, writing to the *New York World* of May 14, says that one morning when he was watching a spider's nest a wasp alighted within an inch or two of the nest, on the side opposite the opening. Creeping noiselessly around towards the entrance of the nest the wasp stopped a little short of it and for a moment remained perfectly quiet; then reaching out one of his antennæ he wiggled it before the opening and withdrew it. This overture had the desired effect, for the boss of the nest, as large a spider as one ordinarily sees, came out to see what was wrong and to set it to rights. No sooner had the spider emerged to that point at which he was at the worst disadvantage than the wasp, with a quick movement, thrust his sting into the body of his foe, killing him easily and almost instantly. The experiment was repeated on the part of the wasp, and when there was no response from the inside he became satisfied, probably, that he held the fort. At all events he proceeded to enter the nest and slaughter the young spiders, which were afterwards lugged off one at a time.

IN a series of papers on the northern part of the continent, contributed to an Australian paper under the somewhat odd title of "Northern Lights," the writer mentions a curious feature of the creeks and lagoons in the north of Queensland. This is what is called "floating grass." It is a tall aquatic grass, which, while growing in the mud when within reach, is quite independent in that respect, and extends its creeping stems into the deepest water; and by the interweaving of these, and of the roots emitted from every joint, makes a dense mat of verdure, which, at first sight, seems to have its origin on solid ground. It is however quite possible to walk on it without risk of entanglement. The method is to keep going, lifting the feet well, and with the body in as flat a position as possible. Horses and cattle are fond of this grass, and it is said that the masses of it are sometimes so dense, although with twenty feet of water underneath, that horses have been known to cross on them.

ON the French Eastern Railway Achard electric brakes are being tried, and are said to work satisfactorily. The electricity is not supplied by ordinary cells, but by Planté's accumulating battery.

A MEETING of the Epping Forest and County of Essex Naturalists' Field Club was held on Saturday, May 29, at Buck-

hurst Hill, when a lecture was delivered by Mr. Henry Walker, F.G.S., entitled "A Day's Elephant Hunting in Essex." At the conclusion of the lecture Sir Antonio Brady, who has taken an active interest in the formation of the Club, gave a detailed account of his method of removing and subsequently preserving the mammalian remains from the brick-earth pits at Ilford.

MR. C. S. SARGENT, Harvard Professor of Arboriculture, has published, in his capacity of special agent of the approaching United States census, a "Catalogue of the Forest Trees of North America," preliminary to one which will be added to the census report on the forest wealth of the United States. He desires information concerning the geographical range of any species, the most favourable region and elevation and geographical formation for its multiplication and perfection, its exceptionally large dimensions, its common or local name, and its products and uses.

THE number of persons who die from small pox is increasing daily in Paris. Statistics prove that 858 died in 1879, and not less than 1,038 in the four first months of 1880. This circumstance has created a great impression, and Dr. Liouville, in the Chamber of Deputies, has proposed a law to render vaccination compulsory. It has been reported upon favourably by the committee, and will accordingly in all probability soon become a part of the law of the land.

SEVERAL papers have stated that an official commission will be appointed in France to witness the crossing of the British Channel by a balloon travelling from France to England (weather permitting). The fact is that the experiment is to be made from Boulogne by M. Javis, with his own balloon and at his own risk. But the port authorities have agreed to send M. Javis such information as will enable him to select for starting a time when the wind is blowing with some sufficient prospect of reaching England. M. Javis will keep watch from June 1 to 20. A steamer will follow as far as possible the hardy aëronaut on his adventurous trip.

A BRANCH of the recently-founded Thüringer-Wald Club has been formed at Leipzig. A similar club, at present numbering twenty-five members, has been opened at Plauen (Saxony) with a view of promoting and furthering visits of tourists to the so-called Voigtland. The club will improve the roads, undertake excursions on a larger scale, see to the fixing of proper sign-posts, &c.

ON the shores of the Lake of Constance the rare phenomenon of a perfect solar halo was noticed on May 4 at noon. The large ring, which from time to time assumed splendid rainbow tints, remained visible for more than two hours. At Berlin the phenomenon of mock suns was observed on the 9th inst. at 8 a.m.

INTERESTING discoveries are reported from Italy. Near Este, in the Veneto, at the foot of the Eugancian Mountains, Prof. Prosdocismi discovered a prehistoric burial-ground with many bronze and clay vessels. Eighty-two tombs were found, of which forty-four seemed to have been opened already by the Romans, while the contents of the others seemed untouched. The urns belong to three different periods, some are stained black with linear ornaments, others are striped red and black. Some vases are of such exquisite workmanship that they could even to-day serve as patterns. A small case of bronze is adorned with human and animal figures.

M. VAROY, French Minister of Public Works, has visited in state the regional competition of Bar-le-Duc, and gave an address at a banquet. In this competition the most notable feature was the work done on a large field by a Gramme machine and a Fowler plough before the Minister and an immense crowd on May 23. The electric current also gave motion to some agricultural machines at a distance. This remarkable experiment was conducted by M. Felix, of Germase, a country place in the vicinity of Bar-le-Duc, where similar experiments on a smaller scale were made last year.

THE Twelfth and Thirteenth Annual Reports of American Archæology and Ethnology contain, as usual, several papers of great ethnological interest. From the Report of the curator, Mr. F. W. Putnam, it is evident that much excellent work continues to be done in the museum, which is rapidly becoming one of the most valuable repertories of ethnology in the world. The papers are all connected with American ethnology, the most important probably being that of Mr. Bandelier, on the Social Organisation and Mode of Government of the Ancient Mexicans.

THE *Proceedings* of the Davenport (U.S.) Academy of Natural Sciences, vol. i. part 2, while it contains a number of papers in natural history, is noteworthy mainly for the large number of papers on subjects connected with American ethnology, and chiefly on various mound explorations. We are pleased to see that this society continues to prosper; it had the originality to elect as its president for 1879 Mrs. Mary L. D. Putnam.

