Nature

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

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THURSDAY, MAY 3, 1883

LIFE OF SIR WILLIAM ROWAN HAMILTON

Life of Sir William Rowan Hamilton, Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland; including Selections from his Poems, Correspondence, and Miscellaneous Writings. By Robert Perceval Graves, M.A., Sub-Dean of the Chapel Royal, Dublin. Vol. I. pp. 692. (Dublin University Press Series, 1882.)

WE are glad to welcome the appearance of the first volume of this work, which has long been eagerly watched for by those interested in the career of the wonderful genius whose life is here narrated. To many readers this volume will afford material for no little surprise. Sir William Rowan Hamilton is known to fame as a mathematician. He is known by his memoirs on systems of rays; by his discovery of the great dynamical generalisation which is implied in his theory of the characteristic function; by his exquisitely beautiful prediction of the phenomena of conical refraction; and above all by his theory of quaternions—an imposing mass of profound thought which must be ranked with the very greatest mathematical achievements of any age or nation. Yet here we have a very portly volume of almost seven hundred pages, of which only an extremely small fraction is devoted to Hamilton's mathematical work. The progress of his papers on rays is here and there referred to, and there is an interesting historical chapter on conical refraction, but we may turn in vain to the index for a reference to quaternions, and we have only noticed the word occurring once or twice in the entire volume. But the surprise will disappear when the reader begins to make acquaintance with the volume. He will then see that Hamilton's mathematical labours were only one of the forms in which his most extraordinary genius was manifested. He will see that the early years of Hamilton's life afforded such copious materials to a biographer that the present volume only extends to the time when Hamilton had attained the age of twenty-seven, and that the crowning achievement of quaternions by which Hamilton is best known was the fruit of his riper years, and belongs to his subsequent career.

At the Cambridge meeting of the British Association in 1833, Prof. Sedgwick spoke of Hamilton—then twenty-eight years old—as "a man who possessed within himself powers and talents perhaps never before combined within one philosophical character." The volume before us bears testimony which would go a long way towards justifying this eulogium. We think that Sir W. Hamilton has been fortunate in having a biographer so careful in his facts and so skilful in the manipulation of his copious materials as Mr. Graves has proved himself to be. Hamilton had the habit of putting on record very minute circumstances. He preserved copies of a large proportion of the letters and notes written by him, whether important or not; he often recorded the hour at which they were despatched, and the person to whom they were intrusted for the post. The enormous mass thus accumulated during a long and very studious life were left at Hamilton's death in a state of utter confusion, and it has been the laborious duty of his biographer to extract from the mass those materials which were suitable for his purpose. The very extensive correspondence of Hamilton is also a source from which his biographer has obtained much aid. Of his own qualifications for the task the biographer thus modestly expresses himself in the preface:—

"The public has some right to inquire why one who has to confess himself to be no mathematician should have undertaken the present work. To such an inquiry I may reply as follows: that although unconnected with Sir W. R. Hamilton by any tie of kindred, I became his friend in the youth of both of us, and that our friendship continued unbroken till the day of his death; that when he was applied to by the Editor of the *Dublin University Magazine* in 1841 to name a friend who should be requested to supply to that magazine a biographical sketch for insertion in its portrait gallery of distinguished Irishmen, he did me the honour of designating me, and furnished me with the necessary facts; that he afterwards sought my consent to his nomination of me as his literary executor,—a nomination however which, he told me afterwards, he thought right to withhold when he found that the remainder of my life would probably be spent in England, and that I should therefore be unable to fulfil

the duties of the trust without undue inconvenience. Lastly, that after his death I was asked by his sons to undertake the task, and was at the same time informed by several of the most influential of his friends that this selection met their approval, and that they were willing to trust to my judgment the correspondence over which they had control."

William Rowan Hamilton was born in Dominick Street, Dublin, on August 3-4, 1805. His father, Archibald Hamilton, was a solicitor. When the boy was little more than a year old, it would seem that he gave such indications of unusual talent that his parents decided to commit the education of the child to his uncle, the Rev. James Hamilton of Trim, a man of very remarkable talents, who, with his sister, Jane Sydney Hamilton, reared and educated the child. What that childhood was can be best described in the words of the biographer, who says, on pp. 46-47 :—

"It will then be noted that, continuing a vigorous child in spirits and playfulness, he was at three years of age a superior reader of English and considerably advanced in arithmetic; at four a good geographer; at five able to read and translate Latin, Greek, and Hebrew, and loving to recite Dryden, Collins, Milton, and Homer; at eight he has added Italian and French, and gives vent to his feelings in extemporised Latin; and before he is ten he is a student of Arabic and Sanscrit. And all this knowledge seems to have been acquired not indeed without diligence, but with perfect ease, and applied, as occasion arose, with practical judgment and tact; and we catch sight of him when only nine swimming with his uncle in the waters of the Boyne. In this accomplishment he afterwards became a proficient."

Again, on p. 51 we have a description of a little manuscript book of 30 pages thus entitled "A Syriac Grammar. In Syriac Letters and Characters; Compiled from that of Buxtorf; Translated into the English Language and Syriac Characters by William Hamilton, Esq., of Dublin and Trim. Begun July 4th, 1817; Finished July 11th, 1817." The conclusion of the book is as follows :—"Thus have I gone through what is necessary to be known for reading and writing Syriac. . . . Soon may be expected an account of their irregular and indeclinable words, &c., with a syntax." The author of this production was still under twelve years old.

A couple of years later (November, 1819) we find Hamilton inditing a letter in Persian to the Persian ambassador, Mirza Abul Hassan Khan, then on a visit in Dublin. Hamilton has left a translation of this production, the following extract from which evinces the Oriental aroma which pervades the whole :—

"As the heart of the worshipper is turned towards the altar of his sacred vision, and as the sunflower to the rays of the sun, so to thy polished radiance turns expanding itself the yet unblossomed rosebud of my mind, desiring warmer climates whose fragrancy and glorious splendour appear to warm and embalm the orbit about thee, the Star of the State, of brilliant lustre."

Hamilton's letter met with a very favourable reception; the secretary had observed no mistakes, and inquired whether he had not copied it from something, and the compliments bestowed on the author were all the more pointed, because "Captain Kian," who had also attempted to write a letter in Persian, was informed that his presence would be dispensed with, as *his* letter was totally unintelligible.

A large fraction of the present volume is filled with the poetical effusions, in which on all occasions Hamilton was prone to indulge. The first traces of these "showers of verse," as Wordsworth afterwards playfully called them, is found in Hamilton's letters to his sisters. The biographer has not, however, deemed it desirable to record any poetical effort prior to his sixteenth year, and the first piece we find is (p. 95) "To the Evening Star," of which the first stanza is—

"How fondly do I hail thee, Star of Eve,
In all thy beauty sinking to the west,
And as if loth our firmament to leave
Slow and majestic sinking to thy rest."

Hamilton lived and thought in an atmosphere of poetry; he wrote poems on all occasions and all sorts of subjects. It was perhaps not unnatural that as a disappointed lover he should bewail his sorrows in verse, that he should write birthday addresses to his sisters, and sonnets on the Beauty of the Dargle, but we also find him addressing an "Ode to the Moon under Total Eclipse," and to use his own words in writing to Wordsworth, "I have always aimed to infuse into my scientific progress something of the spirit of poetry, and felt that such infusion is essential to intellectual perfection." He has, however, indicated very clearly where his real ambition lay, for at the age of twenty, writing to his friend, Miss Lawrence, he says :—

"But while you concur with my own sober judgment in refusing to award me the crown of poetic power you would not I am sure desire to extinguish in me that love of 'sacred song' to which I can with truth lay claim. There is little danger of its ever usurping an undue influence over a mind that has once felt the fascination of science. The pleasure of intense thought is so great, the exercise of mind afforded by mathematical research so delightful, that having once fully known it, it is scarce possible ever to resign it. But it is the very passionateness of my love for science which makes me fear its unlimited indulgence. I would preserve some other taste, some rival principle; I would cherish the fondness for classical and for elegant literature which was early infused into me by the uncle to whom I owe my education, not in the vain hope of eminence, not in the idle affectation of universal genius, but to expand and liberalise my mind, to multiply and vary its resources, to guard not against the name but against the reality of being a mere mathematician."

A year later (1822) we find Hamilton entering upon the path of original mathematical discovery. The title of one of the first of these early papers is "Examples of an Osculating Circle determined without any Consideration repugnant to the utmost rigour of Analysis." With two others, one on "The Osculating Parabola to Curves of Double Curvature," and the other on "The Contacts between Algebraic Curves and Surfaces," Hamilton paid his first visit to Dr. Brinkley, then the Astronomer Royal of Ireland. Dr. Brinkley was impressed by their value and by the genius which at the age of seventeen had produced work of so much originality.

The first year of Hamilton's career in Trinity College, Dublin (1824), justified all the expectations entertained by his friends. In his Freshman year he distanced all his competitors alike in classics and in mathematics, while he was also awarded a Chancellor's prize for his poem on the subject of the Ionian Islands. In the same year we read that he commenced another friendship, which remained unbroken to the end of the long life of the brilliantly gifted Maria Edgeworth, and which brought to Hamilton

many of her delightful notes and letters, and in them cordial sympathy and wise counsel. Of Hamilton Maria Edgeworth writes: "Mr. Butler came with young Mr. Hamilton, an 'admirable Crichton' of eighteen, a real prodigy of talents, who, *Dr. Brinkley says, may be a second Newton.*"

At the age of twenty-one came the turning-point in Hamilton's career—his appointment to be Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. The vacancy arose from the promotion of Brinkley in 1826 to be the Bishop of Cloyne. The following incident of the occasion is given by his biographer:—

"Candidates for the post came over from England, among them Mr. Airy of Cambridge (already distinguished by his Senior Wranglership and by optical researches), and some who had already gained the rank of Fellow in Hamilton's own college were competitors. It appears that before the end of April he met Airy and other eminent men at the table of Dr. Lloyd, and we remember hearing that, in the scientific discussion to which the meeting gave occasion, he took his part with striking ability, modesty, and firmness, when it became necessary to defend some of his optical results against the objections of Mr. Airy."

Hamilton seems to have felt that it would be presumptuous for an inexperienced undergraduate to put himself forward as a candidate; he therefore retired to the country to carry on quietly his work for the classical medal. It was only a week before the appointment had to be made that he received at Trim, from his tutor, Mr. Boyton, an intimation that the Board were favourably disposed towards him, and urging him to come up at once to take the advice of his friends. That advice concurring with the strong opinion of his zealous friend and tutor, he was unanimously appointed on June 16, 1827.

A few months later Hamilton paid a visit to Keswick, and commenced his memorable friendship with Wordsworth. That the philosopher and the poet were mutually interested is manifest from Hamilton's account written in a letter to his sister Eliza:—

"He (Wordsworth) walked back with our party as far as their lodge, and then, on our bidding Mrs. Harrison good night, I offered to walk back with him while my party proceeded to the hotel. This offer he accepted, and our conversation had become so interesting that when we arrived at his home, a distance of about a mile, he proposed to walk back with me on my way to Ambleside, a proposal which you may be sure I did not reject, so far from it that when he came to turn once more towards his home I also turned once more along with him. It was very late when I reached the hotel after all this walking."

Hamilton quickly followed up his introduction to Wordsworth by sending him an original poem entitled "It haunts me yet." Wordsworth replies:—

"With a safe conscience I can assure you that in my judgment your verses are animated with the poetic spirit, as they are evidently the product of strong feeling. The sixth and seventh stanzas affected me much, even to the dimming of my eyes and faltering of my voice while I was reading them aloud. Having said this I have said enough. Now for the *per contra*. You will not, I am sure, be hurt when I tell you that the workmanship (what else could be expected from so young a writer?) is not what it ought to be. . . ."

"My household desire to be remembered to you in no formal way. Seldom have I parted—never, I was going to say—with one whom after so short an acquaintance I lost sight of with more regret. I trust we shall meet again."

The biographer adds that Wordsworth has said in his hearing that Coleridge and Hamilton were the two most wonderful men, taking all their endowments together, that he had ever met.

At the commencement of his career at the Observatory Hamilton entered with diligence into the practical work of observing, but it would seem that the necessary exposure told injuriously on his health. It does not appear that he made any observations of importance. His tastes pointed strongly in the direction of mathematical research, and the development of his discoveries occupied more and more of his time, until at length, with the full consent of the authorities of the University, Hamilton practically relinquished all observatory work and gave his splendid mathematical genius full scope. Unquestionably this was the best course for the credit of Hamilton himself, best for the credit of his University, and best for the interests of science. Hamilton could never have made even a moderately successful practical astronomer. He tells Dr. Robinson that he disliked observing; he was essentially a man of speculation rather than of action. Like his friend De Morgan, Hamilton was not "a man of brass, a micrometer-monger, a telescope-twiddler, a star-stringer, a planet-poker, or a nebula-nabber"—he had none of the qualifications necessary for a routine of observatory work. His workshop was his study, where he sat immersed in what he calls his "mathematical trances" and elaborated his great discoveries.

The latter half of the volume describes his early life at the Observatory. He was fortunate in obtaining as a pupil Lord Adare, afterwards Earl of Dunraven, between whom and Hamilton a lifelong friendship of the tenderest character arose. Many other friendships are here copiously illustrated by the letters which have been preserved. The letters to and from Sir J. W. Herschel and Sir G. B. Airy relate chiefly to the discussion of Hamilton's labours on the systems of rays and other matters of purely scientific interest; but there are stores of other letters. The voluminous correspondence between Hamilton and Wordsworth will itself possess a wide interest even in circles where Hamilton's more serious labours are unknown. There are letters to and from Coleridge, as well as many others relating to purely literary matters. There is an extensive correspondence with Dr. Robinson, in which the Armagh astronomer gives kindly counsel to his younger brother at Dunsink. There is the correspondence with his friend, Aubrey de Vere. There are the numerous letters to his lady correspondents, to his sisters, to Maria Edgeworth, to Lady Dunraven, to Lady Campbell, and to Miss Lawrence. Then there is the visit of Hamilton to London, chiefly for the purpose of visiting S. T. Coleridge, to whom he had an introduction from Wordsworth; and there are interesting accounts of the visits of Wordsworth to the Observatory at Dunsink, where a shady walk in the garden still bears the poet's name.

A chapter towards the close (p. 623) gives a sketch of the discovery of conical refraction made in the year 1832, while the author was still only twenty-seven. The importance of this discovery was speedily recognised, and the biographer writes: "At the Cambridge meeting of the

British Association, 1833, the attention of the mathematical and physical section was largely given to the subject, and Herschel, Airy, and others spoke warmly in praise of the discovery. In the introductory discourse with which the proceedings of that meeting was opened, Prof. Whewell made it a topic, and expressed himself in the following words: 'In the way of such prophecies few things have been more remarkable than the prediction that under particular circumstances a ray of light must be refracted into a conical pencil, deduced from the theory by Prof. Hamilton and afterwards verified experimentally by Prof. Lloyd.' Previously, in the same year, Prof. Airy had publicly recorded his impression upon the subject as follows: 'Perhaps the most remarkable prediction that has ever been made is that lately made by Prof. Hamilton.'"

The view Hamilton himself took of the discovery of conical refraction was characteristic. "It was," he writes to Coleridge on February 3, 1833, "a subordinate and secondary result when compared with the object I had in view to introduce harmony and unity into the contemplations and reasonings of optics regarded as a branch of pure science."

At the close of this volume we still leave Hamilton quite a young man. The great labour of his life has not yet commenced; its nature has not indeed even dawned upon him. We shall therefore look forward with pleasure to the continuation of the present most interesting work. The development of Hamilton's more mature genius, his correspondence with De Morgan, in itself no inconsiderable mass, and above all the gradual evolution of quaternions, will form most attractive materials for his biographer.

It is by the liberality of the Board of Trinity College, Dublin, that the present instalment of the work has been brought out, and we sincerely trust that the same liberality will be extended to enable the biographer to continue to do real justice to his subject. But besides the present work another debt is due to his memory. Hamilton's earlier papers are very inaccessible: many of them are scattered about in various periodicals, and his two noble treatises on quaternions are out of print. A complete edition of Hamilton's works would be an appropriate sequel to this biography, and they would be not unfitting companions for the works of Lagrange and of Gauss. It is not often that a University has so gifted a son as Hamilton. Let us hope that the University which is proud to claim him will see fit to raise this further monument to his genius.

LETTERS TO THE EDITOR

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

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

Sheet-Lightning

In NATURE, vol. xxvii. p. 576, a statement is made that the "opinion so long and generally entertained" that "sheet-lightning and the so-called summer or heat-lightning are nothing else than the reflection of, or the illumination produced by distant electrical discharges, is not supported by observation." This statement surprises me, for I should have said that the opinion once commonly entertained that sheet-lightning is a distinct form of lightning unaccompanied by sound, is now for the most part rejected, the results of observation being distinctly against it. The question is an old one; but as the writer of the above statement only refers to the observations made at Oxford during the twenty-four years ending 1876, I will confine myself in the main to an examination of these. I must premise that I do not assert that lightning never occurs at such an altitude that the thunder accompanying it is not audible. In rare instances in Europe lightning is observed in the zenith, followed after an interval of twenty seconds or more by faint rolling thunder immediately overhead. It is therefore antecedently probable that lightning may occur at too great an elevation for the thunder to be heard at the earth's surface at all; and this is especially likely to happen in some of those thunderstorms within the tropics, the altitude of which is extremely great.

The distance at which the illumination produced by lightning in a dark night can be observed depends upon the altitude and the intensity of the discharge, and further upon the altitude, character, and amount of the clouds. It is possible that the diffused particles of ice (at a much greater altitude than the cirri), which produce the phenomenon called "rayons du crépuscule," are capable in some cases of reflecting the illumination. However this may be, it is certain that the illuminations of an ordinary thunderstorm at midnight, when there is no moonlight, have an average radius of more than forty miles. The distance at which thunder is heard depends on a variety of conditions; but we may safely state that in the open country in calm weather at midnight the sound is rarely heard at a greater radius than fifteen miles. At the Radcliffe Observatory, which is scarcely out of the reach of rumbling sounds produced by the traffic of a town, the average distance at which thunder is distinguished may probably be safely reduced to seven miles. Assuming then that at Oxford the area of illumination has a radius of forty-two miles, and that of thunder one of seven miles (and in this assumption we are probably not very far from the truth), we conclude that in the darkest hours "lightning without thunder" should occur at Oxford with a frequency which is expressed by the figures 35 : 1 as compared with "thunder with or without lightning." A deduction ought, of course, to be made for the effects of moonlight. But when this has been made, the figures quoted by your reviewer are not only satisfied by the hypothesis for the refutation of which he employs them, but further, if his mode of reasoning were legitimate, they would lead us to the conclusion that in nearly seven cases out of eight the thunder heard at Oxford is not the result of electrical discharge at all! Such thunder does not occur elsewhere, and was not in vogue at Oxford "in my time."

