THURSDAY, NOVEMBER 9, 1882

A SEARCH FOR "ATLANTIS" WITH THE MICROSCOPE

THE revival of the idea of a former "Atlantis" has given rise in recent years to much ingenious argument. The presence of so many widely separated islands or groups of islets along the depression filled by the Atlantic Ocean has to some writers been in itself sufficient proof of a submerged continent, the islands remaining still above water as the last visible relics of the foundered land. The same conclusion has been drawn from the Atlantic soundings, which have undoubtedly shown the existence of a long ridge running down the length of the Atlantic at an average depth of some 2000 fathoms from the surface. From this ridge rise the oceanic islands of Tristan d'Acunha, Ascension, St. Paul, the Azores, and Iceland. Other writers have invoked the former presence of land over the Atlantic area, from the difficulty of otherwise accounting for the resemblance of the flora in North America and Europe during later geological times. On the other hand, it has been forcibly argued that in every case the peaks of the supposed submerged land are of volcanic origin, that not a single fragment of any truly continental rock has been detected on any of these islands, and therefore that no evidence can be adduced save of a submarine ridge on which volcanic cones have gradually been built up above the sea-level. Reasoning based on similar data furnished by the other great oceans, and also upon the evidence supplied by the stratified rocks as to the permanence of the continental areas, has led many thoughtful geologists to regard the ocean-basins as primeval depressions of the globe's surface, and consequently to reject the tempting hypothesis of a lost Atlantis.

This vexed question was one on which it was hoped that the *Challenger* Expedition might cast new light. The careful surveys of the ocean-floor made by that Expedition, and the attention it paid to the nature of the emergent peaks were precisely the kinds of direct observation needed to supply facts in place of previous mere speculation. We must patiently await the completed Reports before the final answer of the *Challenger* observers is given. But an interesting and important instalment of evidence and argument has just been published in the form of a "Report on the Petrology of St. Paul's Rocks," by M. Renard of Brussels, whose name is itself a guarantee for the accuracy and exhaustiveness of the memoir. Sent in to the *Challenger* authorities as far back as October, 1879, it is now issued as Appendix B in volume ii. of the *Narrative of the Expedition.*

No more typically oceanic an island anywhere rises out of the deep than the lonely wave-washed rocks of St. Paul. Lying nearly on the equator and between 500 and 600 miles to the east of the South American coast, these rocks consist of four principal rugged horse-shoe-shaped masses not a quarter of a mile in their greatest length, and mounting into five peaks, the highest of which does not exceed 60 feet in height. Their bare rough summits have a yellowish tint that deepens into black towards sea-level. So utterly barren are they that not a plant of any kind—not even a lowly lichen—clings to their sterile surface. Are these rocks the last enduring remnants of a continent that has otherwise disappeared, or are they portions of a volcanic mass like the other islands of the same ocean?

To those who have not noted the modern progress of geological inquiry it may seem incredible that any one should propose to solve this problem with the microscope. To seek for a supposed lost continent with the help of a microscope may seem to be as sane a proceeding as to attempt to revive an extinct Ichthyosaurus with a box of lucifer matches. Yet in truth the answer to the question whether the St. Paul's rocks are portions of a once more extensive land depends upon the ascertained origin of the materials of these rocks, and this origin can only be properly inferred from the detailed structure of the materials, as revealed by the microscope. The importance of microscopic examination in geological research, so urgently pressed upon the notice of geologists for some years past, has sometimes been spoken of disparagingly as if the conclusions to which it led were uncertain and hardly worth the labour of arriving at them. We occasionally hear taunts levelled at the "waistcoat-pocket geologists," who carry home little chips of rock, slice them, look at them with their microscopes, and straightway reveal to their admiring friends the true structure and history of a whole mountain-range or region. That the sarcasm is often well-deserved must be frankly conceded. Some observers with the microscope have been so captivated by their new toy as to persuade themselves that with its aid they may dispense with the old-fashioned methods of observation in the field. But there could not be a more fatal mistake. The fundamental questions of geological structure must be determined on the ground. The microscope becomes an invaluable help in widening, and correcting the insight so obtained; but its verdict is sometimes as ambiguous as that of any oracle. In any case it must remain the servant not the master of the field-geologist.

Perhaps no more suggestive example could be cited of the use of the microscopic study of rocks even in the larger questions of geological speculation than that which is presented by an examination of the material composing the islets of St. Paul. These rocks were described many years ago by Mr. Darwin as unlike anything he had ever seen elsewhere, and which he could not characterise by any name. He found veins, of what he believed to be serpentine, running through the whole mass. The observers of the *Challenger* Expedition looked upon the St. Paul's Rocks as composed of serpentine. But these remote islets have never until now been subjected to modern methods of petrographical investigation. M. Renard has studied them chemically and microscopically, and finds them to be composed of a granular olivine-rock, containing chromite, actinolite, and enstatite. A remarkable structure is presented in the thin sections when seen under the microscope. The large crystals or grains of olivine and enstatite are arranged with their vertical axes parallel to the lines of certain bands in which the minuter constituents are grouped, the whole aspect of the section suggesting at once a movement of the component particles in the direction of the bands. When the rock was first sliced and examined by the naturalists of the

Challenger some years ago this minute structure was looked upon as what is known to petrographers by the name of "fluxion-structure," such as may be seen in obsidian and other volcanic rocks, the ingredients of which have arranged themselves in layers or planes according to the direction in which the mass while still molten was moving. The same view was at first adopted and published by M. Renard. He now, however, expresses himself more doubtfully on the subject, and indeed is rather inclined to class the rock among the crystalline schists.

Now the importance of the point in question will be at once perceived when it is stated that if St. Paul's Rocks belong to the series of schists, they must once have lain deeply buried beneath overlying masses, by the removal of which they have been revealed. They would thus go far to prove the former existence of much higher and more extensive land in that region of the Atlantic; land too, not formed of mere volcanic protrusions, but built up of solid rock-masses, such as compose the framework of the continents. If, on the other hand, the rock is volcanic, then the islets of St. Paul belong to the same order as the oceanic islands all over the globe.

M. Renard reviews the arguments so cautiously that only towards the end do we discover him rather inclining to the side of the crystalline schists. With all deference to so competent an authority, however, we venture to maintain that the balance of proof is decidedly in favour of the volcanic origin of the rock. In the first place, as the distinguished Belgian petrographer himself admits, the law of analogy would lead us to expect the peridotite of St. Paul to be a volcanic protrusion. So cogent, indeed, is the argument on this head that, unless some irrefragable evidence against it is furnished by the rock itself, it must be allowed to decide the question. When the rock is studied under the microscope it presents precisely the banded fluxion-structure of true lavas, thus corroborating the inference of a volcanic origin for the mass. To say that this structure also resembles the foliation of true schists is to repeat what may be remarked of hundreds of examples of undoubtedly eruptive rocks. Unless some peculiarity can be shown to exist in the St. Paul's rock inconsistent with the idea of its being a volcanic extravasation, we are surely bound to regard it as no exception to the general rule that all oceanic islands are fundamentally of volcanic origin. M. Renard, however, fails to adduce any such peculiarity. He appears to have been led to doubt the validity of his first conclusions, and, be it also remarked, those of other observers, by finding so many published instances of peridotic rocks among the crystalline schists. A bed of peridotite among a group of schists, however, need not be of contemporaneous origin, any more than an intrusive sheet of basalt can be supposed to have been deposited at the same time and by the same processes that produced its associated sandstones and shales. Synchronism is not necessarily to be inferred from juxtaposition. We do not mean to dispute the assertion that some peridotites belong to the series of crystalline schists. But others are most assuredly eruptive rocks. It is among these that we should naturally seek for analogies with the rock of St. Paul.

To sum up the reasoning we may infer that, judging from the structure of other oceanic islands, the material comprising the rock of St. Paul should be of volcanic origin; this inference is confirmed by chemical and microscopical analysis, and especially by the discovery of a minute structure in the rock identical with that of many lavas, though a similar structure can be recognised in some schists; the islets of St. Paul furnish therefore no evidence of an ancient land having formerly existed in the middle of the Atlantic Ocean, on the contrary they have probably been built up on the submarine Atlantic ridge by long continued volcanic eruption like the other islands of the same Ocean.

The exhaustive methods of research employed by M. Renard in the study of the rock of St. Paul furnish an excellent illustration of the great strides made in recent years by petrography. The other rocks collected by the *Challenger* Expedition are to be treated in the same manner, but it is understood that instead of being thrown into separate Reports the petrographical details will be interspersed through the "Narrative" at the places where the localities are described. These contributions will form not the least important parts of this great work, the advent of which has been so long and so patiently waited for.

ARCH. GEIKIE

THE LIFE OF CLERK MAXWELL

The Life of James Clerk Maxwell, with a Selection from his Correspondence and Occasional Writings, and a Sketch of his Contributions to Science. By Lewis Campbell, M.A., LL.D., Professor of Greek in the University of St. Andrews, and William Garnett, M.A., Late Fellow of St. John's College, Cambridge, Professor of Natural Philosophy in University College, Nottingham.

THIS volume will be heartily welcomed by all who knew Clerk Maxwell, and who cherish his memory, and by the still wider circle of those who derive pleasure and new vigour from the study of the lives and work of the great men that have gone before them.

The work consists of three parts, a biography with selections from Maxwell's correspondence, a popular account of his scientific work, and a selection from his poetry, both juvenile and of later years, including the serio-comic verses on scientific subjects, some of which are already so well known.

The biography is mainly the work of Prof. Lewis Campbell, whose schoolboy friendship and life-long intimacy with Maxwell amply qualified him for the task.

As far as vicissitudes of fortune are concerned, the life of Clerk Maxwell was absolutely uneventful. Worldly struggles he had none; from the very first he was warmly, if not always quite fully, appreciated by all whose good opinion he could have valued; promotion such as he cared for came almost unsought, and scientific distinction of the honorary kind was conferred upon him unstintedly while he lived to enjoy it. But in truth all these things moved his serene spirit as little as they disturbed his outward life; the interest of his biography lies in tracing the growth of a mind which was dedicated, literally from infancy, to the pursuit of science, and which nevertheless neglected nothing becoming a man to know. For unity of aim and singleness of heart, for high-minded neglect of the worldly strife that is begotten of vanity, ambition, or love of gain, for the steadfast pursuing of a path remote from the ways of ordinary men, the life of Maxwell stands in our mind associated with the lives of Gauss and Faraday. Nevertheless, without seeking to compare him with either of these great men in respect of intensity of genius, we may safely assert that he was superior to both in universality and many-sidedness. The mere objective circumstances of the career of such a man count for little, and the biographer tells his tale so far as these are concerned, with an artless grace that befits the subject. It is needless to dwell upon them here, for our readers have already been furnished with a summary of the outward events of Maxwell's life (NATURE, vol. xxi. p. 317). The interest and freshness of Prof. Campbell's story lie in the light it throws on the subjective influences that moulded the character of the gentle physicist, a character which was the most extraordinary combination, that this generation has seen, of practical wisdom, child-like faith, goodness of heart, metaphysical subtlety, and discursive oddity, with wonderful critical sagacity and penetrating scientific genius.

Intellectual power, and to some extent also eccentricity, appear to have been hereditary with Maxwell, as will be seen from the racy notes at the end of the first chapter on the Clerks of Penicuik and the Maxwells of Middlebie. After the early loss of his mother, he became the constant companion and confidant of his father, who initiated him into all his economic mysteries, interested him in applied sciences of every kind, encouraged his boyish essays in physical experimenting, and anxiously patronised his earliest memoir, on Cartesian Ovals and kindred curves, read to the Royal Society of Edinburgh by Forbes when its author was a boy of fourteen. This sympathy between father and son continued unbroken to the end, and had undoubtedly the happiest effect on Maxwell's destiny.

The chapters on the student life at Edinburgh and Cambridge are deeply interesting, and we earnestly commend them to the young men of our time who wish not to seem, but to be indeed, men of science.

With his appointment to the chair in the Marischal College, Aberdeen, begins his career as a recognised authority in scientific matters. Henceforth the biography is mainly an account of Maxwell's contributions to the advancement of physical science; the purely personal interest revives in the sad chapter that recounts his last illness and death.

Glimpses into his mental history during the later period of his life are afforded us by means of extracts from his intimate correspondence, and from essays, some read at Cambridge to a select circle of friends, others, not intended for publication even to that limited extent, but merely written as records of the author's communion with his own soul. We thus learn how the great physicist dealt with the grand problem of man's relation to that which went before, and that which shall be hereafter. It cannot but be profoundly interesting to read what was thought on such a subject by one of the greatest scientific minds of our day. We are left in no doubt as to the solution in which Maxwell ultimately reposed, and it is instructive to note how in this respect, as in so many others, he was akin to Faraday. Some will doubtless think that needless emphasis is laid upon the exact form of the final solution, and upon the precise methods by which it was reached. It must be remembered that the difficulties of the man of action and of the scientific man or professed thinker, are widely different. The former rests naturally in the arms of precept and dogma; he is distracted merely by the choice of preceptor and authority. The thinker by profession *must* examine for himself; it is a necessity of his nature so to do; and his difficulties arise from having to deal with matters in which the best of his scientific methods fail. Thus it happens that the example of a scientific mind is little likely to profit the unscientific; and that one scientific mind is scarcely in such matters to be led by the experience of another. The solutions of the great problem by different minds of the highest order have, as we know, differed, in outward appearance at least, very widely. But is it well to dwell on these differences? seeing that no man of finite intellect can tell how little or how great after all the distances may be that separate the resting places in the infinite of good men and true.

With regard to the selections from the correspondence it might have been better perhaps, in the interest of science, to have given more of the scientific correspondence. It must be known to many of our readers from pleasant experience that Maxwell was indefatigable in writing and answering letters on scientific subjects. His letters rarely failed to contain some sagacious criticism, some ingenious thought, or some valuable suggestion. Most possessors of such letters would we imagine be glad to put them at the disposal of a competent editor for publication, or at all events to take some steps to prevent the ultimate loss of matter so full of interest for all scientific men. Those that have read the volumes containing the correspondence of Gauss with Bessel and Schumacher will understand how instructive such collections can be.

Not the least interesting parts of the biography are the chapters containing extracts from the occasional essays already referred to. Maxwell when a student at Edinburgh had attended the lectures of Hamilton, and had been greatly impressed by that distinguished philosopher and accomplished enemy of the exact sciences. Accordingly, we find that among the studies of his earlier years mental and moral science had no small share. He resolves, for instance, at one period to read Kant and to make him agree with Hamilton, and, at the same time, he criticises in a somewhat unflattering strain the flaccid morality embodied in the lectures of Christopher North. It is not surprising, therefore, that the subjects of these occasional essays are mainly metaphysical or psychological. They are mostly very discursive, and their graver meaning is often veiled in a cloud of that humorous irony which figured so much in his familiar conversation. The general tendency is, however, sufficiently plain: in the essay on Psychophysik, for example, he thus delivers his opinion on the theory of "Plastidule Souls," which played so prominent a part lately in the classic duel between Virchow and Haeckel, and in sundry ultra-physical discussions nearer home:—

"To attribute life, sensation, and thought to objects in which these attributes are not established by sufficient evidence, is nothing more than the good old figure of personification."

At the end of the same essay he thus sums up the answers that have been given to the great ontological problem "What am I?":—

"In this search for information about myself from eminent thinkers of different types, I seem to have learnt one lesson, that all science and philosophy, and every form of human speech, is about objects capable of being perceived by the speaker and the hearer; and that when our thought pretends to deal with the Subject, it is really only dealing with an Object under a false name. The only proposition about the subject, namely, 'I am,' cannot be used in the same sense by any two of us, and, therefore, it can never become science at all."

Prof. Campbell has succeeded in presenting to us a most vivid picture of Maxwell's character. The view which he gives will be fresh, and partly strange, to many even of those who knew Maxwell well. It is no reproach to him to say that, in our opinion, he has by no means exhausted the different aspects of his subject. So many-sided was Maxwell's character, that it would have required the united efforts of several biographers to do it the fullest justice.

In the second part of the book will be found a good account by Mr. Garnett, of Maxwell's scientific work. Of this nothing further need be said, for an excellent summary has already been given in the pages of NATURE by Prof. Tait (vol. xxi. p. 317).

It may be questioned whether the literary merit of many of the pieces of occasional poetry in the third part will be sufficient to secure for them the interest of the general reader; but many will greet with pleasure the reappearance of old friends among the serio-comic verses. We are glad to find among them our favourite, "To the Committee of the Cayley Portrait Fund"; finer compliment to a mathematician surely never was penned. Among those hitherto unpublished may be mentioned the Paradoxical Ode to Hermann Stoffkraft, beginning as follows:—

My soul's an amphicheiral knot,
Upon a liquid vortex wrought
By Intellect, in the Unseen residing.
And thine doth like a convict sit,
With marlinspike untwisting it,
Only to find its knottiness abiding;
Since all the tools for its untying
In four-dimensioned space are lying,
Wherein thy fancy intersperses
Long avenues of universes,
While Klein and Clifford fill the void
With one finite, unbounded homaloid,[1]
And think the Infinite is now at last destroyed.

We ought to mention in conclusion that the book is beautifully illustrated; there are vignettes of Maxwell and of his father and mother; some quaint and suggestive illustrations of scenes from his early life, after originals by Mrs. Blackburn; and a variety of diagrams, several of them beautifully coloured, reproduced from originals—by Maxwell's own hand—in illustration of his researches on light and colour.

G. C.

[1] Here the author takes a poetic licence.

OUR BOOK SHELF

Description Physique de la République Argentine d'après des Observations Personelles et Etrangères. Par le Dr. H. Burmeister. (Buenos Ayres, 1876-82.)

SOME account of the progress of this extensive work, in which the veteran naturalist, Dr. H. Burmeister, formerly of Halle, proposes to give a complete physical history of his adopted country, may not be unacceptable. Of the octavo text, which is accompanied by folio atlases, in order to give the illustrations on a large scale, we have seen four volumes, numbered 1, 2, 3, and 5. The fourth volume, which we suppose will contain the birds, is not yet issued, and the atlases in some cases do not appear to be complete.

The first volume (issued in 1876) is devoted to the history of the discovery and general geographical features of the Argentine Republic; and the second, published in the same year, to its climate and geological conformation. The third volume, of which the text was issued in 1879, has been already noticed in our columns (NATURE, vol. xxiv. p. 209). It contains an account of the Mammal-fauna both recent and extinct. We have now just received the first *livraison* of the folio atlas to this volume, containing a series of plates illustrating the whales of the Argentine coasts, a subject to which Dr. Burmeister has devoted special attention for many years. Of the fifth volume, devoted to the Lepidoptera of Buenos Ayres, we have already likewise spoken (see NATURE, vol. xx. p. 358).

It remains, therefore, for us only to wish the venerable author, who, for fifty years at least, has been a most energetic worker in many branches of zoology, health and strength to bring this important work to a conclusion.

Nomenclator Zoologicus. An Alphabetical list of all Generic names that have been employed by Naturalists for Recent and Fossil Animals, from the earliest Times to the close of the Year 1879. In two parts. I. Supplemental List. By Samuel H. Scudder. (Washington: Government Printing Office, 1882.)

