Nature. Vol. VII, No. 171 February 6, 1873

London: Macmillan Journals, February 6, 1873

https://digital.library.wisc.edu/1711.dl/LBXITYVRTMAPI83

THURSDAY, FEBRUARY 6, 1873

SEDGWICK

GEOLOGY has lost her veteran leader! While yet firm in intellect, full of kind and generous feeling, and occupied on the last pages of the latest record of his labours, in the ninth decad of a noble life, Sedgwick has gone to his rest. Under the shadow of this great loss we look back through more than half a century, and behold no more conspicuous figure in the front ranks of advancing geology than the strenuous master workman, the eloquent teacher, the chivalrous advocate of science, who has now finished his task. Severe illness, borne with fortitude, had gradually withdrawn him from scenes once brightened by his ever-welcome presence, but could not tame the high spirit, or cloud the genial sympathies which had won for him, more than for other men, the loving admiration of his fellows in age and followers in study. Rarely has a patriarchal life been crowned with such enduring and affectionate respect.

Born in 1785, of a family long resident in a secluded Yorkshire Valley under the shadow of Wharnside, the boy early acquired the hardy habits and imbibed the free spirit of the north, and the man retained till his latest hour, a romantic love of the bold hills and rushing streams. amidst which he first became an observer of nature. Every homestead and every family in his native dale of Dent were treasured in his memory, and one of the latest of his minor literary essays was to plead against the change of the ancient name of a little hamlet situated not far from his birth-place.

Educated under Dawson, at the well-known school of Sedbergh, while Gough and Dalton were residing at Kendal, he proceeded to the great college in Cambridge, to which Whewell, Peacock, and Airy afterwards contributed so much renown. Devoted to the Newtonian philosophy, and especially attracted by discoveries then opening in all directions in physical science, he stood in the list as fifth wrangler, a point from which many eminent men have taken a successful spring. He took his degree in 1808, became a fellow in 1809, was ordained in 1817, and for some years occupied himself in the studies and duties of academic life. His attention to geology was speedily awakened, and became by degrees a ruling motive for the long excursions, mostly on horseback, which the state of his health rendered necessary in the vacations.

It was not, however, so much his actual acquirements in geology as the rare energy of his mind, and the habit of large thought and expanding views on natural phænomena, that marked him out as the fittest man in Cambridge to occupy the Woodwardian chair vacated by Hailstone. Special knowledge of rocks and fossils was not so much required as a well-trained and courageous intellect, equal to encounter theoretical difficulties and theological obstacles which then impeded the advance of geology.

The writer well remembers, at an evening *conversazione* at Sir Joseph Banks's, to which, as a satellite of Smith, he was admitted at eighteen years of age, hearing the remark that the new professor of geology at Cambridge promised to master what he was appointed to teach, and was esteemed likely to do so effectually. In the same year Buckland, his friendly rival for forty years, received his appointment at Oxford, where he had previously begun to signalise himself by original researches in palæontology.

At this time the importance of organic remains in geological reasoning, as taught by Smith, was not much felt in Cambridge, where a new-born mathematical power opened out into various lines of physical research, and encouraged a more scientific aspect of mineralogy, and a tendency to consider the phænomena of earth-structure in the light of mechanical philosophy. This is very apparent in the early volumes of the Cambridge Philosophical Society, established in 1819, with Sedgwick and Lee for secretaries. Accordingly, the earliest memoirs of Sedgwick, which appear in the Cambridge Transactions for 1820-21, are devoted to unravel the complicated phænomena of the granite, killas, and serpentine in Cornwall and Devon; and to these followed notices of the trap-dykes of Yorkshire and Durham, 1822, and the stratified and irruptive greenstones of High Teesdale, 1823-24. In his frequent excursions to the north he was much interested in the varying mineral characters and fossils of the magnesian limestone, and the remarkable nonconformity of this rock to the subjacent coal, millstone grit, and mountain limestone; and at length his observations became the basis of that large systematic memoir which is one of the most valuable of the early contributions to the Transactions of the Geological Society. Begun in 1822 and finished in 1828, this essay not only cleared the way to a more exact study of the coal formation and New Red sandstones of England, but connected them by just inference with the corresponding deposits in North Germany, which he visited for the purpose of comparison in 1829.

To one of these equestrian excursions the writer was indebted for his first introduction to Sedgwick. In the year 1822 I was walking across Durham and North Yorkshire into Westmoreland. It was hot summer-time, and after sketching the High Force, in Teesdale, was reclining in the shade, reading some easily carried book. Came riding up, from Middleton, a dark-visaged, conspicuous man, with a miner's boy behind. Opposite me he stopped, and courteously asked if I had looked at the celebrated waterfall which was near; adding that though he had previously visited Teesdale, he had not found an occasion for viewing it; that he would like to stop then and there to do so, but for the boy behind him, "who had him in tow to take him to Cronkley Scar," a high dark hill right ahead, where, he said, "the limestone was turned into lump-sugar."

A few days afterwards, on his way to the lakes, he rested for a few hours at Kirkby Lonsdale to converse with Smith, who was engaged on his geological map of the district, and had just discovered some interesting fossils in the laminated strata below Old Red sandstone, on Kirkby Moor, perhaps the earliest observation of shells in what were afterwards called the upper Ludlow beds. The two men thus brought together were much different, yet in one respect alike: alike in a certain manly simplicity, and unselfish communication of thought. Eight years after this Adam Sedgwick was President of the Geological Society, and in that capacity presented to William Smith the first Wollaston medal. The writer

r

may be permitted the pleasure of this reminiscence, since from the day when he learned the name of the horseman in Teesdale, till within a few days of his death, he had the happiness of enjoying his intimate friendship.

Sedgwick had acquired fame before Murchison began his great career. After sharing in Peninsular wars, and chasing the fox in Yorkshire, the "old soldier" became a young geologist, and for many years worked with admirable devotion to his chief, and carried his banner through Scotland, and Germany, and across the Alps, with the same spirit as he had shown when bearing the colours for Wellington at Vimiera.

Important communications on Arran and the north of Scotland, including Caithness (1828) and the Moray Firth, others on Gosau and the eastern Alps (1829-1831), and still later, in 1837, a great memoir on the Palæozoic Strata of Devonshire and Cornwall, and another on the coeval rocks of Belgium and North Germany, show the labours of these intimate friends combined in the happiest way—the broad generalisations in which the Cambridge Professor delighted, well supported by the indefatigable industry of his zealous companion.

The most important work in the lives of these two eminent men was performed in and around the principality of Wales; Sedgwick, as might be expected, lavishing all his energies in a contest with the disturbed strata, the perplexing dykes, and the cleavage of the lowest and least understood groups of rocks; Murchison choosing the upper deposits exceptionally rich in fossils, and on the whole presenting but little perplexity as to succession and character. One explorer, toiling upward from the base, the other descending from the top, they came after some years of labour (1831 to 1835) in sight of each other, and presented to the British Association meeting in Dublin a general view of the stratified rocks of Wales.

Thus were painfully unfolded the Cambrian and Silurian systems, which speedily became, in a sense, the scientific property of the discoverers, and were supposed to be firmly separated by natural and unmistakeable boundaries. They were, however, not really traced to their junction, though Murchison stated that he had found many distinct passages from the lowest member of the Silurian system into the underlying slaty rocks named by Prof. Sedgwick the "Upper Cambrian;" while Sedgwick admitted that his upper Cambrian, occupying the Berwyns, was connected with the Llandeilo flags of the Silurian system, and thence expanded through a considerable portion of South Wales (Reports of Brit. Assoc., 1835). The Bala rocks were disclaimed on a cursory view by Murchison, the Llandeilo beds surrendered without sufficient examination by Sedgwick; thus the two kingdoms overlapped largely; two classifications gradually appeared; the grand volume of Murchison was issued; and then began by degrees a difference of opinion which finally assumed a controversial aspect, always to be deplored between two of the most truly attached and mutually helpful cultivators of geological science in England:—

"Ambo animis, ambo insignes præstantibus armis."

This source of lasting sorrow to both, if it cannot be forgotten, ought to be only remembered with the tenderness of regret.

Familiar as we now are with the rich fauna of the Cambrian and Silurian rocks, and their equivalents in Bohemia and America, it is not difficult to understand, and we may almost feel again the sustained enthusiasm which welcomed the discoveries which seemed to reveal the first state of the sea, and the earliest series of marine life, "primaque ab origine mundi," almost to complete the physical history of the earth. Starting with a general view of the structure of the Lake Mountains of the north of England, and the great dislocations by which they have been separated from the neighbouring chains (Geol. Proc. Jan. 1831). Sedgwick won his difficult way through North Wales to a general synopsis of the series of stratified rocks below the Old Red sandstone, and attempted to determine the natural groups and formations (Geol. Proc. May, 1838). Three systems were named in order—Lower Cambrian, Upper Cambrian, Silurian—the working out of which, stream by stream, and hill by hill, worthily tasked the energies of Ramsay and his friends of the National Survey for many useful years, after increasing ill-health had much reduced the field-work of the Professor.

But now he began to labour more earnestly than ever in the enlargement and setting in order of the collections which were under his personal charge. In 1818, these consisted almost wholly of the small series bequeathed by Dr. Woodward; now they have been expanded by the perpetual attention and generosity of Sedgwick, into one of the grandest collections of well-arranged rocks and fossils in the world. One of the latest acquisitions is the fine cabinet of Yorkshire fossils, purchased by Cambridge as a mark of loving respect for her great teacher in his fast decaying days.

In this work of setting in order a vast collection gathered from various regions, and from all classes of deposits, Prof. Sedgwick, with wise liberality, engaged the willing aid of some of his own pupils, and of other powerful hands brought to Cambridge for the purpose. Ansted, Barrett, Seeley, M'Coy, Salter, Morris, have all helped in this good work, and to their diligence and acumen were added the unrivalled skill and patience of Keeping, one of the best "fossilists" in Europe. Those who in this manner have concurred in the labours of their chief, one and all found in him the kindest of friends, the most considerate of masters—one who never exacted from others, and always gave to his assistants more than the praise and the delicate attention which their services deserved.

The ample volumes entitled "British Palæozoic Rocks and Fossils, 1851-5," by Sedgwick and M'Coy, must be consulted for a complete view of the classification finally adopted by Sedgwick; and further information is expected from the publication of a Synoptic Catalogue, to which Salter gave some of his latest aid.

Never was a man so universally welcome among the members, and especially the junior members of his own university. Wonderful was the enjoyment of a voyage to Ely with a happy crew of his pupils (1850). If one stopped at Upware, the oolite there uplifted became the topic of an amusing and instructive discourse; the great cathedral was visited in a more serious mood; the shores rang with the merriment of the returning boat; and the evening closed with a joyous banquet in the hospitable college rooms.

During his long tenure of a Fellowship in Trinity College, Prof. Sedgwick witnessed great changes in the mathematical training, and contributed as much as any man to the present favourable condition of Science in Cambridge.

To defend the University against hasty imputations, to maintain a high standard of moral philosophy, and a dignified preference for logical induction to alluring hypothesis was always in his thoughts. Hence the "Discourse on the Studies of the University of Cambridge," at first an eloquent sermon, grew by prefix and suffix to a volume which he himself likened to a wasp—large in front and large behind, with a very fashionable waist.

Under such feelings he spoke out against the "Vestiges of Creation" with a fervour of argument and declamation which must have astonished the unacknowledged author of that once popular speculation. Nor was he silent when the views of Darwin came to fill the void places of biological theory, against which he not only used a pen of steel but made great use of his heavy hammer.

The vigour—vehemence we may call it—of his pen and tongue in a matter which touched his sense of justice, morals, or religion, might mislead one who did not thoroughly know his truth and gentleness of heart, to suppose that anger was mixed with his honest indignation—

ου γαρ μειλιχος εσκε εν δαϊ λυγρῃ

But it was quite otherwise. In a letter addressed to the writer, in reply to some suggestion of the kind, he gave the assurance that he was resolved "no ill blood" should be caused by the discussion which had become inevitable.

He never failed in courtesy to the honest disputant whose arguments he mercilessly "contunded." Taken altogether, Professor Sedgwick was a man of grand proportion, cast in a heroic mould. Pressed in early life through a strict course of study, he found himself stronger by that training than most of his fellow geologists, but never made them feel his superiority. Familiar with great principles, and tenacious of settled truths, he was ready to welcome and encourage every new idea which appeared to be based on facts truly observed, and not unprepared or unwilling to stand, even if alone, against what he deemed unfair objection or unsubstantial hypothesis.

This is not the place to speak of his private worth, or to indulge in reminiscence of his playful and exuberant fancy, the source of unfailing delight to those who knew him in his happier hours. Unmarried, but surrounded by plenty of cheerful relatives, his last hours of illness were soothed by sedulous affection; his kindly disposition no suffering could conceal; his lively interest in passing events nothing could weaken. Ever

"Against oppression, fraud, or wrong,
His voice rose high, his hand waxed strong."

With collected mind, on the verge of the grave, he would express, with undiminished interest, his latest conclusions on his own Cambrian system, purely as a matter of scientific discussion, free from all personal considerations. It will be well if this mode of treatment be reverently followed by those who while speaking of Protozoic and Palæozoic Rocks, know enough to feel how much they have been benefited by the disinterested labours of a long and noble life.

JOHN PHILLIPS

PALMIERI'S VESUVIUS

The Eruption of Vesuvius in 1872. By Prof. Palmieri, Director of the Vesuvian Observatory. With Notes and an Introductory Sketch, &c. By Robert Mallet, F.R.S. (London: Asher and Co., 1873.)

THAT, in these days of rapid intercourse, the re-appearance of volcanic phenomena on the large scale in any part of the earth's surface should awaken a far more than mere local interest, was well illustrated in the case of the late great outbreak of Mount Vesuvius, during the continuance of which the telegraphic bulletins received from the fiery mountain became the subject of general inquiry and discussion in all parts of the civilised world; and even now that the eruption has entirely subsided, the publication of a translation by Mr. Mallet, of the report of the well-known Italian *savant*, Professor Palmieri, entitled "Incendio Vesuviano del 26 Aprile, 1872," will be welcomed as a valuable contribution to English scientific literature quite independently of its being a book likely to secure numerous readers amongst the non-scientific public also.

This report of Professor Palmieri, who so courageously stuck to his post in the Observatory on the side of Mount Vesuvius, when that building actually stood between two torrents of liquid fire, the heat from which cracked the glass in the windows and even scorched the very habitation itself, is one of the most important records of volcanic phenomena which we possess. Written in the most unassuming style, it does not go into theoretical points, but confines itself all but entirely to recording such facts as were considered by its author to be important or interesting from a scientific point of view, alluding only incidentally to the destruction caused by the lava and ashes on the morning of April 26. In point of fact it is to be regarded as a scientific rather than a popular description of the eruption. Although the professor specially excels in details, the main features of the different phases of the eruption are well described, and a vivid impression of the enormous force developed on such occasions is conveyed by his observation that on April 26 the volume of smoke, ashes, lava fragments and bombs projected upwards from the crater attained a height of no less than 1,300 metres (4,265 feet) above its edge.