Practically, however, two considerations must not be omitted: (1) some localities enjoy a special immunity from thunderstorms, while others are responsible for the production of an exceptionally large number; in the former the frequency of illumination will be greater in comparison with the frequency of thunder, in the latter it will be less: (2) (and this is a consideration of much more importance, though frequently neglected when a conclusion is deduced from records of phenomena) the relative frequency of two sets of *occurrences* often differs widely from the relative frequency of the *records* of the occurrences. The relative frequency of records of thunder and of lightning is to a large extent dependent on the position of the observer's residence, his habits, the keenness of his eyes and ears respectively, and his attentiveness to the impressions which those organs respectively experience.

No one who has on a summer night carefully watched the gradual approach of a great thunderstorm, counting the flashes, and registering the time-interval and number of claps from the minute when the first flickers begin above the southern horizon to that at which the storm is in its full roar and rattle overhead; no one who in a long night journey by train has run into a thunderstorm whose distant coruscations he has noticed two or three hours beforehand; no one, at least, who after watching sheet-lightning in one particular direction has made careful inquiries as to the occurrence or otherwise of thunder over the district from which the light proceeded, will hesitate in pronouncing the verdict that ordinary sheet or summer lightning is simply the illumination produced by a distant thunderstorm.

W. CLEMENT LEY

St. Andrews

ST. ANDREWS is the one rural university in Scotland. Its small constituency is of a somewhat peculiar kind, drawn from many sources, not by mere "gravitation," but by natural choice, and probably would not follow it if removed to a town. When the Tay Bridge has been set up again, St. Andrews will be within thirty-five minutes of Dundee. The changes which may result from this are difficult to forecast. Meanwhile the University is doing, although a limited, yet a good and useful work, and is blessed with many distinguished sons. If the career of each of these men could be traced from the Peebleshire U.P. manse, or the Forfarshire village schoolhouse, or the Cupar building-yard, to the place in life which they now fill and adorn, the history would be in many ways instructive, and it would be seen that the ideal of a "ladder" of merit (for lads of merit) is to some extent realised north of the Tweed.

The English universities, with all their wealth and all their noble endeavours, have never yet, like those in Scotland, had "their root spread out by the waters" of the life of the people. The Scottish universities fulfil the Christian precept of asking the poor to their feast. But as a consequence of this they have few rich friends, and have the more need of being visited with "the dew of heaven from above."

St. Andrews, however, has been unfairly dealt with in a special way, and it is an unfairness which can be remedied under the present Bill without making any demand upon the public funds. Three of her Chairs and more than half of her bursaries were left by the Commissioners of 1858 under the care of private patronage. The removal of this blot would inevitably be followed by an accession of healthy life. And the place is already by no means deficient in corporate vitality. Its undergraduates, numbering a few more than those at Exeter College, Oxford, and a few less than those at Balliol or Christ Church, have their football club, golf club, gymnastic club, two debating societies, musical association, domestic and Shakespearian association, and others, to which has recently been added a volunteer artillery corps. At football they have somehow managed to hold their own against the larger universities. Suppose that by the efforts of the new Commission some *Concordat* were arranged between this old yet vigorous life and the Herculean infant across the Tay, that by this means a complete Science Faculty could be established in this part of Scotland, and a new development given to the already existing St. Andrews Science Degree, would there not be then a promise for the future?

In spite of rail and telegraph, the feline attachment to places is still shared by man. To deracinate is easier than to plant, easier to plant than to make what is planted grow. Wise statesmanship will follow nature, and avail itself of elements which exist, if only life is found in them.

To return to the more general aspect of the question: the Scottish Universities have a claim to State recognition which has hardly been sufficiently considered. They are the spiritual progenitors ("though honest, yet poor," like Launcelot Gobbo's father) of all University life in Great Britain that does not directly flow from Oxford and Cambridge (see the *New Monthly Magazine* for the year 1825), and for much of this too. Prof. Stuart of Cambridge is a St. Andrews man. Had he been an Etonian or Harrovian it is not too much to say that the higher education in many English towns would be in a different position from that on which they congratulate themselves to-day. X.

Cape Bees and "Animal Intelligence"

I KEEP a large number of hives, chiefly of Cape bees, and find that their habits closely resemble those of European honey-bees; but in the course of my observations I have met with an instance of sagacity on the part of Cape bees, which, although it may also have been observed with regard to European or American bees, has not, so far as I am aware, been recorded in any treatise upon the subject. Last year my gardener hived a swarm of bees, which were not however satisfied with their new hive, their scouts having probably already selected some hollow tree for their future habitation. They accordingly left, but were soon again secured. In order, if possible, to prevent their deserting the new hive, I placed the queen in a queen-cage (a small perforated metal box with circular holes of the diameter of an ordinary pin's head), which I fixed to the roof inside the hive. A few days afterwards there were several honeycombs in the hive, and in most of the cells eggs had been deposited. Now there could be only three ways of accounting for these eggs in the cells: there might have been more than one queen in the swarm, or there might have been an egg-laying neuter among them, or else the eggs must have been those of the imprisoned queen. Accordingly I several times examined the swarm and the honeycombs (the hive being a frame hive), and satisfied myself that there was no other queen in the swarm. The queen was kept in the cage until some of the larvæ had come to maturity, the bees of course feeding her through the holes of the cage, and I found that the young bees were neuters, and not drones as they would have been if the eggs had been laid by a neuter. The only explanation, therefore, of the presence of the eggs in the cells was that they had been laid or passed by the queen through the holes of the cage, and taken up and deposited in the cells of some of the workers. This performance showed so much sagacity on the part of the bees, especially the mother bee, that I subsequently repeated the experiment with eight other swarms, and in two instances there was an exactly similar result. Two of the six remaining swarms were so dissatisfied with the new hives offered to them that they refused to build any comb, and ultimately deserted the hive, leaving the caged queen behind, although I was quite satisfied that neither swarm had a second queen among their number. I may here remark that it is much more difficult to retain a swarm of Cape bees in an artificial hive selected for them than appears to be the case in Europe or America, the explanation perhaps being that they are not sufficiently domesticated, and prefer being queenless in a natural hive selected by themselves to remaining with their imprisoned queen in a hive they do not approve of. It is possible of course that the two swarms which left their queen behind may have joined some other occupied hives or may have returned to their own former hive; but I may state that on each occasion I had removed the hives from which the swarms had issued to a considerable distance from their former position. The four remaining swarms upon which I experimented were satisfied with their new hives and built combs, but no eggs were found deposited in the cells. One of these swarms had an imported fertile Italian queen; the second and third had Cape queens, and the fourth had an Italian queen, the progeny of the imported one; the three first began laying in the cells soon after being released, but the fourth never laid eggs at all. As to the last of these queens, I fear she was rather roughly handled when caught, and that this may explain her not laying at all; but I may add that I have not yet succeeded in obtaining queens proved to be fertile from among the progeny of imported Italian queens. There are very few Italian drones in the colony, or at all events in the neighbourhood of Cape Town, and if the Cape drone does not cross with the Italian queen this would be a sufficient explanation of my failure. While upon this subject I may state that we have a yellow bee in South Africa somewhat resembling the Italian, but the neuters are a little smaller. They more closely resemble the Egyptian bees, judging by the descriptions I have read of the latter; but some of their habits are different, for they have only one queen in a hive, and they gather and use propolis, which the Egyptians are said not to do. But most of our Cape bees rather resemble the English bee, although considerably smaller, and the rings of their abdomen are of a lighter brown colour, and I confess till a few years ago I was not aware that we had any other variety. To my surprise, however, about three years ago a swarm of the yellow-winged bees arrived at my place. At first I took them to be Italians, but I had not yet then imported any myself, nor have I since been able to discover that any one else had done so. The queen and drones were exactly like the Italian queen and drones, but the neuters were a little shorter and more slender. I have unfortunately not secured any fresh swarms from the one which I hived, but the neuters that are now in the hive cannot be distinguished from the ordinary Cape worker. There are not at present any drones in the hive, and, as the hive has no frames, it is difficult (without first driving the swarm) to discover whether the queen, now in the hive, has the same appearance as the one which originally arrived. Strangely enough I continually find drones of the yellow variety in hives of the ordinary Cape brown bee. I sometimes, but rarely, see yellow workers visiting my flowers and fruit, and on a recent visit to Natal I saw numbers of bees visiting a sugar store in Durban, all of which were of the yellow variety. I was not sufficiently long in Natal to be able to say whether there are any of the ordinary Cape bees in that colony, but in the Transvaal I have seen both varieties in the fields.

Before concluding I wish, with your permission, to make a

few remarks upon a passage in Mr. Romanes' very interesting book on "Animal Intelligence." At p. 188 he says: "Bee-masters who attend much to their bees, so as to give the insects a good chance of knowing them, are generally of the opinion that the insects do know them, as shown by the comparatively sparing use of their stings." If by this he means that the bees recognise and become accustomed to the scent of persons who attend much to them, I quite agree with him, but I do not believe that their recognition goes any further. I keep two apiaries at a considerable distance from each other, to one of which my gardener, a coloured Malay, attends, and to the other a Kafir labourer. At first they were generally stung when passing too near the entrance of a hive, but now they pass and repass with impunity. They work with the bees more frequently than I do, and yet when either of them assists me in his own apiary, he receives more stings than I do. This I ascribe to the gardener's using snuff in his mouth very freely, and to the Kafir's very pronounced odour. To test the recognition of the bees I once requested the Malay and the Kafir to change clothes with each other, and wear thick veils over their heads and faces. They did so, and assisted me first in the apiaries to which they were respectively in the habit of attending, with the result that they received no stings, but when either began to work with the bees in the apiary he usually did not attend to, he was so stung about the hands that he had to beat a hasty retreat, whilst I remained uninjured, although not veiled. The two men are almost of the same size and build, so that if the bees had any power of general recognition they would probably (as some of the other servants did) have mistaken the one for the other. I can, therefore, only account for the conduct of the bees by the unpleasant, and to them strange, odour. At my request the gardener discontinued the use of snuff in his mouth for some time, and during that time he was not stung more than I was while working with bees, but if the Kafir stands before the entrance of an unaccustomed hive he is remorselessly stung. I may add that Cape bees are very much more vicious than European ones seem to be, and that, if not skilfully handled, they will unmercifully sting their most familiar friends. On one occasion a bunch of carrots was left near the gardener's apiary, which so enraged the bees that they stung him and every one else they came across, and very nearly stung a cow to death at a distance of about a hundred yards from the apiary; and on another occasion a horse, still wet with sweat, trespassed too near a hive, with the result that the whole apiary was in an uproar, and some of my children and servants were stung, the chief victim being a Malay girl who used to apply quantities of scented pomatum to her hair, and who was severely stung on the head. Mr. Romanes continues thus: "Again, many instances might be quoted, such as that given by Gueringius, who allowed a species of wasp, native to Natal, to build in the doorposts of his house, and who observed that, although he often interfered with the nest, he was only once stung, and this by a young wasp; while no Kafir could venture to approach the door, much less to pass through it." It does not appear whether any white stranger was ever stung, and the only inference that can be reasonably drawn from the conduct of the wasps is that they disliked the odour of Kafirs, which, as is well known, is peculiarly disagreeable. If a particular Kafir had been in the habit of passing through the door, the wasps would probably have become accustomed to his scent in the same way as a swarm of bees, upon the testimony of Sir John Lubbock, became accustomed to the scent of eau-de-cologne repeatedly dropped at the entrance of their hive. J. H. DE VILLIERS

Wynberg House, Wynberg, Cape of Good Hope, April 3

The Metamorphic Origin of Granite

As I had charge of the granite quarries in Mull during the five years ending 1875, and am still closely connected with them, I would like to say that the conclusions stated in the Duke of Argyll's letter in your issue of last week (p. 578) are beyond all question correct, and are the same as I formed from independent observation while I lived at the quarries.

In addition to the facts mentioned in the Duke's letter, I would say that the structure shown by the granite while decaying under atmospheric action and the cleavage which it shows in the quarry all may point to its having been a stratified rock at one time; and in several places on the shore of the Sound of Iona and in North Bay Quarry, patches of semi-metamorphosed schist are found in the granite. One very fine specimen is on the north side of Fionphort Bay.

The change from schist to granite on the north side of the peninsula of Ross, which the Duke speaks of as "obscured at the head of Loch Laigh," does, according to my observation, not take place there, but a little further west, in a bay between Loch Laigh and the inlet leading to Ardfenaig. The change can be traced foot by foot there most perfectly, and any number of specimens of it in all stages can be picked up on the beach.

Though, however, the metamorphic origin of the Mull granite is, in my opinion, beyond doubt, I think that the metamorphic agent has yet to be discovered. The most plausible hypothesis is that it was a superincumbent mass of trap, but an inspection of the very destructive influence of the trap dykes that we meet with in the quarries upon the granite about them makes this very unlikely to my mind. For some distance on each side of such dykes the granite is quite useless.

9, Angel Place, Edmonton, April 23 WM. MUIR

Helix pomatia

As *Helix pomatia* appears to be very partial in its distribution in this country, it may be worth while to record the fact that I have met with it on and near the chalk downs in the neighbourhood of Epsom, and on the chalk downs above the village of Hambledon, in South Bucks; while Mr. J. E. Harting states that it is not uncommon on the chalk hills in the vicinity of Reigate and Dorking, and in parts of Kent.

Forbes and Hanley, in their "History of British Mollusca," say "it is entirely confined to the southern counties, living chiefly on cretaceous soils"; but we learn from Mr. Gwyn Jeffreys (NATURE, vol. xxvii. p. 510) that it is abundant at Woodford, in Northamptonshire; and from Mr. Blomefield (NATURE, vol. xxvii. p. 553) that it occurs sparingly in Gloucestershire, neither of these counties being cretaceous.

With regard to its possible introduction into this country by the Romans, we gather from Venables' trustworthy work on the Isle of Wight that *Helix pomatia* has not been met with in the island, although it was occupied—and probably permanently—by that people; but *H. scalaris*, which, according to some malacologists is a monstrous form of this species, has been found there. Its absence from the Isle of Wight may be said to be somewhat remarkable, seeing that the species extends in the south at least as far as the borders of West Sussex, and that the other British chalk-frequenting *Helicidæ*, *H. caperata*, *H. ericetorum*, and *H. virgata*, are very abundant in the island. Either of two causes may account for its absence from this locality:—it may be a geologically recent importation from its original (?) centre in France, and has not yet succeeded in navigating the salt waters of the Solent; or its exceptionally large size may have proved its destruction in its exposed favourite haunts. The latter supposition is the more probable one, as it would account for its general rarity, and at the same time help to explain the prevalence in the same exposed haunts of the smaller *Helicidæ*. PAUL HENRY STOKOE

Wycombe Court, Bucks

The Zodiacal Light (?)

REFERRING to the sunset phenomena described by J. W. B., of Bath, in NATURE, vol. xxvii. p. 580, permit me to inform you that I also was an observer and was well aware from previous experience that it was not the zodiacal light, which, as seen in the evening from any latitude north of the tropics always inclines to the left, and, if seen in the morning, in the east, then to the right, whilst the phenomena in question appeared as a vertical column, of a warm tint, extending upwards to about 5° from where the sun had just set moving to the right, and descending with that luminary, continuing visible for about thirty minutes from the time I first noticed it immediately after the sun had gone down behind the low range of the Yorkshire Wolds, distant from my garden five or six miles in a north-west direction.

Having never before witnessed a similar phenomenon, although I have had for upwards of eleven years an uninterrupted view of the sunset region of the sky, and, except in midwinter, am nearly always at home at sunset, and on fine evenings in the garden, I was somewhat puzzled as to whether the cause was local and atmospheric or otherwise.

If your correspondent can refer to the "Heavens," by Guillemin, p. 86, 1st edition, or to Milner's "Gallery of Nature," 1st edition, p. 62, he will there see woodcut representa-

tions of the zodiacal light, or to "Chambers's Astronomy," 3rd edition, p. 92, where a short chapter is devoted to the subject.

Speaking from my own experience, the zodiacal light is best observed in this neighbourhood during the clear evenings of February or March, in the late twilight, and of course in the absence of moonlight.

On referring to my copy of the *Astronomical Register* for 1875, vol. xiii. p. 196, I find a letter from Mr. T. W. Backhouse in reply to a previous communication from Canon Beechey in the same volume, p. 174, describing what appears to have been a much finer display of this sunset phenomenon as seen by the rev. gentleman from Downham, Norfolk, than either your correspondent or myself witnessed.

Mr. Backhouse states: "It is purely an atmospheric phenomenon ascribed to the sun shining on particles of water or ice."

May I ask if the above explanation is an established fact or only a theory?

I shall be glad if you receive and can make room for the accounts of other observers, as I cannot think the appearance is a very common one—at least not in this neighbourhood.

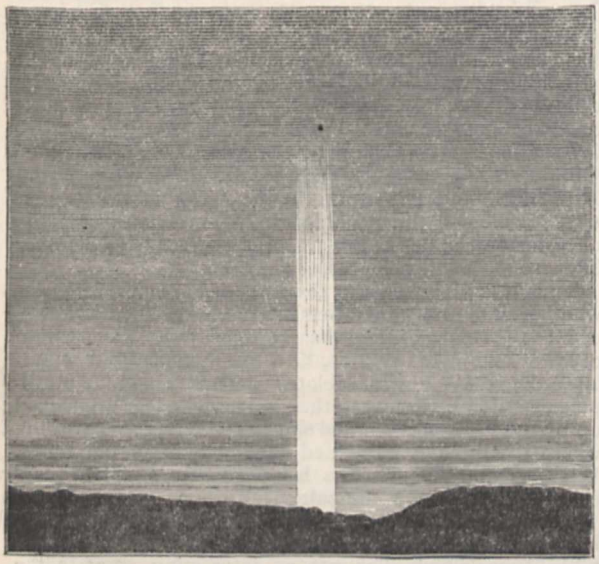
Hull, April 24 WILLIAM LAWTON

REFERRING to the letters in your columns on this subject, I beg to forward two photographs of the sun, which show distinct horns of light on each side of the disk. They were taken—the sun high in the heavens at the time—some two months ago in a simple camera, without any special arrangement, except a rapid shutter, but the development was undertaken with some care, and arrested as soon as the light fleecy clouds around made their appearance. H. B. P.

Blackheath, April 27

[WE have received the photographs, which are certainly very remarkable if our correspondent can certify that the strange prolongations which appear on them are special to them, and not in any way dependent upon any possible reflection from the lenses employed.—ED.]

THE phenomenon described on pages 580 and 605, under the heading "The Zodiacal Light (?)" was that generally known as a "Sun Pillar." I send herewith an engraving of one seen from Sidmouth in 1871, full descriptions of which were given in the *Meteorological Magazine* for May, June, and July of that year.



Sun Pillar seen near Sidmouth, April 4, 1871.

I believe that it is merely a portion of a halo passing vertically through the sun; in the recent case, that portion of the halo which was *above* the sun was alone seen, sometimes the portion *below* it is seen alone, and occasionally both are visible, together with a parhelic circle (or parts of one), and then of course we have the rare phenomenon of the sun as the centre of a luminous cross. I have called this complete phenomenon of the solar cross rare, for I know of only three occasions of its being seen, and even these I have not verified in the originals, but those interested may search in *Hugenii Opuscula posthuma*, ii. 48, for the details of the phenomenon seen in Cassel in January, 1586, by Roth; and in the *Mém. de l'Acad. des Sciences* for 1693 and 1722, for descriptions by Cassini and Malézieu. G. J. SYMONS

62, Camden Square, N.W.