EVERY working naturalist must be acquainted with Agassiz's "Nomenclator Zoologicus," published at Solothurn in 1846, which is, in fact, a dictionary of generic terms used in zoology. Without its valuable aid it is almost a fruitless task to endeavour to ascertain where or by what author any particular generic term has been instituted, or whether a generic term has been already used in zoology or not. Agassiz's work, in the preparation of which he was assisted by some of the best zoologists of the day, though by no means perfect in its manner of execution or free from occasional errors, answers very well for all practical purposes for genera established prior to the date of its preparation, and affords an excellent basis to work upon. It contains upwards of 32,000 entries of names of generic terms and of names of higher groups. In 1873 Graf A. v. Marschall, of Vienna, prepared and issued for the Imperial and Royal Zoological and Botanical Society of Austria, a supplementary volume, on something of the same plan. But to Marschall's "Nomenclator" no general index was attached, and, as those who have used the volume know full well, it is neither so accurate nor so complete as the work which it purports to supplement.

A new "Nomenclator Zoologicus," carrying the subject up to the present day, and correcting the errors and omissions of its two predecessors, has therefore long been a work of paramount importance to working naturalists. The question was who would undertake the ungrateful task, which was likely to confer neither fame nor fortune on the performer, and would be, above all others, long and laborious. Mr. Samuel H. Scudder of Boston, a well-known American entomologist, in response to appeals from his friends, has consented to devote his energies to the subject, and the first portion of his work is now before us.

The present part of the new Nomenclator is of a supplemental character, as is explained by Mr. Scudder in his preface, and contains "15,369 entries of genera established previous to 1880, not recorded, or erroneously given in the nomenclators of Agassiz and Marschall."

The second part, which will be of still greater consequence to naturalists will be a universal index to the first part and to the previous nomenclators and will contain altogether about 80,000 references. We shall thus shortly have, it is to be hoped, a most useful general work upon this important though technical subject brought up nearly to the present date.

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.*]

"Weather Forecasts"

HAD the Bishop of Carlisle, in his letter in NATURE (vol. xxvii. p. 4), instead of extracting from the *Times* a description of some results of the storm of October 24 last, quoted the statements as to the passage of this storm, issued in the reports of the Meteorological Office on October 24 and 25, his query concerning the failure of the weather forecasts would scarcely have needed reply.

A system of six pickets is established on our extreme western coasts, along a line which may be roughly regarded as describing the third of a circle, from Stornoway in the north-west, to Brest in the south-west. The enemy whose movements these outposts are to watch, pours in upon us a series of attacks in the form of cyclonic disturbances, by which the weather experienced in our islands is affected on 63 per cent. of our days. These circulations vary indefinitely in intensity. This element, and also their size, figure, direction, and velocity of propagation, are in great measure dependent on the distributions of atmospheric pressures and temperatures over a larger area than that occupied by our network of telegraphic stations. It will be enough to mention here that the velocity of advance of the cyclonic centres, as also of the front arcs of those exterior isobars which form closed curves, varies from zero to about 70 English miles per hour. In stormy periods like the present, the number and variability of the cyclonic circulations which attack us is extremely great, more than one per diem passing over some part of the British Isles. Now let it be remembered that our pickets sleep through the night, or that however wakeful they may be, they have, during the night hours, no means of communication with their commanding officers. How often a phalanx of the enemy will pass these outposts so as to occupy a position fairly within our area at 8 a.m., no instrumental indications having been given at 6 p.m. of the previous day—this, if treated as a question of probabilities, may be left to the Bishop of Carlisle. It is certainly obvious that such an advance, instead of being "very strange," *must* at times occur, if there be no miraculous interference in behalf of the Meteorological Office. At 8 a.m. on October 24, the centre of the disturbance referred to lay over Dorset, and was then moving to north-east at the rate of thirty-five miles per hour. Supposing the direction and velocity to have been uniform, the position occupied by the centre at 6 p.m. on the 23rd would have been about 180 miles north of Cape Finisterre, and, supposing the extent of the storm to have been also uniform, our outposts at that hour could have received no instrumental indication of the storm's progress, of a character distinct enough to justify the Meteorological Office in the issue of warnings. As a matter of fact the 6 p.m. observations telegraphed to the Office on the 23rd did show, as I think, no indications whatever of the existence of the storm.

It is obvious that the extreme velocity of the propagation of some of our severest storms is the element that especially renders it *possible* "that a storm of the first magnitude" may "come upon us unawares." As a matter of fact, the velocity of propagation on October 24 was considerably above the average. But if we refer to the charts for March 12 and 13, 1876, we find, at 8 a.m. on the former morning, a cyclone-centre occupying the precise position of that of the 24th ult., and that this disturbance moved to east-north-east with a mean velocity of 62·5 miles per hour.

There is a further risk, against which our system of telegraphy cannot protect us, viz., that of a storm centre being primarily developed within our area of observation during the hours when there is no telegraphic communication, and storms in their first stage of development are often the most dangerously rapid and intense. The telegraphic observations transmitted at 6 p.m. on October 23 and at 8 a.m. on October 24, afford no materials for deciding whether this may not have been the case in the instance under consideration, although this question can be decided from data since received. On the whole, to the minds of many students of the subject it will appear rather "strange" that the Office, *with the materials at its disposal*, does not more often fail to furnish satisfactory warnings of the more serious of our gales. It is easy to say, in view of occasional failures, "the system itself must be at fault:" it is still easier to reply, "better it!" If the country cares enough for the welfare of "fishermen and others" to do so, let it provide the necessary funds for a system of night telegrams, and if possible for a series of oceanic stations. If it does not, it must be content with things as they are.

I have been careful to speak of instrumental observations only. It is already well known that observations of the movements of the higher clouds commonly give indications of the position and advance of distant cyclonic systems. But it has hitherto been found impossible to train our observers in the difficult art of taking these observations. To the accomplishment of this task, which would greatly add to the utility of our weather-forecasts, some of us are now devoting ourselves with every prospect of success. W. CLEMENT LEY

Ashby Parva, Lutterworth, November 3

P.S.—Since the above was sent to press a storm-centre has crossed Scotland with a velocity of about 45 miles per hour. Indications of its progress were however afforded by cloud observations at a distance of more than 800 miles in advance of the centre, the velocity of propagation being supposed uniform.—W. C. L.

The Comet

YOUR engraver has missed what I thought the most important feature in the drawings which I made of the comet on the 21st inst., viz. the *shadow* beyond the end of the tail, of the length of 3 or 4 degrees, very obviously darker than the surrounding space, in which it was lost, without demarcation. This was expressed in my sketch by a shade of lampblack, very slight, to avoid exaggeration, and perhaps just sufficient to escape the engraver's notice. The comet, as seen this morning, is diminished much in size, and still more in brightness, and the present moonlight much impairs its beauty and distinctness.

C. J. B. WILLIAMS

Villa du Rocher, Cannes, France, October 30

NOTICING Major J. Herschel's remark in NATURE, vol. xxvii. p. 5, as to the difficulty he experienced in London of observing the comet, apparently owing to the moonlight, I may state that on the morning of the same Sunday to which he refers, I saw the comet very plainly when at Rothsay, Isle of Bute, Scotland. The time was between 5 and 6 a.m., and therefore before sunrise. The moon was brilliant, and the whole sky wonderfully clear, and but few stars noticeable, on account of the moonlight, nevertheless, the comet showed well, extending about 20° across the sky due south, magnetic; the nucleus was well defined, and about as bright as the stars then visible. The tail was straight, spreading outwards to the extremity. No glass was used in the observation recorded. W. J. MILLER

Glasgow, November 3

IT might be interesting to some of the readers of your paper to know that this morning, at 5 a.m., Mr. Manning, the agent here for Messrs. F. and A. Swanzy, merchants, and myself, saw a very fine comet bearing south-east, and the tail of which was as long as my first finger, from tip to last joint; its head, bearing a little to the east, was pointing into the sea, and was about the height from the sea of my four fingers held at arm's length; it was very brilliant, and we seem to have seen it to great advantage. Unfortunately we had only a field glass to view it through, and being also without instruments, were unable to take its proper altitude or bearings. We were standing on the verandah of the house at the time, which is on the beach, and about forty feet above the level of the sea.

We should be glad to know if the comet has been seen further north by anyone else. Quitta is situated 5° N. latitude, and 1° E. longitude.

WALTER HIGGINSON
B. MANNING

Quitta, West Coast Africa, September 25

Two Kinds of Stamens with Different Functions in the same Flower

IT may be worth mentioning that cases strongly analogous to those described in NATURE (vol. xxiv. p. 307, and vol. xxvi. p. 386, are also to be observed among the Monocotyledons in the family of Commelynaceæ, and that these cases offer some graduations.

In *Tradescantia virginica*, L., the flowers, as is generally known, are turned upwards and quite regular, the leafy organs of each whorl (3 sepals, 3 petals, 3 outer, 3 inner stamens, 3 united carpels) being alike and equal in size. As Delpino has clearly shown (*Ulteriori osservazioni*, parte ii. fascic. 2, p. 297) these flowers are adapted to Apidæ, which in order to collect pollen take hold of the articulated hairs of the filaments. In some other species here to be considered the adaptation to pollen-collecting bees has remained, but the flowers have turned laterally, and thus not only has their form become irregular (bi-laterally symmetrical or zygomorphous), but also the function of the stamens has gradually changed.

In *Tinnantia undata*, Schlecht. (Fig. 1), sepals and petals are still almost unaltered in form and size, only stamens and pistil have become markedly irregular. The broad roundish petals, which are light purple, spread in a perpendicular plane. The 3 upper stamens, with shorter filaments projecting from

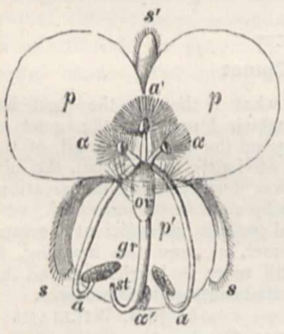


FIG. 1.

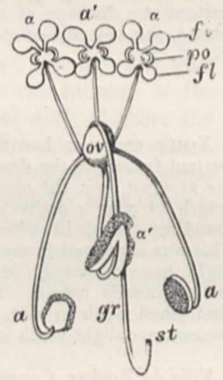


FIG. 2.

FIG. 1.—Front view of the flower of *Tinnantia undata*, Schlecht. FIG. 2.—Front view of the andrœceum and gynæcium of *Commelyna cœlestis*, Willd. *s*, *s*, *s'*, sepals; *p*, *p*, *p'* petals; *a*, *a*, *a'*, outer whorl of anthers; *a*, *a*, *a'*, inner whorl of anthers, or ovary; *gr*, style ("Gr.ffel"); *st*, stigma.

the middle of the flower, are highly conspicuous by a diverging tuft of bright yellow articulated hairs, which on the last third of the light-purple filaments surround the golden yellow anthers like a cone of golden rays. At the tips of these filaments golden yellow pollen-grains are presented by the whole front side of the three upper anthers.

The three lower stamens are much longer, directed obliquely downwards and forwards, with only their tips bending upwards, a little overtopped by the pistil, which has the same direction and incurvation. These parts, like the same parts in the described Melastomaceæ, will hardly be perceived by an advancing insect, "owing to their projection against the broad-petalled corolla of the same colour in the background," for not only the style and the filaments, but also the hairs on the base on the two lateral lower filaments are of the same purple colour as the petals, and even the bluish lower anthers with their yellowish pollen are but feebly conspicuous. Any one of the Apidæ or Syrphidæ of suitable size, however, when making for the upper yellow stamens in order to collect their pollen (I have only once observed the honey-bee doing so), will involuntarily repose on the projecting parts, and at first bring the stigma and then the two lateral of the lower anthers into contact with the under-side of its abdomen, and thus regularly effect cross fertilisation.

Here, then, as in Heeria, &c., the anthers have differentiated into upper ones, which attract insects and afford food to them, and lower ones which attach their pollen to the visitors, and cause it to be transported by them to the stigma of the next visited flowers. Also differentiation in the pollen of the two kinds of anthers in our Tinnantia has begun to take place, but contrary to Melastoma, the pollen-grains of the short stamens here are smaller than those of the longer ones. I measured numerous pollen-grains of two individuals in a moistened state (where they are of elliptical form), and found in the one stem the pollen-grains of the short stamens (in 1·1000 m.m.) 62·75 long, 31·38 broad, those of the longer ones 68·94 long, 38·44 broad; in the other stem, those of the short stamens 53·69 long, 28·37 broad; those of the longer ones 59·78 long, 31·40 broad. Both kinds of pollen proved to be quite fertile.

Commelyna coelestis, Willd. (Fig. 2) possesses in general the same contrivances for cross-fertilisation, but has gone a step further in differentiation. Its upper sepal is plainly smaller, its lower petal plainly larger than the two other ones; its upper anthers (*a*, *a'* *a*) have differentiated in themselves; two small lateral portions of each of them (*po*) produce a little pollen and four cross-like diverging flaps (*fl*), which are much larger, attract insects by their bright yellow colour strikingly contrasting with the azure corolla, and perhaps at the same time serve as food to the visitors. The articulated hairs of the filaments thus having lost not only their original function (which they have in all stamens of Tradescantia) as supports for the feet of pollen-collecting bees, but also their secondary function (which they have in the upper stamens of Tinnantia) of attracting insects, have disappeared altogether. The middlemost of the lower anthers, which in Tinnantia is nearly useless from its position behind the style here, has erected and become much larger than the two lateral ones, so as to be eminently useful.

The pollen-production of the upper anthers appears to be vanishing, not only from the diminution of the quantity of produced pollen, but also from the great variability of the size of the pollen grains. For whilst the pollen grains of the two lateral lower anthers only differ in length from 75 to 90, in breadth from 45 to 68, and those of the middlemost lower anther in length from 56 to 82, in breadth from 37 to 56, those of the three upper anthers fluctuate from 50 to 87 length, and from 31 to 56 breadth.

In *Commelyna communis*, differentiation has gone still further; the upper sepal and the lower petal are relatively very small; the upper filaments, like the upper petals, are blue-coloured; the lower filaments, like the pistil and the lower petal, are colourless. The upper anthers, as far as I have seen (without microscope) produce no more pollen

The examination of other species and genera of Commelynaceæ probably would show a longer scale of gradations.

Lippstadt, October 25 HERMANN MÜLLER

A Curious Halo

THERE appeared in NATURE, vol. xxvi. pp. 268, 293, two articles headed "A Curious Halo," which reminded me of an analogous and still more curious phenomenon occurring sometimes here in China, during the hot season. I beg to hand you a few lines on that subject, from the *Monthly Bulletin* of the Zi-ka-wei Observatory for August, 1877:—

"A phenomenon to which I wish to call the attention of meteorologists was observed many times during that month (August), as also in July. It does not seem to take place in Europe, and I am inclined to think that it cannot occur except with an atmosphere over-charged with aqueous vapour, as it is the case with us in July and August. In the evening, just after sunset, or in the morning even long before sunrise, no matter what the direction of the wind and the barometric pressure may be, provided the day or night were very warm, *bands* of a tint varying from the faintest to the deepest *blue* are seen to appear upon the whitish or roseate vault of heaven. They usually are first seen in the east at evening and in the west at morning time, seemingly radiating from a common centre diametrically opposite the sun's position. At other times they emerge from the very position of the sun, or from both points at once, the interval being either free from bands or completely encircled by them.

"Last year (1876), on the morning of September 4, I enjoyed a most interesting sight. It was about 5 a.m., the moon, then on her nineteenth day, was above the western horizon, and just being partially eclipsed; now from her bright disc, as from a radiating centre, shot out a number of those bands or blue beams; they traversed the whole expanse of the sky, and seemed to converge towards a point whose situation in the east below the horizon corresponded with that of the moon in the west above the horizon.

"These bands or shoots are more or less numerous, bright, and persistent; some have been observed in the evening, forty-five minutes after sunset, and in September, 1876, I saw them appear with the first break of day. They are evidently movable in the sky, and there is no doubt that they are due to cumuli floating about the horizon, below or above, through which the light of the sun is sifted and split; they are, in fact, nothing else than the shadows of the clouds in the faint white or rosy tint of the twilight. According as the clouds before the sun are more or less compact or loose, the bands may be blue, white, or red. More than once also have I seen the sky half white and half blue, the separation of the two colours being plainly perceivable, and Venus shining brilliantly in the blue sky close to that limit, whilst it would probably have been almost invisible through the milky sky hard by."

Any one who gazes for the first time at this beautiful phenomenon cannot help wondering and acknowledging it to be greatly different from anything to be seen elsewhere. The celebrated Jesuit, Father Bouvet, an old missionary to China, witnessed the phenomenon when on his way from China to Europe as envoy of the great Emperor Kang-hi, in the year 1693; the relation of the voyage (du Halde, vol. i., 1755) gives the following account of his observations:—

"25 Juillet, 1693.—Ce jour-là, environ un quart d'heure avant le lever du soleil, je vis dans le ciel un phénomène que je n'ai jamais vu et dont je n'ai point ouï parler en France, quoiqu'il soit fort ordinaire en Orient, surtout à Siam et à la Chine; car je l'ai observé distinctement plus de vingt fois, tantôt le matin, tantôt le soir, dans chacun de ces deux Royaumes, sur mer et sur terre, et même à Péking.

"Ce phénomène n'est autre chose que certains demi-cercles d'ombre et de lumière que paraissent se terminer et s'unir dans deux points opposés du Ciel, savoir d'un côté dans le centre du Soleil, et de l'autre dans le point qui est diamétralement opposé à celui-là. Comme ces demi-cercles sont tous terminés en pointe, tant en Orient qu'en Occident, c'est-à-dire vers les points opposés de leur réunion et qu'ils vont en s'élargissant uniformément vers le milieu du Ciel à mesure qu'ils s'éloignent de l'horizon, ils ne ressemblent pas mal pour leur figure aux *Maisons Célestes*, de la manière dont on les trace sur les Globes, à cela près seulement que ces Zônes d'ombre et de lumière sont ordinairement fort inégales pour la largeur et qu'il arrive souvent qu'il y a de l'interruption entr'elles, surtout lorsque le phénomène n'est pas bien formé.

"Toutes les fois que je l'ai observé, et je l'ai vu quatre fois différentes dans ce voyage en moins de quinze jours, j'ai toujours remarqué que le temps était extrêmement chaud, le ciel chargé de vapeurs, avec une disposition au tonnerre et qu'un gros nuage épais entr'ouvert était vis-à-vis du Soleil. Ce phénomène semble pour la figure *fort différent de ces longues traces d'ombre et de lumière* qu'on voit souvent le soir et le matin dans le ciel aussi bien en Europe qu'ailleurs et auxquelles leur figure pyramidale a fait donner le nom de *verges*. Si l'on demande pour quelle raison ce phénomène paraît plutôt en Asie qu'en Europe et en été que dans les autres saisons, il me semble qu'on pourrait en attribuer la cause à la nature des terres de l'Asie, qui étant pour la plupart beaucoup plus chargées de *nitre* que celles d'Europe, remplissent l'atmosphère, surtout en été, et lorsque le soleil a plus de force pour les élever, d'exhalaisons nitreuses, lesquelles étant répandues également dans l'air, les rendent plus propres à réfléchir la lumière et par conséquent à former le météore."

