THURSDAY, FEBRUARY 27, 1873

WESTERN YUNAN

A Report on the Expedition to Western Yunan, viâ Bhamô. By John Anderson, M.D. (Calcutta: Office of the Superintendent of Government Printing, 1871.)

THIS interesting volume consists of the first section of a report on the expedition from Burmah over the Chinese frontier into Yunan, sent out under the auspices of the British Government, in the year 1868. It was under the charge of Major Sladen and Captain Williams, with the author, Dr. Anderson, as naturalist to the Expedition. They were accompanied by Messrs. Bowers, Stewart, and Burn, as representatives of the commercial community at Rangoon; the main object in view being to ascertain how far it was possible for the great highway to China by the valley of the Tapeng, could be made open to British commerce. The desirability of this access to the western frontiers of China has long been felt, and many attempts have been made during the last two centuries to establish an emporium either at Bhamô or in its neighbourhood, and one of the results of the recent expedition has been the sanction on the part of the Burmese Government of the residence of a British representative at Bhamô for the protection of our commercial interests.

The first part of the volume before us is chiefly historical, and deals with the relations of the ancient Shan kingdom of Pong, with the neighbouring States of Burmah and China, and the wars which resulted in Pong becoming a Burmese province. The wars between China and Burmah are also described, but during the last hundred years or more the intercourse between the two nations has been one of peace.

The European intercourse with Bhamô is next traced from the days of Marco Polo downwards; for from some of the details given by that traveller as to the customs of the inhabitants of the province of Kardandan, there can be but little doubt that his route must in part at least have almost coincided with that of the expedition.

The description of the physical features and geology of the Bhamô district and of Western Yunan forms an interesting and important chapter. At Bhamô itself the Irawady, though 600 miles from the sea, is one and a half miles in breadth during the heavy rains, and about a mile during the dry season. Its great valley is, however, in places broken up by low isolated ranges which confine its waters to comparatively narrow but deep channels. These hill ranges are usually of metamorphic and crystalline rocks on which Eocene and Miocene strata, consisting of limestone, sandstone, clay, coal, and ferruginous conglomerates, have been deposited together with interbedded traps. The Tapeng, along the valley of which the course of the expedition lay, has a course of about 150 miles from its rise in the Kananzan hills to its confluence with the Irawady above Bhamô. For a considerable portion of this distance there is a continued succession of waterfalls and rapids, though it is navigable for about twenty miles when it reaches the Burmese plain. The Kakhyen hills through which it passes attain a height of 5,000 or 6,000 ft., and appear to be mainly composed of metamorphic and crystalline rocks. Their surface, even to the highest peaks, is strewn with water-worn boulders, to which Dr. Anderson assigns a marine origin, believing that since their deposit this tract of country has been raised from beneath the sea, and that the immense valley of the Irawady was subsequently excavated. The Kananzan range appears to attain an elevation of about 9,000 ft., and to consist of rocks of the same character.

The Nantin valley leading to Momien seems to belong to another geological age, as in that district there has been a comparatively recent outflow of trappean rocks, while the country to the west is exclusively granitic and metamorphic. There, as well as in the Sanda Valley, are hot springs which issue at almost the boiling-point, and at the head of the Nantin valley is the large extinct volcano of Hawshuenshan. An extremely interesting feature in this valley and lower down the stream in the Mawphoo gorge, consists in the well-marked river terraces. Two of these seem to extend the whole length of the valley of Nantin—about sixteen miles—and there are indications of a third at a still higher level.

Of the mineral products, the coal seems to hold out the promise of good fuel and in fair quantity. It crops out on the surface in several places on the right bank of the Irawady, but as yet has been but little worked. Its geological age has yet to be determined.

Galena, rich in silver, is found in the valley of the Tapeng, and gold also occurs, sometimes in grains as large as small peas. The most interesting products of this part of Burmah are, however, amber and jade. The amber mines are at an elevation of about 1,050 ft., in a low range of hills to the S.W. of the Meinkhoom plain, in the Hukong valley. It is procured in a primitive manner by digging holes about 3 ft. in diameter, and sometimes as much as 40 ft. in depth. "Fifteen to twenty feet of the superficial soil is clayey and red, but the remainder consists of a greyish black carbonaceous earth. Foliated limestone, serpentine, and coal, are among the other strata. The amber is found in both of the former, and its presence is indicated by small pieces of lignite which are easily detected." It is made into Buddhist rosaries, finger-rings, pipe mouth-pieces, &c. The dark sherry-coloured amber is most highly valued.

Jade is found in more or less rounded boulders embedded in a reddish yellow clay. Pits are sunk in search of it on no defined plan, and at certain seasons of the year there are as many as 1,000 men engaged in digging for jade in the Mogoung districts. Blocks are occasionally found so large that they require three men to turn them. Everything in connection with the trade is taxed—diggers, purchasers, jade, and even the ponies used for its transport—and the revenue from the mines was, in 1836, about 4,000*l.* The jade used to be largely worked at Momien, and the manufacture is still carried on there to some extent. It is cut by means of thin copper discs about eighteen inches in diameter, used in conjunction with fine siliceous grit, composed of quartz and little particles resembling ruby dust. The boring of ear-rings and bracelets is effected by a revolving cylinder tipped at the free end with the same siliceous mixture. The most valuable jade is of an intense bright green colour, but the red and pale pink varieties are also prized. A pair of bracelets of the finest jade costs about 10*l.* at Momien.

At some remote period the jade appears to have been applied to useful rather than to ornamental purposes, for celts formed of this material are found all over the district, lying on the surface soil, and doubtless turned up by the plough. They have also been formed of various other rocks, such as quartz, Lydian-stone, green-stone, clay-slate, &c. Lithographic plates are given of twenty-three of these instruments of various size, form, and material; but about 150 were procured by different members of the expedition. A good series of them has been presented to the Christy collection by Major Sladen.