THE curious luminous projection after sunset on the 6th inst., noticed by several of your correspondents, was also seen for some time very soon after sunset in Herefordshire. Its shape was somewhat like a vertical pillar of soft, hazy, yellowish, luminous light, about the width of the solar disk, 10° in height above horizon, and finishing rather abruptly with a conical termination in a clear sky. R. P. GREG

Coles, Buntingford, Herts, April 29

ALLOW me to call the attention of such of your readers as are interested in the above phenomenon, to a communication from Mr. J. J. Murphy of Belfast, in your issue of July 13, 1876, and to another from myself, a fortnight later, describing a sun pillar seen in the north of Ireland on June 27, 1876. R. V. D.

Beragh, co. Tyrone, April 28

Mock Moons

THE mock moons mentioned in your last week's issue (p. 606), by Mr. Mott, were seen here. The circle subtended an angle of 50°. When first seen, a line drawn through the mock moons passed through the moon itself. At 11 p.m. such a line was 3° above the moon. At 1 a.m. the appearance was as at first. This change of level of the refracting cloud is what Mr. Mott alludes to when he says it "seemed to be unaccountably out of place." I was not aware that there was any fixed place for the brighter portions of the halo. SM.

Temple Observatory, Rugby

The Freshwater Medusæ

IT may interest some of your readers to know that the little freshwater Medusæ (*Limnocodium Sowerbii*), which appeared in the Victoria Regia Tank here on June 9, 1880, for the first time, again on June 12, 1881, and not at all during 1882, appeared again in the tank on Saturday morning, April 28, many of them being full grown individuals. The tank, which remains empty during the winter, was filled with water on March 8.

April 30 W. SOWERBY

The Circles of a Triangle

CANNOT the method of "portmanteau" words be advantageously applied? I beg leave to suggest the following names: *circumcircle*, *incircle*, *excircle*, and *midcircle*; these are for speech, in print or writing they might appear C⊙, I⊙, E⊙, M⊙.

April 28 W. H. H. H.

Flight of Crows

IN watching crows as they fly overhead, I often think they are not flying straight forward, but have the line from head to tail at an angle of about fifteen degrees with the line of flight. Can this be corroborated? I do not like to trust my own observing powers in such a matter. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, co. Antrim, April 24

METAMORPHIC ROCKS OF SCANDINAVIA AND SCOTLAND

MUCH interest attaches to the researches of the Swedish geologists among the older crystalline rocks of Scandinavia. In the year 1873 Mr. A. E. Törnebohm published an important paper in which he showed that in the high grounds of Sweden Lower Silurian rocks, with recognisable fossils, pass up conformably into a vast overlying series of quartzites, schists, and gneisses. These metamorphic rocks were divided by him into two groups—the Seve group, composed mainly of quartzites and schists, and the Köli group, consisting

largely of mica-schists and clay-slates. In another memoir just published he furnishes additional information regarding the succession of these rocks. The old or fundamental (Archæan) rocks composed of gneiss, granite, &c., are overlain by thick masses of reddish sandstones, followed by quartzites and limestones, over which come Augen-gneiss, hornblende-schist, mica-schist, &c. This order of sequence, which is shown in numerous natural sections, will be at once recognised as that which Murchison first showed to be the stratigraphical succession in the north-west of Scotland. It is interesting to find that the parallelism which was traced many years ago between the structure of the Highlands of Scotland and the uplands of Scandinavia continues to be confirmed by the more detailed surveys of recent years.

OBSERVATION OF THE GREAT COMET OF 1882

(*Communicated by Vice-Admiral Rowan, Superintendent U.S. Naval Observatory*)

1883.	Washington mean time.	Comet −+. α.	Comet −+. δ.	No. of comps.	Mag. of star.
April 4	h. m. s. 8 29 49·8	m. s. −2 17·59	′ ″ −1 17·6	12, 4	8

Comet. α App.	log. (∅×Δ)	Comet. δ App.	log. (∅×Δ).	Obs'r.	Comp. star.
h. m. s. 5 57 20·58	s. 9·5575	° ′ ″ −9 18 27·5	″ 0·7877	F.	W 1449

Mean Place of Comparison Star

Star.	α. 1883·0.	δ. 1883·0.	Authority.
W 1449	h. m. s. 5 59 37·14	° ′ ″ −9 16 53·4	Bessel.

Date.	Obs. Δ α.	Comp. Δ δ.	Eph.
1825.	s. +4·06	″ +14	NATURE, vol. xxvii. p. 226, and *Ast. Reg.* No. 243, p. 72.

This observation was made with the 26-inch equatorial, and compared with the following of three bright points in the nucleus. If we had compared the middle point of the nucleus with the comet, the corrections would have been $\Delta\alpha = +1^s{\cdot}3$ $\Delta\delta = +0''{\cdot}3$.

E. FRISBY,
Washington, April 6 Prof. Math., U.S.N.

ANTHROPOLOGY[1]

I.

THE invitation to lecture on anthropology with which I have been honoured gives me freedom to speak both of the races of mankind zoologically, and also of the thoughts, arts, and habits which form their civilisation. It is on the development of civilisation that I especially wish to dwell, a subject of direct interest always and to all, and the more opportune now that the practical question of the instalment of a Museum of Civilisation in Oxford is under discussion. Still, man's bodily and mental history so act and interact on each other that it is well to carry on their study together. Both depend on the great principle of adaptive change, where rise in organisation gives fuller and freer existence, till "correspondence with the environment" fixes a more or less permanent state, or suppression or disuse brings on degeneration. These are processes systematised in the theories of development or evolution which have of late years become predominant, and which seek to account for the change of plants and animals on the earth by modified descent, and of mental and moral phenomena by modified sequence. There is a consideration I wish to bring prominently forward, as not having had the attention it deserves. It is that these processes of development, or evolution, or transformism were long ago recognised to no small extent by ethnologists. Thus Prichard, the leader of the monogenist school forty years ago, brought forward evidence for the derivation of the races of mankind from one original ancestral pair, whom he considered to have been negroes, whose descendants more or less varying by the operation of natural causes became modified or transformed into the various races adapted for life in the various climates of the earth. But this, so far as it goes, is the very theory of development or modified descent. Any ethnologist who argues on natural grounds "that all the races of man are descended from a single primitive stock," is an evolutionist within these limits; in fact these words are quoted not from Prichard or Quatrefages, but from Darwin. Within the last generation the science of man has had new evidence and argument brought within its range. The discovery that men were already making rude flint implements in the Quaternary period, when the contours of hill and valley were quite other than during the few thousand years known to chronology, has made a new scientific departure, placing primæval man in the hands of the geologists, who are now discussing whether he even existed in the yet more vastly remote Tertiary period. A yet greater move has been made by Darwin's systematic application of the principles of variation of breeds or races to account for the transitions between species or genera. How these have become transformed in the course of geological time is seen in Huxley's plate of the bones of the four-toed Orohippus, followed by the three-toed Miohippus and Hipparion, and this again by the horse of the present day. Zoologists thus enabled to reconstruct ideally the ancestry of the horse, are hopeful some day to discover likewise the fossil pedigree of the rider.

Thus it is plain why the new lines of biological research, whether into the general causes of variation in animals, or into the origin of the human species from a succession of lower mammalian forms, have not checked but stimulated the research which relates to man as man. Anthropologists do not feel as if their science had been plucked up by the roots and planted somewhere else; it is growing where it was, only cultivated higher than in old times. What substantial progress has been made of late years is well seen in the difficult department of craniology. That there really is something in the shape of a skull will be admitted when one compares the two before us on the table, types which illustrate an interesting point in the early history of our own country. The narrower skull belonged to one of that dolichocephalic Stone Age population whose remains were buried in the long-barrows on our downs. The broader skull belonged to one of the brachycephalic men of the later round-barrows. In the work of Greenwell and Rolleston will be found the anatomical comparison of these skull-types, and the evidence that the earlier tribes were not exterminated by the later

[1] Two lectures on "Anthropology," delivered on February 15 and 21 at the University Museum, Oxford, by E. B. Tylor, D.C.L., F.R.S.

invaders of the land, but that the two races lived and were buried together, and by intermarrying gave rise to a mixed population. What these early long-headed people were called, or what language they spoke, is still unknown. It is they to whom, on the strength of certain passages in classic authors, the name of Iberian has sometimes been given, and they have been identified with the Basques. But no absolute correspondence has been made out between them and any race past or present in Spain, so that Prof. Rolleston was wise in preferring to call the men of the English long-barrows by the local name of Silurians, and to rely on skulls for defining the type, and the burial-places for marking the state of civilisation, of an ancient race who thus take a well-marked place in the history of our land, but of whom we may possibly never learn much more.

The mixture of races which has gone on for ages in Europe makes European craniology a study of extreme difficulty, but to see its clearest results we must look to races long isolated and intermarrying till their skulls become almost uniform. How such a type will characterise a genuine race has been shown by Prof. Flower in describing the skulls from the burial-caverns of the Kai Colo, the mountain people who appear to have been the original inhabitants of Fiji. These mountaineers, whose distinction it is to have had the narrowest skulls of any known race, are representatives of the frizz-haired blacks so widely spread in the island groups now called after them Melanesian. But the ordinary Fijian population, who have lately been incorporated in the British Empire, are not exactly Melanesians, nor are they Polynesians like the brown Samoans and Tongans of the islands to the eastward. It appears that these black and brown islanders have intermixed and become the joint parents of the present Fijian population. This is perfectly shown by their skulls, whose cephalic index of breadth (71) is intermediate between those of the two parent races, the ancient Melanesian mountaineers (66) and the Polynesians (83). Not only does the cephalic index of length and breadth follow this rule, but it proves true in the same way of the index of height, and of other measurements of jaw, eye, and nose, which almost absolutely follow the same rule of the mixed race between the two parent races. The gradation is so marked, that in the Fijian islands nearest the Polynesian islands the skull-measurements come nearest to the Polynesian type. It is I think the first time that anthropology has made so close an approach to mathematical accuracy in its inferences, and it must be admitted that when arithmetical rule thus finds its way into a descriptive science, the study is becoming serious. Let us now see what comparative philology has to say to this Fijian question. Every student who opens a Fijian grammar is apt to say, Here is a Polynesian language, like Maori or Tongan; the map shows in the names of the islands plain Polynesian words that a New Zealander would understand, such as *vanua* = land, *lima* = five; the Fijian not only has the familiar Polynesian *tabu* = sacred, but he can attach the Polynesian causative prefix *waka* to it and make the verb *wakatabu* = to tabu a thing or make it sacred. Yet this student, as he examines and analyses more deeply, is driven to admit that Fijian must not be catalogued among the Polynesian languages; indeed it seems as though the root and heart of it must be classed as Melanesian, belonging to the black not the brown race; nevertheless the black language has absorbed not only the words but the character of the brown language into an intimacy and depth of mixture hardly anywhere equalled. Prof. Max Müller, in the lectures which near a quarter of a century ago made a new era in the science of language in England, was careful to give the much-needed caution not to trust too much to language in settling questions of race. Here, however, is an example how language, in cases when it is possible to get its bearing clearly into view, may tell its story in perfect accordance with anatomy. The blended parentage of the Fijians is heard in their speech as it is seen in their faces.

Not less important as a distinctive mark of race is the hair. A single hair now enables the anthropologist to judge in what division of the human species he will class its owner; there is no mistaking a Chinese for a European, or either for an African. The cross-section of this single hair, examined microscopically by Pruner's method, shows it circular, or oval, or reniform; its follicle-curvature may be estimated by the average diameter of the curls as proposed by Moseley; its colouring matter may be estimated by Sorby's method. There has been even a systematic classification of man published by Dr. W. Müller, of the Novara Expedition, which is primarily arranged according to hair, in straight-haired races, curly-haired races, &c., with a secondary division according to language. Though we cannot regard such a system as good, the wonder is that it should answer so well as it does; indeed nothing could prove more clearly how real race-distinctions are, that a single bodily character should form a basis for rationally mapping out the divisions of mankind.

It is now well understood that the causes of race-colour are not so simple as Hippocrates thought when he described the nomad Scythians as burned tawny by the cold. But the study of anthropologists is still to notice the characters which mark off the white, yellow, brown, and black races, and to connect therewith the effects of climate and mode of life. The analogy of fair or blond skin to partial albinism is striking, and possibly points to some similarity of cause. A book has even been written by Dr. Poesche to explain thus the formation of the white race. The fair whites, according to this author, are semi-albinos, whose ancestors were once a browner race in Northern Asia, but turned fair in the swampy regions of the Dneiper, where men and beasts grow light in colour, horses grey, the leaves of the trees pale, and all nature dull and colourless. Such imaginative speculation is an example to be avoided by anthropologists, and yet the resemblance of blond to semi-albino skin is one which when worked out by careful observation will doubtless lead to discovery. A yet more striking case of the morbid appearance of race-character is seen in "bronzed skin," a symptom of "Addison's disease." Here the resemblance to mulatto complexion is so marked that in the reports of cases it is quite a regular thing for the physician to mention that he asked the patient if he was of negro blood. Even that well-known negro feature, the comparatively light tint of palms and soles, was there, though there was wanting one of the points which anthropologists look to when they suspect negro ancestry, namely, the yellowness of what we characteristically call the "white" of the eye. It is not however on merely superficial comparison that this analogy depends. Anthropologists unfortunately do not always hear of medical work bearing on their studies, and it is but lately that I learnt from Dr. Wilson Fox that an interesting microscopic section of "bronzed skin" was published years ago by Mr. Hutchinson in the *Pathological Transactions*. All who compare this with Kölliker's section of normal negro skin must admit the extraordinary similarity of coloration, in the manner in which the deep brown pigment cells and grains line the surface of the papillæ of the dermis or true skin. I shall not be charged with propounding here a theory that black men are white men thus transformed, for, indeed, one incident of the obscure disease in question is that the patient always dies. The importance of the comparison lies in its bridging over the physiological differences of race, by showing that morbid action may bring about in one race results more or less analogous to the normal type in another.

The differences in race-characters among mankind are

far better known than are the causes which bring them about. Yet it would be too much to say that we do not know how to alter the type of a race. For instance, stature is one point of race-type, and we know by actual experience that if a population of the Yorkshire dales is brought in to live in factory towns, in two generations they are found to be 1½ inch lower in average stature than their countrybred kinsfolk. Indeed, it appears from Beddoe's careful statistics that the stature of the London population is gradually lessening. The great means of change of race-type is acclimatisation. Dr. Acland has here called attention to the interesting problem presented by the tribes of "unhealthy districts" in India, who live where tribes allied to them in race and language cannot exist, nor can they themselves go back, without falling sick, to the plains whence their ancestors came. That this acclimatisation affects the secretions and hue of skin is certain, but this topic is one on which only a pathologist can speak with any authority. If, however, we look at the map of the world, it is as evident to us as it was to Hippocrates that race depends in some measure on climate and mode of life. The leading fact is the lie of the negro type along the equator, as contrasted with the xanthous or blond type in the northern temperate zone. The permanence of the races of mankind, such as the Egyptian, which the polygenist school interpreted as evidence that it was a species by itself, is better explained in Draper's words that "its durability arises from its perfect correspondence with its environment." It is only when moved into different conditions that a race has to change into harmony with these new conditions.

Turning now from the development of races to the development of their civilisation, the task is made easy by the help of evidence geological in its character. The presence of stone implements in every part of the world proves that they were once used there, and that the races using them had no metal. But now stone implements are distinguished into the ruder Palæolithic and the more finished Neolithic. The ruder, discovered in gravels of great antiquity with the remains of the mammoth and other prehistoric animals in Europe, must therefore be the older, but this also seems to be evident from their very nature. If men with bronze weapons had no more bronze, they might very likely fall back on the best substitute they could make, the hard, ground stone celt; but it seems against all reason that those who knew how to grind a hatchet on a whetstone should have lost that simple if laborious art. Thus culture confirms what geology teaches, that the rude stage of man's history to which the rude implement belongs is also the earlier stage, and the higher polished implement comes later. It comes on indeed into modern times, for the general extinction of the Stone Age in Australia or America only dates from this century, and even at this day in Australia the traveller learns from the blackfellow how the rude chipped axe-flake is to be gummed to the helve, or the white hunter sits down in California to be shown how to chip out the neat obsidian arrowhead with the point of deerhorn. In a few ages after metal has come in, the new people forgets that the old people ever used such things. Thus it comes to pass that, across the world from Iceland to Japan, stone hatchets and arrowheads dug up in the ground are supposed to be the material weapons hurled or shot from the sky, whose flight is seen in the lightning-flash Such "thunderbolts" have for ages been valued for magical power, especially the appropriate uses of guarding against fire and inflammatory disease; Pythagoras was purified with a thunderbolt, and stone arrowheads form the centre-pieces of some of the most beautiful of Etruscan gold necklaces. Even a bronze implement may be taken for a thunderbolt by those who have forgotten its nature; the bronze celt here produced was dug up in Wiltshire, where the lightning had struck an oak, and it has since for many years been the magical thunderbolt of a west country hamlet.

Even where the old use dwindles and changes, survival in altered shape may keep on the old ideas: our own life is full of survivals. In ceremonial processions we still see the javelins and halberds belonging to war before gunpowder, and though the mace no longer smashes helmets, it remains as an emblem of power and dignity. Our books are ornamented with gilt lines which once represented the real cross-binding; as in perhaps the most modern of survivals, where the tape which bound the registered letter has dwindled to blue cross-lines printed on the envelope. Language is full of such records of the past; as when one hears people declare they do not care a *groat*, a *doit*, or a *rap*, when they would not recognise if they saw them these old-fashioned varieties of small change. Thus what with the lasting on of old things among outlying peoples, and what with the survival of them among the civilised world, the thread of connection is by no means lost from remotest times. For my own part, when I look at the utter likeness of the working processes of the mind among the races most different in skin, and when I see the resemblance of rude ideas and customs throughout the inhabited world, I cannot but think that much of the thought and habit of mankind not only goes back to the remote Palæolithic age, but that it may be older than the divisions of race which separate us from the Chinese or the Negro. Let me offer examples of a mental state yet surviving which may have its origin in the very childhood of mankind. Uneducated men, from the savage to the peasant, remain more or less in that childlike state of mind where the distinction between dreams and real events is not yet perfectly made; dreams seem to be visits from phantom souls of others coming to the sleeper, or excursions of his own phantom or soul away from his body. The state of primitive thought in which psychology thus grows out of the phenomena of dreams has perhaps never been better displayed than in a recent account by Mr. Im Thurn in the *Journal of the Anthropological Institute* of his Indian boatmen in British Guiana. One morning a young Macusi was so enraged against him that he refused to stir, declaring that his master, without consideration for his weak health, had taken him out in the night and made him drag the canoe up a series of cataracts. Nothing would persuade him that it was only a dream, and it was long before he was sufficiently pacified to throw himself sullenly into the bottom of the canoe. Food was scarce, and such dreams in consequence frequent, so that morning after morning the Indians were complaining that some man (whom they named) had visited their hammocks in the night, and beaten or otherwise maltreated them. In the middle of one night Mr. Im Thurn was awakened by his headman, an Arawak named Sam, who addressed him in these bewildering words: "George speak me very bad, boss; you cut his bits." On explanation, it proved that Sam had dreamt that George, one of the men under him, had spoken impudently to him, and had come at once to his master to demand that the culprit should be punished by cutting so many bits (*i.e.* fourpenny pieces) off his wages.