NO. 4 of the Columbia College *School of Mines Quarterly* is better than ever, and we are glad to learn that it has successfully passed its brief probationary period, and is now regarded as an assured and unexpected success. Among the articles in this number are "Sanitary Problems of New York City," by Prof. Trowbridge; "Artificial Diamonds," by Mr. Lucius Pitkin; "Volumetric Analysis of Sulphuric Acid," by Mr. A. H. Elliott; "A New Planometer," by Mr. L. M. Hooper.

IN the *Transactions* of the Academy of Science of St. Louis, vol. iv. No. 1, are several papers deserving attention. Mr. N. Holmes has a specially interesting paper on the "Geological and Geographical Distribution of the Human Race," and students of the science of language will be interested in M. Coruna y Colludo's account of the Zoque language, spoken in the State of Chiapas, Mexico. There are two magnetic papers by Prof. Nipher, a paper on *Pentremites* by Dr. G. Hambach; on the genus *Pinus* by M. G. Engelmann, who has also a short paper on acorns and their germination.

AS one of their "Occasional Papers" the Boston Society of Natural History have published a volume of great value on the "Geology of Eastern Massachusets," by Mr. W. O. Crosby. It is evidently the result of long and competent investigation, is well illustrated, and contains a large and well-printed geological map of the region treated of.

THE additions to the Zoological Society's Gardens during the past week include a Grey-cheeked Monkey (*Cercocebus albigena*) from West Africa, presented by the Earl of Lonsdale, F.Z.S.; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, a Balearic Crowned Crane (*Balearica pavonina*) from West Africa, presented by Mr. Frank Simpson; two Cashmere Shawl Goats (*Capra hircus*) from India, presented by Dr. W. Taylor; an Alexandrine Parrakeet (*Palæornis alexandri*) from India, two West African Love Birds (*Agapornis pullaria*) from West Africa, a Common Raven (*Corvus corax*), European, a Crimson-eared Waxbill (*Estrelda phœnicotis*) from West Africa, presented by Mr. C. Williams; a South American Rat Snake (*Spilotes variabilis*) from Demerara, presented by Mr. G. H. Hawtayne, C.M.Z.S.; three Cashmere Shawl Goats (*Capra hircus*) from India, a Malbrouck Monkey (*Cercopithecus cynosurus*) from East Africa, a Philippine Paradoxure (*Paradoxurus philippensis*) from the Philippine Isles, three Black Tortoises (*Testudo carbonaria*) from Demerara, deposited; two Purple-faced Monkeys (*Semnopithecus leucoprymnus*) from Ceylon, a Ludio Monkey (*Cerco-*

pithecus ludio), an African Brush-tailed Porcupine (*Atherura africana*) from West Africa, three Indian Tantali (*Tantalus leucocephalus*) from India, an American Bison (*Bison americanus*) from North America, a Schomburgk's Deer (*Cervus schomburgki*) from Siam, two Side-striped Jackals (*Canis lateralis*) from West Africa, two Spotted Hyænas (*Hyæna crocuta*) from South Africa, two Crested Screamers (*Chauna chavaria*) from Buenos Ayres, five Black-necked Swans (*Cygnus nigricollis*) from Antarctic America, purchased; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Occultation of a Fixed Star by Saturn.—It is recorded by Whiston, in his life of Dr. Clarke, that the father of the latter once saw a star in the dark space between the ring and the ball, though, so far as we are aware, no date for the observation or other particulars have been preserved. Gottfried Kirch, the discoverer of the great comet of 1680, appears to have been very nearly a witness of a similar phenomenon, if indeed his telescope had been equal to the occasion. Observing Saturn at Leipsic on the evening of January 16, 1679, he remarked, about 10h., that the star *o* Tauri of Bayer (114 Tauri Fl.), of the sixth magnitude, was distant only one diameter from the extremity of the ring. The night was changeable, and clouds subsequently interfered, but two hours after midnight he found the star "quartâ forsan parte diametri Saturni, a Saturno distantem." A quarter of an hour later he saw that the distance had sensibly diminished, and in another half hour the star had become so small "adeo ut fermè conspectum fugeret. Neque procul aberat a Saturno, ut spatium inter Saturnum et stellulam, ipsius stellæ magnitudinem non superare videretur;" and he continues: "Stellula postea tangebat fermè extremum Saturni." An accompanying rough figure shows the star very nearly in contact with the extremity of the ring. Further we read: "Inter primum et secundum quadrantem post horam tertiam nihil dignoscere poteram, primo stellula Saturno adhæsisse mihi videbatur, de quo tamen nihil certi dicere possum, ipse enim dubito; deinde nihil videndum sese offerabat." But although he saw no more, Kirch states that Saturn would necessarily shortly occult the star. On the following evening, at 8h. 30m., the star was distant about a diameter of the planet, or rather, as the figure shows, of the ring. He considered from these observations that the star was in contact at 3 a.m. on January 17, and that the egress took place about 11 a.m. It will be found that Saturn did not set at Leipsic on this morning until nearly 5h. 30m., and by the track of the planet the central distance at conjunction was less than a third of the semi-diameter of the shorter axis of the ring, thus the star might be within the dark space between the ring and the globe before setting. The planet was then about 83° from the node of the ring, which must therefore have been nearly as open as we can see it. Kirch seems to have been well aware of the rarity of such an observation. It was first published in his Ephemerides for 1683.