A bronze celt, socketed, but without any side loop, and of peculiar form, with an oblique segmental cutting edge, was also procured. These are so highly valued that as much as 5*l.* apiece was asked for them. The composition, curiously enough, is identical with that usual in European antiquities of the same class, being 9 of copper to 1 of tin. The stone celts being more abundant than those in bronze, were less valued, being sold in the bazaars and elsewhere at from 4*d.* to 1*s.* 6*d.* each. Both they and the bronze celts are regarded as thunderbolts, which, after they fall and penetrate the earth, take nine years to work their way up to the surface. Not only is this belief in the celestial origin of these implements common to Asia and Europe, but the healing powers attributed to them in most European countries, are also accorded them in Yunan. They are worn as charms and carefully kept in small bags; and water, in which they have been placed, is administered as a medicine, especially in the case of tedious labour. It is rather a compliment to the students of prehistoric archæology that the only objects thought worthy of being figured by Dr. Anderson should be these celts.

The ethnological details given by the author as to the Shans, and what may be regarded as the transitional varieties between them and the Burmese on the one side, and the Chinese on the other, are highly interesting. A more barbarous people with whom the expedition was brought in contact, are Kakhyens or Chingpaws, who, though hemmed in on either side by Buddhist nations, still retain an ancient worship of good and evil spirits whom they call "nâts," and to whom they are constantly making propitiatory offerings of pigs, fowls, and rice.

Their method of producing fire is very remarkable, and is effected by "the sudden and forcible descent of a piston in a closed cylinder. There is a small cup-shaped cavity at the end of the piston rod, into which a little tinder is inserted. The piston is then introduced into the cylinder, which it tightly fits, and by a blow is made to descend with great rapidity and force, and is as rapidly withdrawn, when the little pellet of tinder is found to have become ignited." The instruments are not more than four inches long, and are in general use. It would be highly interesting to trace the origin and date of this invention.

At Bhamô one of the articles exposed for sale in the shops was flint, which would therefore appear to be the fire-producing material of the Burmese-Shans. Iron is abundant, and the Chinese-Shans, who resort annually to Bhamô for the purpose of manufacturing the dâhs or swords, are expert blacksmiths, their bellows consisting of a segment of bamboo with a piston, and a valve at each end.

Among some of the Shan tribes neck-rings or *torques*, curiously like those found in Western Europe, are still in use; but the majority of the ornaments appear to be Chinese in character. It would, however, extend this notice beyond all reasonable limits were an attempt made to give even a short abstract of the chapter on the Shans, Kakhyens and other races to the east of Bhamô. The curious practice of horse-worship in connection with the Buddhism of the Sanda Valley may, however, be noticed, as well as the Shan method of concealment of gold and precious stones, by burying them beneath the skin of their chest and necks by making slits, through which the coins or stones are forced, and which subsequently heal up. When the valuable object is wanted a second cut is made upon the spot, and it is extracted. In some instances, as many as fifteen stones or coins were found to be hidden beneath the skin of men just arrived with a caravan at Mandalay. It is needless to follow the author in his report on the Mahomedans in Yunan, the presence of whom, however, proved of great service to the expedition, as many of their guard were of that religion, and thus found friends. Nor need the trade routes of Upper Burmah be here discussed. The geographer will find much information in the chapter on the Irawady and its sources, and in the accompanying map. This chapter concludes the Report, and the remainder of the volume contains the diary of the author, written during the expedition. His report on the Natural History collections formed during his travels, has yet to appear, and will no doubt contain curious details. Even now we may call attention to the remarkable instance of the taming of fishes in a large river like the Irawady, by the phoongyees or Buddhist priests. At the boatman's cry of *tit, tit, tit*, numbers of fish came to be fed with rice and plantains, putting their heads above water, allowing themselves to be stroked, and even permitting Dr. Anderson to put his fist into their mouths so as to feel their teeth. He was unable to procure a specimen, as there were strict orders from the king that they should not be killed.

With this anecdote we must conclude our notice of this interesting Report, and must express a hope that a certain number of copies of it may be consigned to some London publisher so that it may become accessible to the general public, which as yet it apparently is not.

JOHN EVANS

THE HYGIENE OF AIR AND WATER

The Hygiene of Air and Water. Being a Popular Account of the Effects of the Impurities of Air and Water, their Detection, and the Modes of remedying them. By William Proctor, M.D., F.C.S., Surgeon to the York Dispensary, and formerly Lecturer on Chemistry and Forensic Medicine in the York School of Medicine. (Hardwicke.)

THIS is a useful little book, but it wants some revising: it is too sweeping a statement to say that the oxygen of the air is constant in amount and the carbonic acid variable; it is true that the variations in the amount of oxygen are very small in proportion to that amount. It would have been well to state even in a popular treatise that other substances besides ozone affect Schönbein's papers, which are not "browned" by the way.

We are glad to see that the organic impurities introduced into the air by the respiration of animals receive due attention, and that the gradual deterioration of health caused by breathing impure air is well insisted on.

The pages on the ventilation of sewers, &c., want rewriting, and the three conclusions all require alteration; they are as follows:—

1. "That no sewers, or drains, or pipes, should run into drains in dwelling houses." This sentence as it stands is too ambiguous to be of any value.

2. "If this be impracticable, all sink pipes or waste pipes should be broken off at least one foot above the trapped grating into which they discharge." The first clause here is unnecessary and even misleading; it would be well left out.

3. "On no account should a cesspool be placed within the walls of a dwelling, but as far as possible from the house." Surely it would have been well here to advise the abolition of these nuisances where not absolutely impracticable, or at any rate their construction of suitable impervious materials.

This is certainly the weakest part of the book, and shows how little such matters are generally understood even yet.