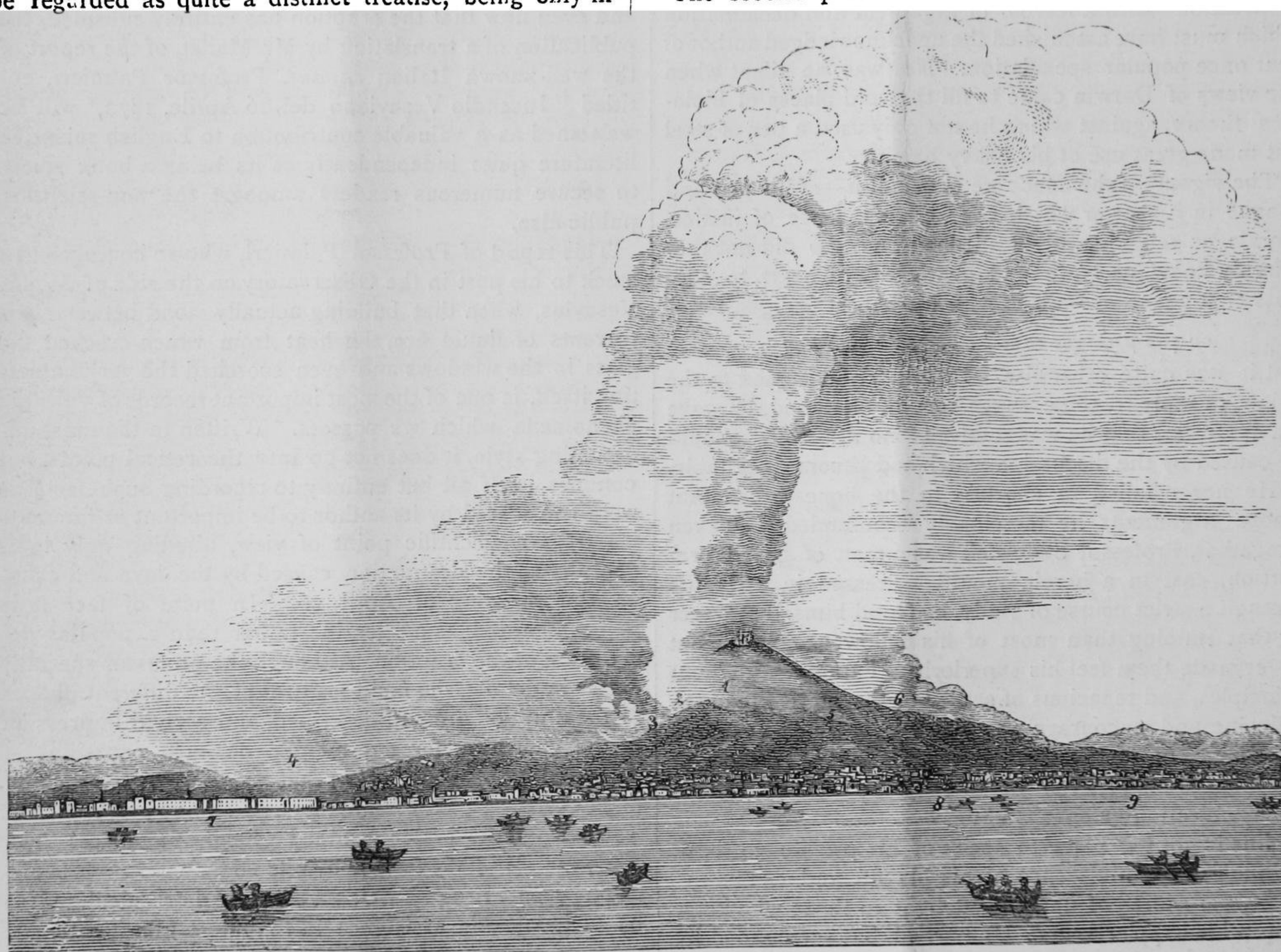
The report itself contains a mass of data calculated to be of invaluable assistance in the future investigation of volcanic phenomena, and although it may be said that the conclusions arrived at from the study of this eruption, do not present us with any strikingly new or startling deductions, their great value lies in the corroboration or correction of those resulting from previous observations. Amongst these may be mentioned, the opinion now held by the professor, that to a certain extent eruptions may be predicted, which he bases upon the observations that when the central crater commences to be agitated, this is followed by a series of slight convulsions which terminate in a grand outbreak or eruption, after which the volcano first settles down again into a state of repose; the evidence brought forward to prove the crystallisation of the leucite out of the fluid lava and against its pre-existence in it, as has been assumed by some previous writers; the order of appearance of the acid vapours; the constant presence of certain metallic compounds and sublimates;

and the respective electrical conditions of the smoke and ashes.

The report is illustrated by eight plates of the instruments employed at the Vesuvian observatory, and of views of the eruption in its different stages, which latter, however, as is frequently the case when taken from photographs, cannot be regarded as altogether satisfactory; the translation is done with evident care, but the nomenclature is open to objections, especially when such terms as sulphide of potash and ferrochloride of ammonia are encountered.

The introductory sketch by which the translation is prefaced, occupies 90 out of 148 pages, and must be regarded as quite a distinct treatise, being only indirectly connected with the report on Vesuvius; and its style, which cannot be regarded as an agreeable one, is not very gracious to the labours of the many eminent men who have preceded or now hold views differing from those of the author. Although brought forward as representing the present state of knowledge of terrestrial vulcanicity, we find no reference to any of the continental men of science, who have done so much in this direction, and it should be more correctly entitled an exposition of the author's views on seismology and what he terms vulcanology, the first 46 pages being but an abstract of his previously published investigations into the phenomena of earthquakes.

The second part of this sketch is a *résumé* of the



Vesuvius, on April 26, 1872, from a Photograph. 1 The Observatory.—2. Fossa della Vetrana. 3. Eruption of Smoke and Ashes, with Stones, from the Surface of the Lava. 4. The Novelle, St Sebastiano, and Massa. 5. Lava which took the direction of Resina. 6. Lava which, from the Crater, took the direction of the Camaldoli 7. The Grain Stores, near Naples. 8. Resina. 9. Torre del Greco. 10. The Camaldoli.

main features of Mr. Mallet's dynamical theory of volcanic energy, published in the Proceedings of the Royal Society for 1872, a hypothesis which explains volcanic action as originating in the secular cooling of our globe, when, to use the words of the abstract, "As the solid crust sinks together to follow down after the shrinking nucleus, the work expended in mutual crushing and dislocation of its parts is transformed into heat, by which, at the places where the crushing sufficiently takes place, the material of the rock so crushed, and that adjacent to it, are heated even to fusion. The access of water to such points determines volcanic eruption." To one who, like Mr. Mallet, assumes that heat, and heat alone, is in the first instance all that is required to account for the varied phenomena of volcanic activity, this explanation may appear satisfactory enough, although even if it be proved experimentally that the intensity of the heat thus produced in such cracks of contraction, or faults, as a geologist would probably term them, is sufficient to fuse the substance of the rocks in immediate contact, it would nevertheless be found even still more difficult to account for the quantity of heat requisite to melt up such vast volumes of rock matter as are known to proceed from volcanoes. Allowing, however, that even this difficulty can be satisfactorily explained away—and it is admitted that the conversion of the mechanical force into heat is sufficient to effect the melting part of the operation—there remains the still greater difficulty of explaining the chemical and mineralogical features which characterise volcanic phenomena. For although mechanical force is admitted to be convertible into its equivalent in heat, which heat may in its turn set in operation chemical action, still no such forces, either alone or combined, can transmute one chemical element into another, or bring about the formation of products having at all times a definite chemical and mineralogical constitution, out of the incongruous materials likely to be met with on the sides of such faults, or cracks, or contraction. Our present knowledge of the mineral characters of the earth's crust does not entitle us to entertain the supposition that the substance of the rocks immediately contiguous to fissures of this character occurring in so many different parts of the globe, could in all, or even in other than solitary instances, when fused by the action of mere heat, afford products identical with those of known volcanoes. On the other hand, nothing is more certain, from the examination of volcanic products, than that, no matter from what part of the world they be derived, whether from volcanoes situated near the north or south poles, in the islands of the Pacific or Atlantic oceans, or from the craters of the Andes or the Apennines, they are all identical in chemical or mineralogical constitution—a result which indicates forcibly that that they must be derived from some one common source, and not be mere local accidents, as Mr. Mallet's hypothesis would require us to assume. For these and other reasons which we need not bring forward on the present occasion, it does not seem probable that this hypothesis will receive the adherence of either chemist, mineralogist, or geologist.

In conclusion, attention might here be directed to the disadvantages which, in a pecuniary point of view, the British student labours under when making himself acquainted with foreign science by means of translations. The original pamphlet of Prof. Palmieri in Italian, and its translation into German by the eminent chemist, Rammelsberg, were procured here in London for the small sum of eighteenpence each, whereas English translations of scientific works, got up, however, in superior paper, wide margin, and elaborate covers, can rarely (if ever) be obtained under several times the cost of the original works.

DAVID FORBES

OUR BOOK SHELF

Human Physiology the Basis of Sanitary and Social Science. By T L. Nichols, M.D. Pp. 479; woodcuts. (Trübner, 1872.)

THE title "Human Physiology," which alone appears on the back of this book, is misleading, and even the title as given above would scarcely prepare a reader for what he will find. The preface, however, gives fair warning. "Physiology," writes Dr. Nichols, "the science of life, has been handed over to the medical profession, which has an unfortunate interest in the popular ignorance of sanitary laws; while metaphysicians, moralists, and theologians have confused rather than enlightened our ideas "as to the moral nature of man and his consequent social requirements." This seems rather hard on the doctors, who have certainly done all that has yet been done in preaching the laws of health and in getting them carried out, both by public supervision or compulsion and by private influence; but the whole volume is an exemplification of the latter part of the melancholy result, whether due to those designing persons who study metaphysics, morals, and theology or to some other cause. Dr. Nichols is an ardent advocate of the numerous theories which blind and bigoted Science has consistently and universally refused to accept, to the great disgust of circle-squarers, anti-Newtonians, popular "scientists," and Social-Science-mongers. The first section of the book treats of preventible mortality, poverty, ignorance, drunkenness, and prostitution; the second of matter, force, and life, including adverse criticism, on the feeblest grounds, of the doctrines of evolution and of materialism, with some remarkable "proofs of immortality." The third part gives a popular account of the human body, with some of the oddest illustrations ever printed. The fourth treats of the laws of generation, including chapters on love and marriage, hereditary transmission, and problems of the sexual relation. This section is, perhaps, the best in the book, and its subjects are handled with freedom and modesty, while the conclusions are sensible enough. The fifth, part on health, disease, and cure, contains a good many useful and obvious remarks on the value of cleanliness, exercise, and temperance, together with a number of utterly unsupported or demonstrably false propositions. The last part, is devoted to the discussion of morals and society, in which important questions in political economy, ethics, agriculture, are stated, benevolent wishes for all classes of mankind are expressed, and the questions left much as they were found.

In a book of this kind the reader is not surprised to encounter the old and new dogmas of phrenology, vegetarianism, clairvoyance, homœopathy, animal magnetism, anti-vaccination, and cure by Psychic force. But though unscientific and sometimes anti-scientific, the author would deserve credit for putting before the public information which, however trite, is too little acted on, if his assertions of the wonderful cures he has made by hydropathy at Malvern, and the quotation from "a little book," by Mrs. Nichols on the same subject, did not suggest a doubt whether in his case singleness of motive can be admitted in excuse of ignorance.

P. S.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Dr. Bastian's Experiments

MR. LANKESTER asks me several questions relating to the experiments by Dr. Bastian, reported by me in NATURE a few weeks ago. In reply I beg to say that new Cheddar cheese was used. The cheese was not weighed, but the quantity added to the contents of each flask probably did not exceed two grains. The turnip infusion was filtered before it was introduced into the flasks: the filtrate was limpid. After boiling, the liquid was somewhat turbid, and contained visible particles.

Feb. 3 J. BURDON SANDERSON

Eyes and No Eyes

MR. RAY LANKESTER'S letter has reminded me of a little experiment of my own which converted me to Bastianism. I had some turnip and cheese flasks which Dr. Bastian had been kind enough to prepare in my presence. I took them home and in due time examined the contents in a good microscope, using what I thought adequate power. I saw nothing, and went triumphant to Dr. Bastian to report my failure, taking the flasks with me. Dr. Bastian looked at the fluid, smelt it, and told me he would eat his hat if it was not full of life. I thought he would have to eat his hat. He put a drop under his microscope and told me to look. It was full of small Bacteria. I was a good deal puzzled at first, but after a little discussion I found out why I had failed to see what was in the fluid. Without going into details, I may say that the short result was that I had been rather a muff with the microscope. May not this explain some other failures?—not Mr. Lankester's, of course.

QUERY

Meteor at St. Thomas

THE enclosed reached me from a meteorological correspondent in St. Thomas. The records of such phenomena must be rare; there may be something peculiar in this one; I therefore forward it to you. RAWSON RAWSON

Government House, Barbados, Dec. 30, 1872

"On November 30, 1872, at 8h 10m P.M. a beautiful large meteor was observed, which passed from west to east with great brilliancy, and exploded in the zenith in numerous little stars. It lasted about three seconds. A little after a rumbling noise, like distant thunder, was heard. It is reported by the watchman of the floating dock, which lies at present on the eastern beach of Long Bay in eight feet water, for repairs, that he was sleeping on the platform under an awning; he awoke from the heat and the strong light which passed close to him through the lattice work; and some ashes fell on the dock which he found but did not collect, not knowing that it was of value. As is well known, aerolites travel at the rate of 10,000 feet per second."

Brilliant Meteor

LAST night about 10.0, the moment after leaving the room in which I had been lecturing, at Wordsley, near Stourbridge, the ground about me was lighted up as by the sudden flash of a near lantern or the emergence of the full moon from a bank of cloud. On looking up at the sky, I saw a rocket-like object shooting down with a slightly zigzag motion like that of a fish, and leaving behind it a trail of mingled and mingling tints of green, purple, and yellow of nearly the semi-diameter of the moon. After a first thought about fireworks, I felt sure it was a meteor, and looked about for the constellations, so that I might be able to describe its path. The sky, however, was covered with clouds, only a star here and there being visible, and the moon, though easily seen, presenting a very hazy appearance. From inquiry at the Rectory as to the aspect of the schoolroom from which I had just come out, I judge that the course of the meteor must have been from north-west to west. When I first saw it, it was about 40° or 50° above the horizon, and it traversed about half the remaining space before disappearing, occupying, I estimate, about six seconds in doing so. Its path formed an angle of about 40° with the horizon.

From the fact that the sky was covered with clouds and that the meteor illuminated the ground with a light superior to that of the "half" moon shining at the time, I judge that the meteor was between the clouds and the earth. This nearness, would, of course, be an element in its great apparent size (which would be added to by the zigzag motion); and as it would also prevent its being seen at great distances and by many observers, I have, after some hesitation, penned this record of my very imperfect observations. GEORGE ST. CLAIR

London, Feb. 4

The Antinomies of Kant

MY attention has been directed by a friend to an address by Prof. W. K. Clifford, in *Macmillan's Magazine* for this month, containing a curious misrepresentation of Kant's teaching, and therein an instructive instance of *ultracrepidism*. The professor remarks: "The opinion that at the basis of the natural order there is something which we can know to be *unreasonable* to elude the process of human thought is set forth first by Kant, so far as I know, in the form of his famous doctrine of the antinomies or contradictions, a later form of which I will endeavour to explain to you." "This doctrine," he continues, "has been developed and extended to the great successors of Kant, and this unreasonable, or unknowable, which is also called the absolute and the unconditioned, has been set forth in various ways as that which we know to be the true basis of all things."

I am sure I should not be allowed, in the columns of NATURE, sufficient space to point out in detail the misapprehensions involved in these remarks. It is plain to me that Professor Clifford has approached the very difficult subject of Kant's Antinomies from the system of Sir William Hamilton. To start with Hamilton, however, is to be handicapped in the pursuit, and to augment the difficulties to be surmounted. In truth the doctrine Professor Clifford expounds is simply that of Hamilton; but Hamilton did not either develop or extend the Antinomies of Kant. He never understood them, but carved his little system out of a few splinters he gathered by the way. All Hamilton's characterisations of Kant are ludicrously false. This doctrine of the Antinomies does not answer, either, to Professor Clifford's touch. The Antithetic is not "*unreasonable*," nor does it "elude the processes of human thought;" for, though it presents an unavoidable *illusion*, Kant has used reason, with matchless power and subtlety, to show that reason is master of the position, can solve every Antinomy, and can therefore guard against the very possibility of delusion. It is not any "natural order" of thought or things, that is found to be unreasonable, but the offence against *common logic* which is involved in every attempt to prove the thesis or antithesis of an antinomy. I refer all who care to see the thing for themselves to Kant's K. r. V., Element. ii. Th., ii. Abth., ii. Buch., 2 Hauptst., 7 Abschnitt: Kritische Entscheidung des kosmologischen Streits der Vernunft mit sich selbst: *et seq.* C. M. INGLEBY

Athenæum Club, Jan. 21

The Source of the Solar Heat

IT gave me great pleasure to find that Captain Ericsson has taken the same views as myself with regard to the Source of the Solar Energy; but there is a certain part of his article in NATURE, vol. vi. p. 539, which I do not quite understand.