The Polar Compression of Mars.—In November last Prof. Young made a numerous series of measures of the diameters of Mars with a filar-micrometer attached to the 9·5-inch equatorial of the School of Science Observatory at Princeton, New Jersey, U.S., the object-glass of which is stated to be of the highest excellence, having repeatedly shown both satellites of Mars, the two outer satellites of Uranus, and, it is said, the Saturnian satellite Mimas. Although measures with the wire-micrometer have been found liable to considerable constant error, it was thought they might safely be used in determining a difference of diameter. Mr. Marth's ephemeris was employed in setting the position-circle and in computing the minute corrections for phase. The total number of micrometer-readings was 1,140. The results applicable to November 12, 1879, are as follow:—

Equatorial diameter	20″·634 ± 0″·034
Polar diameter	20·552 ± 0·043
Mean	20·593 ± 0·035

These absolute values Prof. Young considered not very reliable, being subject to the considerable constant error referred to above.

Dr. Hartwig's determination of the mean diameter of Mars, by combining all the double-image measures at Königsberg, Leyden, Oxford, Berlin, Paris, and Strassburg, gives for the opposition-diameter in 1879, 19″·128, which differs from Prof. Young's result by 1″·46, which he says is a difference "rather unexpectedly large, but not unprecedented." As regards the compression, the immediate object of the Princeton measures, the final result comes out $\frac{1}{21\cdot9}$, the limits of probable error extending from $\frac{1}{16\cdot6}$ to $\frac{1}{30\cdot1}$. The discussion of the measures was nearly finished, when Prof. J. C. Adams's paper upon the orbits of the satellites of Mars was published; he there gives $\frac{1}{22\cdot8}$ as the ellipticity of the planet, if it follows the same law of central density as the earth. This near agreement is probably to a considerable extent an accidental one.

Dr. Hartwig's value for the polar diameter of Mars at distance unity is 9″·352, corresponding, with Leverrier's solar parallax, to a real diameter of 4,180 miles.

The Next Total Solar Eclipse.—At the recent annual meeting of the National Academy of Sciences at Washington, Mr. D. P. Todd, of the office of the *American Ephemeris*, communicated a paper "On the Use of the Electric Telegraph during Total Eclipses applied to the Search for Intra-Mercurial Planets," with the view to illustrate in what manner the rare moments of total eclipses may be utilised to their utmost extent, "the method consisting in the electro-telegraphic transmission of important observations made at western stations to observers at eastern stations, with due speed for their verification or rejection when the lunar shadow reaches the latter stations." Taking as an example the next total eclipse of the sun, on May 16, 1882, it is remarked that the path of totality lies almost wholly on land; commencing in Western Africa, with a north-easterly direction, it crosses Upper Egypt and the Red Sea, passing a few miles south of Bagdad and Teheran, and thence traversing Central Asia, it leaves that continent near Shanghai. Thus several widely-separated regions, connected by telegraphic cables and land lines, are upon the track of the central eclipse. Mr. Todd remarks that from El-Akhmym, on the Nile, a line runs north to Alexandria, from which place Teheran is directly accessible by telegraph. From Teheran a land-line runs south-east through Beluchistan and Hindostan to Madras, which is connected by cable-lines with Singapore, Hong-kong, and Shanghai. He points out that an additional advantage attaches to this eclipse from the circumstance that there is a duplicate line of telegraphic connection between Egypt and Shanghai by way of Constantinople, Vienna, and Moscow, and thence by the Russian line through Siberia to Wladiwostok, and thence to Shanghai. Supposing, then, that an intra-Mercurial planet were discovered during totality in Egypt, a duplicate message might be sent, to insure beyond doubt that the discovery should be known to observers at Shanghai; if a planet were observed at El-Akhmym, 45 minutes of absolute time elapsing before the shadow reaches Teheran, the position might be telegraphed to the latter station so as to give the observer abundant time to verify the discovery, while observations at both places might be telegraphed to Shanghai, which the shadow will not reach until more than two hours after leaving Teheran. Mr. Todd thinks that the telegraph companies, with the courtesy they have always shown in scientific undertakings, would render every assistance in carrying out such a scheme.

We take this outline from a report of his communication to the American Academy, received from Mr. Todd.

BIOLOGICAL NOTES

Chinese Alligators.—Two fine examples of the alligator of the Yang-tse-kiang, of the discovery of which we spoke in our issue of February 13, 1879 (vol. xix. p. 351), have recently been received by Dr. Peters for the Zoological Museum of Berlin. There can be no doubt, we understand, that M. Fauvel is quite right, and that this crocodilian is an undoubted *alligator*—being the first of this genus which has been found to occur in the Old World. It will be recollected that of the remarkable Chondrostean genus of fishes, *Polyodon*, one of the two known species is also found in the Yang-tse, while the other is confined to the Mississippi.

Fossil Corals.—The Cyathocrinidæ, as one of the largest and most ancient groups of fossils, appear to belong to a type worthy of attracting continual study. Wachsmuth and Springer (*Proc.* Acad. Nat. Sci., Philad., 1879) unite the genera Poterfocrinus and Cyathocrinus into one family, finding them agreeing in having large oral plates supporting the ambulacral grooves and covering the

ventral disk, but leaving an opening at the oral centre, which is perfectly covered by the apical dome plates. Food-grooves along the vault, closed by two rows of alternating pieces; in the presence of a porous ventral sac, located posteriorly, and closed at the top, in which the anal functions were subordinate to other offices; in having the calyx constructed of only three rings of plates alternating with each other, proximal plates sometimes imperfectly developed; no interradials. The extreme genera are very distinct, but there are intermediate forms which render it impossible to make a completely satisfactory distinction between successive genera. It is best, no doubt, to recognise (1) the earlier or embryonic types, including Heterocrinus; (2) the typical Cyathocrinidæ, (3) the Poteriocrinus type, (4) the Teacrinus type, including Woodocrinus, (5) and transitional forms towards Eucrinus, such as *Eupachycrinus*. Little difficulty is found in referring all Cyathocrinidæ from the upper Silurian to the close of the carboniferous to one of the groups Poteriocrinus or Cyathocrinus, although the anal plates vary much in form. In the lower Silurian members of the family this is more difficult, yet careful study gives rise to the idea that the later were probably developed from the earlier Silurian types.