On the other hand the remarks on the relations of filth and disease are excellent: "the negligence of the upper and lower classes of society alike, in these matters, entails terrible calamities on both. The fevers and contagious disorders arising from the neglect of the poor, either on their own or on our part, find their way into the dwellings of all classes, and equally establish disease. The poorer class cannot with impunity live in a state of unnecessary filth and dirt; neither, on the other hand, may the rich without danger neglect the sanitary and physical conditions of the poor around them."

The currents of air produced in rooms by differences in the temperature of various parts should, if classed with winds (the aspirating effect of which latter is not mentioned), be at any rate in a separate subsection; and the law of diffusion of gases does not hold for vapours, and it is certainly not in virtue of it that "the dispersion of vaporous matter" in the air is effected. Otherwise the pages on ventilation are well worth study, and the same may be said of the part devoted to disinfectants, which contains much sound practical information.

The second part of the book, on "the impurities of water and their removal," is decidedly good; some of the best known cases illustrating the connection between polluted water and specimens of cholera and enteric fever are given, and the dangers to be apprehended from the habitual imbibition of impure water (apart from specific diseases) are insisted on; the presence of more than a small amount of chlorides is rightly pointed out as a suspicious circumstance, and the simpler tests for the detection of the various impurities are concisely described; then follows a short account of the methods to be employed for the purification of presumably impure water by means of boiling, filtration, &c., and several of the best household filters are mentioned. Clark's process is, however, only casually alluded to, and not by name.

We are glad to find that the importance of a *continuous water supply* especially to the poorer classes is pointed out.

The book before us will, with a small amount of correction, do valuable service if widely circulated, as we have little doubt that it will be. If we have drawn attention to a few defects in it, we have done so because we believe that it is of the utmost importance that popular manuals should contain exact information, and enter as little as possible into disputed points. W. H. C.

OUR BOOK SHELF

The Coal-fields of Great Britain, &c. By Edward Hull, M.A., F.R.S., &c. Third edition. (London: Stanford.)

THIS new edition of Prof. Hull's well-known work is in most respects a great improvement upon the previous ones. Not only are the coal-fields of Britain itself treated of in more detail, but those of the colonies and foreign countries also come in for fuller notice. The introduction of numerous excellent maps illustrative of the English coal fields imparts an additional value to the volume, by enabling the reader to grasp at a glance the leading features in the geological structure of the districts embraced. Prof. Hull has, moreover, largely availed himself of the report prepared by the recent Coal Commission, the chief results of which have been embodied in his work. That report, as everyone knows, has calmed the fears of those who saw looming in the near future the exhaustion of our coal supplies and the consequent decline of our industries. It is comfortable to reflect upon the fact that we have still 146,480 millions of tons available within a depth of 4,000 feet, and something like 48,465 millions of tons at a greater depth. From the first of these estimates, Prof. Hull would deduct one-twentieth for coal-seams under two feet in thickness, thus leaving the available quantity of 139,156 millions of tons lying within a depth of 4,000 feet from the surface. Beyond this depth he believes it will not be practicable to penetrate, owing to the effect of increasing temperature and pressure. This, however, is quite an open question. No good reason can be shown why ventilation should not be made effective at a still greater depth than 4,000 feet. If the deeper-lying coal should ever be needed no doubt the engineers of the future will be equal to the occasion and able to render it available. Then, as regards the effect of pressure, we know from actual experience that the "density of coal-seams is not perceptibly greater at 500 or 600 yards than at half that depth." One might almost have inferred as much beforehand, for many of our coal-fields which are now being worked at easy depths must at one time have been covered with thousands of feet of strata, long since removed by denudation; yet the seams in such fields are not denser than those of fields which do not appear to have been covered by such great rock masses. Again, we have heard mining engineers assert that the increased pressure in the deeper pits actually aids in the excavation of the coal, which comes away in larger lumps than would be the case with a similar coal in shallower workings. But whether or not it will ever be necessary to sink deeper than 4,000 feet, there can be no doubt that there is yet abundance of fuel above that limit to keep our furnaces going for many long years to come, and if Britain be destined ere long to retire from her place in the vanguard of nations her loss of prestige will probably be due to other causes than the exhaustion of her mineral resources.

The author expresses himself strongly on the subject of "waste" in working the coal, but not a whit more strongly than is necessary. Everyone who has any acquaintance with British collieries knows how lamentably great this waste is, amounting in some cases to so much as 40 per cent. No doubt, in many of our best conducted collieries waste is reduced to a minimum, but there is still woful need for improvement in this matter. It is, of course, impossible for Government to interfere in squabbles about disputed boundaries, &c., and hence jealousy and stubbornness will continue to put considerable areas of coal beyond the chance of being "won." But surely something might be done towards increasing the number of our mining schools; and, as Prof. Hull suggests, the Legislature might establish some educational test without which no one should be allowed to have the supervision of colliery workings. With well-educated managers the waste of coal arising from ignorant methods of working would be checked, and we should hear less frequently of those frightful accidents which ever and anon throw whole mining communities into mourning. J. G.

The Natural History of Plants. By H. Baillon; translated by M. M. Hartog. Vol II. (London: L. Reeve and Co., 1872.)

PURSUING the somewhat erratic arrangement to which we alluded in our notice of the first volume of this work (see NATURE, vol. iv. p. 199), Prof. Baillon proceeds to an account of the small order of Connaraceæ, the three sections of the large order Leguminosæ, viz., Mimoseæ, Cæsalpinieæ, and Papilionaceæ, and then goes off at a tangent to four orders of Incompletæ, viz., Proteaceæ, Lauraceæ, Elæagnaceæ, and Myristacaceæ. The same plan is pursued as in the first volume, of giving first of all a general sketch of the characters of the order, and then dividing it into a number of "series," each containing one or more genera. An immense mass of information is thus collected, though wanting in convenient arrangement. The references to original authorities are, however, commendably copious. The illustrations, as before, are excellent, the translation apparently well and carefully done.