The phenomenon described by the old Jesuit astronomer is undoubtedly the same I have witnessed hundreds of times at Zi-ka-Wei. He evidently considers it as different from any hitherto observed atmospheric phenomenon; but his explanation is tainted with the false science of his time. It is quite certain that the phenomenon is due to the atmospheric vapour, but I am rather at a loss to give a more satisfactory explanation. The dispersion of the direct rays of the sun *into* the minute drops resulting from a partial but wide-spreading condensation of the aqueous vapour in the upper strata of the air, might account for the milky or roseate appearance of the sky at morning and evening time. Besides, the interposition of a light cloud in the way of the sun's rays does not impair the transparency of the drops, and the blue sky may be visible. Now, in the morning and evening the rays of the sun are almost parallel with the horizon; they traverse the whole expanse of the sky, and their apparent convergence on the both sides is only due to the same optical illusion which shows us the two rails of a railway track or the walls of a tunnel as converging.

Let this explanation be worth what it may, the fact in itself is interesting, and I would beg you, Sir, to notice it in NATURE, dealing, however, with this long communication as you may deem proper. MARC DECHEVRENS

Zi-ka-Wei Observatory, near Shanghai, (China), August 28

Habits of Scypho-Medusæ

THE communications to NATURE of Mr. Archer (vol. xxiv. p. 307), and of Mr. Alexander Agassiz (vol. xxiv. p. 509), on the subject of Medusæ lying upon the bottom with their tentacles upward, lead me to forward some observations which I made on a similar habit of Medusæ in the island of Simbo, one of the Solomon Islands. The Medusa in question frequents a small mangrove swamp, which lies inclosed in the low point that forms the south shore of the anchorage. Numbers of these animals of a large and dirty-white colour were lying lazily on the mud at the bottom of the water, which varied in depth from one to three feet, with their umbrellas lowermost, and a magnificent mass of arborescent tentacles well displayed. When one of them was disturbed and turned over with a stick, it immediately began to contract the umbrella, until, after swimming a short distance, it resumed its former position on the bottom, of tentacles upward. The dark mud which formed the bottom of the swamp was composed of decayed vegetable matter—low confervoid growths, and a few infusoria and living diatoms. But I invariably observed, after raising several of these Medusæ from the bottom, that a layer of white sand covered over the place where each had lain, its light colour forming a marked contrast with the dark mud around. The form of these patches of sand corresponded with the outline of the animal; but when the Medusa lay in its usual position, the umbrella completely concealed them from view. The sand was sometimes fine, at other times coarse, and was derived from the coral and trachytic rocks in the vicinity, with occasionally fragments of shells intermingled. The sand did not adhere to the surface of the umbrella.

The Medusæ measured generally some eight or nine inches across the umbrella, and appeared to belong to the Rhizostomidæ. H. B. GUPPY

H.M.S. *Lark*, St. Christoval, Solomon Islands, June 29

Prof. Owen on Primitive Man

IN the first number of *Longman's Magazine* Prof. Owen criticises an article of mine on Primitive Man, in the *Fortnightly Review*. In doing so, he quotes some words from my article, which are there given as a quotation from Prof. Schaafhausen. He proceeds to make them the text of his paper, as though the opinions expressed in them were my own. On the question at issue—the Neanderthal skull—I am not competent to form any personal opinion; I merely abstracted the opinions of Rolleston and Schaafhausen. Prof. Owen would hardly have spoken in the same lofty magisterial tone had he attributed those opinions to their real authors, whose reputation can take care of itself. The respect I feel for Prof. Owen's work makes me deeply regret the necessity for this explanation; but I cannot allow him to quote as mine words which I placed between inverted commas, attributing them at the same time to their real author. GRANT ALLEN

Magnetic Arrangement of Clouds

THERE is a curious arrangement of clouds which, though seen myself for the first time this year, may doubtless have been observed by others, though I have never seen it referred to anywhere. Light clouds of the cirrus formation apparently at great elevations range themselves round two poles—one about in the direction of the magnetic north pole, and the other in that of the south. The space between the two poles is filled more or less completely by wispy cirri. The exact point where the various threads or wisps should form themselves into a pole I have never been able to clearly see, owing to the dense stratum of vapour which even on the clearest day accumulates at the horizon. On Sunday, October 29, the arrangement above noticed was remarkably distinct in the afternoon. C. H. ROMANES

Worthing

The Umdhlebe Tree of Zululand

THE word "umdhlebe" does not, I think, appear in Döhne's "Zulu-Kaffir Dictionary." I presume it to be a derivative from the root *hlaba*, which Döhne interprets as denoting, among other things, the giving of pain. Some native tales of the tree will be found in part iv. of Bishop Callaway's "Religious System of the Amazulu," in which it is asserted that "there are several kinds, not one kind only of umdhlebe; some are small." I should be disposed to think the kernel of fact will be found to lie in native observation of the deleterious properties and weird aspects of certain *Euphorbiaceæ*. H. M. C.

Charlton, November 4

The Weather

THE past month has probably been one of the wettest on record. I have registered here 5·14 inches of rain during the month; only on seven days out of the thirty-one has the gauge shown less than 0·1; and on three days out of the seven rain has been recorded. J. M. FOUNTAIN

Hillingdon, Uxbridge, November 2

ON THE GRADUATION OF GALVANOMETERS FOR THE MEASUREMENT OF CURRENTS AND POTENTIALS IN ABSOLUTE MEASURE

THERE are several methods by which galvanometers may be graduated so as to measure currents and potentials in absolute measure, but they all involve, directly or indirectly, a comparison of the indications of the instrument to be graduated with those of a standard instrument, of which the constants are fully known for the place at which the comparison is made. There are various forms of such standard instruments, as, for example, the tangent galvanometer which Joule made, consisting of a single coil of large radius, and a small needle hung at its centre, or the Helmholtz modification of the same instrument with two large equal coils placed side by side at a distance apart equal to the radius of either; or some form of "dynamometer," or instrument in which the needle of the galvanometer is replaced by a movable coil, in which the whole or a known portion of the current in the fixed coil flows. The measurement consists essentially in determining the couple which must be exerted by the earth's magnetic force on the needle or suspended coil, in order to equilibrate that exerted by the current. But the former depends on the value, usually denoted by H, of the horizontal component of the earth's magnetic force, and it is necessary therefore, except when some such method as that of Kohlrausch, described below, is used, to know the value of that quantity in absolute units.

The value of H may be determined in various ways, and I shall here content myself with describing one or two of the most convenient in practice. The easiest method is by finding (1) the angle through which the needle of a magnetometer is deflected by a magnet placed in a given position at a given distance, (2) the period of vibration of the magnet when suspended horizontally in the earth's field, so as to be free to turn round a vertical axis. The first operation gives an equation involving the ratio of the magnetic moment of the magnet to the horizontal component H of the terrestrial magnetic force, the second an equation involving the product of the same two quantities. I shall describe this method somewhat in detail.

A very convenient form of magnetometer is that devised by Mr. J. T. Bottomley, and made by hanging within a closed chamber, by a silk fibre from 6 to 10 cms. long, one of the little mirrors with attached magnets used in Thomson's reflecting galvanometers. The fibre is carefully attached to the back of the mirror, so that the magnets hang horizontally and the front of the mirror is vertical. The closed chamber for the fibre and mirror is very readily made by cutting a narrow groove to within a short distance of each end, along a piece of mahogany about 10 cms. long. This groove is widened at one end to a circular space a little greater in diameter than the diameter of the mirror. The piece of wood is then fixed with that end down in a horizontal base-piece of wood furnished with three levelling screws. The groove is thus placed vertical; and the fibre carrying the mirror is suspended within it by passing the free end of the fibre through a small hole at the upper end of the groove, adjusting the length so that the mirror hangs within the circular space at the bottom, and fixing the fibre at the top with wax. When this has been done, the chamber is closed by covering the face of the piece of wood with a strip of glass, which may be either kept in its place by cement, or by proper fastenings which hold it tightly against the wood. By making the distance between the back and front of the circular space small, and its diameter very little greater than that of the mirror, the instrument can be made very nearly "dead beat," that is to say, the needle when deflected through any angle comes to rest at once, almost without oscillation about its position of equilibrium. A magnetometer can be thus constructed at a trifling cost, and it is much more accurate and convenient than the magnetometers furnished with long magnets frequently used for the determination of H; and as the poles of the needle may always in practice be taken at the centre of the mirror, the calculations of results are much simplified.

The instrument is set up with its glass front in the magnetic meridian, and levelled so that the mirror hangs freely inside its chamber. The foot of one of the levelling screws should rest in a small conical hollow cut in the table or platform, of another in a V-groove the axis of which is in line with the hollow, and the third on the plane surface of the table or platform. When thus set up the instrument is perfectly steady, and if disturbed can in an instant be replaced in exactly the same position. A beam of light passing through a slit, in which a thin vertical cross-wire is fixed, from a lamp placed in front of the magnetometer is reflected, as in Thomson's reflecting galvanometer, from the mirror to a scale attached to a lamp-stand, and facing the mirror. The lamp and scale are moved nearer to or farther from the mirror, until the position at which the image of the cross-wire of the slit is most distinct is obtained. It is convenient to make the horizontal distance of the mirror from the scale for this position if possible one metre. The lamp-stand should also have three levelling screws, for which the arrangement of conical hollow V groove and plane should be adopted. The scale should be straight, and placed with its length in the magnetic north and south line, and the lamp should be so placed that the incident and reflected rays of light are in an east and west vertical plane, and that the spot of light falls near the middle of the scale. To avoid errors due to variations of length in the scale, it should be glued to the wooden backing which carries it, not simply fastened with drawing pins as is often the case.

The magnetometer having been thus set up, four or five magnets, each about 10 cms. long and ·1 cm. thick, and tempered glass-hard, are made from steel wire. This is best done as follows. From ten to twenty pieces of steel wire, each perfectly straight and having its ends carefully filed so that they are at right angles to its length, are prepared. These are tied tightly into a bundle with a binding of iron wire and heated to redness in a bright fire. The bundle is then quickly removed from the fire, and plunged with its length vertical into cold water. The wires are thus tempered glass-hard without being seriously warped. They are then magnetised to saturation in a helix by a strong current of electricity. A horizontal magnetic east and west line passing through the mirror is now laid down on a convenient platform (made of wood put together without iron and extending on both sides of the magnetometer) by drawing a line through that point at right angles to the direction in which a long thin magnet hung by a single silk fibre there places itself. One of these magnets is placed, as shown in Fig. 1, with its length in that line, and at such a distance that a convenient deflection of the needle is produced. This deflection is noted and the deflecting magnet turned end for end, and the deflection again noted. Make in the same way a pair of observations with the magnet at the same distance on the opposite side of the magnetometer, and take the mean of all the observations. These deflections from zero ought to be as nearly as may be the same, and if the magnet is properly placed, they will exactly agree; but the effect of a slight error in placing the magnet will be nearly eliminated by taking the mean of all the deflections as the deflection of the magnet for that position. The exact distance in cms. of the centre of the deflecting magnet from the mirror is also noted. The same operation is gone through for each of the magnets, which are carefully kept apart from one another during the experiments. The results of each of these experiments give an equation involving the ratio of the magnetic moment of the magnet to the value of H. Thus if m denote the magnetic moment of the magnet, m' the magnetic moment of the needle, $2r$ the distance of the centre of the magnet from the centre of the needle, $2l$ the distance between the poles of the magnet which, for a uniformly magnetised magnet of the dimensions stated

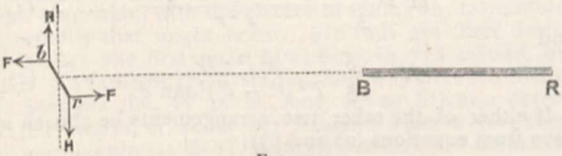


FIG. 1.

above is nearly enough equal to its length, and $2l'$ the distance between the poles of the needle, r, l, and l' being all measured in cms., we have for the repulsive force (denoted by F in Fig. 1) exerted on the blue[1] pole of the needle by the blue pole of the magnet, supposed nearest to the needle, as in Fig. 1, the value of $\frac{m}{2l}\cdot\frac{m'}{2l'}\cdot\frac{1}{(r-l)^2}$, since the value of l' is small compared with l. Similarly for the attraction exerted on the same pole of the needle by the red pole of the magnet, we have the expression $\frac{m}{2l}\cdot\frac{m'}{2l'}\cdot\frac{1}{(r+l)^2}$. Hence the total repulsive force exerted by the magnet on the blue pole of the needle is

$$\frac{mm'}{4ll'}\left\{\frac{1}{(r-l)^2}-\frac{1}{(r+l)^2}\right\} \text{ or } m\frac{m'}{l'}\cdot\frac{r}{(r^2-l^2)^2}.$$

Proceeding in a precisely similar manner, we find that the magnet m exerts an attractive force equal to $m\frac{m'}{l'}\cdot\frac{r}{(r^2-l^2)^2}$ on the red pole of the magnet. The needle is therefore acted on by a couple which tends to turn it round the suspending fibre as an axis, and the amount of this couple, when the angle of deflection is θ, is plainly equal to $mm'\,\frac{2r}{(r^2-l)^2}\cos\theta$. But for equilibrium this couple must be balanced by $m'H\sin\theta$; hence we have the equation :—

$$\frac{m}{H}=\frac{(r^2-l^2)^2}{2r}.\tan\theta \quad . \quad . \quad . \quad . \quad (1)$$

The angle θ is to be measured thus :—The number of divisions of the scale which measures the deflection divided by the number of such divisions in the distance of the scale from the mirror, is, if the scale is placed as described above in the magnetic north and south line, equal to $\tan 2\theta$.

Instead of in the east and west horizontal line through the centre of the needle, the magnet may be placed, as represented in Fig. 2, with its length east and west, and its centre in the horizontal north and south line through the centre of the needle. If we take m, m', l, l', and r to have the same meaning as before, we have for the distance of either pole of the magnet from the needle, the expression $\sqrt{r^2+l^2}$. Let us consider the force acting on one pole, say the red pole of the needle. The red pole of the magnet exerts on it a repulsive force, and the blue pole an attractive force. Each of these forces has the value $\frac{m}{2l}\cdot\frac{m'}{2l'}\cdot\frac{1}{r^2+l^2}$. But the diagram shows that they are equivalent to a single force, F, in a line parallel to the magnet, tending to pull the red pole of the needle towards the left. The magnitude of this resultant force is plainly $2\frac{m}{2l}\cdot\frac{m'}{2l'}\cdot\frac{l}{(r^2+l^2)^{\frac{3}{2}}}$ or $\frac{mm'}{2l'(r^2+l^2)^{\frac{3}{2}}}$. In the same way it can be shown that the action of the magnet on the red pole of the needle is a force of the same amount tending to pull the blue pole of the needle towards the right. The needle is, therefore, subject to no force tending to produce motion of translation, but simply to a "couple" tending to produce rotation. The magnitude of this couple when the needle has been turned through an angle θ, is $\frac{mm'}{2l}\,\frac{2l'\cos\theta}{(r^2+l^2)^{\frac{3}{2}}}$, or $\frac{mm'}{(r^2+l^2)^{\frac{3}{2}}}\cos\theta$. If there be equilibrium for the deflection θ, this couple must be balanced by that due to the earth's horizontal force, which, as before, has the value $m'H\sin\theta$. Hence equating these two couples we have—

$$\frac{m}{H}=(r^2+l^2)^{\frac{3}{2}}\tan\theta \quad . \quad . \quad . \quad . \quad (2)$$

Still another position of the deflecting magnet relatively to the needle may be found a convenient one to adopt. The magnet may be placed still in the east and west line, but with its centre vertically above the centre of the needle. The couple in this case also is given by the formula just found, in which the symbols have the same meaning as before.

The greatest care should be taken in all these experiments, as well as in those which follow, to make sure that there is no movable iron in the vicinity, and the instruments and magnets should be kept at a distance from any iron nails or bolts there may be in the tables on which they are placed.

We come now to the second operation, the determination of the period of oscillation of the deflecting magnet when under the influence of the earth's horizontal force alone. The magnet is hung in a horizontal position in a double loop formed at the lower end of a single fibre of unspun silk, attached by its upper end to the roof of a closed chamber. A box about 30 cms. high and 15 cms. wide, having one pair of opposite sides, the bottom and the roof made of wood, and the remaining two sides made of plates of glass, one of which can be slided out to give access to the inside of the chamber, answers very well. The fibre may be attached at the top to a horizontal wire which can be turned round from the outside so as to wind up or let down the fibre when necessary. The suspension-fibre is so placed that two vertical scratches, made along the glass sides of the box, are in the same plane with the magnet when the magnet is placed in its sling, and the box is turned round until the magnet is at right angles to the glass sides. A paper screen with a small hole in it is then set up at a little distance in such a position that the hole is in line with the magnet, and therefore in the same plane as the scratches. The magnetometer should be removed from its stand and this box and suspended needle put in its place. If the magnet be now

[1] The convention according to which magnetic polarity of the same kind as that of the earth's northern regions is called blue, and magnetic polarity of the same kind as that of the earth's southern regions is called red, is here dopted. The letters B, R, b, r in the diagrams denote blue and red.

deflected from its position of equilibrium and then allowed to vibrate round a vertical axis, it will be seen through the small hole to pass and re-pass the nearer scratch, and an observer keeping his eye in the same plane as the scratches can easily tell without sensible error the instant when the magnet passes through the position of equilibrium. Or, a line may be drawn across the bottom of the box so as to join the two scratches, and the observer keeping his eye above the magnet and in the plane of the scratches notes the instant when the magnet going in the proper direction is just parallel to the horizontal line. The operator should deflect the magnet by bringing a small magnet near to it, taking care to keep the small deflecting magnet always as nearly as may be with its length in an east and west line passing through the centre of the suspended magnet. If this precaution be neglected the magnet may acquire a pendulum motion about the point of suspension, which will interfere with the vibratory motion in the horizontal plane. When the magnet has been properly deflected and left to itself, its range of motion should be allowed to diminish to about 3° on either side of the position of equilibrium before observation of its period is begun. When the amplitude has become sufficiently small, the person observing the magnet says sharply the word "Now," when

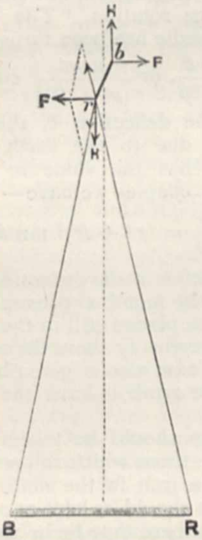


Fig. 2.

the nearer pole of the magnet is seen to pass the plane of the scratches in either direction, and another observer notes the time on a watch having a seconds hand. With a good watch having a centre seconds hand moving round a dial divided into quarter-seconds, the instant of time can be determined with greater accuracy in this way than by means of any of the usual appliances for starting and stopping watches, or for registering on a dial the position of a seconds hand when a spring is pressed by the observer. The person observing the magnet again calls out "Now" when the magnet has just made ten complete to and fro vibrations, again after twenty complete vibrations, and, if the amplitude of vibration has not become two small, again after thirty; and the other observer at each instant notes the time by the watch. By a complete vibration is here meant the motion of the magnet from the instant when it passes through the position of equilibrium in either direction, until it next passes through the position of equilibrium going in the same direction. The observers then change places and repeat the same operations. In this way a very near approach to the true period is obtained by taking the mean of the results of a sufficient number of observations, and from this the value of the product of m and H can be calculated.