This instance of mental rudeness comes from among tribes who are hardly above the savage level, but not less remarkable survivals of primitive thought may be found among peasants. Thus that most archaic practice, the burial of objects for the use of the dead in the future life, is still continued in Europe. One of the latest instances comes from the village of Lückendorf in Saxony, where the schoolmaster, Herr Kühne, describes how when a mother dies in childbirth, they bury in the coffin all she wants for the child gone before—the little earthen pipkin and spoon, and a supply of groats, the baby-clothes, with needle and thread, thimble and scissors to mend them, and even a tiny model of the mangle,

because it is too large to bury. This is in a Wendish district, where prehistoric customs are more obstinately kept up than in purely German parts. Nothing could more perfectly illustrate the early animistic belief in the ghost turning to ghostly use the phantoms of objects laid for it in the grave. Thus we have, parallel with the rude material life of the Stone Age, traces of a corresponding intellectual rudeness, belonging to ages when men had not learnt to distinguish dreams from events, or to realise the meaning of death.

The problem of the order in which the races of men were formed and attained such culture as they have is obscure and perplexed enough, but it has some illuminating facts. The method by which an anthropologist judges of the centre of civilisation of a race is much the same as that of the botanist who looks for the district where a widespread cultivated plant is found wild, as the potato is in Chile, which accordingly he takes to be at or near the centre of distribution; only he has to guard against the possibility of the wild plant being only a cultivated variety run wild. Let us now apply this method to the geography of the Negro race. The negro or negroid spread over the African continent have never risen high in civilisation, scarcely of themselves getting beyond the barbaric stage. But on the other hand they are never very low; they are tillers of the soil, herdsmen, iron-workers, and no negroid tribe has been found in a clearly primitive savage state. The Bushmen, belonging to an allied variety of man, are outcasts and savages by degradation. If however we look along the map of the world for the eastern branch of the black race, we find in the Andaman Islands and in New Guinea and other islands Negro types more or less assimilated to the African, but living at lower stages of culture such as are possible in the rank forest-lands of the equator. In these two districts are found the only well-authenticated accounts of tribes with no knowledge of any means of making fire. The Andamanese have not the fire-drill or any such fire-making instrument, but carry burning brands about with them, and if by any chance they lost their fire, they could kindle it anew at their volcanoes. In an outlying district of New Guinea, Mikluho-Maclay has found a Papuan tribe who only carry fire-brands, and do not know the fire-drill of other districts. This indicates very low culture, whether they are representatives of an originally fireless state, or whether by mere inertness they have disused and forgotten so useful an art as firemaking. In these regions is perhaps the Negro centre whence, rising to a somewhat higher level of culture, the western branch spread over Africa. Let us now look at the white men from this point of view. There may be remains of Stone Age Whites, but there are no certain remains of White savages of a low order. We may well doubt if there ever were any White savages; it is more likely that the White men were developed late in the race-history of the world from ancestors already far on in civilisation; in fact, that this civilisation with its improved supply of food, its better housing and clothing, its higher intellectuality, was one main factor in the development of the White type. Here, however, it must be remembered that there is not a White race in the sense in which there is a Carib race or an Andaman race. It includes several race-types, and even the same language, such as English or German, may be spoken by men as blond as Danes or as dark as Sicilians. The fair-haired Scandinavian type has something of the definiteness of a true race; but as one travels south there appear, not well-defined sub-races, but darkening gradations of bewildering complexity. The most reasonable attempt to solve this intricate problem is Prof. Huxley's view that the White race is made up of fair-whites of the Northern or Scandinavian type, and dark-whites who are the result of ages of mixture between the fair-whites and the darker nations, though it is perhaps hardly prudent to limit these dark ancestors to one variety as he does. If now we cannot trace the White man down to the low level of primitive savagery, neither can we assign to him the great upward movement by which the barbarian passed into civilisation. It is not to the Aryan of Persia nor to the Semite of Syria that the art of writing belongs which brought on the new era of culture. The Egyptian whose hieroglyphics may be traced passing from picture into alphabet had his race-allies in people of North Africa, especially the Berbers of the north coast, people whom no elasticity of ethnological system would bring into the white race. Of the race-type of the old Babylonians, who shaped likewise rude pictures into wedge-phonetic signs, we know but little as yet; at any rate their speech was not Aryan, and the comparisons of Lenormant and Sayce have given some ground for connecting it with the Turanian language, belonging to a group of nations of whom one, the Chinese, had in remote antiquity worked out a civilisation of which the development of an imperfect phonetic writing formed part. If the great middle move in culture was made, not by any branch of the white race, but by races now represented by the Egyptian and the Chinese, it is not less clear that these nations came to the limit of their developing power. The white races had in remote antiquity risen high in barbaric culture when their contact with the darker nations who invented writing opened to them new intellectual paths. The Greeks found in the ancient Egyptian theology the gods of the four elements, but they transferred this thought from theology to philosophy, and developed from it the theory of elements and atoms which is the basis of modern chemistry. They found the Babylonians building terraced temples to the seven planets in the order of their periods, and this conception again they transferred from religion to science, founding on it the doctrine of planet-spheres which grew into mathematical astronomy. It may moderate our somewhat overweening estimate of our powers to remember that the white races cannot claim to be the original creators of literature and science, but from remote antiquity they began to show the combined power of acquiring and developing culture which has made them dominant among mankind.

(*To be continued.*)

PROFESSOR ARTHUR ROCHE

M. ARTHUR ROCHE, Professor of Mathematics and Astronomy at the Lycée of Montpellier, died at that town on April 18 last, in the sixty-third year of his age. M. Roche's name is most intimately associated with researches on the figures of planets and comets, and the cosmogonic theory of Laplace. In the report on the labours of Roche made to the Academy of Sciences last week by M. F. Tisserand, his memoirs were thus classified :—1. Various memoirs on the equilibrium of a homogeneous fluid mass subjected to certain conditions. These had special reference to the beautiful researches of mathematicians on the equilibrium of a homogeneous fluid mass, animated by a movement of rotation around its axis, the molecules of which are attracted according to the law of Newton. M. Roche proposed to determine the figure of equilibrium by taking into account a new force—the attraction exerted by a centre situated at a great distance. M. Roche worked out this idea with great success, applying it specially to the moon, to the satellites of Jupiter and Saturn, to comets, and generally to the evolution of the solar system. 2. Memoirs on the physical constitution of the terrestrial globe, in which he came to the conclusion that the density at the centre is nearly double the mean density. 3. Memoirs on the internal condition of the globe, in which M. Roche was led to pronounce against the complete fluidity of the interior. 4. Various memoirs on the figures of comets.

5. Essay on the constitution of the solar system, in which M. Roche attempted to develop the beautiful cosmogonic theory of Laplace, giving precision to certain points and modifying it in others. M. Roche was a Corresponding Member of the Academy of Sciences in the Section of Astronomy, and had been nominated as a candidate for the place vacant by the death of M. Liouville.

THE LATE MR. W. A. FORBES

MR. WILLIAM ALEXANDER FORBES, Fellow of St. John's College, Cambridge, Prosector to the Zoological Society of London, and Lecturer on Comparative Anatomy to Charing Cross Hospital, whose untimely death on the Niger we announced last week, was born at Cheltenham on June 24, 1855, the second son of Mr. J. S. Forbes, the well-known railway director. He was educated at Kensington School and Winchester College, which he entered at the early age of eleven. On leaving Winchester in 1872, Forbes passed a year at Aix-la-Chapelle studying German, and then became a student of the University of Edinburgh, where he pursued the regular medical course, paying special attention to zoology and botany, and commencing collections of insects and plants. In 1875 Forbes transferred his residence to London, and entered himself as a student of London University with the idea of taking a medical degree in the metropolis. Here he became quickly intimate with other zoologists, who were very soon attracted by the astounding general knowledge of zoology and the acute intelligence of one so young. By the advice of the late Prof. Garrod and other friends Mr. Forbes was induced in October, 1876, to leave London and to become an undergraduate of St. John's College, Cambridge, where he was subsequently elected Scholar, and took his B.A. degree with a First Class in the Natural Sciences Tripos in 1879. The post of Prosector to the Zoological Society of London having become vacant in October, 1879, by the lamented death of Prof. Garrod, Mr. Forbes was appointed (*omnium consensu*) to that office in the January following. Indeed he had been designated by Garrod on his deathbed as his most obvious and proper successor, and had been appointed his literary executor.

Mr. Forbes entered upon the duties of his office with characteristic energy, and during the three following sessions of the Zoological Society brought before the scientific meetings a series of most interesting and valuable communications derived from his studies of the animals that came under his examination. He had a happy knack of putting forward abstruse points of anatomy in an understandable form, and especially directed himself to the muscular structure and voice-organs of birds, in continuation of the researches of his predecessor Garrod on the same subjects. In the summer of 1880 Mr. Forbes made a short excursion to the forests of Pernambuco, Brazil, of which he published an account in the *Ibis* for 1881, and in the following year passed his holiday in the United States, in order to make the acquaintance of his American brethren in science and their collections. In July, 1882, he left England on what promised to be a splendid opportunity of visiting the eastern tropics with every advantage and without much risk. Detained at Shonga—a station some 400 miles up the Niger below Rebba—by the breaking down of his communications, Mr. Forbes fell a victim to dysentery on January 14 last, thus adding another name to the long list of martyrs of science in that deservedly dreaded climate.

Mr. Forbes's published works consist chiefly of papers in the *Proceedings of the Zoological Society* and the *Ibis*, altogether about sixty in number. He was editor of the memorial volume of collected scientific papers of his predecessor Garrod, and just before he left England in July last had finished the last sheets of an excellent memoir on the anatomy of the petrels—since published in the "Zoology of the *Challenger* Expedition." This piece of work was originally undertaken by Garrod, but had been left almost uncommenced at the decease of the latter.

Of Forbes's private qualities as a most efficient and ready fellow-worker, a most charming companion and a most sincere friend, the writer is able to testify, not only from personal experience, but also from the universal regret expressed at the unhappy end of so promising a naturalist. P. L. S.

RECENT INFLUENCE-MACHINES

SEVERAL modified types of influence-machine have recently been brought before the public, and as they are both cheaper and more efficient than the older forms of Töpler, Holtz, and Bertsch, will probably find general acceptance. Of the newer forms, those of Voss and of Wimshurst are illustrated in the accompanying cuts.

In the Voss machine, which may be regarded as a modified Töpler machine, there are two disks of varnished glass, one stationary, the other rotating in front of it on an axis which passes through a central hole through the fixed disk. A pair of pulleys with a strap provide the rapid movement necessary. At the back of the fixed disk are fixed two armatures or inductors of varnished paper,

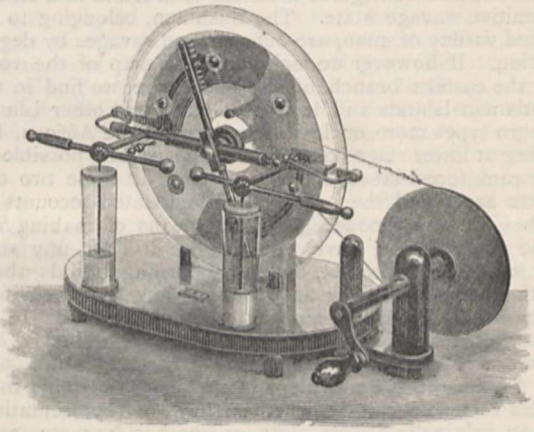


FIG. 1.—Voss's Influence-Machine.

with a narrower central band of tinfoil. These armatures are connected on the right and left respectively with two metal clamps which nip on to the edge of the disk and turn round in front of the front plate, each being provided at this part with a little metallic brush. Upon the front of the rotating plate are fastened six or eight metal buttons at equal intervals. These buttons are touched as they rotate by the metallic brushes. Nearly perpendicular, and in front of the front disk, is a brass rod, which need not be insulated, also furnished with spikes at each end, and with a little metallic brush to touch the buttons of the rotating plate. The action of the machine is as follows:—If a small charge of electricity—say a positive charge—be imparted to one armature—say that on the left—the buttons as they move past will be acted on inductively, and if, while thus under the inductive influence of the positive charge, they are momentarily touched by an uninsulated conductor, they will pass on electrified with a charge of the opposite sign. If the front plate rotates in the clockwise direction, each button as it moves through its highest position towards the right will thus acquire a small negative charge which will be given up on arriving at the right side, the projecting arm conveying the charge to the armature at the back. But as the button passes on downwards it will be influenced inductively by the armature behind it, and when touched by the lower end of the vertical conductor, will assume a positive electrification.

On arriving at the left side it will therefore give up a small positive charge to the left armature, thus charging it more highly than before. Every button as it goes round thus conveys the charges induced in it to the appropriate armatures, and exalts their charge. A very few turns given to the handle suffice to charge those armatures to their fullest extent, so that they begin to discharge pale sparks over the disks. But now begins another action. From right to left in front of the front disk lies an insulating bar of ebonite, holding at each end another brass comb, each connected by a crossbar of brass to the knob of a small Leyden jar. As the charges in the armature rise they act again upon these conductors fixed in front of them, and charge the jars, one positively, the other negatively. A pair of dischargers with ebonite handles serve to discharge the jars when full, and with every turn of the winch, when the knobs of the dischargers are separated by a few centimetres' distance, a torrent of sparks is generated. If the machine is kept free from damp and dust, no initial charge is necessary, as the slight friction of the brushes suffices to give and sustain the requisite preliminary electrification.

Wimshurst's influence-machine is even simpler, and if anything, more efficient. It is the result of a long experimental research carried out with great care and skill by Mr. J. Wimshurst, who is well known as an accomplished amateur electrician. The latest of the many combinations which Mr. Wimshurst has designed is depicted in Fig. 2. It consists of two disks of common window glass mounted upon a common spindle, and provided with driving gear by which an equal speed is given to each, but in opposite directions. Each disk (about fourteen inches in diameter in the smallest size) is well varnished with shellac varnish, and carries twelve narrow strips of thin sheet metal cemented at regular intervals apart. In front, at about 45°, is fixed a diagonal conductor armed at each

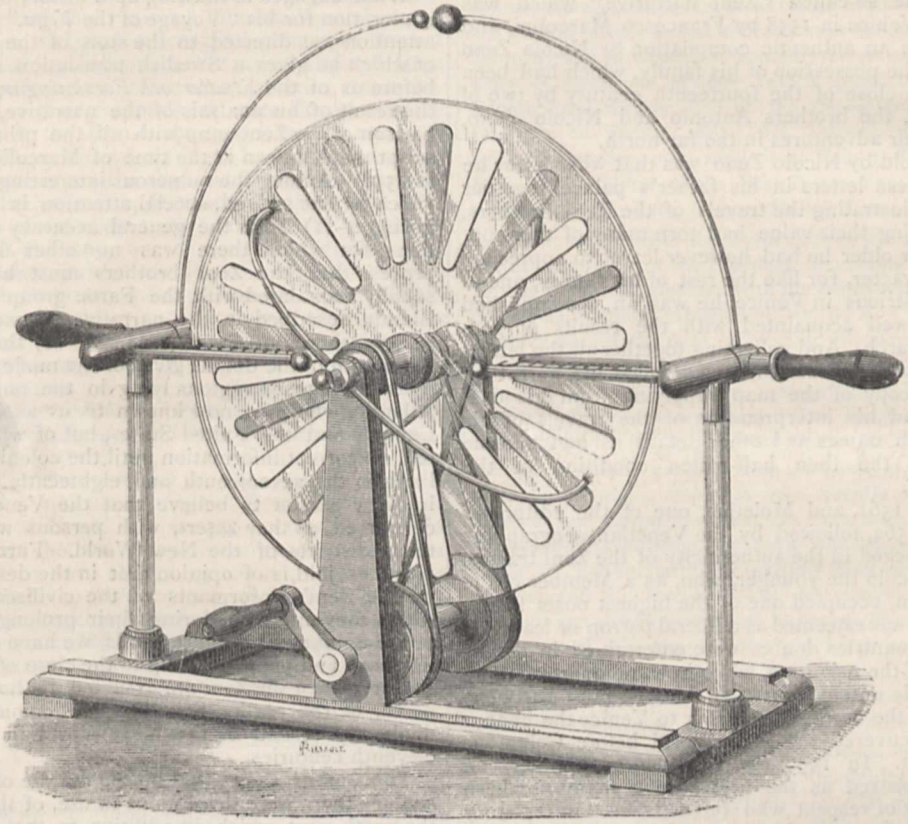


Fig. 2.—Wimshurst's Influence-Machine.

end with a small brush of metallic bristles, which touch the metal strips as they rotate. At the back a similar diagonal conductor is fixed, exactly at right angles to that in front. Right and left are two upright pillars of glass or ebonite which carry each a pair of metallic combs, and serve also to support the dischargers which are carried in an arch over the disks. It appears that in this machine the metal strips affixed to the plates act both as inductors and as carriers. Suppose, for example, that the front plate is rotating clockwise, and the back plate counter-clockwise. If the metal strips descending from the summit on the left on the back disk are charged positively, the metal strips ascending on the front disk from the left will, as they pass under the momentary touch of the brush, acquire a negative charge. As these negatively charged strips of the front plate advance towards the right they will come to a point where they are opposite the upper end of the hinder diagonal conductor, and here, whilst still acting as carriers to bring the negative charge round to the right side, they will act as inductors, and will influence the strips of the back disk, which will, as they are in turn touched by the hinder brush, acquire positive charges. The strips on the front disk will therefore constantly carry a negative charge as they move over the top from left to right, and those of the back disk will carry a positive charge from right to left. In the lower halves of their respective rotations the inverse of these actions will hold good, the front carriers conveying positive charges from right to left, the back ones conveying negative charges from left to right. The result will of course be that the two main conductors on the left and right will become respectively positively and negatively charged. Theoretically, a small initial charge must be imparted to some one or more of the carriers or to one of the two main conductors. Practically, if dry and free from dust, the machine excites itself, and after a couple of turns

have been given to the handle, discharges sparks freely. If the two main conductors are respectively joined to the inner and outer coatings of a large Leyden jar, the discharges take place with short, loud sparks of great brilliancy. If from any cause the machine does not at once charge itself, a gentle rub with a silk handkerchief on either of the ebonite pillars will suffice to provide the requisite stimulus. The Wimshurst machine appears to be less liable than any other influence-machine to have the polarity of its charge reversed. It serves admirably for the production of the electric shadows discovered by Holtz and Righi. Mr. Wimshurst is much to be congratulated on the service he has rendered to experimental science in devising so useful and efficient an instrument.

THE ZENI NARRATIVE[1]

THERE is no greater puzzle in geographical literature than the so-called "Zeni narrative," which was published at Venice in 1558 by Francesco Marcolini, and claimed to be an authentic compilation by Nicolo Zeno of letters, in the possession of his family, which had been written at the close of the fourteenth century by two of his ancestors, the brothers Antonio and Nicolo Zeno, describing their adventures in the far north.