Memorandum des Travaux de Botanique et de Physiologie végétale qui ont été publiés par l'Académie Royale de Belgique pendant le premier siècle de son existence, 1772—1871. Rapport Séculaire per E. Morren. (Bruxelles: Hayez, 1872.)

THOUGH Belgium has not produced any botanical star of the first magnitude, yet a large amount of excellent work has been done in the little kingdom, especially during the period of its independent existence, since 1830, as shown by the labours of Decaisne in the flora of Japan, and of Galeotti in that of Mexico, of Jean Kickx in cryptogamic botany, of Charles Morren in teratology and general morphology, and of Quetelet in the periodic phenomena of vegetation. M. E. Morren's short abstract of the service done by his countrymen in each department of botany, with a list of the dates of publication of the various memoirs, is a useful contribution to the history of the science.

Results of Five Years' Meteorological Observations for Hobart Town.

WE are here presented with carefully constructed tables and valuable remarks on the climate and vital statistics of Tasmania. It includes the results of observations for the five years ending in 1870, with which are incorporated the statistics for the previous twenty-five years, so that it presents us with a complete set of statistics of meteorology for thirty years. That the observations have been carefully and correctly made is proved by the fact that the results of thirty years' observations agree very closely with those of the twenty-five years, the difference in many cases amounting to only a second or third place of decimals. The observations for the five years ending 1870, have been made gratuitously at the Toronto Observatory, by Mr. Francis Abbott, the tables having been constructed by Mr. T. Roblin, Curator of the Museum, and revised by Dr. E. Swarbeck Hall, who appends an elaborate and carefully drawn up health report for Tasmania. The introduction, among other matters, contains a descriptive list of the various instruments used; the set seems to be complete, and all the apparatus trustworthy. The following are the mean resultants from the thirty years' observations for Hobart Town from 1841 to 1870 inclusive:—Barometer (at temperature 32°), 29·580. Thermometer, mean temperature, 54·72; mean diurnal range, 17·91; mean solar intensity, 93·39; mean terrestrial radiation, 43·01. Humidity of air—Dew point—mean position, 45·49; humidity of air, ·75; elastic force of vapour, ·316; condensation, rain in inches, 1·89; number of days on which rain fell, 11·66; Ozone, mean daily amount, 7·24; prevailing direction of wind, N.W., S.E.; prevailing force of wind, 58·37 lbs. per square foot.

Jahrbuch der k. k. Geologischen Reichsanstalt, xxii. band, No. 2. (Wien.)

FRANZ RITTER V. HAUER gives, in this number of the Year-book, an outline sketch of the sedimentary formations met with in Austria. He arranges his materials somewhat after the manner of Studer's "Index der Petrographie," the names of the various deposits following in alphabetical order. The geological horizons are briefly indicated, and copious references to authorities are given. The descriptions are necessarily brief, but they are clear and comprehensive, and the paper will be invaluable to those who may desire to widen their acquaintance with Austrian geology. Among the mineralogical contributions, we notice the description of a new mineral from Mexico—*Guadalcazerite*, the composition of which is given as $6\ H_g\ S + Z_n\ S$. From the laboratory of Prof. Bauer come several useful rock-analyses, chiefly ironstones. Professor Tschermak gives a description of sundry meteorites, and some account of basalts, metaphyres, and other eruptive rocks from the Caucasus. There is also an interesting paper by Professor Inostranzeff on the Vesuvian lavas of 1871 and 1872.

LETTERS TO THE EDITOR

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

Prof. Balfour Stewart on the Spectroscope

I BEG to say a few words in reply to some statements in the letter of Prof. Balfour Stewart in NATURE, February 20.

1st. I wish to state that I had no knowledge of Mr. Proctor's letter in the *English Mechanic* until I saw it by accident in a copy of that journal which had been sent to me for another matter. I have never made the claim to which Prof. Stewart refers.

2nd. The note in Schellen's "Spectrum Analysis," of which Prof. Stewart asks an explanation, consists of three statements of fact.

a "Though to Mr. Lockyer is due the first publication of the idea of the possibility of applying the spectroscope to observe the red flames in sunshine, as a matter of history it should not be passed over that about the same time the same idea occurred independently to Mr. Stone, of Greenwich, and to Mr. Huggins." I wish to remark that I made no claim on Mr. Stone's part or on my own. On the contrary I said expressly "*as a matter of history*" these facts should not be passed over. I conceive that this statement of facts ought to have a place in a book which professes to give the history of the subject.

β "These observers were, however, unsuccessful in numerous attempts which they made to see the spectra of the prominences, for the reason probably that the spectroscopes they employed were not of sufficient dispersive power to make the bright lines of the solar flames easily visible." Prof. Stewart remarks that he "cannot yet understand" why I failed. The reasons can now be a matter of conjecture only. All workers in science know how much more difficult it is to discover the unknown than to recognise the known. It may be that I passed over too carelessly the deep red (C) and the blue (F) where the brightest lines occur. The observation of the bright lines in the star in Corona B (May 1866), in which the same sifting principle of the prism came into operation, should have suggested to me to look for the lines of hyrdogen. Later (June 1867) Mr. Johnstone Stoney showed, in an important paper on the "Constitution of the Sun and Stars," that hydrogen was to be expected. I acknowledge that I ought to have found the lines.

γ "When the position of the lines was known, Huggins saw them instantly with the same spectroscope which he had previously used in vain." Of course in this remark I refer only to my own experience; I do not wish to be thought to imply that such assistance was either needed or received in the case of any other observer. Prof. Stewart asks why I did not see the lines sooner after receiving the news from India. This question awakens painful memories. At the time the Indian reports reached me I was watching by the bed of the dying, and a few days afterwards I suffered so severe a bereavement that I was unable to resume work in the observatory until the beginning of December, when I saw the lines. WILLIAM HUGGINS

The Beginnings of Life

IT seems advisable for me not to pass without comment the communication made by Dr. Wm. Roberts, of Manchester, in last week's NATURE.