My views on this subject were sent to the Royal Astronomical Society, and were published in the Monthly Notices for April 1872, where it was easily shown that if E be the total energy destroyed in a given time by the crushing-in of the sun's mass—

$$E = \tfrac{4}{5}\,\pi\, g_0\, \rho\, z_0\, r_0^3$$

where g_0 is the force of gravity at the sun's surface,

ρ the density, supposed constant,

r_0 the sun's radius,

z_0 the contraction of that radius in the given time; all corresponding to the present epoch.

To find z_0 we must express E in thermal units by means of the dynamical theory of heat, and equate the result to the total amount of heat radiated by the sun; and it is easy to show that z_0 must be 129 ft. per annum; and since Captain Ericsson finds the contraction to be 121 ft., we are so far in agreement.

But $\tfrac{4}{3}\,\pi\,\rho\, r_0^3$ is the mass of the sun, and g_0 varies inversely as r_0^2, hence we may write

$$E = \frac{CZ}{R^2}$$

where C is a constant, and R, Z, the values of the radius and of the contraction at any other epoch of time. Now there is no connection between Z and R; if Z varies as R^2, then E is constant; if Z varies as R, which I believe to be the most probable assumption, then E varies inversely as R, and the total solar radiation must be slowly increasing; but I see no reason whatever for supposing that Z varies directly as R^4, so that the solar radiation must be diminishing in proportion to the square of the sun's radius. MAXWELL HALL

Jamaica

The Twinkling of the Stars

THE phenomenon observed and described by G. F. Burder in NATURE of Jan. 23, p. 222, does not, as I understand it, account in any way for the twinkling of stars, seeing that, by means of any two lights (gas lamps for instance) at the distance of a few hundreds of yards, the same effect may be observed, and this quite irrespective of the angle at which they are placed with reference to the horizon or the "blind spot" of the observer's eye.

THOS. HAWKSLEY

Meteorological Cycles

THE following observation may possess some interest in connection with the subject of recurring meteorological cycles. It is found at the conclusion of Mr. Consul Wallis's report on the trade and commerce of Costa Rica for 1867, dated June 1, 1868 (Parliamentary Papers for 1868-69, vol. lix. p. 520):—"In the state of the public health there is a marked and satisfactory improvement to report. No reason can be assigned here for the large number of epidemic disorders which have afflicted this country for the last *ten* years and since the visitation of the cholera, nor for the improvement which took place in the *eleventh* year." R. G.

London, Jan. 2

ON THE OLD AND NEW LABORATORIES AT THE ROYAL INSTITUTION*

II.

Of the next great name connected with our Institution, namely, Michael Faraday, of his life and his discoveries the history has been already written, so far indeed as it can be written, by Bence Jones, by Tyndall, and by Gladstone. *Si monumentum quæris circumspice.* These volumes of notes, from 1831 to 1856, will give some idea of the amount of work which he did in our laboratory; and their value will be better appreciated through the consideration that before these notes were made, no less than sixty of his scientific papers had been printed, nine of them in the "Philosophical Transactions"

Those of us who were present at Tyndall's two memorable lectures on "Faraday as a discoverer" are not likely to forget the impression of the man left by them on our minds; and for those who were not present it would be an office thankless to your lecturer and burdensome to his hearers, to contribute a feeble reproduction of those life-like memoirs, For our present purpose it will be sufficient to say that the entire fabric of those brilliant and manifold contributions to human knowledge was wrought out within the walls of the Royal Institution.

His great experiments have been so often and so well exhibited in this theatre, that some apology is needed for bringing any of them before you again; but in repeating for my own instruction some of those which bear more particularly upon the subject of Light, I have been tempted to reproduce one of them here. In doing this I I have been perhaps moved more by a fascination of the phenomenon, and by a piece of instrumental good fortune which enables me to introduce an old friend under a new garb, than by any better reason. The experiment in question is that which Faraday called "the magnetisation of light, and the illumination of the lines of magnetic force;" we should now term it the rotation of the plane of polarisation under the influence of the magnetic field. And in order that we may not even by inadvertence confuse the rotation here produced with that due to quartz, or oil of turpentine, I will draw your attention, by way of memorandum, to the nature of the magnetism produced by spiral currents in given directions, and of the rotations of free currents produced by magnets.

[The lecturer then showed the opposite rotations of two sparks discharged about the two poles respectively of an electro-magnet, and the reversal of those rotations, first by a change of the poles, and secondly by a reversal of the direction of the sparks.]

You now see upon the screen an image of the figures produced by a magnificent piece of heavy glass under the action of polarised light. Its size enables me to make use of about four times the amount of light usually available in this experiment; and I have taken advantage of the figure which its imperfect annealing produces, to vary the effect upon the screen. The dark parts of the figure indicate the parts of the beam in which the vibrations are perpendicular to those transmitted by either polariser or analyser, and which are consequently cut off. Now if anything should intervene to change the plane of those vibrations a portion of them will be transmitted, and a partial illumination of the screen will ensue. This turning of the plane of vibration is effected by the magnet as soon as its force is developed by the electric current sent through its coils.

[The lecturer then "dispersed" the dark lines of the figure by means of a plate of quartz; and after turning polariser and analyser so as to colour the centre of the field with the tint intermediate between red and violet (*teinte sensible*), he showed that when the magnet was excited the field was rendered red or green according to the direction of the poles.]

* Continued from p. 224.

Professor Frankland before coming to us had isolated the compound radicals Methyl, Ethyl, and Amyl, and had proved their resemblance to Hydrogen. He had also combined them with the metals zinc, tin, mercury, and boron. By this means he had obtained a very powerful chemical reagent, which proved of eminent service in subsequent operations. An instance of its power will be found in zinc- ethyl, which by its rapid combination with oxygen of the air, bursts into spontaneous combustion as soon as a flask containing it is opened.

In conjunction with Mr. Duppa, Prof. Frankland worked in our laboratory at the artificial formation of ethers. They treated acetic ether with iodine and with the iodides of methyl, ethyl, and amyl; and by their means they arrived at a method for the formation of many organic substances which had previously been obtained only through the agency of animals or of vegetables.

In 1866 Dr. Frankland determined by a long series of calorimetric experiments the maximum amount of force capable of being developed by given weights of the different foods commonly used by men.

In the following year he investigated the effect of pressure (up to 20 atmospheres) upon the luminosity of flames of hydrogen and of carbonic oxides. He found that these flames, so feebly luminous at ordinary atmospheric pressure, burn with brilliant light under pressures of from 10 to 20 atmospheres, and that the spectra of these brilliant flames are perfectly continuous. From the latter circumstance he infers that solar light may be derived from glowing gas and not from incandescent solid or liquid matter.

As these researches have so important a bearing upon spectral analysis and solar physics, I will venture to repeat one or two of the experiments. Here are three closed tubes filled respectively with hydrogen, oxygen, and chlorine, at atmospheric pressure. The densities of these substances are in the proportions $1 : 16 : 35\frac{1}{2}$; and if the spark from an induction coil be made to pass through them, the luminosity of the discharge will be found to be nearly in the same proportions. That this result is really due to the density, and not to the chemical constitution of the gases, may be proved by allowing the discharge to pass through this tube, and by pumping air into it during the discharge. It will then be seen that the brilliancy increases with the pressure.

These researches were suggested by an old experiment of Cavendish's, in which he exploded a mixture of oxygen and hydrogen, first under atmospheric pressure and then under a pressure of from 10 to 12 atmospheres. In the first case there is much noise and little light; in the second, a brilliant flash and no noise. The labours of Dr. Frankland have rendered this experiment intelligible, and have correlated it with other phenomena.

Of Dr. Frankland's successor, Dr. Odling, I should have had more to say, had he not been attracted by a well-deserved offer of the chemical chair at Oxford. As a member of that University I rejoice at the appointment, while here we regret the loss.

Of Faraday's successor, John Tyndall, I am greatly at a loss how to speak. In this place his presence seems so near to us, his thoughts so subtle, his words—even when rung back to us from those busy cities far away on the other side of the Atlantic—so familiar and yet so stirring, that it behoves us that ours should be wary and few. Few men have brought so large a burden and bulk of contribution to the common stock of knowledge; but still fewer have inspired in his hearers so strong a love, such ardent enthusiasm for the subjects of his research.

It is now twenty years since Prof. Tyndall began his researches in our laboratory. During the first thirteen years he produced no less than thirteen papers, which were printed in the "Philosophical Transactions:" on Sound, on Diamagnetism, on Glaciers and Ice, on the

Radiation and Absorption of Heat, and on Calorescence. In these he established the important fact that if the various gases be arranged in order according to their power, first of radiating heat, and secondly of absorbing radiant heat, the order will be the same in both cases. He further proved that the chief absorbing action of our atmosphere on non-luminous heat is due to its aqueous vapour. He applied his discovery to the explanation of many meteorological facts: *e.g.* the great daily range of the thermometer in dry climates; the production of frost at night in the Sahara; the cold in the table-lands of Asia, &c.

He discovered also the means of separating the invisible from the visible radiations, and proved that in the case of the electric light the former is no less than eight times as powerful as the latter. He also made the daring experiment of placing his eye at a focus of dark rays capable of heating platinum to redness.

Since 1866 his attention has been largely occupied in examining the action of heat of high refrangibility (instead of low), as an explorer of the molecular condition of matter

In this investigation one obstacle to be overcome was the presence of the floating matter in the air. The processes of removal of these particles became the occasion of an independent research, branching out into various channels; on the one hand, it dealt with the very practical problem of the preservation of life among firemen exposed to heated smoke; and, on the other, it approached the recondite question of spontaneous generation.

He subjected the compound vapours of various substances to the action of a concentrated beam of light. The vapours were decomposed, and non-volatile products were formed. The decompositions always began with a blue cloud, which discharged perfectly polarised light at right angles to the beam. This suggested to him the origin of the blue colour of the sky; and as it showed the extraordinary amount of light that may be scattered by cloudy matter of extreme tenuity, he considered that it might be regarded as a suggestion towards explaining the nature of a comet's tail.

[The lecturer then exhibited the polarisation of light scattered by small particles suspended in the medium traversed by a beam from the electric lamp, employing for the purpose the chromatic effects due to the circular porlarisation of quartz.]

His volume of contributions to molecular physics in the domain of radiant heat, which contains only his original investigations on this subject, would alone suffice to show what is doing in the laboratory of our Institution.

If we compare him to Faraday at the same time of life, he has still many years of intellectual energy, the conversion of which into its scientific equivalent may, perhaps, be effected within these walls.

No one has regretted the destruction of the laboratory of Davy and of Faraday more than Prof. Tyndall. He almost prayed for the preservation of the place where their discoveries had been made; but as soon as he saw that in our struggle for existence such material aids as improved buildings would conduce alike to the progress of science and to the permanence of the Institution, he withdrew his objections, and threw all his powers into making the new laboratories as perfect as possible for the good of his successors.

I add a few words on the reasons which led the managers to recommend the rebuilding of our laboratories, and the consequent demolition of the place where the great discoveries that I have touched upon were made. In the opinion of those best qualified to judge, our chemical laboratory was badly ventilated, badly lighted, badly drained, and quite unfit to be occupied for many hours daily. It was probably the very worst, and certainly all but the worst chemical laboratory in London; and compared with more modern ones both at home and abroad, it was nowhere. The physical laboratory had remained for nearly seventy years in its original state. At first it was said to be equal to any laboratory; but then there were hardly any in existence in this country; and during the last few years such splendid edifices have arisen in London, in Oxford, in Cambridge, in Manchester and in Glasgow, and elsewhere, that the laboratory of Davy, of Faraday, and of Tyndall was much inferior to the private laboratories of the professors who carry on their course of instruction in public rooms of still greater size and extent of resource. The main purpose of our laboratories is research, and instead of offering by their excellence an inducement to professors to come and to stay, the one was a makeshift, the other a noble relic. Neither afforded facilities which were not offered in a larger measure elsewhere. And those only who know what is going on both at home and abroad can form an adequate idea of the competition which, in this respect alone, will prevail for a generation to come.

By the construction of new laboratories this material disadvantage will be removed. Future professors will have buildings constructed to aid research. Your liberality has spared no judicious expense; and, so far as the site would admit, our laboratories will be as perfect as the skill of our architect and the advice of our professors can make them.

In conclusion, let me lay before you what must still be done, in order that there may be earned for the new laboratories a reputation comparable with that which has hitherto proved both our glory and our support.

Our first and foremost object, beyond bricks and mortar, and money, and apparatus, must be to find a succession of professors of the old type; men who love research. But even Faraday would perhaps have been compelled to leave us, on account of the smallness of the sum which we could afford him, had not the endowment of the chemical chair, with 100*l.* a year, by the late Mr. Fuller, happily intervened. This timely endowment was probably a critical turning point in the history of the Institution. We may not easily find successors worthy of the great names who have gone before them; but we may do much toward preventing mistakes in future appointments by keeping steadily in view, that the promotion of natural knowledge is our main object; and that instruction and amusement, and brilliant audiences are all secondary to our principal purpose. Not that these subsidiary purposes are to be neglected or despised; and I, as your Treasurer, should be the last to undervalue them, but we feel confident that if the main purpose is effected, all the others will follow as a simple sequence.

Secondly, when we have found professors of the type that I have described, our next need is that we may be able, from independent resources at the disposal of the Institution, to offer them a remuneration which, all things taken into account, shall be an equivalent to what they would receive elsewhere. So that neither Government appointments, nor University professorships, nor the liberality of mercantile men, should be able to lure them from the path of discovery, to tuition, to arts, or to manufactures.

The one act of wisdom, among the many aberrations of an eccentric member of Parliament, saved Faraday to us, and thereby, as seems probable, our Institution to the country. The liberality of a Hebrew toy-dealer in the East of London has made the rebuilding of our laboratories possible.

It is said that Mr. Fuller, the feebleness of whose constitution denied him at all other times and places the rest necessary for health, could always find repose and even quiet slumber amid the murmuring lectures of the Royal Institution; and that, in gratitude for the peaceful hours thus snatched from an otherwise restless life, he bequeathed to us his magnificent legacy of 10,000*l.* If this evening's discourse shall have ensured one such blissful hour to any of his audience, your lecturer's efforts will not have been altogether in vain. But to each such happy individual he would express the hope that, as you have resembled Mr. Fuller in your experience of life, so may you emulate him in your liberality at death. In short, I would conclude almost in the words of old Bishop Andrews: "Unum operæ meæ pretium abs te peto, hoc autem vehementer expeto, ut mei pecatoris meorumque in precibus interdum memor sis." Which being interpreted is: "For these my efforts I beg but one thing in return, and this I beg most earnestly, viz. that you will now and then remember me a sinner against your patience and forbearance in your prayers, and that you will also be mindful of our professorships in your wills."

The following Table of the principal items of original work done by our Professors, taken in connection with their long series of laboratory notes, forms a monument of the intellectual activity, the manual dexterity, and the persevering industry, developed in the laboratories of the Royal Institution:—

DAVY

1806	Chemical Agencies of Electricity.
1807	Decomposition of Potash.
1810	Chlorine.
1812	Discourse on Radiant or Ethereal Matter.
1813	Iodine.
1815-6	Researches on Fire-damp and Flame.
1817	The Safety Lamp.

FARADAY

1820	Alloys of Steel.
1821	History of Electro-magnetism.
"	Magnetic Rotations.
1823	Liquefaction of Chlorine and other Gases.
1825-6	New Compounds of Carbon and Hydrogen.
1825-9	Manufacture of Optical Glass.
1831	Vibrating Surfaces.
"	Magneto-Electricity.
1832	Terrestrial Magneto-Electric Induction
1833	Identity of Electricities.
1834	Electro-Chemical Decomposition.
"	Electricity of the Voltaic Pile.
1835	The Extra Current,
1837-8	Frictional Electricity.
"	Specific Inductive Capacity.
1845-8	Magnetisation of Light.
"	Lines of Magnetic Force.
"	Magnetic Condition of all Matter.
"	Diamagnetism.
"	Magne-Crystallic Action,
1849-50	Magnetism of Flame and Gases.
"	Atmospheric Magnetism.
1856	Relations of Gold and other Metals to Light.
1860	The Regelation of Ice.