For a small angular deflection θ of the vibrating magnet from the position of the equilibrium the equation of motion is

$$\frac{d^2\theta}{dt^2} + \frac{mH}{\mu}\theta = 0,$$

where μ is the moment of inertia of the vibrating magnet round an axis through its centre at right angles to its length. The solution of this equation is

$$\theta = A \sin\left\{\sqrt{\frac{mH}{\mu}}\,t - B\right\}$$

and therefore for the period of oscillation T we have

$$T = 2\pi\sqrt{\frac{\mu}{mH}}.$$

Hence we have

$$mH = \frac{4\pi^2\mu}{T^2}$$

Now, since the thickness of the magnet is small compared with its length, if W be the mass of the magnet μ is $\frac{l^2}{3}W$, and therefore

$$mH = \frac{4\pi^2 l^2 W}{3T^2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

combining this with the equation (1) already found we get for the arrangement shown in Fig. 1.

$$m^2 = \frac{2}{3}\cdot\frac{\pi^2(r^2-l^2)^2 W\tan\theta}{T^2 r} \quad . \quad . \quad (4)$$

and

$$H^2 = \frac{8}{3}\cdot\frac{\pi^2 l^2 r W}{T^2(r^2-l^2)^2\tan\theta} \quad . \quad . \quad . \quad (5)$$

If either of the other two arrangements be chosen we have from equations (2) and (3)

$$m^2 = \frac{4}{3}\cdot\frac{\pi^2 l^2}{T^2}(r^2+l^2)^{\frac{3}{2}} W\tan\theta \quad . \quad . \quad (6)$$

and

$$H^2 = \frac{4}{3}\cdot\frac{\pi^2 l^2 W}{(r^2+l^2)^{\frac{3}{2}} T^2\tan\theta} \quad . \quad . \quad . \quad (7)$$

Various corrections which are not here made are of course necessary in a very exact determination of H. The virtual length of the magnet, that is, the distance between its poles or "centres of gravity" of magnetic polarity, should be determined by experiment: and allowances should be made for the magnitude of the arc of vibration; the torsional rigidity of the suspension fibre of cocoon silk of the magnetometer in the deflection experiments, and of the suspension fibre of the magnet in the oscillation experiments; the frictional resistance of the air to the motion of the magnet; the virtual increase of inertia of the magnet due to motion of the air in the chamber; and the effect of induction in altering the moment of the magnet. The correction for an arc of oscillation of 6° is a diminution of the observed value of T of only $\frac{1}{80}$ per cent., and for an arc of 10° of $\frac{1}{20}$ per cent. Of the other corrections the last is no doubt the most important; but even its amount for a magnet of glass-hard steel, nearly saturated with magnetism, and in a field so feeble as that of the earth, must be very small.

The deflection-experiments are, as stated above, to be performed with several magnets, and when the period of oscillation of each of these has been determined, the magnetometer should be replaced on its stand, and the deflection experiments repeated, to make sure that the magnets have not changed in strength in the mean time. The length of each magnet is then to be accurately determined in centimetres, and its weight in grammes; and from these data and the results of the experiments, the values of m and of H can be found for each magnet by the formulas investigated above. Equation (5) is to be used in the calculation of H when the arrangements of magnetometer and deflecting magnet, shown in Fig. 1, is adopted, equation (7), when that shown in Fig. 2 is adopted.

The object of performing the experiments with several magnets, is to eliminate as far as possible, errors in the determination of weight and length. The mean of the values of H, found for the several magnets, is to be taken as the value of H at the place of the magnetometer. We have now to apply this value to the measurement of currents. ANDREW GRAY

(*To be continued.*)

THE ITALIAN EXPLORATION OF THE MEDITERRANEAN

I BELIEVE it will interest the numerous readers of NATURE, especially those who have studied the important subject of the deep-sea fauna, or who are geologists, to learn that the further exploration of the Mediterranean this year, on the part of the Italian Government, has not been fruitless, although it has been short. I have just received a letter from Prof. Giglioli, of Florence, the purport of which I will, with his permission, now give :—

It seems that this summer the surveying-vessel, *Washington*, had to undertake a search (which proved unsuccessful) for some imaginary coral-banks in the shallow sea between Sicily and Africa, besides her usual hydrographical work, and that consequently very little time could be devoted to deep-sea exploration. However, Prof. Giglioli was allowed to accompany the hydrographer, Capt. Magnaghi, with the chance of taking any favourable opportunity that might occur. He thus got three deep-sea hauls: the first near Marittimo, in 718 metres, or about 389 fathoms; the second, half-way between Sicily and Sardinia (lat. 38° 38′ N., long. 10° 40′ E.), at a depth of 1583 metres, or about 857 fathoms, when a very rare and peculiar abyssal fish (*Paralepis cuvieri*), was obtained. That day (August 15) was also appropriated to hydrographical researches, and particularly to the successful trial of Capt. Magnaghi's new water-bottle, as well as to the marvellous work of his new currentometer, a most valuable discovery, by means of which the direction and force of sub-marine currents can be accurately determined at any depth. A large new trawl was used, and brought up a block of newly-formed limestone, which had been hardened with recent shells of Pteropods embedded in its mass. The third and last deep-sea dredging was made on September 1, between Tavolara in Sardinia, and Montecristo, in 904 metres, or about 490 fathoms, with indifferent results. He will send me the shells for examination. The Italian Ministry have promised him that a whole month next year will be allowed for deep-sea exploration. J. GWYN JEFFREYS

WIRE GUNS[1]

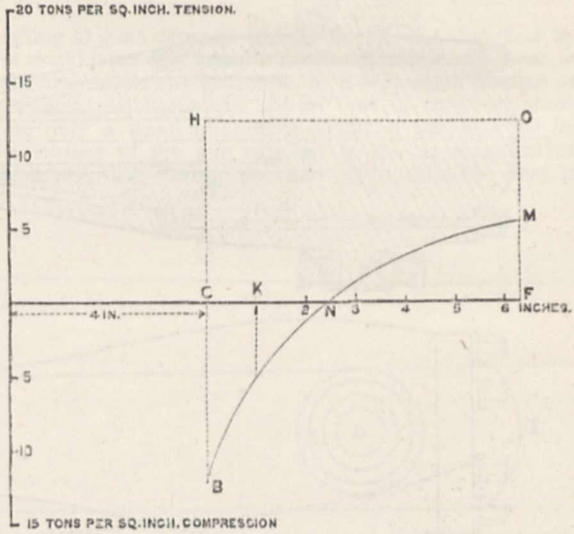
II.

IT has been necessary to dwell thus at length on the hoop method of construction in order to contrast it with the wire system, which we now proceed to describe.

A wire gun consists first of an internal tube, the function of which is to contain the rifling, and to transmit the internal pressure to the wire which is coiled upon it, and which gives the strength. This tube no doubt has a certain amount of strength of its own, but this is not its real function. The gun may be so designed and constructed that the tube is never in a state of tension. It may therefore be made, and possibly with advantage, of hard cast iron. In the 3 inch breech-loading gun made by the writer in 1860, the tube was of cast-iron ½ inch thick, and this gun has been severely tested without injury. Hard cast-iron possesses many advantages, and amongst others that of great economy as compared with the steel tubes now generally used; but whatever be the material of the tube, its principal function is to contain the rifling and transmit the strain to the wires coiled around it.

Upon the inner tube is wound steel wire, square or rectangular in section. The tube is mounted in a machine similar to a lathe, and the wire is coiled upon one or more cylindrical drums, which are fixed horizontally on axes parallel to the tube and provided with proper apparatus for regulating the feed and tension. The tensions having been first calculated, the coiling begins from the breech-end where the end of the wire is made fast. When the muzzle end is reached the wire is coiled back again to the breech, and this process goes on till the whole of the coils are in place. The end of the wire is then made fast, and the gun, so far as strength to resist a bursting strain, which is called circumferential strength, is concerned, is complete.

Before proceeding to show how the longitudinal strength is provided for, it will be well to devote a little time to the substitution of coils of wire for the hoops above described, pointing out as we go along the superiority of the wire system. It has already been shown how important it is in the hoop system that the initial tensions



E

of each hoop should be accurately calculated and applied. This is no less necessary with the wire coils, and it would at first appear that this must involve very intricate and tedious calculation. In the case of the gun represented in Diagram C, it was stated that the same strength which was given by 4 coils of steel, making with the tube a total thickness of 22¾ inches, might be obtained by 6¾ inches of wire, but supposing the wire to be $\frac{1}{10}$th inch square in section there would be required no less than 67 different coils and tensions, and as it is desirable to use even smaller wire for the first portion of the coils, there would probably be not less than 80 or 90 coils and the same number of tensions to be calculated. A formula has, however, been found which makes these calculations comparatively simple. In order to make this intelligible we must resort to another diagram, E, which represents the state of strain of the interior of a wire gun, or rather of the wire portion of it, on which alone we depend for circumferential strength. Assuming the wire to be very small, say $\frac{1}{16}$th of an inch square in section, the strains are represented very nearly by the curved line B N M. The coils between the inner circumference, *i.e.* the first coil, and the point N are all in compression, the maximum being at C; at N is the neutral point, when the wire is neither in compression nor tension; and from N to F all the coils are in tension, the maximum being at F.

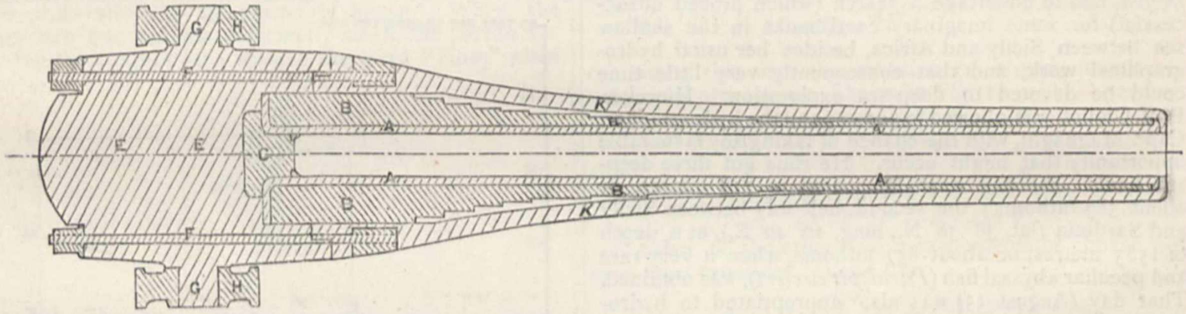
[1] Continued from p. 14.

Now if we consider the case of any one coil, such as that at the position K, we see that when the gun is completed it is under considerable *compression*, but whilst the construction is proceeding, when the coil at this point is being laid on, it is laid on under *tension*, which tension is reduced by every successive additional coil until it attains the state of compression shown in the diagram of the finished structure. The question therefore to be solved is this, What is the proper tension for putting on the coil at K, so that when all the other coils are put on, it may be in the required state of compression? This problem must be solved for every individual coil. This having been done, each coil is laid on by automatic machinery with its proper tension, and the final result is that shown in the diagram.

When the full internal pressure of the explosion operates, the result is as follows:—Every coil is brought up to the same tension simultaneously and exerts the same resistance per square inch of section throughout the whole thickness of the gun as denoted by the line H O.

The ultimate strength therefore of such a gun increases in the simple ratio of the number of coils, a result not attainable by any other mode of construction, and this is the first advantage over the hoop system. The second is, that there is no fear of error through inaccurate workmanship or unequal shrinkage. The tensions of the wire coils are actually measured by the machine by which they are laid on, instead of being *inferred* from presumed accuracy of workmanship or uniform shrinking power of the material. In the next place there is no danger from latent defects. The wire is not subject to such defects as thick hoops are, and can moreover be easily tested before it is applied. Then again the process of construction is simple and expeditious, it is the substitution of accurate automatic machinery for very highly skilled labour. Beyond this it is much less costly, for although the wire itself costs a high price per ton as compared with the raw material used in the hoops of the Woolwich guns, yet when the labour and work in the latter is taken into account, it will be found that it largely exceeds that of

FIG. 1.



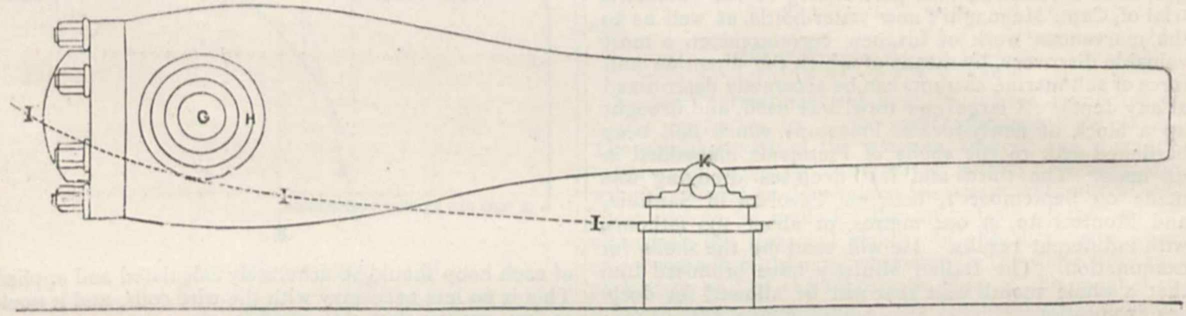


FIG. 2.

the wire gun ton for ton, and as was before pointed out, the wire gun of equal strength can be made very much lighter.

In a paper read before the Institution of Civil Engineers in 1879 the writer estimated the cost of a muzzle-loading 20 inch gun weighing 150 tons, constructed on the wire principle, at £5,041, or £33 16*s*. per ton. We believe that the price paid by Government to Sir Wm. Armstrong for the 100-ton guns produced from his firm was £16,000 each, or £160 per ton.

We now proceed to the question of longitudinal strength. In the old guns, as well as the present Woolwich guns, the Armstrong, Whitworth, and Krupp guns, the longitudinal strain between the breech and the trunnions is borne by the chase of the gun itself, that is to say, that the same material which has to resist the enormous circumferential strain has at the same time to resist a very intense longitudinal strain. Now it has been generally maintained that although this is very large in the gross, yet when it is divided by the sectional arm of the chase, it is comparatively small per square inch of section. This is a very great mistake as was pointed out several years ago by the late Sir William Palliser. The fact is, that this strain is no more uniformly divided over the sectional area of the chase than is the circumferential strain between the inner and outer circumferences.

Sir Wm. Palliser devised a method of breech construction which has since been adopted at Woolwich, by means of which the longitudinal strain is much more equally distributed, and since then the accident of a breech blowing out has been comparatively rare, and we believe has never occurred in Sir Wm. Palliser's own guns. It has always been a difficulty with many people to understand how the breech is to be secured in a wire gun. It is obvious that the coils of wire afford no longitudinal strength, and the general idea has been that it was therefore necessary to resist the whole longitudinal strain by the inner tube.

The writer has always maintained that no real difficulty exists, and that the connection between the breech and the trunnions should be by means of material quite independent of and placed outside of the coils of wire.

It was in this way that his gun made in 1860 was constructed, and we believe the same principle has been adopted by Capt. Schultz in the wire guns built under his directions by the French Government. Thus the circumferential strain is provided for by one portion of material, and the longitudinal strain by another, and it does not admit of a doubt that this is far preferable to subjecting the same material to two strains at right angles to each other at one and the same time.

Another objection has been taken to wire guns, and it is this. It is well known that guns become heated by firing, and it is thought that this heating would disturb

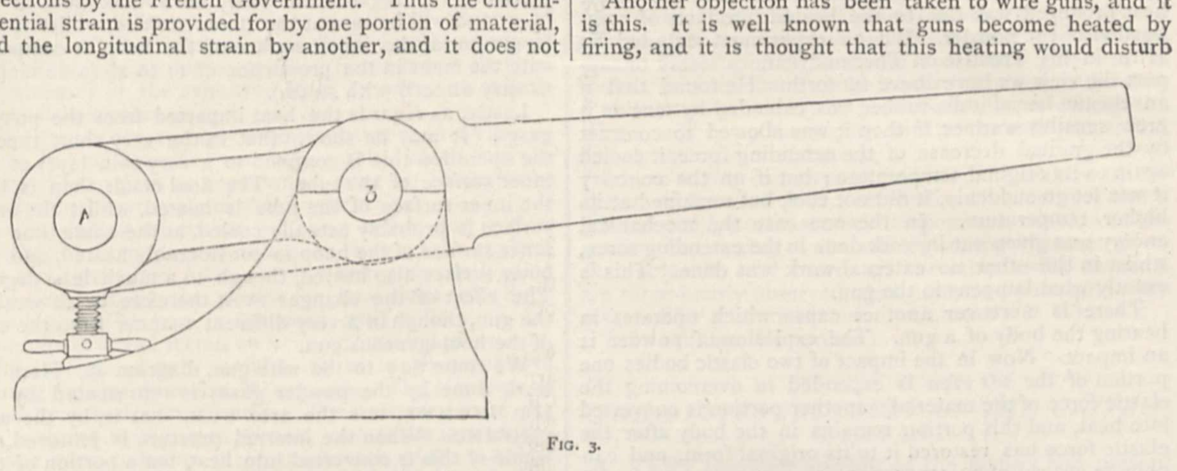
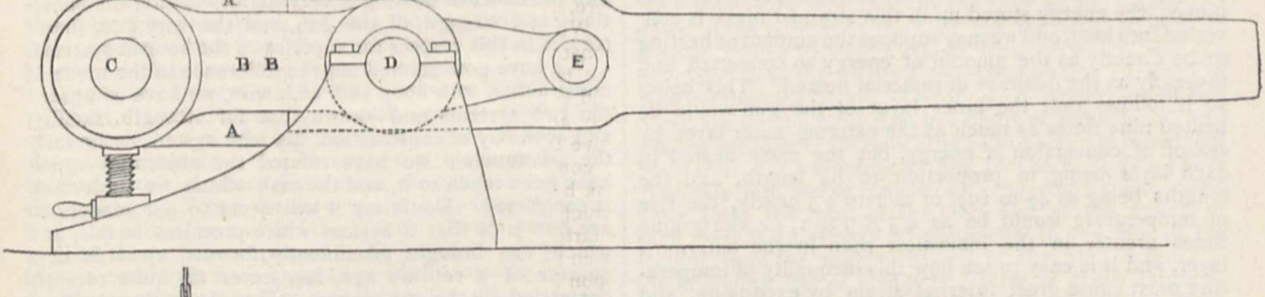


Fig. 3.

the tensions to such an extent as to render all the calculations of strain useless. Now if this be an objection, it applies with far greater force to the system of hoop construction than to that of wire, but as there is much misconception on this point it is desirable to say a few words about it.

In the first place, it is a mistake to suppose that the heating of guns depends chiefly on the heat absorbed by the metal from the powder gases. Though this heat is very intense, its application is for a very small fraction of a second, and it may be shown that in this very short time only a small amount of heat can be absorbed by the surface of the gun exposed to it. It may further be shown, that during the very short time the heat is

Fig. 4.