Dr. Roberts calls attention to what he considers two possible sources of error in my experiments. The first is the "possibility of the introduction of atmospheric germs at the moment of sealing the vessels," owing, as he says, to the fact "that the sealing can only take place just as ebullition is about to cease," and to the consequent risk of some "reflux of air into the flask." After Dr. Roberts has made a series of experiments similar to those which have been recently cited in these columns (see NATURE, Feb. 6, p. 275 with *Erratum* in Feb. 13, p. 296), he may perhaps be a little less apprehensive as to this source of contamination. It is, however, not the fact that flasks cannot be sealed during ebullition, and this I shall be very happy to demonstrate to Dr. Roberts. Moreover, if he will refer to Dr. Sanderson's letter, Dr. Roberts will find that in speaking of the sealing of the flasks in the blow-pipe flame, he says care was taken "to continue the ebullition to the last." And in several series of experiments M. Pasteur also made use of flasks which had been sealed during ebullition—believing that in so doing he was experimenting with vessels from which all living germs had been excluded. Speaking of the preparation of such flasks, Pasteur says (*Ann. de Chim. et de Physique*, 1862, p. 74): "je ferme l'extremité effilée pendant l'ebullition. Le vide se trouve fait dans les ballons." No one has hitherto questioned M. Pasteur's skill as an experimenter.

The second alleged source of error is, according to Dr. Roberts, much more important. My mode of experimentation, he says, "does not insure that the entire contents of the flask are effectively exposed to the boiling heat." Although Dr. Roberts confirms my statement that many fluids treated in the manner I have described do soon swarm with living things, he seems to think their appearance may be due to the fact that several of the mixtures "froth excessively in boiling, and spurt about particles which adhere to the glass, and probably some of these escape the full effect of the heat." I feel quite sure that in my experiments no portion of the inner surface of the glass has escaped the scathing action of the boiling fluid. The vessel has generally been more than three-fourths full before the process of heating has been commenced, so that when ebullition occurs the fluid has always swept over the previously uncovered inner surface and, as Dr. Sanderson testifies, "during the boiling some of the liquid was frequently ejected from the almost capillary orifice of the retort." The inner surface of the vessel was, in fact, always thoroughly and repeatedly washed with the boiling fluid, nearly half of which has been spurted away in order that I might effect this object

Dr. Roberts says:—"Dr. Sanderson is, however, careful not to endorse the conclusions which Dr. Bastian has drawn from these experiments." But this is scarcely a fair statement, since Dr. Sanderson had near the beginning of his letter announced his intention of taking no part in the controversy. Dr. Sanderson's opinions, however, on the elements of the question have already been set forth (see Thirteenth Report of Medical Officer of Privy Council, p. 59). Whilst not believing in the danger of atmospheric contamination by Bacteria germs, he does believe, in common with other biologists, that immersion in boiling liquids is a ready means of destroying them. If Dr. Sanderson had not thought that the conditions of the experiments were such as to be exclusive of the intervention of living germs, why should he have previously doubted "my statements of fact" in respect to them? Does Dr. Roberts consider Dr. Sanderson so much of a tyro in these matters as to suppose that he would doubt the well-known fact that living germs will always rapidly multiply in suitable fluids? If not, then the only other source of doubt that could have arisen, must have been as to the possibility of the appearance of swarms of living things in hermetically sealed vessels in which all pre-existing organisms had been killed. And if Dr. Roberts wishes ample proof that such has been the view also entertained by others I need only refer him to the last few pages of a curious article (purporting to be a review of my work "The Beginnings of Life"), which appeared in a recent number of a journal (*Quart. Journ. of Micros. Science*) of which Mr. Ray Lankester is one of the editors. It is perhaps fortunate for the reviewer's reputation and for his fame as a scientific experimenter that his name does not appear, or that his unsuccessful experiments, destined to upset my views, were not published before the advent of Dr. Sanderson's letter.

In some respects the actual results of the experiments performed by Dr. Roberts differ from those of other experimenters. Thus he has found that filtered infusions of any animal or vegetable substances can be "invariably preserved unchanged when boiled for five or ten minutes in a flask plugged with cotton wool." The results obtained by M. Victor Meunier and by myself have been different, and we have both shown that they are apt to vary according to the strength and nature of the infusions employed. Dr. Roberts says he has also found that many "highly putrescent mixtures" remained perfectly barren "after the flask containing them had been immersed in a water-bath kept at a boiling heat for twenty or thirty minutes," although several of the same mixtures "could not be kept unchanged by simple boiling over the flame," and the sealing of the flask during ebullition. If, after what I have already said concerning the latter mode of experimentation, anything is to be deduced from these facts, it would perhaps be that the partial vacuum within the flask is more favourable to the initiation of putrefactive changes in some boiled fluids than their contact with filtered air. This is what I have always thought, and evidence pointing that way may be found in *Appendix* C of my "Beginnings of Life." Certainly one cannot assent to the conclusion which Dr. Roberts would draw from such experiments, based upon the supposition that the boiling of the sealed flasks in water is a protective measure. Dr. Roberts' results are here again somewhat different from others which have long become matters of history. Need I say that this was essentially the method of experimentation introduced more than a century ago by Needham, and that his results were confirmed by his adversary, Spallanzani, who says: "L'ebullition d'une demi-heure ne fut pas un obstacle à la naissance des animalcules du dernier ordre qui peuplèrent toujours, plus ou moins, tous les vases exposés à son action pendant tout ce temps-là." Does Dr. Roberts forget that Dr. Wyman boiled his flasks for two hours and yet obtained positive results? that he boiled others in a Papin's digester under a pressure of two and five atmospheres respectively, and still obtained living organisms from his flasks. Must I also remind him of the numerous experiments by Prof. Cantoni, of Pavia, in which the hermetically sealed flasks were heated in a Papin's digester to temperatures ranging from 100°—117° C.; and to several of the experiments that I have myself recorded in which undoubtedly—living organisms were obtained from flasks that had been heated in fluids raised to temperatures varying from 130°—153° C. (*e.g.* such experiments as are recorded in "The Beginnings of Life," vol. i. pp. 441, 443, 447, and 463).