Circulation in Worms.—The existence of a double circulatory apparatus in a certain number of types belonging to the class of worms has been known; it consists of a closed vascular apparatus containing a red blood without corpuscles, and of the connected lacunæ of the body (not properly a distinct organic apparatus), containing colourless blood with white corpuscles. From a sealed packet lately opened in the Belgian Academy it appears that M. van Beneden had discovered in 1871 a double apparatus and two sanguineous liquids in the lower Arthropoda; this is found in the genera *Clavella*, *Congericola*, and *Lernanthropus*. The vascular apparatus with red blood and contractile walls, very simple in the two former, becomes very complex in *Lernanthropus*. The foliaceous lamellæ fixed to the posterior part of the body are true branchiæ, organised exactly like those of annelids. There is no central organ of circulation; the circulation of the two liquids is caused by contractions of the body. In *Lernanthropus* the branchiæ, abdomen, and cephalothorax contract and spread alternately.

Large Cuttle Fish.—All exact information about gigantic Cephalopoda is of interest not only as showing what immense marine creatures do exist, but as preparing us for the possibility of meeting with still greater. Prof. Verrill has collected a great deal of accurate and recent information as to the North American species, of which he publishes a list in the April number of the *American Journal of Science*, from which we cull the following:—On November 2, 1878, a fisherman was out in a boat with two other men near Leith Bay Copper Mine, Notre Dame Bay, when they observed some bulky object not far from shore, which they approached, thinking it might be part of a wreck. To their horror they found themselves close to a large fish having big glassy eyes. It was making desperate efforts to escape, and was churning the water into foam by the motion of its immense arms and tail. Finding it partially disabled, they plucked up courage and threw the boat's grapnel, which sank into its soft body. By means of the stout rope attached to the grapnel and tied to a tree the fish was prevented going out with the tide; its struggles were terrific as, in a dying agony, it flung its great arms about. At length it became exhausted, and as the water receded it expired. Its body, from the beak of the mouth to the extremity of the tail, measured twenty feet, and one of the tentacles, or arms, measured thirty-five feet. This is the largest specimen yet measured of *Architeuthis princeps*. Prof. Verrill mentions eighteen species as now known on the north-eastern coast of America.

Sternum in Dinosaurs.—Prof. O. C. Marsh describes, in the *American Journal of Science* for May, 1880, the sternum in *Brontosaurus excelsus*. The Yale Museum has recently received a nearly complete skeleton of this, one of the largest known Dinosaurs. This huge skeleton lay nearly in the position in which the bones would naturally fall after death, and fortunately the entire scapular arch was in excellent preservation. The coracoids were in apposition with their respective scapulæ on each side, and between them lay *two* flat bones that clearly belong to the sternum. This discovery, as interesting as it was unexpected, removes the main uncertainty about the scapular arch of Dinosaurs, and likewise indicates a new stage in the development of this structure, not before seen in adult animals. These two sternal bones are suboval in outline, concave above and convex below. They are parial, and in position nearly or quite joined each other on the median line. The anterior end of each bone is considerably thickened, and there is a distinct facet for union with the coracoid. The posterior end is thin and irregular. The inner anterior margin of each bone is smooth and rounded, and gives no evidence of union with an episternal element, which the vacancy there suggests. The amount of cartilage between these two sternal bones or posterior to them is not indicated by the present specimens. They were evidently separated by cartilage from the coracoids. The nearest analogy among living forms to this double sternum may perhaps be found in immature birds. A close resemblance is apparent in the scapular arch of the young American ostrich. If the ossification of the sternum were permanently arrested at this stage it would afford almost precisely the structure seen in the genus *Brontosaurus;* and this is evidently the true explanation of the fossil specimens. It is more than probable that in many Dinosaurs the sternum long remained cartilaginous, or so imperfectly solidified that it is not usually preserved. Several specimens of the genus *Camptonotus*, found nearly in their natural position, were apparently destitute of an ossified sternum. The large size, and doubtless great age, of the specimen of *Brontosaurus* above mentioned may perhaps have been the cause of its more perfectly developed sternum.

Antipatharia of the "Blake" Expedition.—In vol. iv. No. 4 of the *Bulletin* of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass. (February), L. F. Pourtales describes twelve species of this interesting group taken in the Caribbean Sea (1878-79). In determining the species an attempt has been made to use the differences in the shape of the polyps, as well as the disposition and form of the spines to draw characters for a much-needed revision of their classification. It would seem as if there were at least two different types of spines: the triangular compressed and the more cylindrical. These latter are generally more densely set, even assuming sometimes a brush-like appearance, as in *Antipathes humilis*, a new and wonderfully spinous species, figured but not described by Pourtales. These cylindrical spines are also unequal on the two sides of the pinnules, being longer on the side occupied by the polyps, with a few very much longer around the polyps. The triangular spines are disposed regularly in a quincuncial order around the pinnules, and in a cleaned specimen nothing indicates the place formerly occupied by the polyps. In one species, however, *A. desbonni*, the spines are in regular verticils. There would appear to be a connection between the shape of the polyps and the shape and disposition of the spines. Those species with triangular spines have polyps with longer tentacles than those with cylindrical spines, and the tentacles have a greater tendency to become regular in shape. In many species the tentacles are simply contracted; in a very few they were found retracted, as figured by Lacaze-Duthiers; and in some they are probably not retractile at all. Eight out of the twelve named are either described or figured as new species. *A. spiralis* is a very interesting species, formerly referred to *A. desbonni*, D. and M. The polyps are alternately large and small, with very large digitiform tentacles, much longer than have been figured of any antipathes before. In the spaces between successive polyps the cœnosarc shows transverse canals, and those on the back part of the branch are more transparent than the rest.