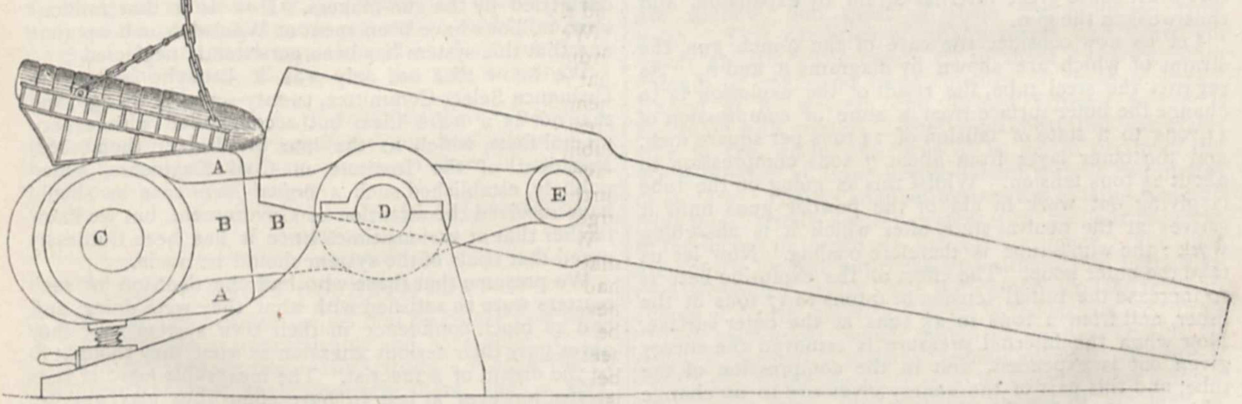


Fig. 5

applied, it can only be transmitted by internal conduction to a very small depth into the metal of the gun. But as guns do heat by firing, how is this to be accounted for?

The reason seems to be the following. By the explosion of the powder, a considerable amount of mechanical energy is absorbed in expanding the gun against the elastic form of the material. When the projectile leaves the gun, the internal pressure is removed, the mechanical energy is thus given back, but as it does no external work, it appears in the form of heat, which remains in the metal of the gun, until it is dissipated by convection through the surrounding air.

We are quite aware that this explanation does not agree with the views of some physicists of great reputation. For instance, in a recent discussion at the Institution of Civil Engineers, Dr. Siemens asserted that not a single unit of heat would be set up in the body of the gun by compressive action, and maintained that the whole heat produced was due to the heated products of combustion of the powder. But an experiment recorded by Hirn in his Treatise on Thermodynamics seems to support the view we have above set forth. He found that if an elastic bar of india-rubber was extended by tension it grew sensibly warmer, if then it was allowed to contract by the gradual decrease of the extending force, it cooled again to its original temperature; but if on the contrary it was let go suddenly, it did not cool, but remained at its higher temperature. In the one case the mechanical energy was given out in work done in the extending force, whilst in the other no external work was done. This is exactly what happens in the gun.

There is moreover another cause which operates in heating the body of a gun. The explosion of powder is an impact. Now in the impact of two elastic bodies one portion of the *vis viva* is expended in overcoming the elastic force of the material; another portion is converted into heat, and this portion remains in the body after the elastic force has restored it to its original form, and can only be got rid of by convection.

Thus there are two causes operating in heating a gun exclusive of the very small effect due to the heated products of combustion. Let us now examine what would be the result of this heating upon the various constructions of guns.

Take first the homogeneous gun, of which the state of strain is represented by diagram A, page 12. The strain at the inner surface of the gun during explosion is about 27 tons, whilst at the outer circumference it is only 3 tons per square inch. Now when the internal pressure is removed, the energy stored up in this strained mass is converted into heat, and we may suppose the amount of heating to be directly as the amount of energy so converted and inversely as the quantity of material heated. This being so, it follows that the inner layer of the gun would be heated nine times as much as the extreme outer layer by reason of conversion of energy, but the mass heated in each layer being in proportion to its length, and the lengths being as $4\frac{1}{2}$ to $19\frac{1}{2}$, or as 1 to 4·3 nearly, the rise of temperature would be as $4{\cdot}3 \times 9$ to 1, *i.e.* thirty-nine times greater in the innermost than in the outermost layer, and it is easy to see how this inequality of temperature must cause great internal strain by expansion, and thus weaken the gun.

Let us now consider the case of the 9-inch gun, the strains of which are shown by diagrams B_1 and B_2. As regards the steel tube, the result of the explosion is to change the inner surface from a state of compression of 11 tons to a state of tension of 12 tons per square inch, and the outer layer from about 7 tons compression to about $2\frac{1}{2}$ tons tension. Whilst this is going on the tube is giving out work in aid of the powder guns until it arrives at the neutral state, after which it is absorbing work; the whole tube is therefore cooling. Now let us take the outer hoop. The effect of the explosion here is to increase the initial tension of 6 tons to 17 tons at the inner, and from 2 tons to $4\frac{1}{2}$ tons at the outer surface. Now when the internal pressure is removed the energy given out is expended, first in the compression of the tube, and this part of the energy gives rise to no change of temperature, but the whole of the rest of the energy represented by 11 tons at the inner and $2\frac{1}{2}$ tons at the outer surface is converted into heat, and taking into consideration the masses the relative rise of temperature will be as $\frac{11}{7\frac{1}{2}}$ is to $\frac{2\frac{1}{2}}{19\frac{1}{2}}$, or as $11\frac{1}{2}$ to 1 nearly. Thus it appears that whilst from this cause the tube is cooled, the hoop is heated and expanded, which is equivalent to reducing the initial shrinkage of the hoop.

But we have still to deal with the heat set up by the percussive force of the explosion. This we may assume to be some direct function of the induced strain. It will therefore, as regards the tube, be a maximum at the inner and will be zero at the outer surface, whilst it will be greater at the inner surface of the hoop as compared with the outer in the proportion of 11 to $2\frac{1}{2}$ (assuming it to vary directly with strain).

Lastly, as regards the heat imparted from the powder gases. It may be shown that in the very short time of the operation this is confined to a very thin layer of the inner surface of the tube. The final result then is, that the inner surface of the tube is heated, whilst the outer surface is probably actually cooled, at the same time the inner surface of the hoop is considerably heated, and the outer surface also heated, though to a much less degree. The effect of the changes must therefore be to weaken the gun, though in a very different manner from the case of the homogeneous gun.

We come now to the wire gun, diagram E. Here the work done by the powder gases is represented by the arm BHOMNB, less the area BCN, that is, by the area CHOMNC. When the internal pressure is removed, the whole of this is converted into heat, but a portion of this between C and N would be neutralised by the cooling effect of the wires whilst converted into mechanical energy in passing from the compressive to the neutral state, and consequently the heating of the gun, though not absolutely uniform throughout, would be very nearly so. The heating from the percussive action would also be nearly uniform, being rather greater towards the inner surface. Now it can be shown that if a gun properly constructed either with hoops or wire be uniformly heated, the strains are not affected, and it therefore follows that in the wire gun the effect of heating is very slightly to alter the conditions and strength of the gun, and the wire gun, therefore, is in this respect far superior to the hooped systems.

We have now pointed out the difference in the mode of construction with hoop and with wire, we have compared the two systems and shown that for strength, facility, and economy of construction, the wire system has greatly the advantage; we have refuted the objections which have been taken to it, and the task which we undertook is completed. Doubtless it will occur to our readers to ask how it is that a system which promises so fair, and which was brought prominently forward upwards of a quarter of a century ago, has never till quite recently been tried by the gun-makers. How is it that millions upon millions have been spent at Woolwich on hoop guns and that this system has been persistently neglected?

We know that not only was it brought before the Ordnance Select Committee, twenty-seven years ago, and that not as a mere idea, but accompanied with experimental facts, which, as the late Mr. Bidder, then (1860) President of the Institute of Civil Engineers, stated publicly, established such a *primâ facie* case as should have received the attention of Government, but we know further that at various times since it has been fruitlessly urged that trials of the system should be made.

We presume that those who had the decision of such matters were so satisfied with what they were doing, and had so much confidence in their own system that they never gave their serious attention to what they thought to be the dream of a theorist. The inexorable logic of facts seems, however, at last to have come into play, and we believe that the recently-constituted Ordnance Committee is at present seriously engaged in the reconsideration of the whole subject of gun construction, and that wire guns will be admitted to be within the region of practical gun-making.

We trust it may be so, and that the system may be fairly tried, but in order that the trial may be fair, it is essential that it be conducted with due regard to those principles which it has been our object to explain—that the initial tensions of the wire coils be duly calculated and applied We insist specially on this, because not only has the Woolwich practice hitherto been to treat the shrinkage question in a hap-hasard rule of thumb method, but also Sir William Armstrong, in his late address as President of the Institution of Civil Engineers, made light of the precise degree of initial tension, and spoke of the tendency of the explosive force to effect an adjustment of the strains.

We cannot too strongly protest against such a view, as crude and unscientific, and any results which may be obtained from guns so constructed must be inconclusive as regards the principle of wire construction.

In concluding this article we bring before our readers sketches of three types of wire guns showing the application of the principle. The first is a heavy muzzle-loading gun, designed by the writer for land defences (Figs. 1 and 2). The gun is furnished with rollers on the trunnions at G, and recoils up a curved inclined plane, I I I, which is mounted on a turnable, so as to be capable of training in any direction in azimuth. The elevation is given by a hydraulic lift at K. The construction of the gun is shown in Fig. 1, in section. A A is the inner tube; B B the wire coiled on it; C the breech plug; E E is a heavy casting of cast iron, against which the breech plug rests, and which also forms the trunnions, G G; K K is a cast-iron casing covering the chase of the gun, and attached to the casting E E by strong iron bolts, F F. In this gun there is no longitudinal strain on the chase; the recoil being taken up by the insertion of the heavy mass behind the breech plug and by the force of gravity on the ascending planes of the carriage, aided by compressors.

The second type, Fig. 3, is a muzzle-loading gun mounted on an ordinary carriage. The main trunnions are behind the breech and are connected to the carriage trunnions B by side links C, so that the longitudinal strain is transmitted direct from the breech to the carriage without the intervention of the chase of the gun.

Figs. 4 and 5 represent the type for heavy breech-loading guns. In this case the breech plug is fixed in a massive block, A A, which slides backwards and forwards along the side rods, B B. Through this block passes an eccentric shaft, C, which terminates on each side in the side rods B B. When the eccentric is in its forward position the sliding block closes the breech. In the backward position the breech is open and the gun tops up on the forward trunnions E, so as to allow of the introduction of the charge as shown in Fig. 5. When the charge is introduced the preponderance is restored to the breech end, the gun falls back to its normal position, the eccentric is removed, the breech closed, and the gun is ready for firing.

In all these cases it is obvious that there is no longitudinal strain on the chase of the gun, and it is obvious that so far as construction is concerned there is no limit to the possible size of the gun.

JAMES A. LONGRIDGE

BEN NEVIS OBSERVATORY

THE conditions of weather on Ben Nevis are now such as to render it impracticable and hazardous to continue the daily observations satisfactorily. I have therefore judged it best to discontinue them, after a very successful season, under the auspices of the Scottish Meteorological Society, of five months from June 1, without the break of a single day. The work at the six intermediate fixed stations has, I am very pleased to say, been well and generally punctually kept up throughout, and I trust that much good will result. Simultaneous observations were of course made at the observatory at Achintore, Fort William. The Stevenson's screens at these stations have now been made firm by wire stays to withstand the storms of winter. Yesterday Colin Cameron, the guide, accompanied me. The track was snowed up, and it was necessary to force a way through great banks and drifts of snow. The average depth was two feet; once we got off our course in the blankness of thick cloud-fog and trackless snow. To-day the weather was very bad on the summit, the hut was partly filled by drift, and the south-east gale was so violent at times that I could hardly make way. Possibly I shall attempt weekly or periodical ascents during the winter to keep up the registrations of the rain-gauges and self-recording thermometers.

I have to-day commenced provisionally a three-hourly system of observation at Fort William (including 3 a.m.). The special features are sea temperature, ozone, and the reading and setting of the self-registering instruments on each occasion. Of course all the other usual elements are three-hourly observed also. Further particulars are reserved for a future number. CLEMENT R. WRAGGE

Fort William, November 1

THE OYSTER INDUSTRY OF THE UNITED STATES

A VERY complete account of the history and present condition of the oyster industry of the United States has been recently prepared by Ernest Ingersoll, under the direction of Prof. Baird, United States Commissioner of Fisheries. The importance of this industry it is not easy to over-estimate, and the United States Government deserve every credit for their efforts to preserve and extend it.

As having an important bearing on the question, the oyster-beds of the maritime provinces of Canada are briefly referred to. The eastern coast of the province of New Brunswick is washed by the Gulf of St. Lawrence; down in the bottom of the Gulf lies the long, irregularly shaped Prince Edward's Island, between which and the mainland flow the shallow but troublesome currents of Northumberland Strait. The shores on either side of this Strait are for the most part low bluffs of reddish soil and sloping meadows; there is little solid rock, few prominent headlands, but a continuous line of shore, shelving very gradually into water, nowhere deep; many rivers come down along the coast of the Gulf, and at the mouth of each there is an estuary proportionate to the size of the stream, from the mighty channel of the St. Lawrence to the miniature bay of Bedeque. Most of these estuaries are shallow, and most of them are protected from gales. This condition of affairs seems well suited for oyster growth, since nearly all of these estuaries either contain or contained large colonies of these mollusks. Except at its western end, Prince Edward Island is engirdled with oysters. That most beautiful salt-water lake in the world, the Bras d'Or, which occupies the whole interior of Cape Breton Island, fattens multitudes of oysters. These Canadian oysters are of large size, and have thick, strong shells; oysters with shells from eight to ten inches in length are not extraordinary. The best are not the longest, but those with straight and narrow, or evenly-rounded shells. All the oysters on the eastern shores of North America, belong to the species known as *Ostrea virginiana*, which embraces many varieties, of which *O. borealis* is perhaps the best marked. Except at wholly unsuitable places, it is to be found almost without interruption from the northern shores of the Gulf of Mexico and the coast of Florida to the Canadian districts just referred to. It is, however, said not to be found along the eastern shores of Maine, nor in the Bay of Fundy, though the shells, in a semi-fossil state, are dug up in quantities from the deep mud in the harbour of Portland, Maine.

Mr. Ingersoll gives a very interesting account of the former extent and condition of the native beds in the Gulf of Maine, and of the evidence of the immense consumption of the oyster by the Indian tribes. The shell mounds discovered are of immense size, and the shells themselves reached a quite monstrous dimension; the animals were killed either by fire, or by smashing in the shell at the attachment of the adductor muscles, and possibly even by the opening of the shell by stone knives. In many localities north of Cape Cod, the disappearance of the oyster has been comparatively recent. Some ascribe this to the pollution of the water by mills, but Prof. Verrill thinks a change of climate may have had something to do with it. Oyster culture has been tried, but unsuccessfully, on this coast; a great business in "laying down" oysters is still carried on at Wellfleet.

Coming south of Cape Cod, we find Buzzard Bay and Vineyard Sound, early known for their fine beds of natural oysters. More than a century ago, strict regulations were made about their take and export, but these beds would seem to be nearly worked out.

The charter of Charles II. gave the colony of Rhode Island (1683) free fishing in every form. At one period large quantities of oysters were destroyed for the sake of the lime in their shells. Now statutes are in force specially guarding the mollusc, and the oysters are now yearly increasing in quantity and lessening in price, and over 960 acres of oyster-ground were let in Rhode Island in 1879. About one-half of the oysters raised are natives, and the other half are Virginia oysters brought to the grounds to be fattened. The probable amount of capital invested in this district may be about 1,000,000 dollars, and the yield and value as against this is about 600,000 dollars at wholesale prices.

The Virginia trade began some fifty years ago, when Capt Farran gathered a sloop-load of some 600 bushels. Now the profits of a single firm in 1856 were 25,000 dollars a year. When the native supply grew slack, very successful efforts at cultivation were made. Out of seven to eight thousand acres marked for oyster-culture in New Haven Harbour, only one-half are in use. One proprietor operates on 1500 acres, and full details of the various methods of culture adopted are given in this report.

Coming further south, the southern shore of Long Island was early famous for its oysters, and we know how the old blue point oysters were relished by the Dutch settlers. In 1853 they were sold for an average of ten shillings a hundred from the beds. In 1873 Count Pourtales called attention to their getting scarce, and since 1879 it has required an importation of 100,000 bushels of seed to keep up the supply. This seed then had only to be gathered, or was worth but little, now its price has increased threefold. The principal market now-a-days for these Blue Points is Europe. In the markets of London they commanded a high price, retaining their supremacy over all other sorts, until in 1879 when the season being a bad one, the oysters grown in Staten Island Sound surpassed them. Not only are they of a superior flavour, but they have a round thin shell, and are of a medium size. The Rockaway district supplies an immense quantity of oysters; it is but the western end of the south shore of Long Island. While most of the stock finds its way to New York, lately the oysters from this district have found their way into the European market, selling as "French" stock. In New York Bay the growth of transplanted oysters is fairly rapid, and a great many are sent from there to Europe. In New York City the oyster trade is of very considerable importance, which centres itself in two localities at the foot of Broome Street, East River, and of West Tenth Street, North River. The quantities handled each year in the city has been approximately estimated as about 765,000,000 oysters. A large number go to England, where the "Blue Points" having lost favour, the "East Rivers" and "Sounds" have taken, in a measure, their place. Between October 9, 1880, and May 14, 1881, being one season, there was exported from New York to Europe a total of 70,768 barrels, of which 68,140 barrels went to Liverpool. Each barrel contained on an average 1200 oysters.

Along the New Jersey shore a large quantity of oysters are raised, and the western shore of Delaware Bay is the scene of planting the southern oysters, which are brought annually from the Chesapeake, and are fattened for the markets of Philadelphia. This city is credited with an intake of oysters, amounting in 1880 to about 800,000,000, but then, unlike New York, this quantity is not wholly consumed in Philadelphia, but is in part distributed to the surrounding regions, but the calculation has been made that this million-peopled city consumes on an average during half the year, 300,000,000. The retail trade gives employment to over 3500 people.

The oyster fisheries of Maryland are among the most important in America, and it is claimed that the beds of Chesapeake Bay, about equally divided between the two States of Maryland and Virginia, contain the best oysters in the world. The oyster trade of this region is immense, giving employment to thousands. A body of police, with a steamer and two tenders, with eight sloops, watch hourly over the grounds, but the territory to be watched is so vast—the beds of Maryland extend for a distance of 125 miles—that the police sometimes fail to catch illegal dredgers, and serious encounters, as in the winter of 1879-80, have occurred.

It cannot be too often asserted that even the splendid beds of this district may, by unrestricted dredging, become exhausted. Properly protected and cared for, this wealth might be increased manyfold. Thirty years ago we read, the depletion of the beds at Pocomoke Sound and in Tangier seemed a thing impossible, now from want of a period of rest they have fallen off in their produce, the former by four-fifths, the latter by two-thirds. The statistics of this great fishery extends over many pages. It was at Baltimore the "steamed" oyster trade began, and this city, the great oyster market of the United States, packs more of this mollusc than any other city in the world.