The story told by Nicolo Zeno was that when a boy he had found these letters in his father's palace, together with a map illustrating the travels of the Zeni brothers, and not knowing their value had torn many of them up. When he grew older he had however learnt to appreciate their true character, for like the rest of his family, one of the most illustrious in Venice, he was an accomplished scholar, and well acquainted with the results of geographical research. And collecting together all the letters that had escaped destruction, he compiled his narrative, and made a copy of the map, supplying from his own knowledge, and his interpretation of the travels of his ancestors, such names and other details as had become illegible from the then half-rotten condition of the original chart.

Ruscelli in 1561, and Moletius, one of the editors of Ramusio, in 1562, followed by the Venetian geographers generally, believed in the authenticity of the Zeni travels, as told by Nicolo the younger, who, as a Member of the Council of Ten, occupied one of the highest posts in the Republic, and was esteemed as a liberal patron of learning. But in other countries doubts were entertained in regard to the truth of the narrative, while in some quarters there arose an utterly untenable notion, that the book had been compiled with the object of securing to Venice the honour of having discovered the New World before Columbus set foot on it. In 1595 the Flemish geographer, G. Mercator, appeared as the first among many northern writers worthy of respect who refused to see in the story told by Nicolo Zeno anything more than a clever forgery. One of the latest, and probably the most formidable, of these detractors, was Admiral Zahrtmann, late Hydrographer to the Danish Admiralty. As an experienced seaman, an accomplished geographer, and a Dane well versed in the maritime history of the Danish Colonies with which he had long been intimately acquainted, he was eminently qualified to judge of the accuracy of a narrative, which professed to describe a voyage among islands and to regions, which the friends and foes of Zeno are alike agreed in believing we must recognise as the Faroe Isles, Iceland, and the eastern shores of Greenland. The substance of his careful analysis of the Zeni narrative, and of the map which accompanied it, was communicated in 1836 to the London Geographical Society, in the fifth volume of whose *Journal* it was subsequently published. And there is no doubt that notwithstanding the evidence that had been advanced in favour of the Zeni voyages by Hakluyt in 1600, and still more emphatically a century ago by Capt. Cook's companion, George Forster, English geographers allowed themselves to be powerfully influenced by the opinions of Zahrtmann. In our day, however, the tide of public favour has changed both abroad and in England. And in addition to the uncompromising testimony to the *bonâ fide* character and the general accuracy of the Zeno story, borne by Mr. R. H. Major in his edition for the Hakluyt Society, in 1873, of the "Voyages of the Zeni," and by M. G. Gravier in his "Découverte de l'Amérique par les Normands au 10ème Siècle," 1874, there is now the all-powerful evidence of Baron von Nordenskjöld to be adduced as corroborative, and seemingly conclusive, proof of the genuineness of this mysterious, and long-questioned story of early Venetian adventure in the northern seas.

While engaged in drawing up a history of north-eastern exploration for his "Voyage of the *Vega*," Nordenskjöld's attention was directed to the story of the Zeni voyages, of which he gives a Swedish translation in the number before us of the *Studier och Forskningar*, together with the result of his analysis of the narrative, and his comparison of the Zeno map with all the printed and manuscript maps known at the time of Marcolini's publication in 1558 Among the numerous interesting conclusions at which he has arrived, special attention is due to the following:—(1) That the general accuracy of the descriptions, for which there was no other known source, proves that the Zeni brothers must have been personally acquainted with the Faroe group and the other islands described in the narrative, as well as with the eastern shores of Greenland; and (2) that, considering the nature of the details given of the mode of life followed by the savages in regions lying in the north-west of the Atlantic, which are now known to us as Newfoundland, Canada, and the United States, but of which Europeans had no correct information until the colonisation of those lands in the seventeenth and eighteenth centuries, there is every reason to believe that the Venetian travellers conversed, as they assert, with persons who had visited these districts of the New World. Further, Baron von Nordenskjöld is of opinion that in the descriptions given by the Zeni's informants of the civilised communities, which they met with during their prolonged wanderings in these unknown western lands, we have evidence of the influence and persistence up to the close of the fourteenth century, when the Zeni are assumed to have been in the north, of the earlier Scandinavian colonies, which undoubtedly existed in the New World in the tenth and eleventh centuries.

The author shows that in the middle of the sixteenth century there were three maps in use, of the north and of the north-west, which, in addition to the Zeno map, had all been derived from northern sources, preceding the date of the discovery of America by Columbus. Of these the most important is a manuscript map, with descriptions of Northern Europe and of neighbouring lands, bearing the date of 1427, on which the Scandinavian countries are for the first time set down with anything like accuracy, and a considerable part of America is delineated. Our knowledge of this important pre-Columbian chart is entirely due to Baron von Nordenskjöld, who discovered it in a manuscript copy of Ptolemy's "Cosmographia," preserved in the Town Library of Nancy, of which he was permitted to make a facsimile, and to give a photographic copy in his *Studier och Forskningar*.

The value of this curious record of the geographical knowledge possessed in the early part of the fifteenth century of Scandinavia, and the adjoining seas, is increased by the fact that the map was laid down by a native of the Danish Island of Fyen, known as Claudius Clavus, or Cimbricus, who undertook the task for and

[1] "Studier och Forskningar, Föranledda af Mina Resor i Höga Norden; Ett Populärt Vetenskapligt Bihang til Vegas Färd kring Asien og Europa." A. E. Nordenskjöld. Häft 1. (Stockholm, 1883.)

at the instigation of the learned Cardinal, Gulielmus Filiastrus. Claudius' map, which is brightly coloured, and well supplied with the names and geographical determinations of places, ends at 74° N. lat., and begins at 55° N. lat., in which meridian a line is drawn through England, Holsatia (Holstein), and Pomerania, thus taking in the whole of the Baltic, whose islands and shores from the then Danish province of Halland, in Scandinavia, to the Gulf of Finland, are laid down with a fair amount of accuracy. In the far west we see Grönlandia, while on the shores of the Arctic Sea, named here "tenebrosum mare," we have at the very north of Scandinavia "Engrönuelandi," which would appear to have been an old designation of part of Finmark, and possibly the region from which Grönland derived its name.

In all respects the chart drawn by C. Clavus in 1427 is so far superior to the Donis map, printed at Ulm in 1482, which had formed the basis of Bordone's, and many other later maps, that, as Nordenskjöld points out, it must have been based on independent sources derived from the actual experience of seafaring observers. As, moreover, the Zeno map corresponds far more closely with the Clavus than with the Donis chart, with whose errors of position and distortions of outline it has little or nothing in common, there is not the slightest ground for asserting that the Benedictine monk, Nicolaus Donis, whose atlas is a mere copy of drawings to be found in the mediæval manuscripts of Ptolemy, was the authority from whom the younger Zeno derived his acquaintance with the far north, in which he included East Greenland and North-West America. We have no space to enter more fully into the interesting details with which Baron von Nordenskjöld supports his argument in favour of the authenticity of the Zeni narrative. But in conclusion we must draw attention to the success and ingenuity with which he has shown, that the often-sought-for and much-talked-of manuscript map of the north, which Admiral Zahrtmann saw in the University Library at Copenhagen, and declared to be the undoubted original from which Zeno's map had been derived, was simply a copy of Donis's chart. This fact he has so conclusively established, that henceforth Zahrtmann's charge against Zeno the younger must be considered to have lost one of its strongest supports; while future commentators on the Zeni voyages need no longer scour the libraries of Northern Europe in quest of a phantom map, whose disappearance soon after it had been seen by Zahrtmann has largely contributed to the tardy solution of the Zeno mystery.

NOTES

THE following awards will be made at the anniversary meeting of the Royal Geographical Society on the 28th inst. :—Founder's Medal to Sir Joseph Dalton Hooker, F.R.S., for his eminent services to scientific geography, extending through a long series of years and over a large portion of the globe, while engaged in voyages in the Antarctic and Australian Seas, and journeys in India and the Himalaya, in Morocco, and in the United States of America; and more especially for his long-continued researches in botanical geography, which have thrown light on the form of the land in prehistoric times, and on the causes of the present distribution of the various forms of vegetable life on the earth. Patron's Medal to E. Colborne Baber, Chinese Secretary of Legation, Peking, in recognition of the great value of his scientific work, chiefly geographical, during many exploratory journeys in the interior of China; and for his reports of these journeys, drawn up with admirable skill, accuracy, and completeness, which he presented to the Society, and which have been published, together with route maps engraved from his own finished drawings, in the first part of the "Supplementary Papers." The Murchison Grant for 1883 to Wm. Deans Cowan for his extensive surveys in the Tanala, Betsileo, and Bara provinces of Central Madagascar, an account of which was read by him to the Society in June, 1882, and published in the September number of the *Proceedings* of the same year; also as an encouragement to him in the new journey of exploration he is about to undertake in Western Madagascar. The Back Grant for 1883 to the Abbé Petitot for his geographical and ethnographical researches in the region of the great lakes of the Arctic basin, between Great Slave Lake and the Polar Sea, and his map of the basin of the Mackenzie. The Cuthbert Peek Grant for 1883 to F. C. Selous in acknowledgment of the value of his geographical researches in South Central Africa, including a journey in 1877 through the Manica country, north of the Zambesi, an examination of the hydrographical system of the Chobe, and two journeys by previously untrodden routes through Mashonaland, carefully prepared maps of which he communicated to the Society; also as an encouragement to him in the further researches in geography and natural history he has undertaken in the same region. The following will be elected as honorary corresponding members: Duca di Sermoneta (Prince Teano), president of the Italian Geographical Society, and of the International Geographical Congress at Venice, 1881; Dr. Schweinfurth, the eminent African traveller, now resident at Cairo; Edwin R. Heath, M.D., the explorer of the Beni River, South America, now residing at Wyandotte, Kansas, United States.

THE annual *soirée* of the Royal Society was held on the 25th ult. in the absence of the President, on account of indisposition. Among the recent scientific work illustrated was a photograph of the nebula in Orion, exhibited by Mr. A. A. Common, which is certainly one of the most interesting astronomical photographs which has ever been taken. We may also mention an interesting exhibit by Mr. W. Galloway, exemplifying the effects of coal-dust in colliery explosions, and "The Firedamp Cap," a phenomenon seen in mines. The only other exhibit of real general interest were some garlands from the tombs of Rameses II. and other kings, whose mummies were recently found at Thebes. Many of our readers have doubtless seen them in Egypt at the famous Boolak Museum, but those who have not done so must thank Dr. Schweinfurth for sending them over to Sir Joseph Hooker, and Sir Joseph Hooker for exhibiting them. These garlands are chiefly formed of leaves of *Mimusops Schimperi*, and petals of *Nymphæa cærulea* and Lotus sewn together with fibres of date-leaf; others of the leaves of *Salix safraf*, with pods and flowers of *Acacia Nilotica*, *Sesbania Egyptiaca*, and *Carthamus tinctorius*, and petals of *Alcea ficifolia*.

DR. HANS GADOW has been appointed to the Strickland Curatorship in the University of Cambridge, vacated by the resignation of Mr. Salvin, F.R.S. Dr. Gadow began his biological studies under the late Prof. Peters in the University of Berlin, but graduated at Jena, whence he proceeded to Heidelberg, and worked there under Prof. Gegenbaur. Coming to England about two years ago, he was engaged, at the suggestion of Dr. Günther, by the Trustees of the British Museum to determine the specimens to be included in volumes viii. and ix. of their collection. The product of his labours in this direction is still in the press, but his contributions to the *Journal für Ornithologie*, the *Proceedings of the Zoological Society*, and other scientific journals, show him to be one of the most promising of the rising generation of ornithologists. In October last Dr. Gadow was appointed to deliver a course of lectures on the Morphology of the Vertebrata in the University of Cambridge, which has given much satisfaction to all concerned.

WE regret to announce the death of Dr. Wilhelm Peters, Professor of Zoology at Berlin University, and Director of the Zoological Museum of that city. He died on April 20, aged sixty-seven. The death is also announced of Dr. Gustav Radicke, Professor of Mathematics at Bonn University. He died at Bonn on April 18, in his seventy-third year.

THE President of the Parkes Museum, H.R.H. the Duke of Albany, has fixed Saturday, May 26, for the opening of the Museum in its new premises, 74A, Margaret Street, W. The central position of the new premises will make the Museum more useful than it has hitherto been to professional men, owners of property, employers of labour, artisans and others, both men and women; and in order that the benefits of the Museum may be extended to all classes, it will be open daily between the hours of ten and seven, during which hours admission will be free, from five to seven and from two to nine on Mondays and Saturdays; while free admission to the library and reading-room may always be had on the recommendation of a member.

THE honour of a baronetcy has been conferred upon Mr. Spencer Wells.

MESSRS. MACMILLAN AND CO. are about to publish "Elementary Lessons in Practical Physics," by Prof. Balfour Stewart and Mr. Gee, Demonstrator in the Physical Laboratory at Owens College, Manchester.

THE *Indian Pioneer* states that a member of the Alpine Club, attended by an experienced Swiss guide, has left Darjeeling, for the purpose of attempting the highest possible ascent of the Kinchinjunger. The task will be a hard one, especially as the difficulties to be overcome are in many respects altogether different from those encountered in Switzerland.

A TORNADO of wide range and great force swept over the states of Mississippi, Georgia, and South Carolina on Sunday week, killing large numbers of people and injuring many more, and destroying hundreds of buildings. The first place struck is stated to have been Georgetown, Mississippi. The tornado is said to have cut a path 1000 yards wide through a swamp in Barnwell county, South Carolina, felling the timber as neatly as if it had been cut to form a highway.

THE diary of the Marquis Tseng, Chinese Minister in London, to which attention has been already drawn in the *Pall Mall Gazette*, contains one or two passages which will be of especial interest to readers of NATURE. His Excellency is in favour of the acquisition of a knowledge of foreign languages by Chinese youth; he thinks that, "if young people with good vocal organs were made to apply themselves, during the intervals of school duties, to the study of a foreign language, they could gain a fluent knowledge of it in four or five years." The sudden withdrawal of the Chinese educational mission in the United States a year ago was the subject of much astonishment abroad, but the Envoy's views on the subject before the mission was despatched in the first instance, will explain the mystery. "The result of sending boys who had not studied their own classics to devote themselves exclusively to the acquisition of Western knowledge in a country like America, where there was no distinction of classes, would be simply to contribute so many citizens to the United States, and to furnish the foreign firms at the Treaty Ports with compradores and interpreters." The advantages derived by the youths in America were far less than the successes of the pupils at the Foreign College in Peking and the schools at Shanghai and Foochow. A Mr. Chang, whom the envoy met in Shanghai, and whose opinion he seems to have valued highly, suggested the establishment at Government expense of a Chinese school for foreigners, where a knowledge of the Chinese language and literature might be attained. The students, he hoped, would translate foreign books for diffusion in China. In addition translations of the educational curriculum used in schools and colleges in the West should be made, and schools where young Chinese might be trained "upon the system practised in olden times, with a slight admixture of foreign methods," should be established. "Education," Mr. Chang says, "is the basis of State administration, and its success is essential to the establishment of proper government." Marquis Tseng does not precisely claim that China in times past had steamers and steam engines, although his language at first sight seems capable of such interpretation; he says, however, that China had no lack of mechanical appliances until her material prosperity declined, when her people fell into idle and thriftless habits, and the mechanical art was lost in transmission. He prophecies that the day will arrive here as it has in China, "when Western workcraft, now so deft, will grow inept, and Western ingenuity give way to homelike simplicity. The fact is," he concludes, "the earth's productions being limited, are not sufficient to provide for the manifold wants of its countless people, and deterioration is one of nature's laws." His Excellency is clearly a man of remarkable shrewdness and capacity; let us hope that to his other gifts he does not add that of prophecy.

THE *North China Herald* reports that Dr. Bretschneider, the physician to the Russian Mission in Peking, and one of the ablest and most industrious students of China, is about to leave that country for ever. Dr. Bretschneider is, we believe, chiefly a botanist, and a few months ago we noticed an elaborate paper of his on Chinese botanical knowledge; but he has laboured in many other fields of research. One of his best known works is a pamphlet on the Early Chinese Travellers in Central Asia, which was published a few years ago. The same journal states that this gentleman, although he has already published much, is reserving his *magnum opus* until his return to Europe. The great advantage of sinologues working in China and Chinese literature on the subjects of which they are otherwise masters is obvious. Thus a botanist, with a knowledge of Chinese, will clearly work to greater advantage on Chinese knowledge of botany, the flora of China, and similar subjects, than he will in any other subject, or than a non-botanical Chinese scholar can do. Dr. Bretschneider seems during his long residence in China to have recognised this, and certainly in his hands the already great scientific reputation of the Russians in Peking has not suffered.

THE work of education in Hong Kong would appear to be conducted under some curious difficulties. Dr. Eitel, the Inspector of Schools, in his last report mentions that he noticed several cases in which Chinese girls, living at a great distance from school, and having to traverse on their way to and fro the most crowded portion of the town, were dressed like boys, and attended the girls' schools all through the year in boys' dresses. This was owing to the prevalence of the practice of kidnapping girls, and the curious change of dress was adopted to deceive the kidnappers.

WE notice in M. Bunge's review of "European Literature in Chemical Technology," published in the *Journal of the Russian Chemical Society*, the appearance of an elaborate Russian work, by M. Radivanovsky, on "Gunpowder, Pyroxyline, Dynamite, and other Explosives," in two large volumes, one of which is devoted to theory, and the other to practice. M. Bunge considers it as decidedly the best work on the subject in Europe for its completeness and lucidity of exposition.

M. YAGU, of the Russian Physical Society, while making experiments with a new parachute-hydromotor on the Neva, came to the unexpected result that the velocity of the current in this river is only half the rate in winter that it is during the summer. It is supposed that this retardation depends upon accumulations of ice at the outflow of the Neva from Lake Ladoga, which accumulations diminish the section of the channel.

M. POMPEIEU has made, before an immense crowd, two successful ascents with an elongated balloon (measurement 1300 cubic metres, elongation 1 to 3½). On both occasions the

descent was very well executed, although the balloon was partly empty, having ascended to an altitude of 1200 metres. Four persons were on board. In the second ascent M. Pompeieu obtained a movement of his aërial craft in the required direction by only moving his rudder. This circumstance is accounted for by the balloon progressing with a less velocity than the wind, owing to its elongation.

THE French Military Engineers have suggested a scheme for extending the area of Paris by suppressing the old fortifications, which cover 2000 acres, and could be sold for building-ground. The proposal is simply to connect the several forts built by Louis Philippe by a trench sufficient to prevent a sudden attack. This new line of defence would utilise the Seine and Marne as a defensive work. The total area of Paris would then be 100 square miles instead of 30, as at present.