American (East Coast) Siphonophora.—In the March and April *Bulletin* of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass. (vol. vi. 5-7), Mr. J. Walter Fewkes gives a sketch of the development of the tentacular knob of *Physophora hydrostatica*; he describes the mantle-tubes of *Apolemia uvaria* and *Gleba hippopus*, the tubes in the larger necto-calyx of *Abyla pentagona;* he adds some critical remarks on the genera Halistemma, Agalma, and Agalmopsis, and he concludes with a notice of the forms of Siphonophora and Velellidæ, to be met with on the eastern coast of the United States. Up to the present few forms of either of these groups have been described from American waters. They seem to be only occasional visitors blown into the neighbourhood from mid-ocean, and brought there from the tropics by the Gulf Stream. The wealth of such species that one meets with in the Mediterranean is unknown on the New England coast; while, as the author says, in one day at Nice he has taken eight different genera of Siphonophoræ, yet at Newport he has but rarely taken as many as two genera in the length of a summer's day, and a whole summer once passed, during most of which he was almost daily on the water without one species being seen. One

or two species of Physalia are, however, more common on the United States coasts than in the Mediterranean. The only member of the long-stemmed Siphonophoræ provided with a float or air-bladder found heretofore on the New England waters is *Agalmopsis cara*. Mr. Fewkes can now add *A. elegans*, and he thinks that extended observation in the southern bays of the country will bring to light some of the well known forms common to all oceans, such as Apolemia, Abyla, Physophora, and Gleba. Some of these have already been taken in the Gulf of Mexico and the Caribbean Sea. Rhizophysa, found in the same localities, might also be expected to be brought to the Eastern American coasts by oceanic currents.

PARASITE ON THE AMERICAN BLUE PIKE.—In the *American Journal of Microscopy* for March, Prof. D. S. Kellicott describes a new species of Argulus found on the blue pike (*Stizostethium salmoneum*, Jord.). The fishermen of the Niagara River at Buffalo say that when the water becomes warm the fish gets too lazy to take food, that it then loses flesh, and through its inertness becomes infested with these lice. Having given this subject especial attention, Prof. Kellicott is inclined to think the account of the fishermen is correct. The parasite occurs usually on the top of the head of the fish. When there are several they are, as a rule, huddled together often in heaps, so that the knife may remove a number at once; it occurs also on the fins. None were found in the mouth cavity. As many as twenty were taken from one lean fish. When living specimens of the Argulus were placed in a tank with a small specimen of *Lepidosteus osseus* and some minnows, they shortly fixed on them, and the minnows soon died, apparently killed by the parasites. When first put in, the fish would pursue and catch them, but would eject them with a suddenness and a queer expression that was most amusing. In a few moments they were left unnoticed by the minnows. The gar recoiled in evident fear when one would be seen approaching. A large female once fastened on to the end of the long nose of the gar, where it clung for several days, despite the vigorous efforts of the fish to dislodge it. Cold weather seemed to destroy them: the fishermen assert that after frosts the blue pike become fat, and then no lice are found on them. The species is called *A. stizostethii*. The author believes—against the assertion of Leydig—that the abdominal lobes have a function of respiration above all other parts of the body, and he describes with a good deal of detail the appendages to the several legs.

MOTION IN ALGÆ.—From some interesting observations recently made by Herr Stahl, as to the influence of light on the motions of algæ (*Verhandl. der phys.-medic. Gesellsch. in Würzburg*, Bd. xiv.) it appears that light has a directive influence on *Closterium moniliferum*, the cell of which tends to place its longitudinal axis in the direction of the light rays, and a certain opposition appears in the two halves of the cell, such that one half is attracted to the light and the other half repelled. Further observation showed that the closteria underwent periodic changes, in virtue of which the two halves alternately at successive intervals turned towards the light. These experiments were made with diffuse daylight of little intensity. When the intensity of the light was increased, the orientation of the closteria was changed; the position parallel to the light rays was given up, and the cells placed themselves at right angles to the incident light. This cross position could be again exchanged for the parallel one by deadening the light. Whether temperature has much to do with these positions of closteria has not yet been determined; the temperature of the minimum seems to be not without action on the period between two reversals. The foregoing experiments should be made with quite healthy vigorous closteria. Some other phenomena of orientation were observed by Herr Stahl in *Micrasterias rotata* and in a species of *Mesocarpus*.

GEOGRAPHICAL NOTES

THE fiftieth anniversary meeting of the Geographical Society was held on Monday afternoon, the Earl of Northbrook presiding. Apart from the flourishing condition of the Society, both numerically and financially, the most interesting feature in the Council's Report was the part relating to the annual grant for scientific purposes. During the past year a plan was put into operation for giving practical instruction to intending travellers in the use of instruments for astronomical observations to fix positions, in surveying, and in the measurement of heights by barometric and hypsometrical methods. This attempt to improve the scientific training of our travellers has already met with considerable success, and several of the pupils who have received instruction have left for China, Afghanistan, Central Africa, Central Asia, &c. In order to facilitate the instruction in astronomical work, an observatory has been built on the roof of the Society's house. The medals and other awards were afterwards distributed by the President, Count Piper, the Swedish Minister, receiving for Prof. Nordenskjöld a copy of a special vote of thanks and his diploma as Honorary Corresponding Member, as well as the royal medal for Lieut. Palander. Mr. W. Giles received the other royal medal for his cousin, Mr. Ernest Giles, and Mr. R. N. Cust the gold watch awarded to Bishop Crowther for his services on the Niger. A copy of a resolution of the Council, eulogistic of his "History of Ancient Geography," was also read and handed to Mr. E. H. Bunbury. The gold and silver medals having been given to the successful candidates in the recent public schools prize examination, the ballot was taken for the new council, resulting in the election of Lord Aberdare as President, and Mr. John Ball, F.R.S., Sir Fowell Buxton, Mr. J. K. Laughton, Sir George Nares, Lord Reay, and Sir Richard Temple, in the place of the retiring members of council. In the course of his annual address Lord Northbrook summed up the results of recent explorations in the Arctic regions, in Asia, and in Africa, as well as of Admiralty surveys in various parts of the world.