TYNDALL

1853	Transmission of Heat through Organic Substances.
1854	Vibrations due to Contact of Bodies at Different Temperatures.
1855	Researches on Diamagnetic Force.
1856	Slaty Cleavage.
1857-8	Physical Properties of Ice and Glaciers.
1859-63	Absorption and Radiation of Heat by Gases.
1865	Calorescence.
1866-7	Action of Heat of high Refrangibility.
1868-9	Formation of Clouds.
"	Colour and Polarisation of the Sky.
1870	Smoke and Dust Respirator.

FRANKLAND

1863-6	Synthesis of Acids of the Lactic Series.
1863	Mercury-methyl, Mercury-ethyl, and Mercury-amyl.
1864	Transformation of Organo-Mercury Compounds into Organo-Zinc Compounds.
"	Combustion of Iron in Compressed Oxygen.
1865	Synthesis of Acids of the Acrylic Series.
"	Synthesis of Fatty Acids.
1866	New Organic Radical Oxatyl.
1866	The Source of Muscular Power. Potential Energy in various kinds of Food.
1867	Source of Light in Flame. Effect of Pressure upon Luminosity of Flame.

THE GROWTH AND MIGRATIONS OF HELMINTHS

THE migration of helminths is one of the most interesting discoveries of modern zoology. These worms, generally parasitic, must often, in order to complete their growth, pass from one animal into another. This passage is of course accomplished by chance, as when one animal devours the whole or part of another, in which the helminth at a certain stage may be imbedded.

It is known that sheep attacked by sturdy, have in their brain a little worm, the *Cœnurus*. That worm when it is eaten by a dog is not digested by him, but grows in the intestine under the form of a peculiar tænia. It is also known that the tænia, or tape-worm, is generated by the growth of the human cysticercus of the pig. Very interesting researches have been made by several physiologists on that subject.

M. Villot has filled up many gaps in the history of the growth of the gordins. The gordins (Müller) are aquatic worms, whose body is very long and slim, the extremities being obtuse.

The form of the embryo is very different from that of the full-grown animal. It is a microscopic worm, cylindrical, not more than 0·209 mm. (0·00807 in.) in length, by 0·049 mm. (0·00177 in.) in breadth, and on which a head and a tail can be easily discerned. The head, as big as the body, is quite retractile; it has a triple crown of prickles, and is terminated in front by a kind of trunk or sucker, which is kept rigid by three strong needles that serve it as support; the head, in its motion of protraction and retraction, turns from its extremity to its base as a glove, and during that time the points of the prickles describe half a circle. When the head is out of the body, the point is directed backward: when it is retracted into the interior of the body the reverse takes place.

Numerous transverse folds exist on the body; they are close to one another and regular as real rings. The tail, not quite so broad as the body, is separated from it by a deep groove.

The great difference between those embryos that are free in the water and the worms which grow out of them after many migrations into the interior of several animals, deserves to be noticed. The embryo after leaving its egg for the water in which it must live, has little means of locomotion. Its tail, cylindrical and scarcely moveable, is useless to it for swimming, so that it may be driven by any current. It probably sticks to pebbles, or to the roots or stems of aquatic plants, where it waits for the larvæ, whose parasite it is to become. The author has verified these statements by putting in the same vessel several embryos with larvæ of tipulars (*Corethra*, *Janipus*, *Chironomus*), and has seen the former encyst themselves in the insects. The worm penetrates with its cephalic prickles into those larvæ, the teguments of which have little power of resistance. It continues the operation, piercing through more and more, till the membranes get solidified around it and form a real cyst, shut up at the posterior post. It continues to penetrate the body of the larvæ, lengthening its cyst and proceeds.

Those cysts do not grow normally in the interior of insects as has been believed up to this time, but in certain fishes, and particularly in the loaches (*Cobitis barbatula*) and minnows (*Phoxinus lævis*). Fishes are generally very fond of the larvæ of insects, but most especially for the larvæ of Chironomus. It is precisely in those larvæ, as we have already seen, that the embryos of gordins encyst themselves. By swallowing them, the fish swallows at the same time the cyst which they contain. The insects and their cysts thus arrive in its intestine; the insects are digested by it, the membranes of the cysts are dissolved, and the embryos included in them are set free. The latter settle immediately in their new living abode; by their cephalic prickles they penetrate into the membrane of the intestines and encyst themselves again.

But that new cyst is not like the one that protects the embryo in the body of the insect; it is spherical or ovoid, not lengthened, and provided with a membrane not thick and opaque, but slender and perfectly transparent.

In that second state it undergoes another and important transformation and becomes a larva. The tail, hardly as long as the body, extends more and more, rolling up on itself; the body extends likewise, and the groove situated between them vanishes and the volume of the cyst increases at the same time. The worm, thus merely transformed, resembles a hematoid in its general appearance, though its unmodified head makes what is more like acanthocephalus.

When in autumn one of the above-named fishes is dissected and the intestine is laid over a glass slide, microscopical examination shows that it is strewed with numerous cysts containing embryos and larvæ of gordins at different stages of growth. The author has always found some. Sometimes they almost touch each other, so numerous are they.

The gordins offer, then, in the course of their growth, complete metamorphosis and very complicated migrations; they take successively three distinct forms, encyst themselves twice, and change three times their abode. In the embryo state they at first live in water, then in the body of several aquatic larvæ of Diptera, and in the state of larvæ they inhabit the intestines of fishes; at last, in the perfect condition, they cease to be parasites and become river worms.

There exists, however, an important hiatus in the history of the growth of these worms. How can we harmonise what has just been said with the assertion (that seems to be trustworthy) of the naturalists who have seen real gordins in the abdomen of terrestrial insects (grasshoppers, crickets, &c.)? Has there been an error of observation committed? Or would these be single individuals gone astray from the water where they had to lay their eggs? M. Villot adopts the latter opinion.

Should any one ask of what service are such curious, difficult, and apparently useless researches, it could be replied that many illnesses, some of them mortal, arise from parasites that attack certain parts of our body (the intestines, the liver, &c.); and every advance in our knowledge of the habits of those beings is a service rendered, not only to science, but also to humanity.

M. CORNU

A PRIVATE CIRCUMNAVIGATING EXPEDITION

IN *Les Mondes*, for some time past, details have been given of a proposed expedition, partly scientific and partly for pleasure, on a somewhat gigantic scale. The proposed scheme seems to be the idea of a single gentleman, M. le Capitaine Bazerque, who has been twice round the world; though it has the hearty commendation of the Abbé Moigno, editor of *Les Mondes*, and of Le Comte Pennazzi, as well as others. The scheme is called "La Caravane Universelle," and has for its main object a grand voyage for scientific exploration over the five parts of the globe. The excursion party may be joined by men of science, and also, we understand, by artists and others belonging to all nationalities, who wish to see the world for themselves under intelligent guidance. A subscription has been opened in the various European countries and in America, to provide Captain Bazerque with a steam-vessel suitable for the expedition. The *modus operandi*, we understand, will be that the vessel shall visit in succession all the most interesting parts of the world, staying long enough at each place to enable all its features to be investigated by the *savants* and artists composing the expedition. "The material organisation of the expedition," says Count Pennazzi in commending it, "will allow those who form part of it to investigate thoroughly the rich treasures of Nature. The eastern slope of the Cordilleras, the sources and upper course of the Amazon, the Rocky Mountains, the country of the Mormons, the eastern coast of Africa, Australia, Japan, China, Indies, are among the regions whose flora, fauna, geology, and ethnography will furnish to the caravan much that is unknown to discover, and many interesting problems to solve." Verily the Count is right in calling the scheme "sympathetique et seduisant."

The organiser of the scheme intends, of course, that the vessel shall be fully furnished with all necessary scientific instruments. As concerns the material and moral well-being of his "sage companions," Captain Bazerque proposes to make the following provisions:—(1) Bi-monthly telegraphic communication between each of the members of the caravan and his family. (2) A Roman Catholic and Protestant chaplain to accompany the expedition. (3) Special and easy camping material, allowing the expedition to sojourn in the midst of countries hitherto unexplored. (4) To ensure the possibility of transit everywhere, a company of sappers will be provided, to go before and clear the way of wood; to construct rafts, bridges, to help as instrument-holders, constructors of beacons and of marks. It is supposed that 35 sailors will fulfil these and many other useful functions.

The Captain proposes to divide the scientific work of the expedition as follows:—(1) Meteorology, astronomy, and terrestrial magnetism; (2) Geography and cosmography; (3) Mineralogy, geology, palæontology, botany, zoology; (4) Anthropology, ethnology, ethnography; (5) Hygiene, medicine and surgery; (6) Photography applied to the works of man; (7) Study and collection of agricultural processes and implements; (8) Study, collection, and photographing of pottery: (9) Metallurgy and metallurgic history; (10) Dye-stuffs; (11) Histology, archæology, biography; (12) "Compte rendu anecdotique de l'expedition." In order to keep the eager world informed of the conquests of this scientific army, the bold originator contemplates the establishment of a periodical, *La Caravane Universelle*, exclusively devoted to the chronicling of its deeds. This journal will be under the care of a central editorial committee, located in Paris, we suppose, to whom will be sent, every month, collections of plants and other objects, photographs, drawings, and statistics of all kinds, together with a scientific and descriptive narrative of what is seen and done. The journal will be printed in handsome type, embellished with engravings, maps, and drawings "by the best European artists;" and each number will appear in English, French, German, Spanish, and Italian.

When we say that *Les Mondes* publishes an elaborate table, showing the states and countries to be visited, the families, tribes, and races of the Aborigines, and the conquering families, our readers will perceive that from beginning to end the scheme is thoroughly French in the ideal perfection and completeness of its conception and plan.

Much, no doubt, can be accomplished by a judicious division of labour; and if the 100 or 150 gentlemen who are expected to compose the expedition should always be of one mind, be all animated by such a love for science as to be willing to endure any hardships, be prepared to submit implicitly to the guidance of a man of perfect organising faculty, wide knowledge and sympathy, combined with promptness and decision; if each confines himself strictly to the department for which his experience and attainments fit him, and if various other important conditions are fulfilled, *La Caravane Universelle* may have something worth listening to, to tell the world monthly. At all events, we heartily wish the project success, and hope that Captain Bazerque may soon have a list of subscriptions large enough to encourage him to commence the practical organisation of his scientific pleasure-party. We see from *Les Mondes* of January 23, that at Captain Bazerque's request, M. de Quatrefages, president of the Academy, has nominated a committee to indicate the principal parts of the earth that ought to be specially explored, and to find out a number of young energetic European men of science, willing to accompany the expedition.

Hitherto such expeditions have been thought practicable only with Government assistance. If Captain Bazerque's scheme is successful in all respects, he will have the merit of showing that Science need not look to Government for help, even in her weightiest undertakings, though we fear the world is not yet ripe for this new application of "the voluntary principle."

FOSSIL CRYPTOGAMS

THE exogenous (circumferential) growth of fossil vascular cryptogams is a subject of so much interest and importance, that I may perhaps be permitted to say a few words regarding it. In a paper which was read at the December meeting of the Edinburgh Botanical Society, I combated the idea of the circumferential growth of calamites. The moist nature of the soil in which calamites must have grown would lead one to expect a poor development of the fibro-vascular bundles, and in comparing what I believe to be the fibro-vascular bundles of calamites with those of our recent equisetums, this idea is fully confirmed. Then in Equisetum there is a large development of the sclerenchyma of Mettenius, which forms the strong hypoderma. In a Brazilian fern which has come under my notice, this sclerenchyma runs to the fibro-vascular bundles, and presents an appearance exactly like Williamson's woody wedges, the large and small cells giving an appearance wonderfully like medullary rays. There is another point which, to my mind, is of much importance; namely, that in most of our recent vascular cryptograms, the embryonic parts do not enlarge; but as each successive leaf and portion of stem is produced, every such leaf and portion of stem is larger than the part preceding it, and this continues until a certain maximum is reached, when the stem becomes cylindrical. It is impossible to overlook that this mode of growth is evident in calamites, and until convincing proof can be brought forward of the circumferential growth of calamites, I must decline to accept it.

Turning from the calamites to Lepidodendron, it is evident that in it circumferential growth was much more likely to have occurred. In the calamites there is no evidence that they required year by year increasing quantities of water for purposes of transpiration, while in Lepidodendron the numerous small leaves which must have gone on increasing in number during the whole life of the plant (which however need not have been very long) demands that some addition to the conducting tissue should be made. As in botany we constantly find the same physiological purpose provided for in many morphologically distinct ways, I do not think it is at all necessary to believe in a form of growth identical with that in dicotyledons, because that would involve a complete change in type. Looking at such a stem as *Lycopodium chamaecyparissus*, in which the cortical tissues become so curiously modified, there is no difficulty in imagining that an increase by means of a cortical meristem might take place, a condition which I believe still exists in Isoetes. Hegelmaier in his paper, "Zur Morphologie der Gattung Lycopodium" in the *Botanische Zeitung*, 1872, p. 796, points out the presence in lycopods of a peculiar layer which he calls the *phloem sheath*, outside the phloem of the bundle, but inside the cortical portion, and therefore a series of cells belonging to the plerom and not to the periblem tissues. It seems to me probable that this phloem sheath may have represented a meristem layer from which new tissue was formed, as it would be the representative of the plerom meristem of the higher plants, while its position outside the vessels would further seem in some way related to the absence of vessels in the secondary wood of conifers.

Passing from the fossil lycopods, of which Lepidodendron is the type, with its central axis of fibro-vascular bundles, we come to Dictyoxylon, which I believe we must take as the type of Strasburger's new group the Lycopteridæ (Die Coniferen und die Gnetaceen, p. 259). Strasburger, in pointing out the relation of the archisperms to the vascular cryptogams, shows that the transition from the lycopods to the conifers is abrupt, and states that a new group intermediate between the two must have existed. To this group he gives the name Lycopteridæ, and I have no hesitation in referring Dictyoxylon stigmaria and sigillaria to it, and considering the former to be the type. The main root of stigmaria has more affinity with conifers than lycopods, while the branching of the root is distinctly lycopodiacous and not coniferous the root of conifers not branching in a dichotomous manner. It is not difficult to understand how the phloem sheath would in Dictyoxylon be still further differentiated, as plerom meristem, and even true cambium formed, thus affording the passage from the lycopodiacious to the archispermous stem. It is also not improbable that trigonocarpon may be referable to the lycopteridæ. While therefore I cannot see my way to accept the theory of the exogenous growth of calamites, I do not see any reason to doubt that in lycopods the circumferential growth may have taken place by means either of a periblem meristem, or plerom meristem, or by both: while in Dictyoxylon the relation of the growth of the stem to that of a conifer must be very close indeed.

W R. McNAB

NOTES

ONE of the principal events of the past week has been the funeral of Professor Sedgwick, whose death, though at a ripe old age and after a life devoted to work of the highest importance, yielding valuable results to Science, has called forth expressions of sympathy and regret from all quarters, from Royalty downwards. In this week's NATURE will be found a sketch of the life and work of the veteran geologist, from the pen of one who knew him long and well.

COALS in London are up to 48*s*. a ton, and there seems every probability that the rising process will continue. If they went at once up to 100*s*. a ton it might be the best thing that could happen to the nation, as thereby it might be "tunded" into adopting one or more of the obvious and easily applied means whereby the scandalous waste of our precious fuel might be avoided. It is a low average when we say that at least three-fourths of our coal is absolutely thrown away, and that simply because people "canna be fash'd" to prevent it. Men of science have dinned the alarming state of "the coal-question" into the ears of the nation for years, but we fear most men's heads, like their hearts, must be reached through their pockets. Sir W Armstrong's address at Newcastle, which we reprint this week, is one of the most practical, forcible, and intelligent on the subject we have hitherto seen. It is deserving of attention from all who have to pay for coals.