When will those who do me the honour of referring to my experiments look all round and cease to argue from one half of the facts? H. CHARLTON BASTIAN

University College, Feb. 24

Himalayan Ferns

DURING the years 1861–66 I took every available opportunity to collect ferns in the Sevalik and Himalaya ranges. There being at that period no published work on the ferns of British India, and one subsequently published in Madras not having come under my notice, my specimens, several hundred in number, and all well dried, remain unclassified.

Would this collection be of any scientific value, and if so, to what society could I present it? I opine it would be worse than useless to offer it to the herbarium of the British Museum, as there it might remain untouched for the next fifty years; whilst at Kew I presume Hooker's superior collection would render my poor mite useless.

If not worthy of presentation to any herbarium, would any competent botanist classify it for the sake of the duplicates?

F. G. S. P.

General Travelling Notes

DURING the years 1857–66 I was in India, and in that period travelled much, both in the Plains and the interior of the Himalaya.

Since my return to England I have constantly regretted that I took few notes, and those few notes, from lack of knowledge, of little or no value, on flora, fauna, geology, and altitudes. In a few months I shall return to the same part of India (North West Provinces and Punjâb), and purpose remaining in that country for some years. There are many men in the army who, like myself, have a general taste for scientific observations, but our efforts end in gratifying our own minds only, our observations lacking sufficient accuracy and classification, whilst much is overlooked from sheer ignorance as to the how and where to look.

To the end that I (and others of like mind) may, perchance, furnish some useful jottings during my next term of foreign service, can any contributor to NATURE inform me where the following are to be met with :—

1. A plain code of what to look for and observe, after the manner of, but shorter than, "The Scientific Orders of the *Challenger*," published in NATURE for Jan. 9 and 30.

2. What is the best text-book on each head (*e.g.* on barometrical and thermometrical observations, Indian geology, botany, &c.). It is very essential each such text-book should be comprised in one handy volume; if possible as clear and concise as Tyndall's "Lectures on Electricity."

3. What instruments should be taken. I suggest—An ordinary thermometer, tested at Kew; a max. and a min. thermometer; an aneroid (of what size?); a prismatic compass; an Abney's clinometer-level for ascertaining the slope and consequent height of mountains and depths of valleys roughly; also a small *portable* rain-gauge, if such is made; a simple microscope, and a magnifying glass. Are these sufficient? and if so, where should they be procured, and at what price? the *cost* being a vital point.

4. Can these, or similar instruments, be obtained in a single case sufficiently small to be carried, like a small theodolite box, in one hand?

F. G. S. P.

Mirage

THE following references to the literature of this subject are in answer to the note by Prof. J. D. Everett in NATURE for January 2 last :—

Bravais, Aug.—"Notice sur le mirage," Annuaire Soc. Meteor. Fr., p. 227 (1852), p. 55 (1855).

Dufour, Charles.—"Mirages et réfractions aunormales sur le lac Leman," Bull. Soc. Vaud. Lausanne, vol. iv. p. 366 (1854-5); 386; vol. v. p. 26 (1856); 217.

Escayrac de Lauture.—"Sur le ragle ou hallucination du désert," Bull. Soc. Geogr, vol. ix. p. 121 (1855).

Gergonne, J. D.—"Recherches sur les refractions terrestres et particulièrement sur le mirage," Notice Trao. Acad. Gard., p. 129 (1808).

Gergonne, J. D.—"Essai analytique sur la phenomène du mirage," Ann. Math. Gergonne, xx. p. 1 (1829).

Giovene, G. M.—"Wunderbare Phänomene nach Art der Fata Morgana," Gilbert, Annal. xii. p. 1 (1803).

Jackson, C. T.—"Observations on the Mirage seen on Lake Superior in July and August 1847," Proc. Amer. Assoc., p. 143 (1849).

Kelly, W.—"On some extraordinary forms of Mirage," Trans. Lit. Soc. Quebec, vol. iii. p. 292 (1837).

Orioli, F.—"Della Fata Morgana," Tortolini Annali, ii. p. 47 (1851).

Parés.—"Note sur le Mirage," Comptes Rendus, vol. xii. p. 87 (1855).

Parés.—"Note sur le Mirage des Côtes du departement de l'Herault," Mem. Acad. Sci. Montpellier, iii. p. 1; 493 (1855).

A. RAMSAY

Brilliant Meteor of Feb. 3

To supplement Prof. Osborne Reynolds' interesting paper on the meteor of February 3, which he saw in Manchester, and which he thinks must have passed over Chester and Liverpool (NATURE, February 20, p. 315), I enclose you a cutting from a local Cheshire paper showing that this meteor *was* seen about the same time in Northwich, which is some twenty-five or thirty miles S.W. from Manchester, and almost in a direct line drawn from Manchester to Chester.

By consulting the various local papers published in Northwich, Chester, Birkenhead, Liverpool, &c., it could easily be discovered at what place it was last seen, and where the loudest explosion was heard, and so the approximate path of this splendid meteor and its height might be traced out. These papers will mostly all be found in the Exchange and the Athenæum Reading Rooms, Manchester, where I believe they are regularly filed.

Merton College, Oxford J. P. EARWAKER

"A METEOR SHOWER AT NORTHWICH.—At Northwich on Monday night, February 3, about ten o'clock, a very brilliant meteor was observed in the sky passing from east to west. The meteor displayed an intense white light in its course, and emitted sparks which appeared of various hues. It was visible about six or eight seconds, and from one to two minutes after the passage of the meteor a loud rumbling report like distant thunder was heard. The night was very clear, and starlight at the time."