HERR VON BOGUSLAWSKI publishes, in the *Annalen der Hydrographie*, the conclusions to which he has been led by recent observations on ocean temperatures:—1. The waters of the North Pacific are in general colder than those of the North Atlantic. 2. The waters of the South Pacific are warmer than those of the South Atlantic, to a depth of 1,300 metres; beyond that they are colder. 3. The bottom temperatures are generally lower in the Pacific than in the Atlantic at an equal depth and in the same degree of latitude; but we do not find any part of the temperature in the former as low as those of the Antarctic part of the South Atlantic between 36° and 38° S. lat. and 48° and 30° W. long., where in seven places temperatures of $-0°{\cdot}3$ to $-0°{\cdot}6$ were found. 4. In the west part of the Pacific and in the neighbourhood of the Indian Archipelago, the temperature of the water reaches its minimum at depths which vary from 550 to 2,750 metres, and remains the same from that depth downwards. In all the Atlantic the temperature from 2,750 metres lowers slowly but regularly.

THE Council of the German African Society has now arranged with the King of Belgium, as president of the International African Association, that, instead of carrying out their former intention of establishing a German station on the southern bank of Lake Tanganyika, their expedition, which is now at Zanzibar, preparing for their tour into the interior, shall first establish a station at Mangasa; that, however, the right to found a second station near Lake Tanganyika shall be reserved to them. Dr. Pogge of Mecklenburg, already well known through his African travels, will become the director of this second station, which will now perhaps be established at Mussumba, the capital of Muata Tamwo. This station will form a link in a complete chain of small settlements which are to extend all over the Dark Continent.

A LETTER in the *Deutsche Zeitung* announces that, after five months of unremitting toil, the Austrian African traveller Marno has been able to break through the obstacles on the White Nile caused by the unchecked growth of twenty months, and has re-opened the navigation for trade and passenger traffic. Accompanied by the photographer Buchta, also an Austrian subject, Marno had made a trial trip on a small steamer belonging to the Egyptian Government, penetrating as far as Ladova, and returning safely.

A LIST of 25,000 geographical terms in most frequent use has been drawn up in Chinese by Li Fêngpao, Chinese Minister at Berlin, with the assistance of Dr. Kreyer and Dr. Allen. This list is the basis upon which a large atlas of the world on Mercator's projection has been prepared and photolithographed at Berlin. It also represents the nomenclature employed by Dr. Kreyer in a translation of Daniel's Geography, a large standard work in sixteen Chinese volumes.

WE regret to learn that Père Horner, who has been a true friend to many an African explorer, died at Bordeaux on May 20. He had but recently returned from Zanzibar, where he had resided for many years, and had taken an active interest in all attempts to put down the slave-trade in Eastern Africa, and in

this connection we believe that he rendered valuable service to Sir Bartle Frere during his mission to Zanzibar.

THE *New York Herald* of May 14 says:—The evidences multiply which go to show that there has been an early and exceptionally large break-up of the ice-fields within the Arctic basin since the sun crossed the Equator. The extraordinary mildness of the last winter was universally marked east of the Rocky Mountains, and it would seem the abnormally high temperature extended far to the north and made its impression on the icy seas. Off the coast of Newfoundland the recently reported ice drift will be memorable not only for the magnitude, but also for the multitude of the icebergs and the ice-fields. On the western side of the continent the winter reports indicated a milder season in the vicinity of Behring Sea and its Polar approaches. It is not improbable, therefore, that the steamer *Corwin*, about to sail for the relief of the missing whalers and to communicate with the American Arctic expedition in the *Jeannette*, will find that the premature development of the spring has already loosened their icy bonds, and that they are preparing to pursue their respective routes. The sun's power may be insufficient to dissolve the *Jeannette's* solid moorings, but the mightier agency of winds and waves attending the storms that sweep the ocean north of Behring Strait in May and early June may be expected to break up the ice off Wrangell Island and accomplish her release sooner than if she had wintered on the north-east side of Arctic America.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. Humphry's Rede Lecture on man was interesting and eloquent, if on the whole rather depressing. He pleaded for long and patient investigation, especially in coming to the discovery or comprehension of any process, whether of natural selection or any other, by which the large cranial cavity of man can have been evolved in early men. He gave full weight to the argument from the size of the brain at birth, and the perfection of the lungs at the same period. At any rate the brain of primitive man appeared to have been structurally fitted for higher duties than they were ever called upon to perform. His brain was prophetic of his future. Ability is to be measured by the power to deal with the material before us; and thus it is doubtful whether the ability of the present was greater than that of preceding generations, prehistoric or historic. Progress did not necessarily imply improvement, and increased means did not imply greater power, however they might enable power to be wielded with better effect. The physical capability, he thought, long preceded functional activity; and man's advance to civilisation was the result of the response of his nature to his conditions. He believed in the great value of contact and blending of varieties, and attributed the stationary condition of certain races partly to their early progress keeping them exclusive, and to the physical conditions which had walled them in. The climate of the temperate portions of the Eurasian Continent proved favourable to the development of the energies of mammals and men, and the configuration of the northern continent was especially favourable to migration. Thus there had nowhere been through any long period the still dulness of pure blood or the cramping domination of one power. The mingling of races in Britain, in a land of great natural advantages and resources, had led to the development of ability in the people to work out freedom, to invent, to adopt international conventions, and to free others. But he perceived dangers in the increased sensitiveness accompanying the great subdivision of labour nowadays. Of the two evils, learned feebleness was a greater evil than ignorant strength. The preservation of the weak and sick did not make the mass of people stronger and healthier; thus there must be sterner sanitary precautions as a foremost question. Would that some of the time spent on Burials Bills could have been spent in considering the crying needs of the health of the living. This misapplication of energy, said the Professor, had its parallel in the mistaken efforts to prevent the investigations by which physiology might be advanced and the laws of health educed. Few things would tend to the improvement of the race so much as judicious matrimonial selection, and he hinted at the importance of providing a healthy race for the future. Finally, as to man's body at least, and its future, he felt compelled to say that we found ourselves floating on the stream of time; the barque, we suppose, moves on. Sufficient for the day must be the knowledge thereof. Whether we peer fore or aft, it is obscurity.