THE Council of the Anthropological Institute has appointed a Committee of Psychological Research, viz., Francis Galton, F.R.S., chairman; Dr. John Beddoe; Hyde Clarke; David Forbes, F.R.S.; Sir John Lubbock, Bt., F.R.S.; E. B. Tylor, F.R.S.; A. R. Wallace; with power to add to their number, and to confer with other scientific bodies.

THE United States exploring ship *Portsmouth*, which has been busily engaged in preparing for her cruise to the Pacific, has finally left for her destination. The scientific corps of the expedition is to consist of Messrs. Byer and Beardsley, from the Hydrographic Office, Washington, Paymaster Horace P. Tuttle as astronomer, and Dr. Streets as naturalist. The *Portsmouth* will carry three steam launches for cruising around shoal places.

THE Tyneside Naturalists Field Club have struck out a new line of work for similar societies throughout the country. They propose to obtain a complete record of all remarkable trees at present growing in the district embraced by the club, whether from their age, dimensions, or historic associations. Seventy or eighty such trees have already been catalogued from information supplied by the members of the club; and it is proposed that the record shall be as full and complete as possible, both in respect to letterpress and illustrations. The letterpress is to consist of the fullest particulars obtainable as to measurements and history, and it is recommended by the Committee appointed on the subject that the illustrations be photographs taken by some permanent process, either Swan's "carbon" or the "Woodbury;" the expenses to be paid out of the general funds of the Club, the catalogue to be supplied to members of the Club for a small subscription, to the general public at a higher rate. It is obvious that such an illustrated catalogue will become very useful in after years, especially if the observations are repeated on the same trees at intervals. Though the Woolhope Club has already published in its Reports photographs of a few remarkable trees, we do not recollect that anything of this kind has been hitherto attempted in a systematic way.

THE Academy of Natural Sciences at Stockholm has recently purchased one of the finest cryptogamic herbaria in existence, the great collection of European mosses formed by Milde.

THE Royal Commission of Scientific Instruction and the Advancement of Science holds its first meeting of this session to day.

THERE are at present five candidates for the vacant Professorship of Geology at Cambridge—the Rev. T. G. Bonney, M.A., Fellow of St. John's College; Mr. W. Boyd Dawkins, M.A., F.R.S., of Jesus College, Oxford, and Director of the Owens College Museum, Manchester; the Rev. Osmond Fisher, M.A., late Fellow and Tutor of Jesus College; Mr. McK. Hughes, Member of the Geological Survey; and Mr. A. H Green, M.A., late Fellow of Caius College.

A CORRESPONDENT writes, with regard to hurricanes in the Mauritius (vol. vii. p. 250), that it is desirable applications should be made to the French Minister of Marine, as it is possible log-books of men-of-war may be preserved, which will fill up the lacunæ in the last century. In the beginning of this century our Admiralty records may supply additional information.

DR. E. L. MOSS, of the Royal Naval Hospital, Esquimalt, Vancouver's Island, writes us that on the night of Saturday, Dec. 14, an earthquake wave passed through the district at 9.33. A rumbling noise and a quick vibration, causing the windows to rattle, preceded the shock a few seconds. The waves then passed from E.N.E. to W.S.W., causing the wooden house in which he sat to creak and strain like a ship at sea, and leaving an index of their direction in the oscillations of a swinging lamp. He could not detect any accompanying marine wave. The ship's lights were reflected from the surface of the harbour in perfectly unbroken lines. The night was clear, the thermometer at 27°, and there was no trace of aurora. From the *Daily British Colonist* we learn that the shock appears to have been more severely felt on the mainland than on the island. At Olympia and Seattle the shock was very severe, and was accompanied by a slight tidal wave. At Clinton the ground was cracked, and the shock was felt at all the towns on the Fraser. Since 1864 Victoria has not experienced so severe a shock of earthquake.

DR. DUDLEY, of Bogotà, South America, writes that on the morning of Dec. 17 last, at $4^h\ 20^m$ A.M., a smart shock of earthquake was felt at that place, which lasted about 20 seconds. It appeared to move in a S.W direction. It was sufficiently strong to awaken the inhabitants from their sleep with some alarm.

THE *Times of India* reports a very destructive earthquake which occurred in Sinde on the evening of December 15 last. A succession of shocks took place about 9 o'clock at Shekarpore and other places, followed by a slight shock at about half-past 10. In the town of Lehree, in Eastern Catchi and Zehri, according to one report 200, according to another 500 persons were killed from the fall of houses and walls. The direction of the earthquake was from east to west, with a slightly undulating motion.

ACCORDING to a telegram in the *Times* from Constantinople, February 4, the island of Samos had been visited with successive shocks of earthquake during the previous four days, gradually increasing in violence. Houses have been destroyed, and the affrighted inhabitants of the island are wandering about the open country.

A CORRESPONDENT sends us the following:—"A correspondent in Salvador, in Central America, under date of December 8, writes to the *Panama Record* as follows:—'The volcano which is some six leagues distant from the town of Santana, has dried up a lake which for 500 years or so existed at the base of the craters; but although vast quantities of steam are ejected, and the trees lining the inside of the crater are scorched up and withered, as also are those to a limited distance near the top on the outside, no ejection of lava has yet taken place. The volcano of Isaleo, which was active until quite recently, now shows no sign of life; and the supposition is that some strata which cut off the communication between the two volcanoes have burst through or fallen in, and so changed the channel of the fire. The Government of Salvador intends sending up an exploring party to examine and report on the subject. At the date of the above letter, no change had taken place in the volcano.

MR. HARDING, senior wrangler at Cambridge, has been declared first Smith's prizeman; while the second prize has gone to Mr. Nanson, the second wrangler.

WE have received a paper by Prof. Theodor von Oppolzer on the comet discovered by Pogson on December 2, following the telegraphic hint of Prof. Klinkerfues. Prof. Oppolzer enters into an elaborate series of calculations to prove that the observed comet was intimately connected with the star-shower of November 27, and that in all probability it was one of the heads of Biela's comet.

A REPORT, coming of course from America, has been going the round of the papers that Prof. Tyndall has been coining money by thousands from his lectures in the United States. Dr. Bence Jones writes to *Les Mondes* of January 30, giving the facts of the case, as told by Prof. Tyndall himself. His expenses in America, partly caused by the death of "poor Millard," his assistant, have been very high. There still remains, however, Prof. Tyndall says, 2,000*l*. This sum he intends to devote, in consultation with Prof. Henry of Washington, to the promotion of some worthy purpose in America.

WE are glad to see that a new edition of Chambers's *Information for the People* is about to be issued. The first edition was issued in 1833, and the last in 1857, since which, science in all its departments has made such rapid strides that scientific treatises published sixteen years ago must now be considered seriously defective and in many cases absolutely misleading. We are therefore glad to see from the prospectus that the scientific treatises have been entirely recast, so as to be adapted as nearly as possible to the present state of knowledge, and we have reason to believe that the various articles have been put into the hands of men who are acknowledged masters of their several subjects. Indeed we think it a sufficient guarantee that the work will in every respect be up to the mark, that the editorial supervision has been entrusted to Dr. Andrew Findlater, who has already deservedly won himself so great credit as Editor of Chambers's *Encyclopædia*; science at least is likely to have fair play in his hands. This work has already done much good in spreading accurate and valuable knowledge among the people. We hope the new edition will have as wide a circulation as its predecessors among the classes for whom it is adapted.

A SUPPLEMENTARY number of *L'Institut* has been issued, containing reports of the French Academy from September 5 to December 26, 1870, during which time, on account of the investment of Paris, the publication of the journal had to be suspended. Besides the French Academy, it contains reports of the Royal Society, the Berlin, Munich, and St. Petersburg Academies of Science, and the Göttingen Society of Science for the same period.

WE have received the "Report of the Birmingham School Natural History Society" for the year 1872, and a very satisfactory one it is. The society was founded in 1869, under the auspices of the Rev. C. Evans, Head Master of the school, since which it has made very creditable progress. Liberal grants have been made by the governors of the school for the purchase of books on Natural History, and the library contains several standard works. In 1871 a museum was fitted up, and during the past year three sections have been formed—botanical, entomological, and geological; and it is hoped that, eventually, new sections will be formed for the study of other subjects, such as physiology, zoology, &c. Three excursions have been made during the year, and there would have been several more, had it not been for unfavourable weather. The report contains some very creditable papers by the youthful members of the society, and we hope that future reports will contain the results of original observations on the part of the members.

FROM the report of the Grant Medical College, Bombay, we learn that during 1872 the total number of students was 283, showing an increase of 37 over 1871. Great improvements have taken place in the Museum, and Dr. Sylvester, the officiating principal, says, that for the last twenty years it has not been in such good order as it is at present. Dr. Sylvester reports that the system of education is not so sound and deep as it ought to be, and wisely reccommends that some subjects should be omitted from the course, and a more strict and penetrating knowledge insisted on in the others. He also seems to think that more care ought to be exercised in the appointment of professors, and that a sort of supplementary professor should be appointed to each chair, who would be ready at any time to undertake the duties of the professorship in case of a vacancy.

WE are glad to notice that the evening lectures to working men at the school of Mines have been eminently successful. The 600 available seats are all occupied, and about 600 more applicants have been necessarily refused. Those who attend are all *bona fide* working men, who in various ways show that they appreciate and understand the scientific lectures delivered. Each professor gives a course of six lectures every other year.

EARLY on Saturday morning a fire broke out in the Royal Military Academy at Woolwich, which terminated in the total destruction of the large central block of the building. A foul flue is supposed to have been the cause of the fire. The damage is estimated at 100,000*l*.

THE principal paper in *La Revue Scientifique* for February 1 is a long analysis of Darwin's Descent of Man, which has recently been translated into French. The writer endeavours to give a perfectly fair view of the work, but the tone of the article shows that Darwin is beginning to be better understood and appreciated in France than he has hitherto been. The writer sees in Darwinism a gigantic effort of the human mind to arrive at an explanation of phenomena which had previously been regarded as beyond the human grasp. He thinks it the duty of every naturalist, whatever may be his leanings, to study the facts and theories put forth by Darwin.

WE have received the prospectus of a German work likely to be of considerable interest and value—a history of Writing ("Geschichte der Schrift und Schrifttums," &c.) and written characters, symbolical and otherwise, from its earliest beginning in the shape of tattoo marks, down to the signs used in modern telegraphy, including an account of the modes of writing among all the nations of the world, savage and civilised. The specimens of the illustrations sent us are carefully executed; one of them represents a man, most elaborately and minutely tattooed from the crown of his head to the tips of his toes. The author is Heinrich Wuttke.

WE noted some time since that the French Government contemplated suppressing the *Bureau des Longitudes*, in order to save its expense to the nation. The French Academy has made a vigorous and indignant protest against such a philistian proposal. The protest recounts the glories which have in former times accrued to France from the discoveries of its eminent astronomers, shows the important position formerly held by the *Bureau*, the valuable assistance it has given to astronomy and navigation by means of its journal, the *Connaissance des Temps*, and declares that by degrees in recent years, the means of doing efficient work have been withdrawn from it. Since 1854 the *Bureau* has ceased to have the control of the Observatory. The Academy demands that instead of suppressing the institution, Government should restore to it the means of making itself more useful.

THE first number of an illustrated paper printed in Japanese, *Tai Sei Shimbun*, or *Great Western News*, was published in London on January 15. Its object is to clearly reflect the opinions of Japanese who have seen the world and learned European languages for the benefit of their countrymen at home. It is edited by a Japanese resident in London, in conjunction with Prof Summers, of King's College.

A CORRESPONDENT writes asking us whether any Alpine walker among our readers has had experience of Sir T. Troubridge's knapsack, the weight of which is borne principally upon the pelvis instead of on the shoulders, thus leaving the chest more free. Also where it can be obtained.

WITH the commencement of volume lxxxi. of *Astronomische Nachrichten*, the office of that journal will be removed from Altona to the Observatory at Kiel, to Prof. C. A. F. Peters, at which address all communications should be sent.

NO. 1917 of *Astronomische Nachrichten* is mainly occupied with letters from various quarters on the star-shower of Nov. 27 1872.

TO NO. 1919 of *Astronomische Nachrichten*, Prof. Sporer contributes the results of observations on the distribution of sun-spots for the periods of rotation, vi. and vii., for the year 1871.

SIR BARTLE FRERE and suite arrived at Zanzibar Jan 12.

NORTH Africa is at present overrun by exploring expeditions. The latest news from Sir Samuel Baker is contained in a telegram dated Khartoum, Nov. 7, 1872. According to this he left Gondokoro in 1871 for Kimrasi, but from the hostility of the natives was compelled to return some distance. In consequence of the prolonged absence of Sir Samuel, we learn from *Ocean Highways*, the Viceroy of Egypt decided upon sending a relief expedition of sixty-five men under the command of Colonel Purdy, an American officer in the Egyptian service. The plan is to start from Mombas and to make a journey to the supposed position of Baker, above Gondokoro. If the expedition is successful, very important geographical results may be expected from the route to be taken by Colonel Purdy, which will lead him across the Victoria Nyanza region.

Ocean Highways for February contains the first part of an article by Dr. Beke, entitled, "Position of the Sources of the Nile," his object being to show the influence which Ptolemy's determination of these sources has had on later geographers, down even to Livingstone, who adheres essentially to Ptolemy's opinion. The almost unanimous conclusion, however, come to by geographers of the present day, Dr. Beke tells us, is that the rivers described by Livingstone are tributaries of the Congo, and that the numerous sources described by him as the great water-parting of Southern Africa, are those of that river, and not of the Nile.

COMANDATORE NEGRI is making satisfactory progress in his endeavour to enlist Italian public opinion in favour of an Italian Arctic expedition.

THE first number of *Kosmos*, an Italian geographical bi-monthly journal, edited by Guido Cora, has just appeared.

IN NATURE for Jan. 23, we noted the supposed discovery of a great Arctic Continent by M. Pavy. The story appeared many weeks ago in the *Scotsman*, which took it from "the American papers." We, however, took no "note" of it till a similar account appeared in the *Times* a week or two ago, when we noted it with some expressed distrust. According to *Ocean Highways*, the story, as we feared, turns out to be, in all likelihood, a hoax. The French Geographical Society have received no such report as the American papers say has been transmitted to them. Far from M. Pavy having reached Wrangell Land, there are now doubts whether the expedition will start at all.

WE learn from the *Athenæum* that Sir John Lubbock is preparing a Bill, to be brought forward early this session, having for its object the preservation of the megalithic monuments to the United Kingdom.

WE have received the first number of the *Journal of the Women's Educational Union*, the main purpose of which is to promote the very commendable objects of that Union.

FROM pamphlets and periodicals before us we cull the following notes:—Dr. Hollis's *Astronomical Almanack* for 1873 contains a large quantity of very valuable and well-arranged information, which will be found useful to the rapidly increasing number of amateur astronomers, and to those who do not possess or who shrink from consulting the "Nautical Almanack."—The *Garden* learns that the celebrated Jardin Fleuriste of the city of Paris, which since the war has been in a ruinous condition, is at last to be entirely abolished, and the ground whereon it stood let for building purposes. A few years ago it was one of the most interesting and instructive gardens in existence. The principal articles in the *Journal de Physique* for January are a review of the fundamental theories relative to electro-dynamics and induction, by M. A. Potter: one by M. Berthelot on Calorimetric thermometers, in which he expounds the results of his studies on the subject for a number of years past: and a short one by M. C. Decharme, giving the results of a number of experiments to show the rate at which different liquids ascend a capillary tube.—A French newspaper, the *Monde*, contains a justly laudatory article on the Abbé Moigno's *Salles du Progrès*, which it seems are being more and more taken advantage of by the Parisian middle classes.—The "Annuaire de l'Academic Royale de Belgique," besides a mass of valuable information concerning the Academy, contains memoirs of a number of deceased Academicians, including one of the late Mr. Babbage, who was an associate of the Academy.—The *Penn Monthly* (Philadelphia) for May, July, August, and September, contains a series of articles by Mr. Edward D. Cope, on "Evolution and its consequences," in which is expounded the theory of evolution so far as it concerns animals and plants.—We have received a reprint from the *Quarterly Journal of the Geological Society* of the admirable paper "On the Evidence for the Ice-sheet in North Lancashire and adjacent parts of Yorkshire and Westmoreland," by Mr. R. H. Tiddeman, M.A., F.G.S., of the Geological Survey. It is accompanied by a well constructed map.—An address delivered before the Chemical Society of the Lehigh University, by Dr. B. Silliman, on "Deductive and Inductive Training," contains a very interesting history of the two systems from the earliest times to the present day.—A translation of Prof. Donati's oration at the inauguration of the new observatory at Florence, October 27, 1872, appears in the *Astronomical Register* for February.