THE Anniversary Meeting of the Zoological Society was held on April 30, Prof. W. H. Flower, LL.D., F.R.S., President, in the chair. The Report of the Council on the proceedings of the Society during the year 1882 was read by Mr. P. L. Sclater, F.R.S., the Secretary of the Society. The Report stated that the number of Fellows on December 31, 1882, was 3213, the same as at the corresponding period in 1881. The total receipts for 1882 had amounted to 34,270*l.*, against 25,810*l.* for 1881. The ordinary expenditure for 1882 had been 26,109*l.*, against 24,651*l.* for 1881, and the extraordinary expenditure 3266*l.*, against 1036*l.* for the preceding year; besides which the sum of 1000*l.* had been devoted to the repayment of part of the mortgage debt due on the Society's freehold premises, which had been thus reduced to 5000*l.* The balance carried forward for the benefit of the present year was 3891*l.* The most important work undertaken in the Gardens during the past year had been the new Reptile House, a site for which, in the south-eastern corner of the Gardens, had been selected some time since. The building was stated to be 120 feet long, by 60 feet in width. Fixed cages for the pythons and larger reptiles would occupy three sides, while the south front was reserved for small movable cases. A large oval tank for crocodiles and two smaller ones for water tortoises would be placed in the centre of the building, which it was hoped would be ready for opening in July or August next. The visitors to the Society's Gardens in 1882 had been 849,776, against 648,694 in 1881, the number having been unusually augmented by the excitement caused at the removal of the large African elephant, "Jumbo," in the beginning of the year. The number of animals in the Society's Collection on December 31 last was 2355, of which 750 were mammals, 1364 birds, and 241 reptiles. The usual ballot having been taken, it was announced that Prof. Bush, F.R.S., Major-General Henry Clerk, R.A., F.R.S., the Hon. J. S. Gathorne-Hardy, Mr. Arthur Grote, and Lord Walsingham, had been elected into the Council in place of the retiring Members, and that Prof. W. H. Flower, LL.D., F.R.S., had been reelected President, Mr. Charles Drummond, Treasurer, and Mr. Philip Lutley Sclater, M.A., Ph.D., F.R.S., Secretary to the Society for the ensuing year. The meeting terminated with the usual vote of thanks to the Chairman, in returning thanks for which Prof. Flower called attention to the loss the Society had suffered by the death of two distinguished Foreign Members (Prof. Troschel and Dr. W. Peters), and more recently by the death of the accomplished Prosector, Mr. W. A. Forbes, at the early age of twenty-eight years.

THE Sunday Society opened the Suffolk Street Galleries on Sunday for four hours to persons who had previously written for tickets. The number of visitors was 1695 (from two to four there were 495, and from six to eight the attendance was 1200). During the evening a meeting was held in the large gallery, Mr. Mark H. Judge in the chair. On the motion of Mr. Hastings Sands, seconded by Mr. Robson J. Scott, a petition in support of Lord Dunraven's resolution was unanimously passed. The annual meeting of the Society will be held on Saturday at the Princes' Hall, Piccadilly.

THE Charing Cross and Waterloo Electric Railway Bill has been withdrawn for the present session.

ON April 8, at 9 p.m., an earthquake was observed in Finland, where this phenomenon is extremely rare. At Nykarleby the shocks were rather severe, and were accompanied by a subterranean rattling and rumbling noise; their direction was from S.W. to N.E. At Wasa the ground oscillated to an alarming extent. At Ytterjeppo even the houses were shaken to their foundations and their downfall was feared; the same intensity in the shocks was observed on the "domaine" of Back.

MR. R. MELDOLA writes to say that an error has inadvertently crept into his address, referred to in last week's NATURE (p. 615). The remark quoted was not made with reference to Mr. Wallace's paper, published by the Linnean Society in August, 1858, but with reference to his first paper, "On the Law which has Regulated the Introduction of New Species," published in the *Annals and Magazine of Natural History* for September, 1855. This mistake, however, does not affect the general tenor of our paragraph.

A PAPER issued by the Isthmus of Corinth Canal Company states that the explosions of the mines will be made with an electric machine moved by hand and Leyden jar. The total weight of dynamite required will amount to 2,500,000 pounds. The work is expected to last four years, and to cost about 1,100,000*l.* The canal will be 6300 metres in length, 22 in breadth, and 8 in depth.

THE Rev. James Sibree has issued in a separate form his instructive paper on Malagasy Place-Names, which originally appeared in the *Journal* of the Royal Asiatic Society.

DR. RUDOLF FALB, the well-known author of various works on earthquakes and volcanoes, has recently written an interesting little book entitled "Wetterbriefe." It contains reflections on meteorology, with special reference to the inundations of 1882, which the author considers to be periodical. The book is published by Hartleben of Vienna.

DR. JOS. CHAVANNE'S edition of Adrian Balbi's "Allgemeine Erdbeschreibung," to which we have already referred some time ago, and which is in course of publication by Hartleben (Vienna), has now reached the twenty-fourth part. It will be completed in forty-five parts.

THE illustration of the "Lion at Rest," lent to us by our Paris contemporary, *La Nature*, which appeared in our issue of April 19, was, we are now informed, engraved from a photograph by Mr. Thomas James Dixon, the copyright of which belongs to Mr. Henry Dixon, of 112, Albany Street, Regent's Park.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. H. G. Wainwright; a Leopard (*Felis pardus* ♂) from East Africa, presented by Capt. Percy Luxmore, R.N., C.B.; a Brown Bear (*Ursus arctos* ♂) from Kamschatka, presented by Mr. C. T. Kettlewell; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. Dudley Sheridan; a Common Badger (*Meles taxus*), British, presented by Mr. J. Snowden Henry, F.Z.S.; a Woodcock (*Scolopax rusticola*), British, presented by Capt. Nicholls; two Edible Snails (*Helix pomatia*) from Cheltenham, presented by Lieut.-Col. C. S. Sturt, C.M.Z.S.; an Ashy-black Macaque (*Macacus ocreatus*) from the East Indies, a Senegal Parrot (*Pœocephalus senegalensis*) from West Africa, deposited; a Great Anteater (*Myrmecophaga jubata*) from Brazil, a Common Sparrow Hawk (*Accipiter nisus*), British, purchased.

CHEMICAL NOTES

THAT the statement of the "law of isomorphism" given by Mitscherlich is not applicable to all cases of isomorphous salts has been recognised for some time. M. Klein has recently described certain pairs of salts which crystallise in identical forms, but are not of similar chemical composition; thus *tungsto-boric acid*, $9WO_3 . B_2O_3 . 2H_2O$, is isomorphous with *silico-tungstic acid*, $12WO_3 . SiO_2 . 4H_2O$. M. Klein proposes to state the *law of isomorphism* in the following terms:—"Isomorphous bodies have either similar chemical composition, or exhibit only small differences in percentage composition; they contain either a common group of elements, or groups of elements of identical chemical formation which form by far the greater part of their weight" (*Compt. Rend.* xcv. 781).

THE rare metal thorium has been obtained in some quantity and in a pure state by Nilson. The properties of this metal are described in *Compt. Rend.* xcv. 727 *et seq.*: the sp. gr. is 11, and the atomic weight 232·36.

F. M. RAOULT (*Compt. Rend.* xcv. 1030) has studied the reduction of freezing-point of a liquid caused by the solution in it of a solid substance. He concludes that a molecule of any compound dissolved in 100 molecules of any liquid of a different nature lowers the freezing-point of the liquid by a nearly constant amount (about 0°·62). This law, he asserts, is general if it is admitted that physical molecules may be composed of two, and in some few cases of three chemical molecules.

WROBLEWSKI (whose experiments have been already referred to in these notes) states (*Ann. Phys. Chem.* [2], xix. 103) that if a little water is introduced into a tube containing CO_2, the whole cooled to 0°, the pressure increased till the CO_2 liquefies, and then suddenly released, care being taken that the pressure does not fall below 12·3 atmospheres, a thin opaque solid forms on the surface of the water, which solid is a definite hydrate of carbon dioxide. Further experiments are detailed, showing that the probable formula of this hydrate is $CO_2 8H_2O$.

M. SPRING continues his investigation on the influence of great pressure on chemical action (*Berichte*, xvi. 324). He has succeeded in preparing definite arsenides of zinc, lead, tin, cadmium, copper, and silver.

A NEW method for preparing the paraffins (C_nH_{2n+2}) has been found by Herr Köhnlein, a student in Prof. Lothar Meyer's laboratory at Tübingen; the method consists in heating together pure dry aluminium chloride and the normal iodide of the paraffin radicle required; *e.g.* $AlCl_3$ and C_3H_7I yield pure C_3H_8; $AlCl_3$ and C_2H_5I yield pure C_2H_6, &c.

AFTER having published his important work on the etherisation of alcohols, Prof. Menshutkin now publishes in the *Journal of the Russian Chemical Society* a new paper on the methods of qualitative determination of aniline and analogous bases which have no alkaline reaction, as well as of triethylamine and similar bases, and of ammonia. All these methods are a generalisation of the method of alkalimetry, and the discovery of them has afforded the author the possibility of studying the classic reaction of the permutation of bases in solutions of their neutral salts. This last is the subject of his first paper. The reaction being made under the most simple unvarying physical conditions, M. Menshutkin begins with the study of complete permutations, and shows that the theory of Berthollet as to the influence of the chemical mass is not true with regard to aniline, which is completely substituted in salts by bases whose temperature of combination with hydrochloric acid is greater than for aniline; the same is true with regard to triethylamine, which is also substituted completely, notwithstanding the increase of its chemical mass, and to ammonia. These researches have led the author to a new method of titration by means of the alcoholate of barium, and to a means of studying the formation and dissociation of acetylanilide, as well as of the amides.

ON THE SUPPOSED PRE-CAMBRIAN ROCKS OF ST. DAVID'S[1]

THE author began by briefly narrating the circumstances under which he had been led to study the geology of St. David's. He had visited the district twice—first in company with Mr. B. N. Peach, with whose cooperation nearly all the field work was done, and again in conjunction with Mr. W. Topley. The paper was divided into two parts, the first being mainly controversial, and the second descriptive.

According to Dr. Hicks, there are at St. David's three distinct pre-Cambrian formations: the "Dimetian," consisting of crystalline, gneissic, and granitoid rocks; the "Arvonian," formed of felsites, quartz-porphyries, hälleflintas, and other highly-silicated rocks; and the "Pebidian," composed of tuffs, volcanic breccias, and basic lavas. He regards the "Arvonian" as later than and unconformable to the "Dimetian," and the "Pebidian" as younger than, and unconformable to both; and he asserts that the basement conglomerate of the Cambrian system lies quite unconformably on all these rocks, and is in great part made up out of their waste.

Taking up each of these groups in the order of sequence assigned to them, the author maintained that the "Dimetian group" is an eruptive granite, which has disrupted and altered the Cambrian strata, even above the horizon of the supposed basal conglomerate. He described a series of natural sections where this relation is exposed, particularly one on the coast at Ogof-Llesugn, where the conglomerate has been torn off and involved in the granite, and has been intensely indurated, so as to become a kind of pebbly quartzite. No other rock occurs within the granite mass except dykes of diabase, which rise through all the rocks of the district, but are especially abundant in the granite. The veins of finer granite, so general in granite areas are conspicuous here. In short, whether studied in hand specimens or on the ground, the rock is so unmistakably an eruptive mass that the author could not understand how this view, which was that expressed on the Geological Survey maps, should ever have been called in question. The manner in which it has risen across the bedding of successive horizons in the Cambrian series proves that, instead of being a pre-Cambrian gneiss, it must be much younger than all the Cambrian rocks of the district.

The "Arvonian group" consists of quartziferous porphyries, or elvans, associated with the granite, and of the metamorphosed strata in their vicinity. Reference was made to natural sections where the actual intrusion of the elvans across the bedding of the rocks could be seen.

The "Pebidian group" comprises a series of volcanic tuffs and breccias, with interstratified and intrusive lavas. The author maintained that this group forms an integral part of the Cambrian system as developed at St. David's. It has been broken through by the granite and porphyries, and is therefore of older date. Instead of being covered unconformably by the Cambrian conglomerate, as asserted by Dr. Hicks, the volcanic group is overlain quite conformably by that rock; and seams of tuff are interstratified with the conglomerate and occur on various horizons above it. The conglomerate, instead of being mainly composed of fragments of the rocks beneath it, consists almost entirely of quartz and quartzite, only 4 per cent. of fragments having been found to have been derived from some of the projecting lava-islands underneath it.

From the evidence now brought forward, the author contended that as the names "Dimetian," "Arvonian," and "Pebidian" had been founded on error of observation, they ought to be dropped out of geological literature.

In the second part of his paper the author gave the results of the survey which he had made of the district with Messrs. Peach and Topley, and of his study of a series of more than 100 thin slices of the rocks collected at St. David's. He found that he could corroborate generally the descriptions of previous writers on the microscopic structure of the rocks, and that investigation with the microscope amply confirmed the deductions he had drawn from observations in the field.

1. *Order of Succession of the Rocks.*—The following rock-groups in the Lower Cambrian series are recognisable at St. David's, and are given in descending order:—

4. Purple and greenish grits, sandstones, and shales.
3. Green and red shales and sandstones, with thin tuffs (*Lingulella primæva*).
2. Quartz comglomerate.
1. Volcanic group (tuffs, schists, lavas).

The volcanic group forms the oldest part of the Cambrian series at this locality. The bottom is not reached, but about 1800 feet are visible. It consists mainly of purplish-red, green, grey, and pale tuffs, with occasional breccias and bands of olivine-diabase. Analyses of some of these rocks had been

[1] Abstract of a paper read at the Geological Society by Archibald Geikie, F.R.S.

made for the author by M. Renard of Brussels, and Mr. J. S. Grant Wilson of the Geological Survey of Scotland. The tuffs are partly basic, derived from the disruption of diabase lavas (48 per cent. of silica), partly acid, from the destruction of felsites (72 to 80 per cent. of silica). The microscopic structure of the tuffs was described, and slides and drawings were exhibited. The lavas are varieties of olivine-diabase. Their augite is remarkably abundant and fresh, and they contain scattered larger well-formed, as well as imperfect, crystals of olivine, generally in the form of hæmatitic pseudomorphs. No instance was observed of a siliceous lava having been erupted at the surface. The felsitic fragments in the tuffs must have been derived from the explosion of lavas that do not seem to have flowed out above ground. It was pointed out that this fact is exactly paralleled in the case of the volcanic group of the Lower Old Red Sandstone in the Pentland Hills.

In relation to the quartz-conglomerate, allusion was made to the constant recurrence of such conglomerates in the series of geological formations, and to the fact that they do not necessarily mark unconformability or the natural base of groups of sedimentary rocks.

2. *Geological Structure of the District.*—It was shown that the rocks have been folded into an isocline or inverted anticline, so that in one-half of the plication the dip of the strata is reversed.

The groups above mentioned are found in their proper order on both sides of the axis which runs through the volcanic group. The granite has risen irregularly through the eastern limb of the isocline. Small faults may occur here and there along the edge of the granite, but they do not in any way affect the general structure.

3. *The Foliation of the District.*—There has been extensively developed at St. David's a fine foliation of particular kinds of rock, more especially of certain fine tuffs and shales, which have passed into the condition of fine silky unctuous hydro-mica-schists or sericite-schists. A series of microscopic slices was described, which showed that the original clastic structure of the beds remains quite distinct, though an abundant development of fine flakes of a hydrous mica has taken place. This structure more particularly characterises the fine parts of the volcanic group, but it occurs also on various horizons in the groups above the conglomerate, thus linking the whole as one great continuous series of deposits. The author connected it with the plication of the district, and pointed out the great interest attaching to these fine schistose bands as revealing some of the incipient stages of the same process that had changed wide regions of sedimentary strata into crystalline schists.

4. *The Granite, Quartz-Porphyries, and accompanying Metamorphism.*—The petrographical characters of these eruptive rocks were described, and their perfect analogy to the familiar granites and elvans of other districts was pointed out. Specimens were shown illustrating the gradation from a true granite into spherulitic quartz-porphyry. The quartz-porphyries of St. David's (described by Mr. Davies, Dr. Hicks and others) exhibit spherulitic structure in an exceptionally perfect manner. Between the felso-spherulites the base is thoroughly micro-crystalline and not felsitic. The rocks belong to a group intermediate between granites and felsites. They occur in bosses, elvans, or dykes round the granite, cutting through all horizons of the volcanic group, and approaching, if they do not actually intersect, the quartz-conglomerate. The metamorphism associated with the granites and porphyries is best seen near the latter. It consists chiefly in the intense induration of certain bands of rock which have been converted into flinty aggregates (adinole). The alteration takes place usually along the bedding, which is nearly vertical; but veins of the same siliceous material ramify across the stratification of the shales. Examined microscopically, the adinole is found to have acquired a micro-crystalline structure, nests of quartz and orthoclase and porphyritic crystals of plagioclase having been developed, together with fine veins and filaments of crystalline quartz. These veins are here and there crowded with approximately parallel partitions of liquid inclusions showing freely moving bubbles. An analysis of a portion of the adinole, made for the author by M. Renard, shows the percentage of silica to be 78·62 with 5·80 of soda, indicating possibly the formation of albite. The author deferred generalising on the question of the metamorphism he described, but pointed out that a further study of the St. David's rocks could hardly fail to throw important light on the theory of metamorphism.

5. *The Diabase Dykes and Sheets.*—These are the latest rocks at St. David's, as they traverse all the others. Their macroscopic and microscopic characters were described, and allusion was made to the perfect fluxion-structure found in many of the dykes.

The paper closed with a summary of the geological history of St. David's. The earliest records are those of the volcanic group, which show the existence of volcanic vents in that region in an early part of the Lower Cambrian period. The volcanic accumulations were covered conformably by the conglomerate and succeeding Cambrian groups; but the same kind of tuffs continued to be ejected after the deposition of the conglomerate. At a later time this thick conformable succession of beds was plicated, and underwent a partial metamorphism, whereby some of the fine tuffs and shales were converted into sericite-schists. Subsequently a mass of granite rose through one side of the fold, accompanied by elvans of spherulitic quartz-porphyry, whereby a second, different, and feebler kind of metamorphism was induced. The last episode was that of the diabase dykes, which, crowded together in the granite, suggest that the granite boss stands on an old line of weakness and of escape for eruptive material from the interior.

As the conclusions drawn by the author from his study of the microscopic structure of the rocks of St. David's had been called in question at the reading of the first part of the paper, he took an opportunity before the reading of the second part to submit a series of typical specimens and microscopic slides to Professors Zirkel of Leipzig, Renard of Brussels, and Wichmann of Utrecht. These observers amply sustained his deductions. M. Renard came from Brussels to be present at the reading of the second part, and in the course of the discussion stated that Professors Zirkel, Wichmann, and himself had arrived at the following conclusions regarding the rocks of St. David's:—

1. The so-called "Dimetian" rock of St. David's is unquestionably a true granite. 2. The quartz-porphyries are just such rocks as might be expected to occur as apophyses of the granite, and the specimens from Bryn-y-Garn, Rock House, and St. David's left no doubt on their minds that such is really their origin. They cannot be confounded with rhyolitic lavas. 3. The conglomerate from the granite-contact shows secondary quartz between its pebbles. 4. The bands of fine tuff found intercalated with, and on various horizons above, the conglomerate, consist of true tuff, and cannot have been derived from the mere superficial waste of older volcanic rocks. 5. Fine foliation is well developed among the strata above the conglomerate as well as in the volcanic group below.