SIR GEORGE JESSEL, the Master of the Rolls, has been elected Vice-Chancellor of London University, in place of Sir John Lubbock, who resigned on his becoming a candidate for the representation of the University in Parliament. The election is not likely to be contested.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, May 24. Anniversary Meeting.—Prof. Allman, F.R.S., president, in the chair.—At this, the ninety-second annual general meeting, there was a large attendance of the Fellows. The President, after a few introductory remarks of congratulation on the prospects of the Society generally, referred to the obituary, pointing out that several of the oldest members would now no longer appear on the list. Among others, Prof. T. Bell (*æt.* 87), J. Miers (*æt.* 91), Gen. Munro, Dr. David Moore, Wilson Sanders, E. W. Cooke, R.A., Fellows, and T. Atthey, Associate, besides Foreign Members of high standing, showed a heavy death-roll. The Secretaries and Treasurer, after full term of service, had proposed to resign, and as a matter of form this had been acceded to by the Council. The Secretary (Mr. F. Currey) then read his report. Since the last anniversary the Society had lost by death ten Fellows, three Foreign Members, and one Associate; and three Fellows had withdrawn. On the other hand, there had been an accession by election of twenty-eight new Fellows, three Foreign Members, and four Associates. The library showed a marked increase and improvement, by additions obtained by purchase, exchange, and donations, and had been amply used in biological reference and loan of books. The scientific communications and exhibitions at the meetings during the session had kept pace with the march of science, and the attendance of the Fellows bore witness to the active interest taken in the proceedings generally. —The Treasurer (Dr. J. Gwyn Jeffreys) then read his report. In resigning office he congratulated the Society on its increasing prosperity in a financial point of view. Notwithstanding the late depression of commerce, which had to a greater or less extent injuriously affected other scientific societies, as well as the additional yearly expenditure consequent on the removal to Burlington House, and the greater amount of salaries paid, the publications had not been restricted; considerably more having been spent on the library than formerly. The Society is quite free from debt; has an invested capital of £3730 12*s.* 8*d.*, and the balance at bankers and on hand at this date is £522 18*s.* 2*d.* Twelve months ago, owing to the unfortunate and long illness of the Librarian, his accounts became confused, and the Asst.-Secretary had since undertaken the receipts and payments, and had the books thoroughly balanced. A Special Committee had also been appointed by the Council for investigating the financial position of the Society, and their valuable suggestions had been adopted, especially as to the reasonable limitation of the publication expenses, which had increased from £796 14*s.* in 1876 to £1100 5*s.* 1*d.* in 1879. With respect to the compositions, which, even if they were altogether invested, must seriously diminish the income of the Society, the Treasurer stated that during his five years of office he had received £1968, and invested £920 15*s.* During the previous five years no part of the compositions appear to have been invested. He had also received and invested £840 for legacies. The Society's capital had been doubled; it was in 1875 £1860, and is now £3730 12*s.* 8*d.* The annual contributions received in 1876 amounted to £694 13*s.*, and last year to £948 12*s.* The ballot for Council and Officers having been proceeded with, the following gentlemen retired from the Council:—Messrs. J. Ball, W. Carruthers, F. DuCane Godman, Dr. A. Günther, and the Rev. G. Henslow. In their places were elected:—Messrs. E. R. Alston, G. Bentham, G. Busk, Dr. M. Foster, and B. D. Jackson. For the Officers, Prof. G. J. Allman was re-elected President; Mr. Fredk. Currey (the outgoing Secretary), Treasurer; Mr. B. Daydon Jackson, Botanical Secretary; and Mr. Edward R. Alston, Zoological Secretary.—Prof. Allman thereafter gave his usual annual address, taking for his subject "The Vegetation of the Riviera, a Chapter in the Physiognomy and Distribution of Plants." In this address (not well adapted for brief abstract), by a few broad outlines, a sketch of the most striking features of the vegetation and its peculiarities as derived from the physical contour of the country, geographical position, and climate, was given. The phenomena extant are of high interest

to the botanist, for though belonging to the European area, the Riviera exhibits in climate and character of vegetation an obvious link between the temperate and tropical zones. Its accessibility and singular flora, with scenes of unrivalled beauty, offer ample material for study.