ON THE COAL QUESTION *

THE North of England Institute of Mining and Mechanical Engineers was, in its origin, a society limited in its scope to the discussion of subjects belonging to the practice of mining, and especially of coal mining. At that period the working of coal and other minerals was carried on with less aid from machinery than at present, and the district in which the society is located was not so distinguished as it now is for the practice of mechanical engineering in all its branches. Hence, the society, in its growth, has gradually assumed more and more of an engineering character; and my recent election, as your president, indicates that mechanical science is no longer regarded by the members as secondary, or merely subsidiary, to the practice of mining. But we must guard against this tendency of the engineering element to outgrow the mining element of this institute. We must not forget that we are situated in the very heart of the coalfield which, more than any other, has rendered England pre-eminent as a producing nation, and that, notwithstanding the increasing magnitude and importance of the engineering works of this district, the raising of coal is still foremost amongst the industries of the North, both as regards the extent of the interests involved, and its importance to the general prosperity of the nation.

For these reasons, although I come before you as the first president of this society elected from the ranks of mechanical engineers, I shall, in this address, make coal the principal topic of my remarks, including, however, mechanical applications associated with its use or involved in its production. As I shall speak of coal in an economic as well as in a technical point of view, I cannot well avoid making some reference to its present excessive cost, because coal, like everything else, must be governed in the extent of its application by its price in the market. In addressing an institution, so largely composed as this is of colliery proprietors, it is not an agreeable task to dwell on the evil of dear coal; but our institution is not a commercial one, and I must speak of this subject, not as affecting individual interests, but as bearing upon mechanical art and national prosperity. For many years past the consumption of coal has been increasing at the rate of about 4 per cent. per annum, computed in the manner of compound interest. We are all familiar with the cumulative effects of compound rates of increase; and it is easy to see that if the consumption of coal continued to advance at this rate, we should speedily arrive at impossible quantities. Thus in 18 years our present enormous consumption would be

* Inaugural Address by Sir William Armstrong, C.B., President of the North of England Institute of Mining and Mechanical Engineers, delivered at Newcastle, February 1.

doubled; in 36 years it would be quadrupled; and in 54 years it would be eight times greater than at present. It is clear, therefore, that our consumption has been increasing at a rate which could not possibly last. If nothing else was destined to arrest it, a failure of mining labour was inevitably approaching to have that effect; but a few years would probably have yet elapsed before the number of hands became inadequate to meet the required demand, had not the miners precipitated the event by restricting the hours of work. The hours of mining labour in this district 25 years ago were 9 per day. At a subsequent date they were reduced to 8, then to 7, and finally to 6. Hitherto, the men have worked 11 days a fortnight, but it seems doubtful whether more than 10 can now be worked consistently with the very proper limitations of the recent Coal Mines' Act, in regard to the labour of the boys. The full hours per fortnight will, therefore, at the most, be 66, or 33 hours per week of labour at the face of the coal; but as it is only the steadiest men that work full time, the average time will, of course, be considerably below that limit.

I am not aware to what extent reduction of time has been carried in other parts of England; but we hear of the same policy of restriction, either of time or output, or of both, being put in practice in all the important coal districts. I do not suppose that the average output, per man, has fallen off proportionately to the reduction of hours. The men work hard, even harder than formerly, while at their post, but it is impossible that so great a reduction of working time can have taken place without so lessening the output, per head, as to neutralise in a great degree the increase of production due to the numerical growth of the mining population. Under these two conditions of increasing consumption and restricted labour, we have reached a point at which the demand has overtaken the supply. As yet, the deficiency cannot be great, for it has only very recently become apparent. Consumption does not advance by jumps; and we may assume that if a progressive increase of four or five per cent. per annum could have been maintained in the production of coal, a balance would still have existed between supply and demand. Though production has ceased to keep up with demand, it has not, so far as we can judge, actually receded, and it would therefore appear that a small addition to the present supply would restore the equilibrium. But small as the deficiency must be, it is sufficient to create a sense of scarcity, and as a consequence, to send up coals to a famine pitch.

The situation is a grave one, and the public has not yet fully realised how very grave it is. Taking the present consumption at 110 millions of tons (exclusive of exportation) and estimating the extra price to consumers at 8*s.* a ton over all, the annual loss to the community from the additional cost of fuel, amounts to 44 millions sterling. Had a Government tax of 44 millions been levied upon coal, in addition to existing taxation, the effect would have been regarded as utterly ruinous, not only in regard to its prodigious amount, but on account of its repressive effect upon every kind of production. Yet it is a fact that we are now paying the equivalent of such a tax, with this unfavourable difference, that the money does not go into the coffers of the nation. Whether it chiefly goes to coal-owners or coal-miners is a question which I need not discuss, but I may observe that the restrictive action of the men has benefitted their employers as well as themselves, and that the public are the only sufferers. Coal-owners have long been aware that limitation of quantity was the only effectual mode of raising price, but they have never been able, by their own action, to maintain a restricted production. At last their workmen have done it for them, and we see the result.

Whether the trade of the country will bear up against the heavy burden of dear coal, combined as it is with dearness of other products, arising from similar causes in other industries, is a question on which I shall not attempt to prophesy. It will be more to the purpose to consider what can be done to mitigate the evils under which the nation is now labouring in regard to the price of coal. It is vain to appeal for relief either to coal-owners or coal-workers. Self-interest is the ruling principle of trade, and it is visionary to expect that men will sell either labour or the produce of labour for less than the market price. However generous a man may be, he will not exhibit his generosity by selling an article below its value. Speaking then, as one of the public and not as a coal-owner, I say, we must strive to economise the use of coal; speaking as president of an institution of mining and mechanical engineers, I say, we must endeavour to make up for the deficiency of human labour by a more extended use of machine labour. The waste of coal, both in domestic and manufacturing use is a threadbare subject, but there never was a time when its consideration was of so much importance as at present. The small deficiency of supply which is now so violently stimulating the market would be just as effectually expunged by economising consumption as by increasing production. If, on the one hand, the mining population could easily, by a few hours' addition to their weekly labour, restore the equilibrium between supply and demand, so on the other hand consumers taken as a body, could do the same thing, by discontinuing in a small degree those reckless habits of wasting coal to which they obstinately adhere.

The consumption of coal takes place under three great divisions, each absorbing about one-third of the whole produce:—(1) domestic consumption; (2) steam-engine consumption; and (3) iron making and other manufacturing processes. In the first two divisions the waste is simply shameful; in the third it is not so great, but still considerable, though in some processes, and especially in the smelting of iron, economy of fuel has been so diligently pursued that there remains but little apparent scope for further saving. I shall not dwell on the waste of coal in domestic consumption, as it is scarcely a subject for engineers; but the circumstances of the times are such as to forbid my passing it unnoticed. It is impossible to conceive any system of heating a dwelling more wasteful than that of sinking the fire-place into a wall directly beneath the chimney which carries off the products of combustion. Nothing can be clearer than the advantage to be gained by merely advancing the fire-place a little into the room, and constructing it with proper heating surfaces, as in the "Gill-stove," and many other stoves acting on the same principle. There is no occasion to shut out the fire from view. Neither is there any difficulty about ventilation, since fresh air can easily be introduced from the exterior by a pipe delivering its supply against the heated plates, so as to temper the air before it enters the room. By this simple and unobjectionable departure from the conventional fire-place, the quantity of coal required to produce a given heating effect might easily be reduced to one-half, and still greater economy would be effected by the use of hot-water apparatus, which, however, has the objection of being too costly in first outlay to admit of very general application. For cooking purposes also, the consumption of coal is in most houses equally extravagant, and I may add, equally inexcusable, since the means of prevention are attainable by the adoption of known methods and appliances for concentrating the heat upon the work to be done.

A more appropriate subject for the consideration of this institution is the wasteful employment of coal for steam power. The steam engine is, at best, a very imperfect machine for utilising the mechanical power of heat, for in no case do we realise more than about one-tenth of the theoretical effect of the fuel. But the difference in economy between our best steam engines and our worst is enormous, and unfortunately by far the most numerous class belong to the category of the worst. In the best kind of engines, the consumption of coal per horse-power is rather less than 2 lbs., but there are thousands of steam engines in daily use which burn from 12 to 14 lbs. per horse-power. This excessive wastefulness arises from defects, both in the mode of raising the steam and in the mode of applying it. Theoretically, 1 lb. of coal is capable of evaporating 13 lbs. of water, but the conclusion arrived at on this subject by the late Royal Commission on the duration of coal was, that in practice 1 lb. of ordinary coal did not, on an average, evaporate more than 4 lbs. of water. The causes of this deficient result are perfectly understood, and, therefore, cannot be excused by ignorance. They are—insufficient boiler surface to absorb the heat, insufficient steam space to allow of a complete separation of the steam from the water, unclothed boilers, and imperfect combustion of the fuel, arising from badly constructed furnaces and from bad firing. The defects in the mode of applying the steam, or in other words, the defects which belong to the engine, in contradistinction to the boiler, are equally well known and equally remediable. The steam—to begin with—should be taken from the boiler at a much higher pressure than is usual. It should be admitted upon the piston at the full boiler pressure, and allowed to expand in the cylinder until its power is practically exhausted. The cut-off valves should be close to the end of the cylinders, as in the Corliss arrangement, so as to leave the smallest possible amount of space between the valve and the piston when commencing its stroke. Finally, the cylinder should be steam jacketed to prevent its cooling during the expansion of the steam, and thereby causing condensation on the next admission of steam. Nobody disputes these requirements of a good engine, and yet how few engines there are in which these conditions are fulfilled. The responsibility, however, for this waste of coal lies more with the users than with the makers of steam engines. Old-fashioned engines are retained in use partly on account of the outlay involved in replacing them, and partly from a dread of novelties and refinements requiring more care and delicacy of treatment than steam engines commonly receive. Even in replacing old engines the repugnance to any increase of first cost, and the distrust of departure from long-tried patterns, powerfully tend to a conservation of antiquated types of steam engines. As an encouragement to those who contemplate reforming their engine power, I may state what my own experience has been of the advantage of so doing. The engines and boilers originally applied at the Elswick Works, though representing a fair average of efficiency, were of the simple description then almost invariably used in factories. My firm, like others, was naturally averse to changing them on account of the expense of so doing; but about two years ago they determined to begin the renovation of all their old engines by putting down, as a first instalment, two large engines of the Corliss pattern to do the work previously performed by ten smaller engines. These two Corliss engines are now both at work. They have boilers of the best construction, and are fitted with various accompaniments favourable to economy of fuel, including Jukes' arrangement of mechanical firing. One of these engines uses twenty-four tons of coal per week against sixty tons used by the engines it has superseded. The other appears to be doing equally well, but I have not the necessary data for making a similar comparison. Assuming the economy effected to be the same in both cases, the aggregate saving of coal amounts to seventy-two tons per week. The number of firemen required is also much diminished, and the general result is, that, notwithstanding the enormous rise which has taken place in the price of coal, the required steam power is now obtained at a less cost than before, after allowing for interest on the capital expended.

Thus, then, the consumers of coal, as well for domestic use as for steam engines (under which two heads about two-thirds of our own consumption are comprised), have it in their power to economise their use of coal to an enormous extent, without any diminution of effect. In metallurgical and other manufacturing processes there is also room for much saving of coal; but I must not extend my observations into that division of the subject. Speaking generally of coal consumption in all its branches, there can be little doubt that without carrying economy to its extreme limits, all the effects we now realise from coal could be attained with half the quantity we use. If a reduction to that, or any approximate extent were effected, we should hear nothing more of scarcity or prohibitive prices for many years to come.

And now as to the practicability of economising human labour in coal mines by the employment of machinery. Much has already been done in applying machinery for the underground traction of coal, and a great reduction has thereby been effected both in men and horses; but the cutting of the coal is still almost exclusively performed by human labour. The service is a hard and dangerous one, and as it requires skill and experience, it is not easily taken up by untrained men. In every point of view, therefore, there is the strongest inducement to substitute mechanical appliances for manual labour in the process of cutting coal. Many attempts have been made to make a machine do the work of a man in this kind of labour, but with only imperfect success; and yet the problem does not appear, upon the face of it, to be one of very difficult solution to persons accustomed to mechanical invention, and thoroughly acquainted with the conditions under which the work has to be performed.

What is wanted, is a machine capable of cutting a groove at the base of the coal, so as to allow the supermcumbent mass to be easily dislodged. The mode of cutting may be by hewing, by slotting, by sawing, or by scooping. The machine must travel along the face of the coal so as to follow up its cut. It should have a long face to work at, so as to avoid frequent stops and changes, and for this purpose the long-wall system of working must be adopted. The difficulty of supporting the roof may, in some cases, be an impediment to the adoption of the long wall system, but I believe the cases would be few in which the difficulty would be insuperable.

Then, as to the power for driving the machine: that must clearly be compressed air transmitted from a steam-engine at the surface, as is now actually practised for the propulsion of all forms of these machines. Compressed air is not an economical medium for transmission of power, partly because the power expended in its preliminary condensation is not recovered by corresponding expansion in the exercise of its power, and partly because much of the force exerted in compression takes the form of heat, which is dissipated during the transmission of the air. In other respects compressed air is peculiarly adapted for conveying power into a mine, because, unlike water, it requires no provision for its removal, and actually helps to supply the necessary ventilation. This is a fair statement of the nature of the work to be done, and of the conditions under which it must be performed. Whatever difficulties there may be must be of a nature capable of being surmounted by mechanical skill and careful observation of the impediments to be overcome. Partial success has already been realised, and I confidently look forward to a time when, to the many services which we exact from coal as a source of motive power, we shall add the cutting of the parent material from the solid beds in which it is deposited.

But it is not alone in coal-mines that the extension of machinery is called for. The dearth of labour is being felt in every department of industry, and we have to fear on the one hand a ruinous collapse of trade, or on the other a continued rise in the price of all productions, threatening to neutralise the advantage of high wages, and impoverish persons dependent on fixed incomes. The only hope that I see of escaping one or other of these alternatives is by increasing the use of machinery and diminishing the direct employment of men. It is in the interest of working men, as well as of all other classes, that we should throw the burden of our wants as much as possible upon inanimate power; and it is a high function of mechanical science to relieve man from that description of labour which consists in the exertion of mere animal force, and leaves him more free for the exercise of skill which is beyond the province of machinery.

One of the worst effects of dear coal is that it involves dear iron. Coal may be economised, but iron cannot, without positive loss. Production of every kind, as also steam navigation and railway transport, are essentially dependent upon the use of iron as well as of coal. Hence, dear iron, like dear coal, is a burden, both on manufacture and on commerce, and its dearness diffuses itself over every article which we derive either from foreign trade, or from home manufacture. But although the present high price of iron is chiefly due to the scarcity of coal, it is not wholly so. The dearness of labour employed in its production is also telling seriously upon its cost, and the importance of substituting some system of mechanical puddling for the present laborious process is daily becoming more apparent. Many inventions for attaining this object have been tried, but no substantial success was realised, until Mr. Danks produced his rotating furnace in America. If Mr. Danks' success be confirmed by continued trials, he will have conferred an immense benefit, both upon the makers and the consumers of iron. Unhappily for him, the general ideas embraced in his apparatus appear to have been suggested before, and although he has the great merit of having shown how the previous ideas on the subject can be rendered available, the patent laws do not afford him that protection which they so lavishly bestow upon others who have accomplished no practical result. Under an equitable and discriminative system of patents, Mr. Danks would have obtained a monopoly as due to the importance of his invention, notwithstanding the abortive attempts of others to reduce the same ideas to successful practice. It is to be hoped that advantage will not be taken of Mr. Danks' unprotected position to deprive him of an adequate reward.