SOLAR PHYSICS[1]

THE lecturer introduced his subject by drawing attention to the circumstance that the idea of the sun being an exceedingly hot body was of very modern date, that both ancient and modern writers up to the early portion of the present century attributed to him a glorious and supernatural faculty of endowing us with light and heat of the degree necessary for our wellbeing, whilst even Sir William Herschel had attempted to find an explanation to account for his idea that the body of the sun might be at a low temperature, and inhabitable by beings similar to ourselves, which he did in surrounding the inhabitable surface by a non-conducting atmosphere—the penumbra—to separate it from the scorching influence of the exterior photosphere.

It was not till the views of Kant, the philosopher, had been developed by Laplace, the astronomer, in his famous "Mécanique Céleste," that the view gained ground that our central orb was a mass of matter in a state of incandescence, representing such an enormous aggregate as to continue radiation into space for an almost indefinite period of time.

The lecturer illustrated by means of a diagram the fact that of all the heat radiated away from the sun only 1/2,250,000,000 part could fall upon the surface of our earth, vegetation and force of every kind being attributable to this radiation, whilst all but this fractional proportion apparently went to waste.

Recent developments of scientific research had enabled us to know much more of the constitution of the sun and other heavenly bodies than had formerly been possible. Comte says in his "Positive Philosophy" (Martineau's translation of 1853) that "amongst the things impossible for us ever to know was that of telling what were the materials of which the sun was

[1] Abstract of Lecture at the Royal Institution, by Sir William Siemens, F.R.S., April 27.

composed" ; but within only seven years of that time Messrs. Bunsen and Kirchhoff published their famous research showing that, by connecting the dark Fraunhofer lines of the solar spectrum with the bright lines observed in the spectra of various metals, it was possible to prove the existence of those substances in the solar photosphere, thus laying the foundation of spectrum analysis, the greatest achievement of modern science. Dr. Huggins and others, applying this mode of research to other heavenly bodies, including the distant nebulæ, had extended our chemical knowledge of them in a measure truly marvellous.

Solar observation had thus led to an analytical method by which chemistry had been revolutionised, and it would be, in the lecturer's opinion, through solar observation that we should attain to a much more perfect conception of the nature and effect of radiant energy, in its three forms of heat, light, and actinism, than we could as yet boast of. The imperfection of our knowledge in this respect was proved by the circumstance that whereas some astronomers and physicists, including Waterston, Secchi, and Ericsson, had, in following Sir Isaac Newton's hypothesis, attributed to the sun a temperature of several millions of degrees Centigrade, others, including Pouillet and Vicaire, in following Dulong and Petit, had fixed it below 1800° C. ; between these two extremes other determinations based upon different assumptions had placed the solar temperature at between 60,000° and 20,000°.

The lecturer, having conceived a process by which solar energy may be thought self-sustaining, had felt much interested for some years in the question of solar temperature. If the temperature of the solar photosphere should exceed 3000° C., combustion of hydrogen would be prevented by the law of dissociation, as enunciated by Bunsen and Sainte-Claire Deville, and his speculative views regarding thermal maintenance must fall to the ground. To test the question he in the first place mounted a parabolic reflector on a heliostat, with a view of concentrating solar rays within its focus, which, barring comparatively small losses by absorption in the atmosphere and in the metallic substance of the reflector should reproduce approximately the solar temperature. By introducing a rod of carbon through a hole at the apex of the reflector until it reached the focus, its tip became vividly luminous, producing a light comparable to electric light. When a gas burner was arranged in such a way that the gas flame played across the focal area, combustion appeared to be retarded but was not arrested, showing that the utmost temperature attained in the focus did not exceed materially that producible in a Deville oxyhydrogen furnace or in the lecturer's regenerative gas furnace, in which the limit of dissociation is also reached.

Having thus far satisfied himself, his next step was to ascertain whether terrestrial sources of radiant energy were capable of imitating solar action in effecting the decomposition of carbonic acid and aqueous vapour in the leaf-cells of plants, which led him to undertake a series of researches on electro-horticulture extending over three years, a subject which he had brought before the Royal Society and the Royal Institution two years ago. By these researches he had proved that the electric arc possessed not only all the rays necessary to plant-life, but that a portion of its rays (the ultra-violet) exceeded in intensity the effective limit, and had to be absorbed by filtration through clear glass, which, as Prof. Stokes had shown, produced this effect without interference with the yellow and other luminous and intense heat-rays. He next endeavoured to estimate the solar temperature by instituting a comparison between the spectra due to different known luminous intensities. Starting with the researches of Prof. Tyndall on radiant energy, supplementing them by experiments of his own on electric arcs of great power, and calling to his aid Prof. Langley of the Alleghany Observatory to produce for him a complete spectrum of an Argand burner, he concluded that with the temperature of a radiant source the proportion of luminous rays increased in a certain ratio : whereas in an Argand oil-burner only 2½ per cent. of the rays emitted were luminous, and mostly red and yellow, a bright gas flame emitted 5 per cent., the carbon thread of an incandescent electric light between 5 and 6 per cent , a small electric arc 10 per cent., and in a powerful 5000-candle electric arc as much as 25 per cent. of the total radiation was of the luminous kind. Prof. Langley, in taking his photometer and bolometer up the Whitley Mountain, 18,000 feet high, had proved that of the solar energy not more than 25 per cent. was of the luminous kind, and that the loss of solar energy sustained between our atmosphere and the sun was chiefly of the ultra-violet kind, which rays, if they penetrated our atmosphere, would render vegetation impossible. It was thus shown that the temperature of the solar photosphere could not materially exceed that of a powerful electric arc or indeed of the furnaces previously alluded to, leading him to the conclusion already foreshadowed by Sainte-Claire Deville and accepted by Sir William Thomson, that the solar temperature could not exceed 3000° C. The energy emitted from a source much exceeding this limit would no longer be luminous, but consist mainly of ultra-violet rays, rendering the sun invisible, but scorching and destructive of all life.

Not satisfied with these inferential proofs, the lecturer had endeavoured to establish a definite ratio between temperature and radiation, which formed the subject of a very recent communication to the Royal Society. It consisted simply in heating a platinum or iridio-platinum wire, a metre long and suspended between binding screws, by means of an electric current, the energy of which was measured by two instruments, an electro-dynamometer giving the current in amperes, and a galvanometer of high resistance giving the electromotive force between the same points in volts. The product of the two readings gave the volt-amperes or watts of energy communicated to the wire, and dispersed from it by radiation and convection. A reference to the lecturer's paper on the Electrical Resistance Thermometer, which formed the Bakerian Lecture of the Royal Society in 1871, would show that the varying electromotive force in volts observed on the galvanometer was a true index of the temperature of the wire, while being heated by the passage of the current ; a law of increase of radiation with temperature was thus established experimentally up to the melting-point of iridio-platinum, which when laid down in the form of a diagram gave very consistent results expressible by the simple formula—

$$\text{Radiation} = Mt^2 + \phi t,$$

M being a coefficient due to substance radiating.

Sir William Thomson had lately shown that the total radiating energy from a unit of surface of the carbon of the incandescent lamp amounted to 1/67 part of the energy emitted from the same area of the solar photosphere, and taking the temperature of the incandescent carbon at 1800° C. (the melting-point of platinum which can just be heated to the same point), it follows in applying Sir William Thomson's deductions to the lecturer's formula that the solar photosphere does not exceed 2700° C., or, adding for absorption of energy between us and the sun, about 2800° C.—a temperature already arrived at by different methods. The character of the curve was that of a parabola slightly tipped forward, and if the ratio given by that curve held good absolutely beyond the melting-point of platinum iridium, it would lead to the conclusion that at a point exceeding 3000° C. radiation would become as it were explosive in its character, rendering a rise of temperature beyond that limit difficult to conceive.

Clausius had proved that the temperature obtainable in a focus could never exceed that of the radiating surface, and Sainte-Claire Deville that the point of dissociation of compound vapours rises with the density of the vapour atmosphere. Supposing interstellar space to be filled with a highly attenuated compound vapour, it would clearly be possible to effect its dissociation at any point, where, by the concentration of solar rays, a focal temperature could be established, but it was argued that the higher temperature observable in a focal sphere was the result only of a greater abundance of those solar vibrations called rays within a limited area, the intensity of each vibration being the outcome of the source whence it emanated : thus, in the focal field of a large reflector, the end of a poker could be heated to the welding point, whereas in that of a small reflector the end of a very thin piece of wire only could be raised to the same temperature. If, however, a single molecule of vapour not associated or pressed upon by other molecules could be sent through the one focus or the other, dissociation in obedience to Deville's law must take place irrespective of the focal area ; but inasmuch as the single solar ray represented the same potential of energy as numerous rays associated in a focus, it seemed reasonable that it should be as capable of dealing with the isolated molecule as a mere accumulation of the same within a limited space, and must therefore possess the same dissociating influence. Proceeding on these premises, the lecturer had procured tubes filled with highly attenuated vapours, and had observed that an exposure of the tubes to the direct solar rays or to the arc of a powerful electric light affected its partial or entire dissociation ; the quantity of matter contained within such

a tube was too slight to be amenable to direct chemical test, but the change operated by the light could be clearly demonstrated by passing an electric discharge through two similar tubes, one of which had and the other had not been exposed to the radiant energy from a source of high potential. If space could be thought to be filled with such vapour, of which there was much evidence in proof, solar rotation would necessarily have the effect of drawing such vapour towards its polar surfaces, and emitting it equatorially by an action independent of solar gravity, and which might be likened to that of a blowing fan. When reaching the solar photosphere, this circulating dissociated vapour would, owing to its accumulated density, flash into flame, and could thus be made to account in great measure for the maintenance of solar radiation, whilst its continual dissociation in space would account for the continuance of solar radiation into space without producing any perceivable calorific effect.

Time did not permit him to enter more fully on these subjects, which formed part of a solar hypothesis which he had ventured lately to bring forward, his main object on this occasion having been to elucidate the point of cardinal importance to that hypothesis, that of the solar temperature.

The lecture was illustrated by several experiments, showing the methods by which the dependence of radiation upon temperature had been arrived at.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Mr. H. Marshall Ward, M.A., late Scholar of Christ's College, First Class in the Natural Sciences Tripos, 1879, Lecturer at Owens College, and Fellow of Victoria University, has been elected Fellow of Christ's College.

It is proposed to appoint a Curator of the new Archæological Museum at Cambridge at a stipend of 150*l.* a year. Valuable contributions towards developing the Museum in the direction of ethnology have been promised.

In a discussion on the proposed immediate appointment of a Professor of Physiology, it was mentioned that enlarged class-rooms and a lecture-room, which did not exist, would be needed. A hope was expressed that the Professorship of Pathology would be filled up as soon as there was a reasonable prospect of sufficient appliances in the form of laboratory, &c., being provided for the Professor.

MR. W. N. STOCKER, M.A., Fellow of Brasenose, has been appointed Professor of Physics at the Royal Indian Engineering College, Cooper's Hill. Mr. Stocker took a first-class in mathematics and also in natural science, and has been for the last eight years Demonstrator in the Clarendon Laboratory.

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xv. fasc. 1.—Researches on the naphtha of Caucasus, by MM. Beilstein and Kurbatoff. The naphtha from Bakou consists mostly of hydrocarbons of the C_nH_{2n} series, identical with the products of hydrogenisation of the aromatic series C_nH_{2n-6}. That of the Tzarskiye Kolodtsy has a different composition; it contains but little of the hydrocarbons of the C_nH_{2n} series, but chiefly those of the C_nH_{2n+2} types, with a mixture of those of the aromatic series C_nH_{2n-6}. This analysis explains why the petroleum derived from the Bakou naphtha, although having a greater density together with the same volatility, burns brighter than the American, as also the higher qualities of the oils received from this naphtha. Its hydrocarbons being all liquid it contains but little paraffin, and the greasing oils may be cooled to lower temperatures, without liberating paraffin.—On the use of hyposulphite of ammonium, instead of the sulphide of ammonium, in qualitative analysis, by A. Orlovsky.—On the hydrogenisation of turpentine and cymol, by P. Orloff.—Additions to the theory of the action of chloride of ammonium.—On the evaporation of liquids, by B. Sreznewsky, being the conclusion of a treatise which has appeared in several preceding numbers of the *Journal*. The conclusions arrived at are: the velocity of evaporation is not constant; the velocity of evaporation of drops depends upon their height, and increases as the height diminishes; at a height of an average size it is proportioned to the periphery of the basis.—An aërial calorimeter (a project of), by N. Hesehus.—Elementary demonstration of the pendulum formulæ, by V. Wolkoff.

Vol. xv. fasc. 2.—On the transformation of the primary radical of propyl into a secondary, being a continuation of the researches undertaken by MM. Kékulé and Schröter, on the transformation of bromide into isopropyl under the influence of alluminium bromide.—On the heat of dissolution of mixtures of salts, and on the principle of maximum work, by P. Chrustchoff.—Analysis of the mineral waters of Slavinsk, in the Government of Lublin, by M. Kondakoff. They may be considered as one of the best iron mineral waters, as they contain the least mixture of other mineral substance; that is, 0·19 to 0·22 parts of carbonate of iron out of 3·18 to 3·38 parts of other salts, against 0·37 to 4·36, contained in the water of Spa, or 0·45 to 6·14, and 0·24 to 5·45 in those of Altwasser and Reinerz.—On the chloride of pyrosulphuryle, by D. Konovaloff.—Analysis of sulphur concretions in the fireproof clay from Bakhmut, by M. Kondakoff.—On the structure of nitric compounds of the fatty series, by M. Kissel.—On the permutations of bases in solutions of their neutral salts, by Prof. Menshutkin (analysed elsewhere).—On the specific heat of several products of distillation of naphtha, by E. Kuhlin.—On a secondary product obtained during the preparation of allyldimethyl carbinol, by W. Dieff; it distilled at 165° to 185°, and its structure may be represented as $C_9H_{18}O$.—On the critical temperature of isomeric and homologous series, by A. Nadejdine. The supposition formerly made by the author as to the critical temperature increasing in the same proportion as the temperature of boiling is confirmed by experiments with a sufficient degree of accuracy; it would result that the functions which express the dependency of the critical temperature upon the molecular structure are the same as those expressing the same dependency of the temperature of boiling, and differ only by their constants.—On comets and solar radiation, by M. Schwedoff.—Several conclusions from the theorem of Carnot, by M. Sreznewsky, being a confirmation of the formula of Kirchhoff ("Ueber einen Satz der mechanischen Wärmetheorie") for the expression of the absorption of heat during the formation of saturated solutions, and a verification of it for a certain number of salts.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 8.—"Note on the Reversal of Hydrogen Lines; and on the Outburst of Hydrogen Lines when Water is dropped into the Arc." By Professors Liveing and Dewar.

The concentration of the radiation of hydrogen in a small number of spectral lines would lead us to expect that the absorption of light of the same refrangibility as those lines would, at the temperature of incandescence, be correspondingly strong, and that therefore the hydrogen lines would be easily reversed. The mass of hydrogen which can be raised to a temperature high enough to show the lines is, however, so small that, notwithstanding the great absorptive power of hydrogen for the rays which it emits, the reversal of the lines has not hitherto been noticed. In fact, the lines are very readily reversed, and the reversal may be easily observed.

When a short induction-spark is taken between electrodes of aluminium or magnesium in hydrogen at atmospheric pressure, a large Leyden jar being connected with the secondary wire of the coil, the hydrogen lines show no reversal; but if the pressure of the hydrogen be increased by half an atmosphere or even less,[1] the lines expand and a fine dark line may be seen in the middle of the F line. As the pressure is increased, this dark line becomes stronger, so that at two atmospheres it is very decided. As the F line expands with increase of pressure, the dark line expands too, and becomes a band. It is best seen when the pressure is between two and three atmospheres. When the pressure is further increased, the dark band becomes diffuse, and at five atmospheres cannot be distinctly traced. No definite reversal of the C line was observed under these circumstances. The dispersion used, however, was only that of one prism.

By using a higher dispersion the reversal of both the C and F lines may be observed at lower pressures. For this purpose a Plücker tube was used, filled with hydrogen and only exhausted until the spark would pass readily when a large jar was used.

The light of the narrow part of the tube is, under these cir-

[1] The metallic gauge connected with the Cailletet pump used is not at all sensitive, so the pressures here mentioned are only approximate.

cumstances, very brilliant, while the spark in the broad ends is wider and less bright, but does not fill the tube. On viewing such a tube end on, and projecting the image of the narrow part of the tube on to the slit of the spectroscope, a continuous spectrum of the width of the image of the narrow part of the tube is seen, besides the lines of hydrogen given by the discharge in the wide part of the tube. These lines extend above and below the narrow continuous spectrum if the electrode is well placed so that half an inch or so of the spark in the wide part of the tube may intervene between the narrow part of the tube and the spectroscope. The continuous spectrum of the narrow part of the tube seems due chiefly to the expansion of the hydrogen lines when the discharge occurs in so confined a space, and it is much brighter than the lines given by the spark in the wide part of the tube. Where the latter cross the continuous spectrum a very evident absorption occurs. The authors observed it with a diffraction grating. The C line in the third order falls so near the F line in the fourth that both may be observed together. F is much more expanded than C, and the reversal consequently less marked though quite plain. The other lines being still more diffuse, their absorption could not be traced.

The authors have before observed (*Proc. Roy. Soc.* vol. xxx. p. 157) that the C and F lines of hydrogen are visible in the arc of a De Meritens' magneto-electric machine taken in hydrogen; though in the arc of a Siemens' machine the C line can only be detected at the instant of breaking the arc, the F line hardly at all. When, instead of taking the arc in hydrogen, small drops of water are allowed to fall from a fine pipette into the arc taken in air in a lime crucible, each drop as it falls into the arc produces an explosive outburst of the hydrogen lines. Generally the outburst is only momentary, but occasionally a sort of flickering arc is maintained for a second or two and the hydrogen line C is visible all the time. The lines (C and F) are usually much expanded, but are frequently very unequally wide in different parts of the line. F is weaker, more diffuse, and more difficult to see than C, and is visible for a shorter time. There is no sign of reversal. In the explosive character of the outburst and the irregularity in the width of the lines the effect resembles that of an outburst of hydrogen in the solar atmosphere. The elements of the water are, it must be supposed, separated, but from the explosive character of the effect they are not uniformly distributed in the arc. The arc being horizontal, and the image of it projected on to the slit of the spectroscope, it was really a very small section of the arc which was under observation, and this renders the variation in the width of the lines the more remarkable.

April 5.—"On a hitherto unobserved Resemblance between Carbonic Acid and Bisulphide of Carbon." By John Tyndall, F.R.S.

Chemists are ever on the alert to notice analogies and resemblances in the atomic structure of different bodies. They long ago indicated points of resemblance between bisulphide of carbon and carbonic acid. In the case of the latter we have one atom of carbon united to two of oxygen, in the case of the former one atom of carbon united to two of sulphur. Attempts have been made to push the analogy still further by the discovery of a compound of carbon and sulphur analogous to carbonic oxide, but hitherto, I believe, without success. I have now to note a resemblance of some interest to the physicist, and of a more subtle character than any hitherto observed.

When, by means of an electric current, a metal is volatilised and subjected to spectrum analysis, the "reversal" of the bright band of the incandescent vapour is commonly observed. This is known to be due to the absorption of the rays emitted by the hot vapour in the partially cooled envelope of its own substance which surrounds it. The effect is the same in kind as the absorption by cold carbonic acid of the heat emitted by a carbonic oxide flame. For most sources of radiation carbonic acid is one of the most transparent of gases; for the radiation from the hot carbonic acid produced in the carbonic oxide flame, it is the most opaque of all.