Statistical Society, May 11.—Dr. W. A. Guy, F.R.S., in the chair.—Two papers were read: the first by Capt. P. G. Craigie, Secretary of the Central Chamber of Agriculture, on ten years' statistics of British agriculture, 1870-79, and the second by Messrs. J. B. Lawes and J. H. Gilbert, on the home produce, imports, consumption, and price of wheat, over twenty-eight harvest years, 1852-53, to 1879-80, inclusive. Messrs. Lawes and Gilbert in their paper arrived at the following conclusions:—The area under wheat was about 20 per cent. less over the last three than over the first eight years of the twenty-seven. The average produce per acre over the United Kingdom amounted to only 27⅝ bushels over the whole twenty-seven years as compared with 28¼ bushels which we had previously assumed to represent the average produce per acre of the country at large. The annual imports averaged about three times as much over the last three as over the first eight of the twenty-seven years. The total consumption of wheat per annum had increased from an average of about 18 million quarters over the first eight years to nearly 24 million quarters over the last three years. The price of wheat per quarter had declined from an average of 57*s.* 8*d.* over the first eight years (including the period of the Crimean war) to 49*s.* over the last three years. The annual value of the home produce available for consumption had declined from an average of nearly 38,000,000*l.* over the first eight years, to less than 25,000,000*l.* over the last three years. The annual value of the imported wheat had increased from an average of little more than 13,000,000*l.* over the first eight years, to more than 33,000,000*l.* over the last three years. Over the whole period of twenty-seven years, 40·4 per cent. of the wheat consumed had been derived from imports; and the amount supplied from foreign sources had increased from an average of 26·5 per cent. of the total over the first eight years, to 57·4 per cent. of the total consumed over the last three years of the twenty-seven.

PHILADELPHIA

Academy of Natural Sciences, January 6.—On the nudibranchiate gasteropod mollusca of the Northern Pacific Ocean, with especial reference to those of Alaska, by Dr. R. Bergh, Copenhagen (Part 2).—The terrestrial mollusca inhabiting Cook's Islands, by Andrew Garrett.

January 27.—Carcinological notes: Revision of the Gelasini, by J. S. Kingsley.—On the Pacific species of *Caulolatilus*, by W. N. Lockington.

PARIS

Academy of Sciences, May 24.—M. Edm. Becquerel in the chair.—The following papers were read:—On the secular variations of the mathematical figure of the earth, by M. Faye. Regarding the anomaly of the small action of such masses as the Himalayas on the pendulum, and the great attractive force often found at sea, he points out that under seas the cooling of the globe proceeds more quickly and deeply than under continents. The bottom of the first seas would thicken in advance of the dry crust, and would press increasingly on the liquid nucleus, raising the weak parts of the first crust, which were mostly round the North Pole. The water level would rise on our hemisphere and fall on the southern, and the ellipsoid of revolution become a simple spheroid. With further cooling the basins of the southern seas would have increasing attraction and the waters would gradually rise in the southern hemisphere, their surface of level returning to the ellipsoidal form, which, M. Faye thinks, is slightly exceeded at present. Thus the earth's crust shows an alternate balancing movement determined by excess of weight of maritime crusts and the points of less resistance in the heart of continents.—On the refrigerating mixtures formed by an acid and a hydrated salt, by M. Berthelot. The chemical energies act according to the principle of maximum work, giving a first exothermic reaction; then the calorific energies act inversely, causing absorption of heat under the four-fold form of dissociation, disaggregation by the solvent, dissolution, and liquefaction.—Action of acids on alloys of rhodium with lead and zinc, by M. Debray. He describes a peculiar substance (deflagrating at about 400° with heat and light) obtained from treating the rhodium-lead alloy with nitric acid. Rhodium forms, with zinc, alloys which may exist in two isomeric states, giving very different reactions.—Determination of the position of a bridge to be constructed over the Danube, near Silistria, by M. Lalanne.—On the transcendants which play a fundamental part in the theory of planetary perturbations, by M. Callandreau.—On the theory of ideal complex numbers, by M. Dedekind.—Integration of certain differential equations with the aid of functions Θ, by M. Appell.—On elimination, by M. Le Paige.—Industrial utilisation of solar heat, by M. Mouchot. He has been experimenting near Algiers since May last year. He specifies improvements, (*e.g.*, an arrangement for keeping the liquid to be vaporised in contact with the whole heated surface), and indicates results. *Inter alia*, since March the receiver has actuated a horizontal engine (without expansion or condensation) at the rate of 120 revolutions a minute with constant pressure of 3·5 atm.; the disposable work being about 8 kgm. he set it to work a pump giving 6 litres per minute at 3·50 m., or 1,200 litres per hour at 1 m., and to throw a jet 12 m. This goes on from 8 a.m. to 4 p.m.—Combinations of alcohols with baryta and lime; products of decomposition, by heat, of these combinations, by M. Destrem.—Reactions produced between ammoniacal salts and carbonate of lime, by M. Nivet. A double decomposition is shown to occur in the ground and in water, the result being a loss of ammonia, which is greater, the less absorbent the soil, or the less the quantities of CO_2 formed in it.—On the formation of callosity, by MM Rigal and Vignal.—Experiments relative to peritoneal shock, by MM. Reynier and Richet.—On the form and the seat of movements produced by cortical excitation of the brain, by M. Couty. There is no relation between the cortical region excited and the form or the place of the motions. Explanation of the phenomena is possible only by admission of the theory that the cortical white fibres are conductors of bulbo-medullary excitations, and comparable to the peripheric conductors, notwithstanding their course and their much more complicated connections.—On the fixing power of certain organs for alkaloids introduced into the blood which traverses them, by M. Héger. The hepatic tissue retains most; the lungs absorb very little.—Discovery of horse-pox vaccination, by M. De Pietra-Santa. Several heifers were successively (and with effect) inoculated in Paris with lymph from a young blood horse which had come from Germany, and had horse-pox.—On a phenomenon of sensibility observed in acacia, by Mr. Phipson. He obtained this by striking the terminal leaflet several times with his finger.—On the tertiary strata of Brittany; environs of Saffré (Loire-Inférieure), by M. Vasseur.—M. Dubrunfaut returned several pieces (letters, memoirs, and reports) belonging to the Archives of the Academy.

CONTENTS