In North Carolina the business in oysters and their culture is of small proportions, and not much is known of the fisheries of Georgia. Of the oyster interests in Florida there is little to be said. Coming to the Gulf of Mexico, the Mobile supply must be noted, as they have a high reputation for excellence. The New Orleans market is supplied from an extent of coast comprising the whole water front of North Mississippi and Louisiana.

Appended to this report there is a condensed account of the anatomy and development of the oyster, taken from the memoir of Dr. W. K. Brooks, of the John Hopkins University of Baltimore, and accompanied by a full series of drawings of the growth of the young oyster.

NOTES

THE following is the list of names nominated for the Council of the Royal Society to be balloted for on November 30:—President, William Spottiswoode, M.A., D.C.L., LL.D. Treasurer, John Evans, D.C.L., LL.D. Secretaries: Prof. George Gabriel Stokes, M.A., D.C.L., LL.D., Prof. Michael Foster, M.A., M.D. Foreign Secretary, Prof. Alexander William Williamson, LL.D. Other Members of the Council: Prof. W. Grylls Adams, M.A., F.C.P.S., John Ball, M.A. F.R.A.S., Thomas Lauder Brunton, M.D., Sc.D., Prof. Heinrich Debus, Ph.D., F.C.S., Francis Galton, M.A., F.G.S., Prof. Olaus Henrici, Ph.D., Prof. Thomas Henry Huxley, LL.D., Prof. E. Ray Lankester, M.A., Prof. Joseph Lister, M.D., Prof. Joseph Prestwich, M.A., F.G.S., Prof. Osborne Reynolds, M.A., Prof. Henry Enfield Roscoe, B.A., LL.D., Marquis of Salisbury, K.G., M.A., Osbert Salvin, M.A., F.L.S., Warington W. Smyth, M.A., F.G.S., Edward James Stone, M.A., F.R.A.S.

THE death is announced, at the early age of thirty-two years, of Prof. Marino Palmieri, Professor of Physics at Naples University, and so well known for his seismological researches. We hope to refer to Palmieri's work in an early number.

WE also regret to announce the death of Prof. J. Th. Reinhardt, Professor of Zoology at Copenhagen University and Inspector of the Natural History Museum of that city, an ornithologist of great merit; he died at Copenhagen on October 23, aged sixty-six. The death is also announced of Dr. F. H. Troschel, Professor of Zoology at Bonn, and of Dr. Julius Friedländer, the head of the well-known Berlin publishing house and scientific agency of that name.

PROF. VIRCHOW has had a serious attack of illness, but we are glad to learn from the latest intelligence that he is slightly better.

WE see from *The Gazette* of Montreal that the meeting held in that city on October 26, in connection with the proposed visit of the British Association to Canada in 1884, was large and influential. Much enthusiasm was displayed at the prospect of the Association's visit, and several resolutions were passed guaranteeing a hearty welcome and every provision for the success of the meeting, and the comfort and entertainment of the visitors. A large committee was appointed to carry out arrangements, and at the close of the meeting a considerable sum was subscribed as a guarantee fund. Dr. Sterry Hunt stated that in 1884 the American Association would probably meet at Newhaven, at such a time as to admit of the English visitors attending both meetings.

ON October 9 was unveiled, at the University town of Würzburg, a memorial to Von Siebold, the celebrated Oriental *savant*. For some years past the Horticultural Society of Vienna has collected subscriptions for this purpose, and it is interesting to note that a considerable sum was subscribed amongst the Japanese, although they have already erected a colossal stone to his memory at Nagasaki. Siebold was the greatest of all the students of Japan during what may be called the Dutch period, that is, from about 1620, when all Europeans except the Dutch were expelled from Japan, down to 1854, when Perry succeeded in making the first of the recent treaties with that country. During this time the facilities for the foreign student were few. The members of the Dutch factory were confined to the settlement at Deshima, which was about the size of a small London square; all egress, except on certain rare occasions, was denied to them, and this intercourse with the people was confined to the few interpreters and officials employed to watch their movements. Once a year the head of the factory, with a small suite, journeyed overland to Yedo with presents to the Shôgun; but while on the road the foreigners were as closely guarded as prisoners, and all opportunity of conversation or intercourse with the people was denied them. Notwithstanding these unpromising circumstances, however, Kaempfer, Titsingh, Thunberg, and especially Siebold, succeeded in obtaining the materials for works which will for years to come retain their position as the very best works in the country. About 1820 Siebold was appointed surgeon to the Dutch forces in Java, and in 1826 made his first voyage to Japan, where he became physician to the factory at Deshima. He seems first to have acquired a sound knowledge of the language, and then, through the native *employés*, to have procured books as he required them. For eight or ten years he remained quietly in Japan, accumulating vast stores of information for subsequent use, and journeying occasionally with the annual mission to Yedo. On his return to Europe he proceeded to publish his great works, "Fauna Japonica," and "Flora Japonica," the expenses of which were defrayed, we believe, by the King of the Netherlands. He again returned to Japan, and was there during the signing of the American and other treaties, and was even in this early time constantly employed by the Japanese Government in advising them how to thread their way through the difficulties of their new position. On one of his previous journeys to Yedo he had received permission to reside there for a period, provided he taught western medicine to a number of Japanese students. He got into serious danger through having in his possession a complete native map of Japan, which one of his pupils had succeeded in conveying to him. The latter is said to have lost his life, and Siebold returned to Deshima. On his second return to Europe with his large collection of Japanese books, maps, specimens of the artistic productions of the country, of the fauna, flora, &c., he was received with honour by the Emperor of Russia and other European potentates. He then commenced the publication in parts of his *Magnum opus Nippon*, which he never lived to complete. This work might with much justice be styled the Encyclopædia Japonica. Besides native works, every book published in the East in European language was consulted. Whatever the labours of subsequent students, large sections of this book, such as the history of European discoveries in the Eastern seas, will always retain their value. After his death his vast collections were distributed among various museums on the Continent. The larger share, as was only natural, went to Leyden; but the British Museum succeeded in obtaining his splendid library of Japanese books and maps.

THE August number of the *Mittheilungen der deutschen Gesellschaft* of Yokohama contains several papers of much interest. The numerous and curious New Year's customs of Japan are described by Mr. Sataro Hirose, a native medical student, while Mr. Schült gives a topographical sketch of Mount Fugi and its neighbourhood. Dr. Scheube contributes a long paper on the food of the Japanese. He was enabled, in the college with which he is connected, to examine the food of various classes, and from his statistics, meat appears to play but a small part in the nourishment of the people. Rice occupies about 50 per cent. of their total diet. Dr. Baelz describes the various infectious diseases of Japan, and Mr. Leysner furnishes statistics for the past ten years of the climate of Niigata, the principal town on the West Coast. The number and value of the contributions of this small society—it numbers only forty-nine resident members—would be little short of astounding, did we not recollect that most of the Germans employed by the Japanese Government are men of scientific attainments, and devote much study to the country in which they live.

WE have received from M. Georges Dary, of Paris, a note commenting on Prof. S. Thompson's article upon Electric Navigation. M. Dary informs us that the source of power upon which M. Trouvé has fallen back is a bichromate (primary) battery weighing only 120 kilogrammes, or less than one-tenth of the accumulators used by Mr. Volckmar in the iron launch *Electricity*. This battery, M. Dary states, has an electromotive force of 96 volts—equal to that of the 45 accumulators—but he does not state what strength of current it will furnish, nor for how many hours. M. Dary adds that 500 similar apparatuses—he does not say whether this means 500 boats, or 500 batteries, or 500 motors—like that used by M. Trouvé in navigating the Seine in his skiff, have already been exported from Paris. This bichromate battery, it appears, has enabled M. Trouvé to undertake journeys which with little exaggeration may be called long voyages, as, for example, from Havre to Rouen; and there are numerous owners of electrical boats who run every day between places twelve or fourteen miles apart, using two sets of cells for the run. We are glad to be able to do so ingenious an inventor as M. Trouvé the justice of making more widely known the real progress which he has made in this matter.

A COLOSSAL statue of George Stephenson, and another of James Watt, both after models by Prof. Keil, are now being completed in the studio of the eminent German sculptor, Herr Bock, and are intended for the new Polytechnic at Charlottenburg, near Berlin.

THE comet was seen at the Paris Observatory by M. Bigourdan, one of the astronomers, on October 23. It was found to be very brilliant. The observation was presented by M. Mouchez, with two others done by M. Thollon at the Nice Observatory. The sodium lines, which were very brilliant on September 18, had wholly disappeared on October 9, when the comet was seen for the first time after a very long observation of the sky.

THE first meeting of the One Hundredth and Twenty-Ninth Session of the Society of Arts will be held on Wednesday, November 15, when the Opening Address will be delivered by Charles William Siemens, D.C.L., LL.D., F.R.S., Chairman of the Council. The following papers are announced for reading at the meetings before Christmas:—J. Hopkinson, D.Sc., F.R.S., Ice-making and Refrigerating; W. H. Preece, F.R.S., Electrical Exhibitions; William A. Gibbs, the Artificial Drying of Crops; P. L. Simmonds, the Utilisation of Waste; W. K. Burton, the Sanitary Inspection of Houses. For meetings after Christmas:—J. H. Evans, the Modern Lathe; Capt. J. H. Colomb, R.N., Collisions at Sea; A. J. Hipkins, the History of the Pianoforte; J. Donaldson, the Construction of Torpedo Boats; C. F. Cross. F.C.S., Technical Aspects of Lignification; W. N. Hartley, F.R.S.E., Self-purification of River Waters; James J. Dobbie, D.Sc., and John Hutchinson, the Application of Electrolysis to Bleaching and Printing." Arrangements have been made for Five Courses of Cantor Lectures:—On Dynamo-Electric Machinery, by Prof. Silvanus P. Thomson, D.Sc.; on Solid and Liquid Illuminating Agents, by Leopold Field; on the Decorative Treatment of Metal in Architecture, by G. H. Birch; on the Transmission of Energy, by Prof. Osborne Reynolds, M.A., F.R.S.; on Secondary Batteries, by Prof. Oliver J. Lodge, M.A., D.Sc. The usual short Course of Juvenile Lectures will be given during the Christmas holidays by Prof. Henry Nottidge Moseley, M.A., F.R.S., on the Inhabitants of the Ocean.

PROF. GEORGE M. MINCHIN will publish very shortly, at the Clarendon Press, a work on "Uniplanar Kinematics of Solids and Fluids, with Applications to the Distribution and Flow of Electricity." It aims at supplying a deficiency in the course of mathematical physics usually pursued by the higher-class students in our colleges and universities, by enabling them to enter into the study of kinetics with clear notions of acceleration and other leading conceptions which belong to the province of kinematics.

THE delegates of the Clarendon Press have determined to issue a series of translations of important original papers in foreign languages on biological subjects, and have committed the editing of these memoirs to Dr. Michael Foster, Dr. Pye-Smith, and Dr. Burdon Sanderson. It is proposed that the series should begin with a single volume of about 750 pages, to be divided into three parts: the first to comprise the treatise of Prof. Heidenhain on "The Physiology of the Process of Secretion"; the second a series of four papers by Prof. Goltz on "The Functions of the Brain," and a memoir by N. Bubnoff and Prof. Heidenhain on "Excitatory and Inhibitory Processes in the Motor Centres of the Brain"; and the third a series of memoirs by Prof. Engelmann on "The Structure and Physiology of the Elementary Contractile Tissues." It is intended that each part should be complete in itself, and should be published separately.

THE medical faculty of the Göttingen University has announced as a subject of prize competition, for 1883, a thorough investigation with the more recent aids of microscopical art, of the mucous membrane of the bladder and urethra of both sexes, especially with reference to their gland-contents, and the varying forms of the epithelial cells in expansion of the ducts. The philosophical faculty propounds two subjects, one of which is an investigation and setting forth of the mode of development of the flower of our common mistletoe (*Viscum album*), with critical consideration of the literature of the subject.

MOUNT ETNA has for some days been showing great and increasing activity, emitting flashes of fire and dense volumes of smoke.

AN Arabic manuscript of the year 1365, from which Herr Gildemeister has translated several extracts for the Göttingen Society of Sciences, affords an interesting peep at nautical matters among the Arabians of those times. The author deals separately with the ships of the Mediterranean, of the Indian Ocean, and Red Sea, and of the Nile and other rivers. *Inter alia*, he describes a mariner's compass; and this is noteworthy, inasmuch as only one description of the instrument in an Arabian work has hitherto been known (it is of date 1242). The following is a curious picture:—"A ship [of the Indian Ocean] carries generally four divers, whose only duty is, when the water rises in the ship, to smear themselves with sesame oil, stop their nostrils with wax, and, while the ship is sailing, jump into the sea. Each has two hooks connected with a thin line; one of these he fixes in the wood of the ship, and with the other he dives. He swims like a fish a little under the water, and uses only his ear. Where he hears the trickling of water he stops with wax where there are holes, stopped with palm stems, and where there is sewing, he often passes a piece of cocoa fibre through the fixed palm stem. The thing is easy to him; in a day he stops over twenty or thirty leaks. The diver comes up, without inconvenience, whether there is wind or calm."

THREE new Lyceums, in which instruction will be given in Finnish, will be opened in a few weeks in Finland, at Abo, Uleaborg, and Björneborg, thus raising the number of Finnish Lyceums to eight. In the Helsingfors University, lectures in Finnish are delivered on all subjects in connection with the Archæology and History of the north, as also in Botany by Prof. Wainio.

M. W. DE FONVIELLE has just published (Hachette and Co.) a little volume on "La Pose du Premier Cable," in which the principal incidents connected with this great undertaking are told in a dramatic and popular manner.

MR. MUYBRIDGE has issued a series of his well-known instantaneous pictures of animals in motion, adapted for the zoetrope. Those sent to us include the horse under various conditions, the deer, and the dog. They are exact reproductions of the photographs, and in their faithfulness to reality are a great improvement on the existing zoetrope pictures. Mr. Muybridge is preparing for publication a complete series of his original photographs, adapted for his zoopraxiscope.

UNDER the title of "La Navigation Électrique" (Paris, Baudry), M. Georges Dary gives some interesting notes on electric navigation, with special reference to the experiments of M. Trouvé. Bemrose and Son have issued a little handbook, "The Electric Light Popularly Explained," by Mr. A. Bromley Holmes; and Macmillan and Co. a useful manual of "Electric Light Arithmetic," by Mr. R. E. Day, M.A.

THE Austrian Archæological Expedition to Asia Minor has returned to Vienna, and the objects found in the excavations made and packed in 167 cases have arrived there.

PROF. SIMONY has recently ascended the Dachstein in order to make some exact measurements concerning the decrease of the Dachstein glaciers. He found that the so-called Karlseisfeld has since 1856 lost about 50-60 metres in thickness, the middle portion about 40-50 metres. The decrease in the thickness of the ice is most noticeable in the high and steep descent from the middle to the lower portion of this glacier. Here a piece of the glacier-bed—a rock of about 30 metres in height and 60 broad—has been laid quite bare. Up to 1856 the glaciers were steadily increasing, but since then the decrease has been equally incessant.

IN the ordinary air thermometer the pressure of the air in the thermometric bulb is generally measured by means of a mercury manometer. M. Schneebeli, of Zurich (*Archives des Sciences*), employs, instead of the latter, a metallic manometer, of the Hottinger-Goldschmidt system. The bulb of the thermometer terminates in a capillary tube, to which the manometer is connected by means of another capillary tube of lead. The space between the latter and the elastic membrane of the manometer is filled with glycerine. M. Schneebeli believes the arrangement capable of being really serviceable to industry, because of the simplicity of its construction and of the manipulations required. A mere reading of the position of the manometric pointer gives the temperature.

OUR ASTRONOMICAL COLUMN

COMET 1882, *b*.—In consequence of cloudy mornings, it is stated that this comet was not seen at Melbourne until 5 a.m. on September 10; it was visible with the telescope till within one minute of sunrise, and its intrinsic brightness was estimated equal to that of the planet Jupiter. The tail was well defined and bright, but extending only over 3° or 4° at most. At 5h. 24m. 51s. a.m. its right ascension was 9h. 45m. 46·61s., with 0° 53′ 36″ south declination.

At Adelaide the comet was remarked from the observatory on the morning of September 9, but Mr. Todd reports that a police-constable had seen it a few mornings previously.

Prof. Riccò observed it at 11 a.m. on September 22, with the Palermo refractor of 0·25 m. aperture; there was a trace of a tail towards the south-west. At the same hour on September 23 Prof. Millosevich saw it at Rome, and describes it as "un fiocchetto di lana disegualmente illuminato."

It appears by no means improbable that with our larger telescopes the comet may be visible till the end of the year, or later. About the time of new moon, or at midnight on January 8, its place will be in R.A. 6h. 53m., with 23° south declination, distant from the earth 2·21, and from the sun 2·57, so that it will be upon the meridian at 11h. 40m. p.m., with an altitude of more than 15° at Greenwich.

With regard to the distinguishing letter which has been attached to the comet in this column, Mr. T. W. Backhouse writes from Sunderland:—"Surely it is a mistake to call the present comet 'Comet *b* 1882.' Is not Well's comet *a;* the comet seen in the eclipse, *b;* the great comet, *c;* Barnard's comet, *d;* and Schmidt's, *e?*" On this point we should reply that the main or indeed only reason for attaching letters to comets as they are discovered is to afford a ready means of distinguishing them *while they are under observation:* when the orbits are catalogued the comets appear as I., II., III., &c., of a particular year. The comet of May 18 was only seen for a minute during the totality of the eclipse, having been looked for unsuccessfully morning and evening subsequently, at least by M. Trepied. It is not likely to be mentioned except in connection with the eclipse, and there is, consequently, no apparent utility in assigning a letter to it. We may take the opportunity to remark that M. Trepied, who did not regard this object as a comet while he had it in view, has informed us in conversation within the last fortnight that he is now quite convinced of its cometary nature.

THE NOVEMBER METEORS.—The first comet of 1866, in the track of which the periodical meteors of November are found to move, has probably just passed the aphelion point of its orbit, which is distant from the sun 19·673, the earth's mean distance being taken as unity. It may be interesting to note the character of the shower under this condition, should it be repeated when the earth arrives at the descending node of the comet's orbit on the evening of November 13.

On the morning of October 23, when the great comet was so favourably viewed in the vicinity of London, a number of bright meteors diverged from a point not far from the radiant of the November shower.

GEOGRAPHICAL NOTES

ACCORDING to the Russian newspaper *Sibir*, the meteorological expedition to the mouth of the Lena has started on board large boats provided with all necessaries for building a house, and for successful wintering. The station will be erected on the Tumanskaya branch of the Lena, if the water is deep enough in this branch to allow the passage of the boats. It is hoped that, with the exception of the three summer months, the reports of the station will reach Yakutsk regularly. They will be sent, first, by M. Jurgens to Bulun; thence they will be forwarded to Nerkhoyansk, where they will be taken up by the post, which will run twice a month instead of once every four months as before. In the summer, the *tundra* being covered with water, messages can be sent only *viâ* the Lena; they will be taken by the merchants who leave Bulun for Yakutsk, as soon as the ice is melted, and reach Yakutsk in the end of July; another message can be sent with the returning fishermen, who reach Yakutsk in September.