Again, for all ordinary sources of radiant heat, bisulphide of carbon, both in the liquid and vapourous form, is one of the most diathermanous bodies known. I thought it worth while to try whether a body reputed to be analagous to carbonic acid, and, like it, so pervious to most kinds of heat, would show any change of deportment when presented to the radiation from hot carbonic acid. Does the analogy between the two substances extend to the vibrating periods of their atoms? If it does, then the bisulphide, like the carbonic acid, will abandon its usually transparent character, and play the part of an opaque body, when presented to the radiation from the carbonic oxide flame. This proves to be the case. Of the radiation from hydrogen, a thin layer of bisulphide transmits 90 per cent., absorbing only 10. For the radiation from carbonic acid, the same layer of bisulphide transmits only 25 per cent., 75 per cent. being absorbed. For this source of rays, indeed, the bisulphide transcends, as an absorbent, many substances which, for all other sources, far transcend *it*.[1]

Chemical Society, April 19.—Dr. W. H. Perkin, president, in the chair.—The following gentlemen were elected Fellows: T. L. Briggs, J. A. Basker, J. B. Coleman, W. H. Cannon, E. C. Conrad, C. Gillett, E. C. Henning, N. K. Humphreys, L. Levy, A. Ness, V. I. Schopoff, A. E. Wilson.—The following papers were read:—On the gases evolved during the conversion of grass into hay, by P. F. Frankland and F. Jordan. The authors find that comparatively dry grass soon evolves considerable quantities of carbonic anhydride with mere traces of hydrogen and hydrocarbons; this evolution of gas occurs in air and in an atmosphere of carbonic anhydride or hydrogen: in oxygen a notable proportion of nitrogen accompanies the carbonic anhydride. Under water, grass also evolves carbonic anhydride with some hydrogen, due probably to lactic fermentation, acetic, lactic, and propionic acids being simultaneously formed.—Note on an apparatus for fractional distillation under reduced pressures, by L. T. Thorne. The object of this apparatus is to facilitate the removal of the various fractions of the distillation without breaking the continuity of the distillation.—Notes on the condition in which carbon exists in steel, by Sir F. A. Abel, C.B., and W. H. Deering. Two series of experiments are given by the authors; in the first the differences between cold rolled, annealed, and hardened samples of the same steel are investigated. The steel disks were subjected to the action of a saturated solution of potassium bichromate containing 5 per cent. by volume of sulphuric acid. In each case a blackish residue consisting of a carbide of iron was left; in the case of the cold rolled and annealed disks, the carbon in this residue corresponded pretty closely with the total carbon present; but in the hardened disk only one-sixth of the total carbon was found in this residue. In the second series of experiments, the action of various strengths of bichromate solution on cold rolled steel is studied, and it is proved that, if the oxidising solution be not too strong, a residue consisting of a definite carbide Fe_3C is left, and that the carbon is therefore not simply diffused through the mass, but exists as a definite compound capable of resisting the action of a solvent which rapidly dissolves metallic iron.—On the spectrum of beryllium with observations relative to the position of that metal among the elements, by W. N. Hartley. From a photographic study of the spectrum, the author concludes that beryllium is the first member of a dyad series of elements of which in all probability calcium, strontium, and barium are homologues.

Linnean Society, April 19.—Sir John Lubbock, Bart., president, in the chair.—Messrs. T. W. Coffin, F. H. Collins, C. D. F. De Laune, D. Morris, J. Jardine Murray, and Hon. J. B. Thurston were elected Fellows of the Society.—Mr. J. Britten exhibited and made remarks on specimens of *Arum italicum* from Torquay, South Devon.—Mr. G. F. Angas showed several vegetable products from the Island of Dominica, among others an unusually large seed-pod of *Cassia fistula*, and other examples of Leguminosæ, also Polyporus fungi from the Roseau Falls.—Mr. F. V. Dickins called attention to a Japanese work issued by the University of Tokio, giving descriptions and illustrations of plants grown in the Botanic Gardens of Koiskikawa.—A paper was read by Sir John Lubbock on the sense of colour amongst some of the lower animals (vol. xxvii. p. 619).—There followed a communication by Prof. P. T. Cleve of Upsala, on the diatoms collected during the Arctic expedition of Sir George Nares.—The Rev. A. E. Eaton gave a digest of an extensive monograph of the Ephemeridæ or Mayflies, part i. In this the subject is prefaced by an historical account and general view of the group; the genera are defined, and a

[1] Nearly twenty years ago I observed, among other changes of diathermic position, the reversal of bisulphide of carbon and chloroform, when the pale blue flame of a Bunsen burner was the source of heat. When, for example, the rays issued from a luminous jet of gas, the absorptions of the bisulphide and of chloroform were found to be 9·8 and 12 per cent. respectively; whereas when the Bunsen flame was employed, the absorptions of the same two substances were 11·1 and 6·2 per cent. The cause of this reversal doubtless is that in the Bunsen flame hot carbonic acid is the principal radiant (*Phil. Trans.*, 1864, p. 352).—April 6.

tabular conspectus of the present known species indicated.—A paper was read on the joint and separate work of the authors of Bentham and Hooker's "Genera Plantarum," by George Bentham.

Zoological Society, April 17.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of March, and called special attention to three Sirens (*Siren lacertina*) from South Carolina, presented by Dr. G. E. Manigault, C.M.Z.S., and to an American Teetee Monkey of the genus *Callithrix*, which it was difficult to determine satisfactorily in its living state, but which was certainly new to the Society's Collection.—Prof. Flower, F.R.S., gave an exposition of the systematic classification of the Mammalia which he had recently prepared for use in arranging the specimens in the Museum of the College of Surgeons, and in a treatise on the subject of Mammals in the "Encyclopædia Britannica."—A communication was read from Mr. W. L. Distant, containing the first of a series of contributions to an intended monograph of the Homopterous family Cicadidæ. In the present paper the author gave the results of an examination of the Cicadidæ contained in the Dresden Museum (including the specimens collected in Celebes by Dr. A. B. Meyer), and added the descriptions of other species belonging to the collections of Dr. Signoret and the author. Eleven species were described as new from various localities.—Mr. Sclater read a second paper on the birds collected in the Timor Laut or Tenimber group of islands by Mr. H. O. Forbes, based on additional specimens lately received. The avifauna of the group, as indicated by Mr. Forbes's collection, contained 59 species, of which 22 were peculiar to these islands.—A communication was read from Mr. F. Moore, F.Z.S., containing the first part of a monograph of the butterflies belonging to the groups *Limnaina* and *Euplœina*.

Physical Society, April 14.—Prof. G. Carey Foster in the chair.—New Members: Mr. W. F. Smith, Mr. George Forbes, M.A.—Mr. W. Lant Carpenter read a paper on science demonstration in Board schools, in which he showed the drawbacks of the present system of leaving science to be taught by the other masters, and pointed out the marked advantages of the system followed in Birmingham and Liverpool, where skilled lecturers are appointed to go from school to school, and provided with an assistant demonstrator and proper apparatus. Mr. Carpenter advocated the extension of this system to London and the country in general. He also showed the evil of the present system of cramming for examinations. Dr. W. Carpenter pointed out the advantages of object lessons in training the minds of children. Dr. J. H. Gladstone stated that much had been done in London to introduce object lessons, and that under the Mundella code science would be taught in all Board schools to all the children, who, however, might have the opportunity of choosing between science and literature. Mr. W. Baily, Prof. Foster, and Prof. W. Chandler Roberts, also advocated the system of special science teachers.—Prof. Roberts then took the chair, and Mr. Glazebrook explained a new polarising prism which he had devised to prevent displacement of the pencil of rays. He also showed how the curved diffraction-gratings of Prof. Rowland do not always give perfect definition, and calculated the aberration of the rays.—The Secretary then read a paper by Mr. W. H. Stokes and Mr. A. E. Wilson on experiments on the viscosity of saponine. When a disk is rotated in water, the resistance to its motion is greatest when the plate is immersed a little below the surface; but with saponine the viscosity is greatest when the disk is not wholly, but only partially, immersed below the surface.

Entomological Society, April 4.—Mr. J. W. Dunning, M.A., F.L.S., &c., president, in the chair.—The death of Prof. P. C. Zeller of Stettin, one of the Honorary Members of the Society, was announced and commented upon.—Two new Members were elected.—Mr. W. F. Kirby exhibited specimens of *Acridium succinctum*, Linn., one of the most destructive species of migratory locusts in India.—Prof. Westwood mentioned that a Myriopod, *Polydesmus complanatus*, Linn., had lately been erroneously announced to be the cause of the potato disease.—Rev. A. E. Eaton exhibited a patent revolving object-holder used by mineralogists, which seemed likely to be useful to entomologists also.—Mr. E. A. Fitch exhibited galls of *Cecidomyia violæ*, Loew., and of *Aploneura lentisci*, Licht.—Sir S. S. Saunders read a short paper on the classification of the germ-feeding races of fig-insects.—Mr. H. Goss exhibited specimens of *Pimelia angulata*, Fabr., from the temple of the Sphinx at Ghizeh.—Papers read:—On a small collection of Clavicorn *Coleoptera* from North Borneo, by Mr. A. S. Olliff; Descriptions of new genera and species of *Hymenoptera*, by Mr. P. Cameron; and notes on new or little-known species of *Hymenoptera*, chiefly from New Zealand, by Mr. W. F. Kirby.

EDINBURGH

Royal Society, April 16.—Mr. Murray in the chair.—Mr. Sang read a paper on some properties of the curve of simple flexure, of which he gave neat geometrical demonstrations. A simple construction was given for finding the radius of curvature at any point and so affording a ready means for tracing the curve. The related theorems in pendulum motion were also given.—Dr. Knott communicated the results of electrometer measurements of the resistance of electrolytes, which had been carried out lately in the Edinburgh University Laboratory. The method seemed capable of giving fairly accurate values.—In a note on the electrical resistance of hydrogenised palladium, Dr. Knott gave 1·51 as the ratio of the resistances of the fully-charged and pure palladium, the increase of resistance being very nearly proportional to the charge for smaller charges. It was also noted that the electromotive force between palladium and platinum dipping in dilute sulphuric acid was greatly increased for a slight charge of hydrogen, falling off again very markedly as the charge reached its maximum.—Dr. Macfarlane, in a note on plane algebra, or double algebra, as De Morgan named it, demonstrated with facility certain theorems that ordinarily require considerable algebraic manipulation.—Prof. Tait presented a continuation of his theoretical investigations on heat conduction in heterogeneous bodies, as modified by the Peltier and Thomson effects, and gave the result of his investigation of the thermo-electric position of pure ruthenium. On the diagram this metal lies below iridium, to which it is in other thermoelectric respects very similar.

BERLIN

Physical Society, April 6.—Dr. Aron reported on the accumulators, on which he has been making experiments for several years past. Even before M. Faure's discovery, at the time when M. Planté announced his first essays with the secondary batteries, Dr. Aron was endeavouring to determine a convertible electric element which, being theoretically possible, might also be available for practical purposes. He first of all tried to make the Daniell chain convertible by using, instead of the two amalgamating fluids, hydrate of soda and sulphate of copper which do not amalgamate, but without success. Like many others he repeatedly tested Planté's already published statements regarding convertible cells of plates of lead immersed in diluted sulphuric acid, and which had to be charged in a very definitely prescribed way, but without any certain results. The cell sometimes became charged and discharged alternately, at other times not. He accordingly tried plates of lead which had been previously crystallised by corrosion, and these he found far more reliable. He therefore constructed accumulators of plates of lead in sulphuric acid to which some nitric acid had been added. Although more certain in their application, these were by no means equal to the practical requirements. The favourable results of the corrosion, as regarded the crystalline surface, a point also confirmed by Planté himself, was explained by Dr. Aron, who attributed it to the disintegration of the metal. He therefore tried to increase the effect by using lead-sponge, but without result. At that time he also thought of red lead, but made no experiments with it, because he knew of no means of fixing this powder to the lead plate conductor. It is now known that M. Faure simply spread the red lead on the plates, and thus produced his powerful accumulators possessing great storage capacity. When this became known, Dr. Aron carried out an extensive series of similar experiments in order to test its practical value, and even increase it. For the latter purpose he introduced a substantial improvement by attaching the red lead with collodium, which in the practical application of the chains is of course out of the question. But as regards their practical utility the accumulators have fallen far short of the hopes generally entertained of them. The main difficulty lies in the thin plates of lead which, when thickly covered with red lead, although very effective, become corroded and useless after being once used, while thick plates, by the formation of sulphate of lead, are rendered ineffective. As to the theory of accumulators, to rightly understand it, it is very important to bear in mind the

fact established by Messrs. Gladstone and Tribe, that in the cell, consisting of two plates in diluted sulphuric acid, the electric current changes the sulphate of lead generated at the positive pole into peroxide of lead, $PbSO_4 + H_2O + O = PbO_2 + H_2SO_4$, whereas at the negative pole the sulphate of lead is simply decomposed into sulphuric acid and disintegrated lead. Hence, after charging, the cell consists of Pb | H_2SO_4 | PbO_2 | Pb, a combination which yields a very powerful discharge, available al o for a protracted period. To this theory it has been objected that at the negative pole the sulphate of lead cannot be decomposed into lead and sulphuric acid. But Dr. Aron has satisfied himself that, under the influence of the hydrogen beginning to be generated, very thin layers of sulphate of lead become so reduced, thicker layers alone resisting decomposition. The process at the positive electrode being really such as is described by Gladstone and Tribe, the above theory of accumulators may, broadly speaking, be accepted as correct. As regards the peroxide of lead, the speaker pointed out that this combination is admittedly of a brown colour, whereas the substance deposited on the positive plate is black. From a more searching examination of this substance, it resulted that it is not the peroxide, but a hydrate of the peroxide of lead. And Dr. Aron suspects that there is here less question of a hydrate PbO_2H_2O than of a combination of the oxide of lead with peroxide of hydrogen. A series of theoretically interesting isolated phenomena may possibly be produced by following up the processes here in question. But in the present conditions Dr. Aron holds the practical application of the accumulators to be hopeless.—Prof. Neesen briefly described a slight improvement in the quicksilver air-pump, illustrating it with a diagram.

PARIS

Academy of Sciences, April 23.—M. Blanchard in the chair.—The death of Prof. Roche of Montpellier, Correspondent in Astronomy, was announced. (A report on his work by M. Tisserand is inserted in *Comptes Rendus.*)—A new method for determination of the right ascension of polar stars, and of the inclination of the axis of a meridian above the equator (continued), by M. Lœwy.—On some relations between the temperatures of combustion, the specific heats, the dissociation, and the pressure of explosive mixtures, by M. Berthelot.—Note on the inland African sea, by M. Cosson.—On a manner of determining the angle of position of a point of the surface of a star with the aid of a horizontal telescope, by M. Trépied.—On the use of the horizontal telescope for observations of solar spectroscopy, by M. Thollon. His apparatus is essentially a horizontal telescope deprived of the tube and reduced to its most simple expression. It is more easily managed than an equatorial. The mirror used is guided by the two hands, and the solar surface is explored at will. The author shows how he solved the difficult problem of determining position.—Determination of a particular class of surfaces with plane lines of curvature in a system, and isotherms, by M. Darboux.—On the reduction of ternary positive quadratic forms, by M. Minkowski.—Law of periods (concluded), by M. de Jonquières.—On a relation of involution, concerning a plane figure formed of two algebraic curves, one of which has a multiple point of an order of multiplicity inferior by unity to its degree, by M. Fouret.—Study of infra-red radiations by means of phenomena of phosphorescence, by M. Becquerel. He indicates the results of his method with telluric bands, the absorption spectrum of water and of some earthy metals, and the emission spectrum of metallic vapours.—On the specific heat of some gases at high temperatures, by M. Vieille. He verifies, for the gases H, O, N, and CO, the identity of the molecular heats with constant volume up to 2700°. The measurement of pressures leads him to attribute to certain reactions temperatures much higher than have been supposed practically realisable.—On the variation of indices of refraction of water and quartz under the influence of temperature, by M. Dufet. He indicates a new application of Talbot's fringes in measurement of this variation. The number for quartz is almost identical with that obtained by M. Fizeau.—Experimental studies on the production of vowels in whispered speech, by M. Lefort. Air is blown into a cavity of variable capacity, open and closable at the upper part. The sounds characteristic of vowels are thus produced. The author claims to prove that the vowels are not timbres (as generally taught); they are notes of different heights of the instrument of speech (quite distinct from the vocal instrument). Various timbres may be communicated to them by action of the muscles of the organ of voice.—On the liquefaction of nitrogen, by MM. Wroblewski and Olszewski. Nitrogen cooled in a glass tube to −136° C., and under a pressure of 150 atm., does not liquefy. On sudden release there is tumultuous ebullition. Gradual release, not passing 50 atm., yields the liquid, clear and colourless, with a distinct meniscus; it evaporates very quickly. The liquefaction of CO under like conditions on April 21 was announced.—On iodised apatites, by M. Ditte.—Action of water on Theil's lime, and the existence of a new hydraulic compound, *pouzzo-portland*, by M. Landrin. The composition of this compound is silica 44·55, lime 55·45. It is the principal element of all Theil's compounds.—On some phenolic derivatives, by M. Henry.—Jurassic Echinida of Algeria, by M. Cotteau. Of the 47 species found, 28 occur in Europe about the same stratigraphic levels. Some curious species peculiar to Algeria are noted.—Clayballs of Macaluba, by M. Contejean. These were found (of all sizes from a cannon-ball to a boy's marble) in the dried bed of a ravine, near the mud volcano named. They are of coarse clay, with small crystals of gypsum, giving a rough surface. It is thought they are formed by the autumn rains, and are dissolved by the heavier winter rains.—The perception of white and of complex colours, by M. Charpentier. His curves show, *inter alia*, that what artists term warm colours are distinguished from a colourless ground *more* easily than white, the cold colours *less* easily.—On the functions of pyloric appendices, by M. R. Blanchard. These appendices digest effectively cooked starch, less effectively raw starch, and transform albuminoids; as they do not effect emulsion and decomposition of fats, they are but imperfect representatives of the pancreas.—On the bite of the leech, by M. Carlet. He detached the animal from the shaved skin of a rabbit at different stages. Suppose a scarifier, with three toothed and equidistant blades withdrawing from one another while they press into the skin, and operating several times successively in the same place: this gives a pretty exact idea of the mechanism.—Comparative study of the bacteria of leprosy and of tuberculosis, by M. Baber. The differential properties indicated by Koch do not, he holds, exist; but there are others, bearing on chemical and molecular reaction, on form, and on arrangement in the tissues.—Influence of sensitive (nerve) roots on the excitability of motor-roots, by M. Canellis. Section of the sensitive root increases considerably the excitability of the motor nerve.—Immunity of workers in copper during the last epidemic of typhoid fever; confirmation of anterior observations, by M. Burq.—Influence of altitudes on phenomena of vegetation, by M. Angot. The harvest-time for winter wheat is retarded in France on an average four days where the altitude is increased about 100 metres.

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