Having spoke of steam engines in reference to the great defects of those in most general use, it is only fair that I should acknowledge the great improvements which are exhibited by nearly all classes of those engines in their most modern forms. Mr. Bramwell, in his recent presidential address to the Mechanical Section of the British Association at Brighton, points out with justice how much has recently been done to improve the efficiency of marine, locomotive, and agricultural engines, and urges the importance of carrying out to a still greater extent the application of those principles which have already been productive of so much advantage. To this recommendation I may add that we must not neglect to follow up any new line of improvement which the progress of discovery may present to us.

(To be continued.)

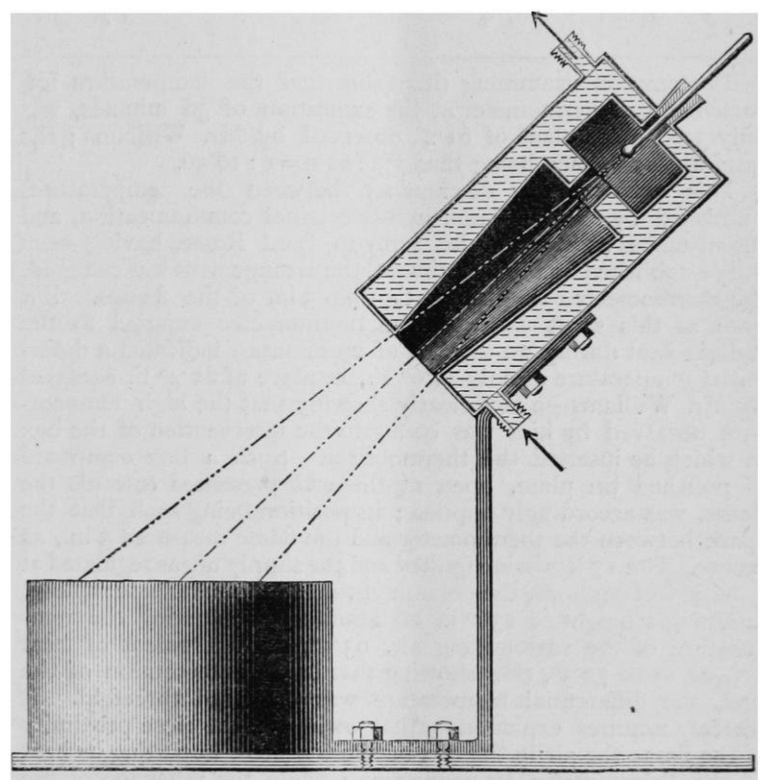
RADIANT HEAT

LORD ROSSE has shown* that the diathermacy of flame cannot be determined by the method described by Mr. W. Mattieu Williams, in his communication to NATURE, vol. vi. p. 506. Referring to the discrepancy which the reader may remember that Mr. Williams pointed out, Lord Rosse says: "The explanation of the discrepancy seems to be that the radiant heat from a flame, like that from any other body, varies as the inverse square of the distance and therefore the total effect is proportional to $\frac{1}{d^2} + \frac{1}{d'^2} + \frac{1}{d''^2}$ + &c., not $\frac{1}{d} + \frac{1}{d'} + \frac{1}{d''}$ + &c., where d, d'', &c., are the distances of the flames from the thermometer; in which latter case the order of lighting the jets would answer the desired object."

Mr. Williams, in order to meet the objection raised, presents calculations based on the assumption that the mean distance between the seventeen small flames and the thermometer is 14 in. The space from centre to centre of the flames being $\frac{1}{4}$ in., the distance between the thermometer and the centre of the nearest flame will be 12 in. Evidently Mr. Williams is not aware that a thermometer placed at a distance of 12 in. from his cluster of diminutive flames, cannot indicate 53° C. (127·4° F.), unless the surrounding atmosphere be heated to a temperature exceeding 123° F. Had he ascertained, experimentally, that the radiation of a cluster of such feeble flames, at the distance of 12 in. from the thermometer, imparts a temperature less than 3° C. above that of the atmosphere, he would no doubt have admitted the correctness of Lord Rosse's explanation of the supposed discrepancy, as freely as he admits the correctness of the theory on which that explanation is based.

The subject having attracted much attention, the writer has deemed it necessary to institute a series of experiments in order to test the accuracy of the table of temperatures which Mr. Williams desires Lord Rosse to accept on the ground that "the maximum error is less than $\frac{1}{10}$ of a degree, and the mean error lies between that and $\frac{1}{781 \cdot 25}$ of a degree."

Before entering on an examination of the result of the experiments adverted to, it will be necessary to call attention to the fact that, the transverse sectional area of a flame produced by 17 jets arranged in a straight line, $\frac{1}{4}$ in. apart, consuming 5 cubic feet of gas an hour, corresponds with the area of a circle of 0·87 in. diameter. The distance between the nearest point of the flame and the thermometer being 12 in., it will be found on calculation that the mean angle subtended by the heat rays projected towards the thermometer will be 4° 9′. Agreeably to the laws of radiation, the temperature produced at a given point by the heat rays projected from a deep radiating body, depends on the mean angle subtended. It may be shown, therefore, that in order to produce the differential temperature of 53° — 19° = 34° C. (61·2° F.), observed by Mr. Williams, the intensity of the flame must far exceed that capable of being developed by any chemical means. A brief explanation of this important subject will be proper in this place. The accompanying illustration represents a pyrometer constructed by the writer for measuring with desirable precision intensities of all degrees. The pyrometer consists of a conical vessel communicating with a cylindrical chamber, as shown in the sectional elevation, both being surrounded by an external vessel through which a current of water, of uniform temperature, is circulated. The thermometer for registering the temperature produced by the radiation of any incandescent body, is inserted in the cylindrical chamber at a fixed distance from the opening of the conical vessel; hence the angle subtended by the heat rays projected by the radiating body towards the bulb of the thermometer, will remain constant whatever be the distance of that body from the instrument. Of course the radiation must be large enough to cover the entire field contained within the radial lines drawn from the bulb through the circumference of the opening of the conical vessel. We have already adverted to the fact that the temperature transmitted to the thermometer depends on the subtended angle. Consequently, by ascertaining practically what degree of temperature is imparted to the thermometer of the pyrometer, by a radiator of *known* intensity, we can determine the intensity of any other radiator by merely observing the temperature it imparts to that thermometer. It should be stated that in the pyrometers which have been constructed, the diameter of the opening of the conical vessel is $\frac{1}{5}$th of the distance from the thermometer; hence the angle subtended is very nearly 11° 26′ Experiments made with an incandescent block of cast-iron, arranged as represented in the illustration, have shown that when the temperature of the block is 1930° above that of the surrounding atmosphere, the thermometer of the pyrometer indicates a temperature 20·7° higher than the circulating water in the casing. Applying the pyrometer in a similar manner, for ascertaining the temperature of a mass of overheated fused cast-iron, the indication of the thermometer has been found to reach 31·4° above that of the water in the enclosure. Now, the temperature of radiators is proportional to the radiant heat which they transmit, provided the subtended angles be alike; hence it follows that the temperature of the fused metal must be $\frac{31 \cdot 4 \times 1930}{20 \cdot 7} = 2940°$ above that of the water in the casing surrounding the conical vessel. Adding the latter temperature, viz. 60°, we ascertain that the actual temperature of the fused metal will be very nearly 3000°. The result of several experiments shows that this temperature corresponds with that determined by the practical expedient resorted to during the investigation, of melting wrought-iron in the fused mass. It should be mentioned that in



Pyrometer for various intensities.

constructing the scale of the new pyrometer, the radiant power corresponding with given subtended angles and given temperatures, has been ascertained with critical nicety by experiments conducted within a vacuum. For the purpose of demonstrating that the distances assumed by Mr. Williams in his reply to Lord Rosse are greatly exaggerated, a reference to the amount of radiant heat transmitted to the thermometer by the fused metal will no doubt be most convincing. We have before stated that the heat rays projected towards the thermometer from a flame produced by seventeen gas-jets subtend a mean angle of only 4° 9′, while the heat rays projected from the fused metal towards the thermometer of the pyrometer, subtend an angle of 11° 26′ The areas corresponding with these angles being $4 \cdot 15^2 : 11 \cdot 43^2 = 1 : 7 \cdot 6$, it follows that, unless the intensity of the gas flame is $3000° \times 7 \cdot 6 = 22800°$ F., it cannot transmit to the thermometer the same temperature as the fused metal, viz. 31·4° F. But Mr. Williams records an increment of temperature of 53° – 19° = 34° C. (61·2° F.); hence $\frac{61 \cdot 2 \times 22800}{31 \cdot 4} = 44723°$ F., must be the temperature of his flame, if twelve inches be a true distance.

Having thus proved by demonstration that the distances assumed by Mr. Williams are exaggerated, let us now briefly examine the result of the experiments which have been made with an apparatus constructed agreeably to the description contained in his original communication. In carrying out these experiments, it was deemed necessary, before inserting the recording thermometer in a box as directed, to expose the same to the radiant heat of the flame, freely suspended in the atmosphere

* NATURE, vol. vii. p. 28.

but carefully protected from currents of air by screens appropriately arranged. The horizontal gas-pipe with its perforations, ½ inch between each, having been so adjusted that the distance between the central perforation and the thermometer was 14 in., the 17 jets were ignited, and the supply of gas regulated at precisely 5 cubic feet per hour. The temperatures imparted to the thermometer during the experiment are recorded in Table A. It

TABLE A.

Time.	Indication of Thermometer.	Temperature of surrounding Atmosphere.	Differential Temperature.
m. s.	Deg. Fah.	Deg. Fah.	Deg. Fah.
0 0	62·8	62·8	0·0
6 2	64·4	62·8	1·6
12 5	65·6	63·0	2·6
18 6	66·5	63·2	3·3
24 8	67·0	63·4	3·6
30 11	67·3	63·6	3·7
36 9	67·4	63·7	3·7

will be seen on examining this table that the temperature imparted to the thermometer at the expiration of 36 minutes, was only 3·7° F., in place of 61·2° observed by Mr. Williams; the rate of discrepancy being thus 3·7 : 61·2 = 1 : 16·56.

This extraordinary discrepancy between the temperatures published by Mr. Williams in his original communication, and the distances assumed in his reply to Lord Rosse, having been fully established by the experiment, the arrangement was changed, the thermometer being brought within 3 in. of the flames. But even at this short distance, the thermometer exposed to the radiant heat during an interval of 29 minutes, indicated a differential temperature of only 22·6° F., in place of 61·2° F. as stated by Mr. Williams—a fact clearly showing that the high temperature observed by him was owing to the intervention of the box in which he inserted the thermometer. Such a box composed of polished tin plate, open at the end presented towards the flame, was accordingly applied; its position being such that the space between the thermometer and the flame measured 3 in., as before. The 17 jets being ignited and the supply of gas regulated at 5 cubic feet per hour, the column of the thermometer rose rapidly, attaining a height of 136° in 20 minutes. Deducting the temperature of the surrounding air, 63·5°, the increment of heat proved to be 72·5°, thus showing that by the intervention of the box, the differential temperature was increased threefold. It scarcely requires explanation that owing to the close proximity of the flame the air in the box becomes heated, imparting its heat to the thermometer, by convection; while the reflection of the heat rays against the sides and bottom of the polished box, imparts radiant heat to those parts of the bulb which are not exposed to the direct radiation of the flame.

In view of the foregoing explanation it will be evident that, in a properly conducted experiment, the temperatures recorded in Mr. Williams' table cannot be produced unless the thermometer be placed even nearer than 3 in. from the flame. But admitting that the recorded temperatures could be developed at a distance of 3 in., it will be found that the mistake to which Lord Rosse has called attention is fatal to Mr. Williams' deductions. Referring to Table B, constructed in accordance with

TABLE B.

No. of jet from Thermometer.	Energy Transmitted.	No. of jet from Thermometer.	Energy Transmitted.
1	2·77	10	0·90
2	2·37	11	0·82
3	2·04	12	0·75
4	1·77	13	0·69
5	1·56	14	0·64
6	1·38	15	0·59
7	1·23	16	0·55
8	1·11	17	0·51
9	1·00		

the theory pointed out by Lord Rosse in his letter to NATURE, it will be seen that each pair of jets so far from developing an equal amount of radiant energy, as indicated by Mr. Williams' table, they differ to a very great extent. For instance, while the two jets on each side of the centre develope respectively 1·11 and 0·90 (the energy transmitted by the central jet being represented by unity), the two outside jets develope respectively 2·77 and 0·51. Accordingly, the energy developed by the central pair will be 1·11 + 0·90 = 2·01, while the outside pair develope 2·77 + 0·51 = 3·28. Leaving out of sight the imperfections of the method adopted in making the observations, this great difference of the radiant energy transmitted to the thermometer by each pair of jets, is conclusive against the deduction concerning diathermacy of flame, which Mr. Williams has based on his published table of temperatures. J. ERICSSON

SCIENTIFIC SERIALS

THE *Archives des Sciences Physiques et Naturelles* contains a long and admirable article by Prof. Plantamour, on the meteorology of Geneva and the Great St. Bernard for 1871, a year of very exceptional weather at these places. In a series of carefully compiled tables, the various meteorological phenomena observed are compared in every possible way, and deserve the study of meteorologists. The second paper is an exceedingly interesting one from the work published by M. de Candolle, "Histoire des Sciences et des savants depuis deux Siècles," &c., containing the result of much acute and original research, on Transformations of Movement among Organised Beings. The other two principal papers are one by M. Ernest Favre, on the Geology of the Ralligstöcke on the banks of Lake Thun, and one by MM. de la Rive and Sarasin on the rotation under magnetic influence of the electric discharge in rarefied gases, and on the mechanical action which this discharge may exercise in its movement of rotation.

Transactions of the Wisconsin Academy of Science, Arts, and Letters, 1870-72. This academy was organised in 1870, "by a convention called by the Governor and more than one hundred other prominent citizens of the State," its general objects being "the material, intellectual, and social advancement of the State," as well as, or rather by means of the advancement of, science, literature, and the arts. This first volume of Transactions contains some specimens of the work already done by the Academy in its various departments, to which is prefixed an extremely interesting *résumé* of what has already been done by Wisconsin for science. This is followed by a long list of papers on various subjects read before the Academy since its formation. Of the scientific papers contained in the volume before us, Dr. Lapham contributes one "On the Classification of Plants;" Mr. J. G. Knapp "On the Coniferæ of the Rocky Mountains;" Prof. Irving on "The Age of the Quartzites, Schists, and Conglomerate of Sank Co. Wisconsin;" Prof. Chamberlain a few suggestions, some of them original, as to a Basis for the Gradation of the Vertebrata; and Prof. Davies "On Potentials and their Application to Physical Science;" in which he attempts to give a *physical* interpretation to the potential function, and to illustrate it and its use by some simple examples. We hope the Academy will continue to produce as satisfactory work in the future as it has done since it commenced.

WE have received numbers 8, 9, 10, and 11 of the *Australian Mechanic and Journal of Science and Art* for August, September, October, and November, and highly creditable is the quality of the contents to its able editor, Mr. Ellery, Superintendent of Melbourne Observatory, and a hopeful sign of the intelligence and progress of the Australian people it is, that such a high-class scientific journal should have a paying circulation in so young a colony. Mr. Ellery himself is contributing a series of valuable and well-illustrated articles on "How to make and how to use a Spectroscope," while another contributor, "Delta," concludes in the August number a series of seven papers on "Spectrum Analysis." The subjects treated of are very various, and mostly practical, but whatever the subject of an article may be, science and the application of scientific principles are never lost sight of. There is a series of articles on agriculture, in which the application of science to this department of industry is well illustrated; and in an article on "Science and Government," principally with reference to the supply of coal, the writer concludes thus:—"There is scarcely any subject within the range of material science, however trifling it may at first appear, that has not a direct and important interest for the whole community, and especially for those who hold the responsibility of conducting the affairs and guarding the interests of the State." Would that all ministers would realise and act upon the great truth, so clearly and pithily expressed. Mr. Ellery contributes monthly a very valuable and interesting set of "Astronomical Notes," in which he gives all the details in a tabular form necessary to find out the positions, on the first of each month, of the planets, nebulæ, clusters, and double and other peculiar stars. We hope the journal will have all the success it well deserves.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Jan. 30.—Prof. George Busk, vice-president, in the chair. The following communications were read:—"Note on the Origin of *Bacteria*, and on their Relation to the Process of Putrefaction." By Dr. H. Charlton Bastian, F.R.S.