THE *Germania,* which conveyed the German North Polar Expedition to Kingawa in Cumberland Sound, has returned to Hamburg. When the *Germania* left Kingawa on September 6, the observatory was completed, so that observations had already begun. Besides the two larger expeditions sent out by the German Government, Dr. Koch has also been sent to Labrador in order to establish meteorological observatories among the missionary settlements of the Moravian brotherhood. Dr. Koch arrived at Hoffenthal Port on August 10, and was liberally supported by the missionaries. All the stations set down in the programme, viz.: Hoffenthal, Zoar, Nain, Ramah, Hebron, and Obak have now been established. A meteorological station has also been established on the Falkland Islands. It is to form an intermediary between the stations on the South American continent and that on South Georgia, and also to help in rendering more valuable the observations made on board of vessels passing through the neighbouring seas. Capt. Seemann, who was sent to the Falkland Islands by the Deutsche Seewarte, reports that work has begun.

A DESPATCH, dated September 19, has been received in Stockholm from the Swedish Meteorological Expedition at Smith's Observatory, Spitzbergen. It states that observations are being regularly made, and that all was well with the members.

THE November part of Hartleben's "Deutsche Rundschau für Geographie und Statistik" contains articles on land formations in the Sunda district, by Jos. v. Lehnert; on the position of women in the life of peoples, by Dr. M. Geistbeck; on the North Sea according to the investigations of the Norwegian Expedition during the years 1876 to 1878, by Dr. J. Chavanne; on the ethnography of Central Asia, by Prof. Ujfalvy; on the transit of Venus and the solar parallax, by Dr. J. Holetschek; on the hydrography of Africa and the Welle problem, by J. Chavanne. There is a good ethnographical map of Central Asia.

A CATALOGUE of the fine commercial collections in the Oriental Museum in Vienna has been issued, as also a small volume of "Neue Volkwirthschaftliche Studien über Constantinopel und das anliegende Gebiet." In the latter, especially, the ornithologist will find several things to instruct him.

THE Municipal Council of Paris has granted unanimously a gold medal of 120*l*. to M. Savorgnan de Brazza, for his discoveries in Tropical Africa.

LIEUT. BOVE, together with the Italians of the Antarctic Expedition scientific staff, arrived at Genoa all well.

THE well-known Bremen naturalist, Dr. Otto Finsch, to whose travels in Polynesia we recently referred, has just returned to Berlin. During the last six months the traveller was in New Guinea, and instituted anthropological comparisons between the Papuans and the Eastern Melanesians. He is accompanied by a native of New Britain, aged fifteen. His sketches of New Zealand, New Britain, New Guinea, and the Caroline Archipelago are exceedingly well drawn and valuable. He brings about 100 cases of ethnographical specimens intended for the new Ethnological Museum at Berlin.

THE AIMS AND METHOD OF GEOLOGICAL INQUIRY[1]

IN entering upon the duties of this Chair I can hardly do better, perhaps, than try to set before you what are the primary aims and general bearings of that branch of natural science which we are about to study, and to indicate the nature of the problems with which it deals. In doing so I will endeavour at the same time to point out the method of research and the mode of reasoning which we must pursue if we are to be successful investigators. Geology (in which comprehensive term I include mineralogy and palæontology), is concerned in the first place with observations of minerals, rocks, and fossil organic remains, and in the second place with the inferences which may be drawn from those observations. Its object is thus not only to note the nature and position of the various materials which constitute the solid crust of our globe, but by processes of inductive and deductive reasoning to ascertain how minerals and rocks have been formed and caused to assume the different appearances which they now present. In few words, then, our science might be defined as an inquiry into the history or development of the earth's crust, and of the several floras and faunas which have clothed and peopled its surface. It thus treats of the genesis of oceanic and continental areas—of mutations of climate—of the appearance and disappearance of successive tribes of plants and animals. More than this, in revealing the past it throws strong light upon the present, and has, perhaps, more than any of the cognate sciences, tended to revolutionise our conceptions of nature, and to lead zoologists and botanists into fruitful fields of inquiry which their own proper studies, no matter how assiduously prosecuted, could never have enabled them to reach.

Dealing, as geology does, with the operations of Nature in the past, it is obvious that before we proceed to interpret the record of the rocks we ought to have a clear knowledge of the mode in which Nature works at present. Without this preliminary knowledge, it is just as hopeless to attempt to decipher that record as it would be to endeavour to understand a page of Greek without having first mastered the grammar and rudiments of that language. We must turn our attention then, at the very outset, to a study of those great forces by the action of which the crust of our globe is being continually modified. It is essential that we learn to appreciate the work done by the atmosphere, by frost and snow and ice, by rain and underground water, by rivers and lakes, by the sea, by plants and animals, and by the subterranean forces, before we can hope to recognise the different parts which those various agents of change have performed in the past. All geologists are agreed upon this, and are ready to acknowledge it as the chief article of their faith. Nevertheless, this obligatory article has received different interpretations. Some, for example, have held that the present condition of things must be taken as the exact type of all the phases through which the earth's surface has passed, during the different stages of which we have any recognisable records preserved to us in the stratified rocks of the globe. They admit that countless modifications of land and sea have taken place—that the climate of particular areas has varied again and again—that the subterranean and volcanic forces have manifested themselves with unvarying intensity, now in one place, now in another—but they hold that all these changes have been accomplished upon the same scale and at the same rate as at present, and that, as a consequence, the development of floras and faunas, so far as that is dependent upon physical conditions, has proceeded no more rapidly in former times than in our own day. They do not, indeed, deny that in the very earliest stages of the earth's history the agents of geological change must have acted with greater intensity than now, but of such a period, they tell us, we have no certain evidence treasured up in the sedimentary rocks, or at least such evidence, if it should exist, has not yet been detected. Only allow time, they say, and the constant drop will wear away the hardest stone. The gradual elevation of land, which is now going on in certain parts of the globe at so slow a rate that some have been inclined to doubt whether there is any movement at all, would nevertheless suffice in time to lift tracts now within tide-wash into stupendous table-lands and mountains. Nor is it necessary, we are assured, to suppose that the apparent evidence of convulsive rending and displacement of strata, which is often so conspicuous in the heart of great mountain-chains and ranges, is really any proof of paroxysmal action. All the rupturing and confusion which we may note among the Alps and not a few mountain-regions, may quite well have been brought about, we are informed, in the most gentle and gradual manner.

Other theorists, again, are of opinion that, while the agents of change have necessarily been through all time the same in kind, they have yet varied again and again in degree, and that the present moderate condition of things cannot therefore be taken as an exact type and pattern of all preceding phases in the world's history. They cannot allow that the elevation of mountain-chains and the larger fractures and displacements of strata are the result of the repetition of such small movements of the crust as are taking place now. Admitting that considerable areas of the earth's surface are rising at the rate of a yard or more in a century, they yet cannot agree that this is a criterion by which to estimate the time required for the elevation of all protuberant parts of the earth's crust. They remind us that in our own day we have had experience of paroxysmal changes of level, nor can they doubt that similar sudden catastrophes must have happened oftentimes in the lapse of ages. They point to the appearance of ruin and confusion which may be traced along a line of mountain-elevation, and maintain that the broken and shattered strata are proofs of a more or less sudden yielding to enormous strain or tension. They do not deny that upheaval may have been going on over a given area at an extremely slow rate during long periods of time, but they argue that a point would at last be reached when the tension to which the strata were subjected could no longer be resisted. A sudden fracturing would at last take place—the strata would be violently dislocated, thrust forward, crumpled, and heaped, as it were, in confused and steeply-inclined masses along the main line of dislocation. Again, it is objected to uniformitarian views that these do not explain and cannot account for certain remarkable mutations of climate which are known to have occurred. It is not denied that the earth has been receiving for untold ages the same annual amount of heat from the sun, but it is maintained that, owing to certain astronomical changes, and the modifications induced thereby, that heat must have been very differently distributed over the globe at various epochs in the past. It is held, in short, that the climate both of the northern and the southern hemispheres has thus been frequently modified, and that in consequence of this the action of the geological agents has been influenced again and again—the decay and reconstruction of rocks the oscillations of the land—and the development of floras and faunas having been alternately accelerated and retarded according as extreme or moderate conditions prevailed.

Thus each school has its own method of interpreting the fundamental axiom of our science—that the Present is the key to the Past. And as the primary aim of geology is to interpret the stony record with a view to the reconstruction of our earth's history, it is obviously important that we should be able to satisfy ourselves as to which of these rival conceptions is most consonant with truth. In other words, we must do our utmost to ascertain which gives the most reasonable interpretation of geological phenomena. Each view must in its turn be tested by an appeal to facts, and a rigorous application of logical analysis. Probably we shall find that while there is much to be said on both sides, we can agree entirely neither with the one school nor the other. Before we are in a position, however, to discuss such questions, we must first have ranged over a very wide field of inquiry, and obtained a thorough grasp of the principles of our science.

Meanwhile, our chief concern in beginning our studies must necessarily be to detect resemblances between the present and the past. For every observation we make we must endeavour to discover a correlative phenomenon in the present order of things. And so long as we confine our attention to the facts before our eyes and to the more obvious interpretations of these which are suggested by forces now in action, we shall not fail to be impressed with the uniformity of nature.

We examine, let us suppose, a section of strata exposed upon the sea-shore or along the banks of a river. Our knowledge of the different kinds of sediment in course of transportation and

[1] The Inaugural Lecture at the opening of the Class of Geology and Mineralogy in the University of Edinburgh, October 27, 1882, by James Geikie, LL.D., F.R.S. L. and E., Regius Professor of Geology and Mineralogy in the University.

accumulation at the present day enables us at once to recognise, in the conglomerate sandstone and shale of our section, simply the consolidated sediments of earlier times. The occurrence of fossils in the strata determines whether the deposits were formed in fresh water, brackish water, or the sea—whether near to a coast-land, or at a greater distance from the shore, and so forth. If some of the fossils be of terrestrial origin, while others are brackish-water and marine, we gain not only certain knowledge of the life of the period, but, if the evidence be full enough, we may even form more or less reliable conclusions as to the physical and climatic conditions which at one time existed in the locality under our examination. In short there are many almost obvious conclusions, as we may term them, which the appearances presented by an individual exposure of rocks must suggest to any observer who has previously become familiar with the operation of the natural forces in the world around us. He simply compares the facts with what is now taking place, and is thus led to conclude that effects the same in kind have been produced in the same way.

Sometimes, however, the rocks present appearances which are harder to interpret in this obvious and ready manner. We encounter, for example, a rock-mass having none of the features presented by ordinary sedimentary strata. Instead of being made up, like conglomerate and sandstone, of rounded stones or grains, arranged in layers, it is entirely composed of larger and smaller crystalline particles, not lying in lines and layers, but scattered indiscriminately through the whole mass. It does not occur in beds like ordinary sedimentary strata, but on the contrary we see it cutting, as it were, across other rocks, and sending ont veins which penetrate the latter in all directions. The observer immediately concludes that the crystalline rock is of younger age than the beds traversed by it; and not only so, but that the whole mass with all its veins was injected into its present position in a liquid, semi-liquid, or pasty, and probably heated condition. And in confirmation of this last conclusion he may perhaps note that the rocks immediately adjoining the dykes and veins betray the appearance of having been subjected to the action of heat. The grits, we shall suppose, are hardened and much cracked and shattered, and the shales baked and porcellanised; both rocks, when closely examined, showing traces of an incipient fusion along the line of contact with the intrusive rock. They may even lose their original granular texture, and assume a more or less crystalline aspect for some distance away from the dykes and veins that intersect them. All these features the observer may have seen exemplified in a modern volcanic district, and he may therefore feel justified in the opinion he has formed as to the formerly molten state and therefore igneous origin of our crystalline rock. His induction, however, is not complete. He compares his supposed igneous rock with the undoubted products of existing volcanoes, and although many of these last send out dykes and veins, and have a crystalline texture, yet not a single one may have any further resemblance to the crystalline rock of his section. He cannot, therefore, be any longer certain that his dykes and veins have originated in the same way as those of Etna and Vesuvius. The origin of such a crystalline rock as I am speaking of (which we may suppose is granite), cannot be determined, like that of conglomerate or sandstone, by direct comparison with similar rocks in process of formation. Exhaustive examination of the granite itself, an intimate knowledge of its ingredients, and the conditions of formation which these imply, combined with careful observation of the mode in which this rock occurs wherever it is met with—these and other studies must be prosecuted before any assurance can be obtained as to the precise mode in which granitic dykes and veins have originated. The observer then learns that these are really of igneous origin, as he at first inferred, but his notion that they have been injected into strata at or near the surface like the dykes of modern volcanoes, cannot, he finds, be maintained. All the evidence supplied by careful microscopical examination and physical considerations, leads to the conclusion that granite has been formed and consolidated at considerable depths. Having satisfied himself upon this point, the observer will readily conclude that the dykes and veins that now appear at the surface were formerly buried under great masses of rock, which have since been removed. Of course there are many other facts connected with the history of granite which I do not touch upon at present. By and by we shall learn that all masses of granite are not intrusive, but that certain considerable areas of this rock, although agreeing in composition with the granite of dykes and veins, are nevertheless not irruptive.

The conclusion that granite is of deep-seated origin is not, you will observe, contrary to our canon that the past is to be interpreted by the present. Molten rock, as we know, is forced into fissures in the neighbourhood of active volcanoes, and there consolidated, and chemical analyses show that some volcanic rocks have the same ultimate composition as granite. Partly by observation and partly by experiment we detect in granite evidence to prove that it has consolidated under pressure, and that, had the original molten mass cooled more rapidly and under moderate pressure, the resulting rock would have presented a very different appearance. Had injection taken place at or near the surface, or had the melted matter flowed out of a volcanic orifice, it might well have resembled some of the products of modern volcanoes.

Let us now take another sample of the mode of interpreting geological phenomena. We shall go back to our section of conglomerate, sandstone, and shale—and these deposits we shall suppose belong to a comparatively recent date—to the Tertiary period, let us say. Suppose, moreover, that the fossils are numerous, and so well preserved that we are enabled to compare them with living forms. A few, we find, belong to existing species, others are closely related to these, while yet others, although without doubt extinct, can nevertheless be referred with confidence to living genera. These facts enable us to come to a trustworthy conclusion as to former climatic conditions, for all we have to do is to examine the conditions under which the existing species presently flourish, and draw the obvious inference. Of course the larger the number of living species, and the more highly organised these are, the more reliable our theoretical results will be. But suppose our fossils indicate a warm and genial climate, and that the locality in which we discover our section lies far within the Arctic Circle—what must our conclusion be? Simply this: that the climate of those high latitudes was formerly much warmer than it is now. We appeal to the present, and that is the reply we get. But the next question arises: How could such a climate obtain within the Arctic Circle? This is one of those crucial cases which must eventually determine whether Uniformitarians are justified in maintaining that the present is the exact type of all that has gone before, within known geological periods. According to them it is not necessary to look beyond this earth itself for an explanation of such an apparent anomaly as the occurrence of southern faunas and floras in the Arctic regions. All we have to assume, they tell us, is a former very different distribution of land and water. They refer us to the well-proved fact that there have been freqnent considerable elevations and depressions of the land, which must have indirectly affected the climate of wide areas by modifying the course of oceanic and aërial currents. They argue that were the larger land-areas of the globe to be grouped about the equator, with oceanic islands scattered over the higher latitudes, this arrangement of land would induce all the conditions that are necessary to account for the former growth of walnuts and oaks and beeches within the Arctic Circle.

This hypothesis is opposed by others who maintain that no such distribution of land and water existed at the epoch in question. According to them, the position of the main continental ridges and oceanic depressions was established at a very early period in the earth's history. The persistence of these main features, however, does not imply a total invariability of outline. On the contrary, the protuberant areas, it is admitted, have been modified again and again all through the geological ages—considerable portions having been alternately depressed below and lifted above the sea-level. But as the relative positions of the more important ridges and depressions of the earth's surface—the continental areas and oceanic basins—were determined long anterior to the deposition of the Tertiary strata, and probably date back to azoic times—such a re-arrangement of land and sea as the Uniformitarian view requires cannot have taken place. It is further maintained that, even could such a re-arragement be substituted for the present, it would not bring about a genial climate in the Arctic regions. We must look beyond our globe itself, we are told, if we wish to find the key to those greater revolutions of climate of which we have evidence in such a case as the occurrence of a southern flora within the Arctic Circle. The greater climatic revolutions of the past are due, we are assured, to periodical changes in the eccentricity of the earth's orbit, combined with the precession of the equinoxes, and the influence which such mutations must have exerted upon the ordinary agents of geological change.

The soundness of these opposing views must of course be tested by an appeal to facts, and it will be our duty in the course of our investigations to examine all the data which have been adduced in their support. I have referred to them on this occasion merely to show you that above and beyond the more or less obvious interpretation of geological phenomena, larger questions arise, the consideration of which demands not only laborious and far-extended observation, but must call into exercise all the varied powers of the human mind.

In the initial stages of our geological investigations we are occupied in detecting the more apparent resemblances and correspondences between the present and the past. We readily discover in sedimentary strata the evidence of their accumulation by the action of water, nor do we experience much difficulty in discovering the igneous origin of many rock-masses in regions now far removed from scenes of volcanic activity. But each observation we make and every well-founded correspondence we establish between the present and the past leads on to larger and larger deductions, until, as in the case of our granitic dykes and veins, we eventually find that geological investigations frequently increase our acquaintance with forces now in action and give us some insight into the hidden operations of nature. It is not indeed too much to say that in many cases our knowledge of such operations is derived in large measure from a study of the effects produced by the work of nature in past ages. The examination, for example, of the fragmentary relics of ancient volcanoes, in this and other countries where volcanic action has long been extinct, has enabled us to picture to ourselves many details of the structure of those interior and basement parts of a volcanic mountain, which otherwise must ever have remained unknown. The long-continued action of the agents of denudation has often removed those superficial rock-masses which gather around volcanic orifices, so as to lay bare, as in a dissection, the interior and basal portions—showing us the fractured and baked strata through which the heated gases, molten matter, and loose ejectamenta were erupted, and the dykes and veins of crystalline rock which were injected into the cracks and fissures of the shattered strata. Nay, a study of those vast masses and sheets of granitic, gneissose, and schistose rocks, of which large portions of the Scottish Highlands, Scandinavia, and other countries are composed, induces the belief that these rocks originally existed as ordinary sedimentary strata, and that their present crystalline condition has been assumed at a time when they were deeply buried underneath other and of course younger strata. And thus we have hints given us as to what may be taking place now throughout extensive areas underneath the surface of the earth, where other sandstones and shales may be undergoing a gradual metamorphism and conversion into crystalline rocks.