A VERY bright meteor was imperfectly seen here by me at $9^h\ 58^m$ on Monday evening, February 3. At the time of its appearance the sky was much clouded though not entirely overcast, and became suddenly illuminated by what I at first considered to be flashes of lightning. The clouds in the north sky particularly were illuminated, and as I thought it possible that the phenomenon might be due to the appearance of a large fireball behind the clouds, I noted the exact situation in which the greatest quantity of light (which was about equal to the moon when five days past conjunction) existed. This was, as accurately as could possibly be determined, at a place about 10° eastward of the north point, or north by east, and in the vicinity of the horizon. When traversing this part of its path it is possible that the meteor was at its brightest, and on the point of disappearance. It was impossible to note any further details as to the exact course of the luminous appearance seen, inasmuch as but few stars were perceptible, and the north sky was much obscured by cumulus clouds. This meteor was also seen at Manchester at $9^h\ 57^m$; it appeared near the zenith of that station.

Bristol WILLIAM F. DENNING

Inherited Feeling

As every instance of inherited antipathy in the offspring of Turk adds to the weight of proof, I beg to state that a mastiff in my possession, a grandson of Turk, and a brother of Mr. Brooke's dog, showed the same unaccountable antipathy to butchers, manifesting violent rage when any one of that honourable fraternity showed himself in the yard where he was kept. He was otherwise of a remarkably mild and gentle disposition.

Bowdon, near Manchester, Feb. 21 ARTHUR RANSOM

WOULD it not test the correctness of Mr. Wallace's ingenious theory as to animals finding their way back over an unseen country by their sense of smell, to shut up a cat in a basket along with a piece of stale fish, the scent of which would certainly overpower any external scent by which it might be able to trace the way back? It seems to me that many instances are on record of this curious power of certain animals, especially of cats, which are quite inexplicable on Mr. Wallace's hypothesis.

ALFRED W. BENNETT

External Perception in Dogs

THE view to which Mr. Wallace gives expression in your last number had occurred also to me, and I should like, with your leave, to offer a remark or two in support of it.

That a dog shut up in a basket may through smell acquire a series of impressions so definitely marked as to be able therewith to find its way back to the place it was taken from, becomes less improbable if we think what is the part that must be played by smell in its ordinary objective experience. Our external world (whether as actually perceived or imaginatively represented) may be called a world of sights and touches, blended with and modifying each other in the most intimate way. These mutually involved sights and touches, in our consciousness, are run out into the form of a *continuum* in space (how or why it is not to the present purpose to inquire), while all other sensations, as of hearing, smell, and taste, come before us only discontinuously and intermittently, not being had from all things nor always from the same things. But in a dog's experience touch cannot possibly co-operate with sight as it regularly does in ours. The organ of effective touch in man—touch that gets associated with vision—is in the last resort the hand, combining mobility and sensitiveness in the highest degree; and the dog has no hand. Its mobile limbs are not sensitive at the extremities, and, though it has sensitive lips, these, having no such active mobility as the human hand has, are extremely limited in the scope of their apprehension. Its touch being thus defective, what is there then in the dog to play second to sight, which as leader needs support, were it only because there is not always light to see with? Smell, I cannot but think, seeing that, while the organ is incontestably acute, it has the great advantage over the tactile surface of the lips, of receiving impressions from things already at a distance. If we only suppose—what the facts make very likely—that the dog's smell is acute enough to have some sensation from all bodies without exception, nothing more is wanting to enable a psychologist to understand that the dog's world may be in the main a world of sights and smells continuous in space. In that case a dog conveyed in a basket might by smell alone find its way back pretty much as a man blindfolded finds his way by touch alone.

To argue properly so difficult a question is impossible in a short letter, and I must be content now, for reasons like those indicated rather than stated above, with giving my adhesion to Mr. Wallace's view—so far at least as dogs are concerned, and to the extent that in smell we have a source of explanation for the phenomena which has never been sufficiently considered. That the explanation covers all the facts related even about dogs is more than I would assert; and whether it is equally serviceable for other animals like cats and horses, concerning which not less wonderful stories are told, is not so clear. Cats, however, seem to have very acute smell. What is the truth about the smell of horses? G. Croom Robertson

University College, Feb. 24

Fiords and Glacial Action

In Nature, vol. vii. pp. 94, 95, I find the following:—

"*Poggendorf's Annalen*—A. Helland adduces a large amount of evidence to show that the fiords in Norway have been formed by glacial action."

It appears an obvious remark, and yet I have not met with it, that fiords are chiefly found in those coasts where from the geographical conditions there must have been the most glacial action. The most favourable conditions for glacial action are evidently those of a mountainous coast in a high and therefore cold latitude, fronting the rain and snow-laden west winds of the higher latitudes as they blow in from the ocean. These conditions are fulfilled in the highest degree by the coasts of Norway and Western Scotland: the western coast of North America from Vancouver's Island northwards; and the western coast of South America from Chiloe southwards; and these coasts are accordingly more cut up into fiords than any others in the world.

The western coast of America along the enormously long line from Vancouver's Island to Chiloe is one of the most unbroken in the world. It is significant that the change in the coast at Chiloe from an unbroken one to one very much broken into fiords is accompanied by a great and comparatively abrupt change in the height of perpetual snow on the Andes. The following are the heights of perpetual snow at three different latitudes, according to Mrs. Somerville's "Physical Geography." The first two are north of Chiloe, the third south of it.

About 33° S. (near Valparaiso) . . .	12,780 feet
,, 37° 40′ S.	7,960 ,,
,, 53° (Strait of Magellan)	3,390 ,,

Although the height of the snow-line depends chiefly on latitude, it is sensibly influenced by the aspect of the mountains respecting the rain and snow-bearing winds. The best instance of this is probably that of the Himalayas, where, according to Mrs. Somerville (page 314), the height of the snow-line is 16,620 feet on the north side, and only 12,980 on the south. According to another authority (Capt. Strachey), quoted by Mrs. Somerville (p. 54), the heights are 19,000 to 20,000 feet on the north side, and 15,500 on the southern. The difference of the two estimates is about the same. The reason of the difference is evidently that the south side receives the moisture-laden winds from the Indian Ocean.