In his now celebrated memoir of 1862, M. Pasteur asserted and claimed to have proved (1) that the putrefaction occurring in certain previously boiled fluids after exposure to the air was due to the contamination of the fluids by *Bacteria*, or their germs, which had before existed in the atmosphere; and (2) that all the organisms found in such fluids have been derived more or less immediately from the reproduction of germs which formerly existed in the atmosphere.

The results of a long series of experiments have convinced me that both these views are untenable.

In the first place, it can be easily shown that living *Bacteria*, or their germs, exist very sparingly in the atmosphere, and that solutions capable of putrefying are not commonly infected from this source.

It has now been very definitely ascertained that certain fluids exist which, after they have been boiled, are incapable of giving birth to *Bacteria*, although they continue to be quite suitable for the support and active multiplication of any such organisms as may have been purposely added to them. Amongst such fluids I may name that now commonly known as "Pasteur's solution," and also one which I have myself more commonly used, consisting of a simple aqueous solution of neutral ammonic tartrate and neutral sodic sulphate.* When portions of either of these fluids are boiled and poured into superheated flasks, they will continue quite clear for many days, or even for weeks—that is to say, although the short and rather narrow neck of the flask remains open the fluids will not become turbid, and no *Bacteria* are to be discovered when they are submitted to microscopical examination.

But in order to show that such fluids are still thoroughly favourable media for the multiplication of *Bacteria*, all that is necessary is to bring either of them into contact with a glass rod previously dipped into a fluid containing such organisms. In about thirty-six hours after this has been done (the temperature being about 80° F.), the fluid, which had hitherto remained clear, becomes quite turbid, and is found, on examination with the microscope, to be swarming with *Bacteria*.†

Facts of the same kind have also been shown by Dr. Burdon Sanderson‡ to hold good for portions of boiled "Pasteur's solution." Air was even drawn through such a fluid daily for a time, and yet it continued free from *Bacteria*.

Evidence of this kind has already been widely accepted as justifying the conclusion that living *Bacteria* or their germs are either wholly absent from, or, at most, only very sparingly distributed through the atmosphere. The danger of infection from the atmosphere having thus been got rid of and shown to be delusive, I am now able to bring forward other evidence tending to show that the first *Bacteria* which appear in many boiled infusions (when they subsequently undergo putrefactive changes) are evolved *de novo* in the fluids themselves. These experiments are moreover so simple, and may be so easily repeated, that the evidence which they are capable of supplying lies within the reach of all.

That boiling the experimental fluid destroys the life of any *Bacteria* or *Bacteria* germs pre-existing therein is now almost universally admitted. It may moreover be easily demonstrated. If a portion of "Pasteur's solution" be purposely infected with boiled *Bacteria* and subsequently boiled for two or three minutes, it will continue (if left in the same flask) clear for an indefinite period; whilst a similarly infected portion of the same fluid, not subsequently boiled, will rapidly become turbid. Precisely similar phenomena occur when we operate with the neutral fluid which I have previously mentioned; and yet M. Pasteur has ventured to assert that the germs of *Bacteria* are not destroyed in neutral or slightly alkaline fluids which have been merely raised to the boiling-point.*

Even M. Pasteur, however, admits that the germs of *Bacteria* and other allied organisms are killed in slightly acid fluids which have been boiled for a few minutes; so that there is a perfect unanimity of opinion (amongst those best qualified to judge) as to the destructive effects of a heat of 212° F upon any *Bacteria* or *Bacteria* germs which such fluids may contain.

Taking such a fluid, therefore, in the form of a strong filtered infusion of turnip, we may place it after ebullition in a superheated flask with the assurance that it contains no living organisms. Having ascertained also by our previous experiments with the boiled saline fluids that there is no danger of infection by *Bacteria* from the atmosphere, we may leave the rather narrow mouth of the flask open, as we did in these experiments. But when this is done, the previously clear turnip infusion invariably becomes turbid in one or two days (the temperature being about 70° F.), owing to the presence of myriads of *Bacteria*.

Thus if we take two similar flasks, one of which contains a boiled "Pasteur's solution," and the other a boiled turnip infusion, and if we place them beneath the same bell-jar, it will be found that the first fluid remains clear and free from *Bacteria* for an indefinite period, whilst the second invariably becomes turbid in one or two days.

What is the explanation of these discordant results? We have a right to infer that all pre-existing life has been destroyed in each of the fluids; we have proved also that such fluids are not usually infected by *Bacteria* derived from the air—in this very case, in fact, the putrescible saline fluid remains pure, although the organic infusion standing by its side rapidly putrifies. We can only infer, therefore, that whilst the boiled saline solution is quite incapable of engendering *Bacteria*†, such organisms are able to arise *de novo* in the boiled organic infusion.

Although this inference may be legitimately drawn from such experiments as I have referred to, fortunately it is confirmed and strengthened by the labours of many investigators who have worked under the influence of much more stringent conditions, and in which closed vessels of various kinds have been employed.‡

Whilst we may therefore infer (1) that the putrefaction which occurs in many previously boiled fluids when exposed to the air is not due to a contamination by germs derived from the atmosphere, we have also the same right to conclude (2) that in many cases the first organisms which appear in such fluids have arisen *de novo*, rather than by any process of reproduction from pre-existing forms of life.

Admitting, therefore, that *Bacteria* are ferments capable of initiating putrefactive changes, I am a firm believer also in the existence of not-living ferments under the influence of which putrefactive changes may be initiated in certain fluids—changes which are almost invariably accompanied by a new birth of living particles capable of rapidly developing into *Bacteria*.

"On Just Intonation in Music; with a description of a new Instrument for the easy control of all Systems of Tuning other than the ordinary equal Temperament." By R. H. M. Bosanquet.

The object of this communication is to place the improved systems of tuning within the reach of ordinary musicians; for this purpose the theory and practice are reduced to their simplest forms. A notation is described, adapted to use with ordinary written music, by which the notes to be performed are clearly distinguished. The design of a key-board is described, by which any system of tuning, except the ordinary equal temperament, can be controlled, if only the fifths of the system be all equal. The design is on a symmetrical principle, so that all passages and combinations of notes are performed with the same handling, in whatever key they occur. The theory of the construction of scales is then developed, and a diagram is given, from which the char-

* In the proportion of 10 grains of the former and 3 of the latter to 1 ounce of distilled water.

† "The Modes of Origin of Lowest Organisms," 1871, pp. 30, 51.

‡ Thirteenth Report of the Medical Officer of the Privy Council (1871), p. 59.

* How unwarrantable such a conclusion appears to be, I have elsewhere endeavoured to show. See "Beginnings of Life," 1872, vol. i. pp. [illegible] 33, and pp. 372–399.

† See "Beginnings of Life," vol. ii. p. 35, and vol. i. p. [illegible]

‡ See a recent communication by Prof. Burdon Sanderson [illegible] in NATURE January 9.

teristics of any required system can be ascertained by inspection. An account is then given of the application of such systems to the new key-board, and particularly of a harmonium, which has been constructed, and contains at present the division of the octave into fifty-three equal intervals in a complete form. Rules for tuning are given. Finally, the application of the system of fifty-three to the violin is discussed.

Throughout the work of former labourers in the same field is reviewed; the obligations of the writer are due to Helmholtz, the late General T. Perronet Thompson, F.R.S., and others.

"On the Composition and Origin of the Waters of a Salt Spring in Huel Seton Mine, with a Chemical and Microscopical Examination of certain Rocks in its Vicinity." By J. Arthur Phillips.

After giving some tables, the author proceeds as follows:—A consideration of the various phenomena connected with the occurrence of this and other apparently similar springs, which have at different times been discovered in the district, would seem to lead to the inference that they all have some more or less direct communication with the sea, and that they are either the result of infiltration of sea-water through faults, or are true and independent sources which, before being tapped below the sea-level, had found their way to the ocean through faults or channels.

The following would appear, in the present state of our knowledge, a probable explanation of the origin of the Huel Seton spring. The cross-course is believed to extend through both granite and clay-slate to the sea. From the close contact of its surfaces, the presence of clay, and from other causes, this fault may be supposed not to be uniformly permeable by water, which can only follow a circuitous passage. In this way it penetrates to depths where reactions take place, which, although not entirely in accordance with the results of daily experience in our laboratories, can, after the investigations of M. Daubrée, M. de Sénarmont, and others, be readily understood. By the action of *sea-water* on *silicates of calcium*, *silicates of sodium* and *chloride of calcium* may be produced. The *sulphate of sodium* of the sea-water will be decomposed by this *chloride of calcium*, with the production of *sulphate of calcium* and *chloride of sodium*. The decomposition of clayey matter by *common salt* may produce *chloride of aluminium* and *silicates of sodium*, while the *magnesium* of the chloride of magnesium may be replaced by *calcium*; lastly, a portion of the *potassium* in the sea-water appears to have been replaced by the *lithium* of the granite.

Royal Geographical Society, Jan. 27.—Major-General Sir H. C. Rawlinson, K.C.B., president, in the chair.—"Journey from Bunder Abbas to Meshed, by Seistan," by Sir Frederick Goldsmid. The object of the author's journey was to carry into effect a settlement of the frontiers of Seistan, with which he had been entrusted. He left Bunder Abbas for the interior, with his party, on December 23, 1871, travelling in an E.N.E. direction first towards Bam. Beyond Bam and Azizabad, the country was fertile and well cultivated; this afterwards ceases, and near Fahraj the central desert begins. Beyond this, to the west, is another tract of mountainous country, bounding the fertile district of Seistan. The Hamun Lake was found dry, except pools of water at the mouths of the rivers, and the party crossed its southern part, where the bed was perfectly dry. Its limits are, however, well-marked by belts of reeds. The waters of the Helmund near and in the Delta had been led off by irrigation canals. The area of Seistan Proper was estimated at 947 square miles, and the population at 35,000. Majors St. John and Lovett, R.E., the surveyors attached to the party, had superintended the execution of a new wall-map of Persia, which was exhibited, and which gave quite a new character to the geography of many parts of Persia. The two great central areas of desert (1,500 to 3,000 feet above the sea-level) were clearly shown, and the snowy-ranges running in a north-west and south-east direction, nearly parallel to the Persian Gulf, well defined. One of these ranges rises to a height of more than 17,000 feet.—"On the Comparative Geography and Ethnology of Seistan," by the President. The country physically is dependent entirely on the River Helmund; and it is probable the earliest Aryan colonists drew off the whole of the water for irrigation, for in the earliest Geographical List, that contained in the "Vendidad," the country was called, not from the lake, but from the river. None of the sites of the cities and places named in ancient history could be identified with certainty. Seistan formed the most southerly province of the ancient Aryan country of Iran.

DIARY

THURSDAY, February 6.

Royal Society, at 8.30.—On the Osteology of Hyopotamidæ: Dr. W. Kowalevsky.—Magnetic Survey of Belgium in 1871: G. J. Perry.
Royal Institution, at 3.—Formation of Organic Substances: Dr. Armstrong.
Linnean Society, at 8.—Notes on Aristolochiaceæ: Dr. Masters.
Chemical Society, at 8.—On Anthrapurpurin: W. H. Perkin.—On the Solidification of Nitrous Oxide: T. Wells.—On Isomerism in the Terpene Family: Dr. C. A. Wright.
Society of Antiquaries, at 8.30.—On Donnington Castle: H. Goodwin.

FRIDAY, February 7.

Royal Institution, at 9.—Old Continents: Prof. Ramsay.
Geologists' Association, at 7.30.—Annual Meeting.—On the Diprionidæ of the Moffat Shale: Charles Lapworth.
Philological Society, at 8.15.
Archæological Institution, at 4.
Old Change Microscopical Society, at 5.30.—On the Internal Economy of Insects: T. Rymer Jones.

SATURDAY, February 8.

Royal Institution, at 3.—Comparative Politics: Dr. E. A. Freeman.
Royal Botanic Society, at 3.45.

MONDAY, February 10.

Royal Geographical Society, at 8.30.
London Institution, at 4.—Physical Geography: Prof. Duncan.

TUESDAY, February 11.

Photographic Society, at 8.—Annual Meeting.—The Achromatisation of an Object Glass: Prof. G. Stokes.

WEDNESDAY, February 12.

London Institution, at 7.—Fresco and Siliceous Painting: Prof. Barff.
Society of Arts, at 8.
Archæological Association, at 8.

THURSDAY, February 13.

Royal Society, at 8.30.
Society of Antiquaries, at 8.30
Mathematical Society, at 8.—On Systems of Linear Congruences: Prof. H. J. S. Smith.

BOOKS RECEIVED

English.—On a Hæmatozoon inhabiting Human Blood: T. R. Lewis, Calcutta.—A Report of Microscopical and Physiological Researches into the Nature of the Agent or Agents producing Cholera: T. R. Lewis and D. D. Cunningham.—The Useful Plants of India: Col. H. Drury. Second Edit. (W. H. Allen & Co.).—A Handbook of Hygiene: George Wilson (J. A. Churchill).—Chambers' Arithmetical Exercises: J. S. Mackay (W. & R. Chambers).—Standard Algebra (W. & R. Chambers).—Chambers' Elementary Physical Geography: J. Donald (W. & R. Chambers).—Chambers' Scientific Reader (W. & R. Chambers).—Chambers' Electricity: R. M. Ferguson (W. & R. Chambers).—Recollections of Canada: Lieut. Carlile, R.A., and Lieut.-Col. Martindale, Quebec (Chapman & Hall, London).

Foreign.—Die Kalkschwamme: eine Monographie. 3 vols. Ernest Haeckel (Williams & Norgate)—Gespinnst Fassern, &c.: Dr. R. Schlesinger (Williams & Norgate).

PAMPHLETS RECEIVED

English.—Potential Functions and their Applications in Physical Science: Prof. J. E. Davies.—Symon's Monthly Meteorological Magazine, No. 74, Vol. vii January.—Quarterly Journal of Education, No. 5, January (Groombridge).—Messenger of Mathematics, No. 21, January (Macmillan & Co).

Foreign.—Correspondenzblatt des Naturforcher: Riga.—Sulla Corona Sollare: Prof. L. Respighi.

CONTENTS

	Page
Sedgwick By Prof. Phillips, F.R.S	257
Palmieri's Vesuvius. By David Forbes, F.R.S. (*With Illustration.*)	259
Our Book Shelf	261
Letters to the Editor:—	
Dr. Bastian's Experiments.—Dr. J. Burdon Sanderson, F.R.S.	261
Eyes and no Eyes	261
Meteor at St. Thomas.—Hon. Rawson Rawson	262
Brilliant Meteor.—G. St. Clair, F.G.S.	262
The Antinomies of Kant.—Dr. C. M. Ingleby	262
The Source of the Solar Heat.—Maxwell Hall	262
The Twinkling of the Stars.—Thos. Hawksley	262
Meteorological Cycles	262
On the Old and New Laboratories at the Royal Institution, II. By W. Spottiswoode, Treas R.S.	263
The Growth and Migrations of Helminths. By M. Cornu	265
A Private Circumnavigating Expedition	266
Fossil Cryptograms. By Prof. McNab	267
Notes	267
On the Coal Question. By Sir W. Armstrong, C.B.	270
Radiant Heat. By Capt. J. Ericsson (*With Illustration.*)	273
Scientific Serials	274
Societies and Academies	275
Books and Pamphlets Received	276
Diary	276