(*To be continued.*)

THE SENSES OF BEES

AT the meeting of the Linnean Society on Thursday last, Sir John Lubbock read an account of his further observations on the habits of insects, made during the past year. The two queen ants which have lived with him since 1874, and which are now, therefore, no less than eight years old, are still alive, and laid eggs last summer as usual. His oldest workers are seven years old. Dr. Müller, in a recent review, had courteously criticised his experiments on the colour sense of bees, but Sir John Lubbock pointed out that he had anticipated the objections suggested by Dr. Müller, and had guarded against the supposed source of error. The difference was, moreover, not one of principle, nor does Dr. Müller question the main conclusions arrived at, or doubt the preference of bees for blue, which indeed is strongly indicated by his own observations on flowers. Sir John also recorded some further experiments with a reference to the power of hearing. Some bees were trained to come to honey which was placed on a musical box on the lawn close to a window. The musical box was kept going for several hours a day for a fortnight. It was then brought into the house and placed out of sight, but at the open window and only about seven yards from where it had been before. The bees, however, did not find the honey, though when it was once shown them, they came to it readily enough. Other experiments with a microphone were without results. Every one knows that bees when swarming are popularly, and have been ever since the time of Aristotle, supposed to be influenced by clanging kettles, &c. Experienced apiarists are now disposed to doubt whether the noise has really any effect, but Sir John suggests that even if it has, with reference to which he expressed no opinion, it is possible that what the bees hear are not the loud low sounds, but the higher overtones at the verge of, or beyond our range of hearing. As regards the industry of wasps, he timed a bee and a wasp, for each of which he provided a store of honey, and he found that the wasp began earlier in the morning (at 4 a.m.), worked on later in the day. He did not, however, quote this as proving greater industry on the part of the wasp, as it might be that they are less sensitive to cold. Moreover, though the bee's proboscis is admirably adapted to extract honey from tubular flowers, when the honey is exposed, as in this case, the wasp appears able to swallow it more rapidly. This particular wasp began work at four in the morning, and went on without any rest or intermission till a quarter to eight in the evening, during which time she paid Sir John 116 visits.

INVERTEBRATE CASTS VERSUS ALGÆ IN PALÆOZOIC STRATA

THE distinguished Swedish geologist, Dr. A. Nathorst, having made numerous experiments, has come to the conclusion that invertebrate animals, when creeping over a soft sea-bottom, will leave imprints which are identical with the markings which have hitherto been considered those of fossil Algæ. If these Algæ are examined, it will be found, he states, that the appearance of a great many of them indicate that they have not been organisms at all, but formed in some mechanical way, and that analogous forms may even be found in existing species.

Dr. Nathorst considers that with the exception of three groups, the greatest number of Algæ enumerated in Mr. Schimper-Zittel's work on Palæontology as "undefined," are merely imprints of invertebrate animals.

Some time ago Prof. Martens of Berlin demonstrated that ichthyological members of the genus *Periophtalmus* which he had watched on the coast of Borneo when creeping over a clay bottom, left regular and defined impressions from their body and fins on the surface which would, if preserved, easily be mistaken for cryptogamic fossils, and in a paper on casts of Medusæ in the Cambrian strata of Sweden, Dr. Nathorst further shows that the so-called *Eophyton spatangopsis*, &c., which have been considered imprints of certain zoophytes and mollusks, are traces of Medusæ. These "fossils" are, according to his theory, either traces which Medusæ leave when carried by the motion of the water over a soft bottom (*Eophyton*), or imprints of their belly and adjacent organs when at rest. He further shows, that a more solid kind of Medusæ than the common have left traces in the calcareous slate of Central Germany, which makes it possible, in some measure, to define their relation to existing species.

Hitherto, Medusæ have only been traced back to the Jurassic period, but Dr. Nathorst shows that these organisms have existed from at least Cambrian times. The imprints which the lower organisms leave on mud or sand vary in appearance with the creeping or swimming habits of the animals, as well as with the nature of the bottom, whilst it is particularly interesting to note that certain worms produce imprints and vermiculated holes, which are exactly like the radiant Algæ, and which would not be supposed to be the work of invertebrata, if their formation had not been clearly demonstrated.

In connection herewith it should be mentioned, that imprints may also be made in a soft sea-bottom by stones, which are carried along with the tide by floating sea-weeds, regarding which observations have recently been made by the Scottish naturalist, Mr. Symington Grieve. C. S.

BIOLOGY IN ITALY[1]

IN welcoming the appearance of this new journal under the editorship of Prof. Emery, of Bologna, and Prof. Mosso of Turin, it may not be amiss to mention briefly the programme of its originators. They will endeavour each year to give a classified list of all works published in Italy on biology, in its widest sense. The list for 1881, with an index of the names of authors, appears in volume I. They will try and bring together and illustrate original memoirs on subjects which treat of life in every form. In addition to these there will from time to time appear *résumés* and notices of memoirs appearing in other Italian journals; and as far as practicable the *résumés* will be drawn up by the authors of the papers abstracted. The archives will be

[1] "Archives Italiennes de Biologie," tome i., 1882. Tome ii. fasc. i., October 15, 1882. (Rome, Florence, Turin: H. Loescher.)

published in French, "because this language is, without the possibility of contradiction, that one the most universally known among all the living languages."

Most heartily do we echo the following words of the editors :—

"L'Italie a été jadis le berceau de la renaissance des arts et des sciences. D'autres nations nous ont depuis lors dépassés; mais l'unité de la patrie est venue rallumer le foyer du travail, et donner un nouvel essor aux études scientifiques, dont nous constatons chaque année les rapides progrès. Les travaux qui verront le jour dans les *Archives Italiennes de Biologie* seront, pour notre pays, nous l'espérons, un nouveau titre à l'estime de tous ceux qui prennent intérêt à l'avancement des sciences de la vie."

Among the chief articles in volume I. are the following :—*Physiology:* On a new element in the blood of mammals, and its importance in thrombosis and in coagulation; on the production of the red globules in extra uterine life; and on small blood discs in mammals, by G. Bizzozero; on the reproduction of the marrow in long bones; and on the regeneration of articular extremities in sub-capsular periosteal resections, by D. Bajardi; on the hæmatopoetic functions, and on the complete reproduction of the spleen, by G. Tizzoni; on hepatic glycogenesis, by Ph. Lussana; on the functions of the bladder, by A. Mosso and A. Pellacani; on the structure of the spinal cord, by J. B. Laura; on varietes in the cerebral circumvolutions in man, by C. Giacomini; critical experimental study of the cortical motor centres, by A. Marcacci; on the caducousness of the ovarial parenchyma and its total rehabilitation, by J. Paladino; origin of the olfactory tract, &c., in mammals, by C. Golgi. *Pathology:* Contribution to the pathology of the muscular tissue, by E. Perroncito; contribution to the study of endocartitis, by V. Colomiatti; contribution to the subject of intestinal cysts, by H. Marchiafava; on the discovery of the specific ferment of malaria in the blood, by the Editors. *Zoology:* On the origin of the central nervous system in annelids, by N. Kleinenberg, of Messina; on the nervous system and sense organs of *Sphæroma serratum*, by J. Bellonci; on a new genus (Distaplia) of Synascidians, by A. Della Valle; on the metamorphoses of some Insecticole Acari, by Ant. Berlese. *Botany:* On the action of ether and chloroform on the sensitive organs of plants, by C. Cugini; on the active principle of *Adonis vernalis*, by V. Cervello; contribution to the study of the genus Cora, Fr., by O. Mattirolo; researches on the anatomy of leaves, by I. Briosi.

Vol. ii. part 1, contains: On the early phenomena of development in Salpa, by F. Todaro; on the anatomy of the compound Ascidians; and on budding in the Didemnidæ and Botryllidæ, and on the enterocœtlic type in the Ascidia, by A. Della Vallee; polymorphism and parthenogenesis in some Acari (Gamasidæ), by A. Berlese; on an unobserved organ in some vegetable embryos, by S. Briosi; experimental study of the cortical motor centres, by A. Marcacci; experiments on the formation of uric acid, by J. Colasanti; on the action of oxygenated water (H^2O^2) on animal organisms, by J. Colasanti and S. Capranica; on the toxic action of human saliva, by L. Griffini.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—In addition to the Scholarships in Natural Science offered by Balliol and Christ Church this term, of which details have been published in NATURE, a scholarship in Natural Science will be offered for competition next term by Queen's College. Papers will be set in Chemistry, Physics, and Biology. No candidate will be expected to offer more than two of these subjects. Candidates are requested to signify their intention of standing by letter to the Provost, not later than February 1, and to state the subjects they propose to offer.

The Natural Science Scholarship at Exeter College has not been awarded. Mr. H. O. Minty, of the Royal College of Science, Dublin, has been elected to an Exhibition. Mr. Minty was *proxime* at the late examination for the Trinity Natural Science Scholarship, but being over the statutable age, was not eligible for a scholarship at Exeter College.

CAMBRIDGE.—Prof. C. C. Babington, F.R.S., Professor of Botany in the University of Cambridge, has been elected to a Professorial Fellowship at St. John's College. Prof. W. J. Sollas, F.G.S, Professor of Geology at University College, Bristol, has also been elected Fellow of St. John's College.

THE number of students at Dorpat University is vastly increasing from year to year. While in 1867 the number was only 573, it reached 728 in 1872, 858 in 1877, 1105 in 1880, and now stands at 1367 students.

SCIENTIFIC SERIALS

Journal of the Royal Microscopical Society for August, 1882, contains: On some micro-organisms from rain-water, ice, and hail, by Dr. R. L. Maddox.—On the relation of aperture and power in the microscope, by Prof Abbe.—Description of a simple plan of imbedding tissues for microtome cutting in semi-pulped unglazed printing paper, by B. W. M. Richardson.—Note on Rev. G. L. Mills' paper on diatoms in Peruvian guano, by F. Kitton.—The usual summary of current researches relating to zoology and botany (principally invertebrate and cryptogamia), microscopy, &c., including original communications from Fellows and others.—Proceedings of the Society.

THE same journal for October, 1882, contains: On plant crystals, by Dr. Aser Poli (plate 6), and the summary of current researches relating to zoology and botany (principally invertebrata and cryptogamia), microscopy, &c., including original communications from Fellows and others.

The Quarterly Journal of Microscopical Science, No. 87, for July, 1882, contains:—Note on the formation of fibrine, by Mrs. Ernest Hart (plate 21).—On the genesis of the egg in Triton, by T. Iwakawa (plates 22-24).—On the germination and embryogeny of *Gnetum gnemon*, by F. O. Bower (plate 25).—The organ of Jacobson in the dog, by Dr. E. Klein (plate 26).—On Saprolegnia in relation to the salmon disease, by Prof. Huxley.—Notes on certain methods of cutting and mounting microscopical sections, and on the central duct of the Nephridium of the leech.

No. 88, for October, 1882, contains: On the development of *Ostrea edulis*, by Dr. R. Horst (plate 27).—The morphology and life-history of a tropical Pyrenomycete, by H. Marshall Ward (plates 28 and 29).—The thread cells and epidermis of Myxine, by R. Blomfield (plate 30).—The eye of Spondylus, by Sydney J. Hickson.—Note on open communication between the cells in the pulvinus of *Mimosa pudica*, by W. Gardiner.—Notes on the development of Mollusca, by Prof. Haddon.—Note on Echinoderm morphology, by P. Herbert Carpenter (woodcuts).—On the vertebration of the tail of Appendicularia, by Prof. Lankester.—Notes on the structure of Seriatopora, Pocillopora, Corallium, and Tubipora, by Prof. Moseley (woodcut).—Note on pacinian corpuscles, by Dr. V. Harris.—Reviews of Strasburger's structure and growth of the cell wall, and of Bergh's researches on the cilio-flagellata.

Proceedings of the Royal Society of Tasmania for 1880, contains:—Algæ of the New Hebrides, by Dr. Sonder, contains new species of Sarcodia, Caulerpa, and Chætomorpha.—On some Australian slugs, by Prof. R. Tate.—On the Unios of the Launceston Tertiary basin, by R. Etheridge, jun. (with a plate).—On a fossil helix, by R. M. Johnston (with a plate).—The lichens of Queensland, by F. M. Bailey.—On some fossil leaves and fruits, by Dr. C. E. Bernard.—On some introduced plants, by Rev. G. E. Tenison Woods.—On some new species of fish, by R. M. Johnston.—On oyster culture, by Capt. Stanley, R.N.

Bulletin de la Soc. Imp. des Naturalistes de Moscou, 1881, No. 4, contains: On new species of European Mints, by M. Gandoger.—On the Amphibia and Reptiles of Greece, by Dr. J. v. Bedriaga.—On new species of Hemiptera from the Aral and Caspian districts, by V. Jakovlev (in Russian, but the diagnoses of the new genera and species are given in German).—Catalogue of the Lepidoptera of the Moscow district, by L. Albrecht (Supplements Dr. E. Assmus's catalogue of 1858, and raising the number of species from 675 to 1172.—On new Lepidoptera from the Amur Land, by H. Christoph.—Meteorological observations (Moscow) for 1881, by J. Weinberg.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, November 2.—F. A. Abel, F.R.S., vice-president, in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting (November 16).—The following papers were read:—On dihydroxybenzoic acids and iodosalicylic acids, by Dr. A. K. Miller. The author has succeeded in preparing the sixth dihydroxybenzoic acid; five being already known. It was obtained by heating salicylic acid and iodine in alcoholic solution, two iodosalicylic acids were formed, which yielded two distinct dihydroxybenzoic acids when heated with potash.—On crystalline molecular compounds of naphthalene and benzene with antimony trichloride, by Watson Smith and G. W. Davis. By melting three parts by weight of antimony trichloride with two of naphthalene, minute crystals were obtained, $3SbCl_3, 2C_{10}H_8$; similarly with benzene, a body, $3SbCl_3, 2C_6H_6$, was prepared.—Additional evidence, by an analysis of the quinoline molecule, that this base belongs to the aromatic series of organic substances, by Watson Smith and G. W. Davis. The authors have studied the effect of exhaustive perchlorination (by heating with antimony pentachloride) on quinolin; perchlorethane, perchlorbenzene, and nitrogen were obtained.—On orcin and some of the other dioxytoluols, by R. H. C. Nevile and Dr. A. Winther. The authors have prepared the dioxytoluol 1 . 3 . 5, starting from the dinitrotoluol 1 . 3 . 5, and have found it to be identical in all its reactions and physical properties with orcin. They have also prepared the dioxytoluols 1 . 2 . 4 and 1 . 2 . 5, and have investigated the preparation of the body 1 . 3 . 4.—On the varying quantities of malt albumenoids extracted by waters of different types, by E. R. Moritz and A. Hartley.—On the derivatives of ethylene-chlor-bromide, by J. W. James. The author gives details as to the preparation of this body, and has studied the action of sodium sulphite upon ethylene chlorobromide, ethylene dibromide, and ethylene chlorothiocyanate; also the action of ammonia upon an ethereal solution of chlorethylsulphonic chloride.

Paris

Academy of Sciences, October 30.—M. Blanchard in the chair.—The following papers were read:—Remarks on the theory of shocks, by M. Resal.—Results of experiments made at the Exhibition of Electricity on machines and regulators with continuous current, by MM. Allard, Joubert, Le Blanc, Potier, and Tresca. Thirteen different combinations are dealt with, and data regarding mechanical work, electric resistance, intensity, luminous power, economical efficiency, &c., tabulated. Another paper, to appear soon, will treat of other systems. In nearly all the experiments the total motor work is very well represented by the corresponding electric work.—Rational conception of the nature and propagation of electricity (continued), by M. Ledieu. Electricity is, no more than heat or light, to be regarded as a special agent under particular mechanical laws. As to the phenomenal cause, it is simply the potential energy of the ether associated with the ponderable matter, especially in the form of atmospheres round the molecules. It has for counterpart the portion of potential energy of the ponderable matter, which constitutes chiefly *latent heat*.—On the efficacy of lightning conductors, by M. Hirn. A very faulty conductor may *sometimes* protect a house. One such near Colmar, on a house 15m. high, consisted (in descending order) of a conical brass point, an iron rod about 8m. long, on which this was screwed, and a wire, hardly 0·007m. diameter, in pieces with terminal rings, passing down to a piece of iron 0·5m. long in a hole in the moist ground. In a violent storm (the thunder of which brought down plaster from ceilings), the rod was struck, and the brass cone fused, but no part of the current left the conductor. During over forty years' observations, M. Hirn has never seen lightning strike any of the forty or fifty lightning rods on the works of Logelbach. Yet, during a thunderstorm, these rods work actively; as he has proved by means of derived circuits from the uninterrupted conductors, yielding currents with magnetising power. He has even drawn currents from a conductor separated by a thin leaf of caoutchouc; the thin copper wire was never fused.—Application of the law of complementary colours to temporary decoloration of diamonds tinted yellow, by MM. Chatrian and Jacobs. The yellow diamond is merely put in a solution of the complementary colour (violet), and it comes out white; but mere washing brings back the yellow.—Chemical studies on the sugar beet called the white beet of Silesia, by M. Leplay.—On certain quadratic forms, and on some discontinuous groups, by M. Picard.—On trigonometric series, by M. Poincaré.—Reply to M. Faye's objections to Dr. Siemens' theory of the sun, by Dr. Siemens.—On an extension of the principles of areas and of movement of the centre of gravity, by M. Lévy.—On the longitudinal vibrations of elastic rods, and the motion of a rod carrying at its end an additional mass, by MM. Sébert and Hugoniot.—New expressions of the work and economic efficiency of electric motors, by M. Deprez.—On a modification required in enunciation of the law of isomorphism, by M. Klein. In the second part of the law, stating that isomorphous bodies have a similar chemical composition, it is necessary to say, instead, that they have either a similar chemical composition, or present a centesimal composition slightly different, while containing a group of elements that are common or of identical chemical functions, and which form much the largest part of them by weight.—Researches on the thorite of Arendal, by M. Nilson.—Rapid process of determination of salicylic acid in beverages, by M. Rémont.—Distribution of ammonia in the air and aqueous meteors at great altitudes, by MM. Muntz and Aubin. On the Pic du Midi (2877 m.), the quantity of ammonia in the air was much the same as on low ground (or 1·35 mgr. per 100 cub. m.); that in rain water considerably less; also that in snow and in mist.—New chemical and physiological researches on some organic liquids (water of sea-urchins, water of hydatic cysts and cysticerci, amniotic liquid), by MM. Mourson and Schlagdenhauffen.—On the evolution of Peridinians and the peculiarities of organisation connecting them with Noctilucæ, by M. Pouchet.—Hypsometric map of Turkey in Asia, published at Tiflis, under direction of General Stebnitzky. Previous maps are shown to need correction in orography.—Action of oil on sea-waves, by M. Virlet d'Aoust. An experience of his in Greece in 1830 shows that the method was practised by seamen there. He also notes the calming effect of petroleum rising in the bed of a Mexican river, and carried into the sea.—On the cultivation of opium in Zambesia, by M. Guyot. This was begun in 1879 at Chaima, near Niopea, about 6 km. from the Zambesi. In 1881 it engaged 300 workers, 250 of whom were blacks and 50 natives of India. In India the opium sells for 50 to 60 francs the kilogramme.

Göttingen

Royal Society of Sciences, June 10.—On the occurrence of cleistogamous flowers in the family of the Pontederaceæ, H. Grafen zu Solms-Laubach.—On Arabian navigation, by S. Gildemeister.—On gradually developing contact-electricity with co-operation of air, by W. Holtz.—Optical studies on garnet, by C. Klein.

August 1.—On the measurement of the winding surface of a wire-coil by the galvanic method, and on the absolute resistance of the mercury-unit, by F. Kohlrausch.—On triazo compounds, by H. Hubner.—On the method proposed by M. Guébhard for representation of equipotential lines, by H. Meyer.—On the neurology of the Petromyzonts, by F. Ahlborn.

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