Old Forge, Dunmurry Joseph John Murphy

NOTE ON A POLYDACTYLOUS CAT FROM COOKHAM-DEAN

By the kindness of Dr. Plumbe, of Maidenhead, I have been able to procure one of these cats; and from the many curious points he possesses, I think a note on his peculiarities will interest some of the readers of Nature.

Readers of Mr. Darwin's "Origin of Species" are familiar enough with the illustration he gives of correlation of arrest of development in the deafness of blue-eyed cats. Some years ago I showed that our great naturalist had fallen into error on this point, and that the correlation is not between the blue eyes and the deafness, but between the latter and the sex of the cat.

I have made a great many inquiries on this point, and have completely confirmed my former observation, that all perfectly white tom-cats are deaf, and that they have blue eyes occasionally, because that item of beauty is common among white cats. I have seen many white Tabithas with blue eyes, but none of them were deaf. My little "Pudge" from Cookham is perfectly deaf, and has one blue eye and a yellow one. For the first few days after I had him, I thought he could hear a little, but am now quite satisfied that his deafness is complete, though he is alive to sounds conveyed through solid media. A further point of interest is that he is not mute as most deafs are, but there is a kittenish shrillness in his voice and a loudness in his purring, which are not commensurate with his age. I think, therefore, that it is possible that early in life he may have heard a little, for I know of two instances where perfect mutism accompanied the deafness in cats, and I do not know of any contrary condition. The one yellow eye favours my view that "Pudge" may have heard in infancy his mother's voice. His sense of touch is extremely acute compared to that of another cat I have, but his sight does not seem so sharp as that of cats generally is. He has twenty-six digits, and these are arranged—seven on each fore limb, and six on each hind limb. The supernumerary digits on the fore limbs are thumbs, and are placed one on either side of the true pollex, being joined to it, but having no metacarpal bones. In the hind limb the supernumerary digit is probably of the same nature, or a supernumerary index, being placed on the outer side of the hallux, and attached to the tarsus by a completely-developed metatarsal bone.

Lawson Tait

ON ACTION AT A DISTANCE*

I have no new discovery to bring before you this evening. I must ask you to go over very old ground, and to turn your attention to a question which has been raised again and again ever since men began to think.

The question is that of the transmission of force. We see that bodies at a distance from each other exert a mutual influence on each other's motion. Does this mutual action depend on the existence of some third thing, some medium of communication, occupying the space between the bodies, or do the bodies act on each other immediately without the intervention of anything else?

The mode in which Faraday was accustomed to look at phenomena of this kind differs from that adopted by many other modern inquirers, and my special aim will be to enable you to place yourselves at Faraday's point of view, and to point out the scientific value of that con-

* Lecture delivered at the Royal Institution, Feb. 21, 1873, by Prof. Clerk Maxwell.

ception of *lines of force* which, in his hands, became the key to the science of electricity.

When we observe one body acting on another at a distance, before we assume that this action is direct and immediate, we generally inquire whether there is any material connection between the two bodies, and if we find strings, or rods, or mechanism of any kind, capable of accounting for the observed action between the bodies, we prefer to explain the action by means of these intermediate connections, rather than to admit the notion of direct action at a distance.

Thus when we ring a bell by means of a wire, the successive parts of the wire are first tightened and then moved, till at last the bell is rung at a distance by a process in which all the intermediate particles of the wire have taken part one after the other. We may ring a bell at a distance in other ways, as by forcing air into a long tube at the other end of which is a cylinder with a piston which is made to fly out and strike the bell. We may also use a wire, but instead of pulling it, we may connect it at one end with a voltaic battery, and at the other with an electro-magnet, and thus ring the bell by electricity.

Here are three different ways of ringing a bell. They all agree, however, in the circumstance that between the ringer and the bell there is an unbroken line of communication, and that at every point of this line some physical process goes on by which the action is transmitted from one end to the other. The process of transmission is not instantaneous, but gradual, so that there is an interval of time after the impulse has been given to one extremity of the line of communication, during which the impulse is on its way, but has not reached the other end.

It is clear, therefore, that in many cases the action between bodies at a distance may be accounted for by a series of actions between each successive pair of a series of bodies which occupy the intermediate space, and it is asked, by the advocates of mediate action, whether, in those cases in which we cannot perceive the intermediate agency, it is not more philosophical to admit the existence of a medium which we cannot at present perceive, than to assert that a body can act at a place where it is not.

To a person ignorant of the properties of air, the transmission of force by means of that invisible medium would appear as unaccountable as any other example of action at a distance, and yet in this case we can explain the whole process, and determine the rate at which the action is passed on from one portion to another of the medium.

Why then should we not admit that the familiar mode of communicating motion by pushing and pulling with our hands is the type and exemplification of all action between bodies, even in cases in which we can observe nothing between the bodies which appears to take part in the action?

Here for instance is a kind of attraction with which Prof. Guthrie has made us familiar. A disc is set in vibration, and is then brought near a light suspended body, which immediately begins to move towards the disc as if drawn towards it by an invisible cord. What is this cord? Sir W. Thomson has pointed out that in a moving fluid the pressure is least where the velocity is greatest. The velocity of the vibratory motion of the air is greatest nearest the disc. Hence the pressure of the air on the suspended body is less on the side nearest the disc than on the opposite side, the body yields to the greater pressure, and moves toward the disc.

The disc, therefore, does not act where it is not. It sets the air next it in motion by pushing it, this motion is communicated to more and more distant portions of the air in turn, and thus the pressures on opposite sides of the suspended body are rendered unequal, and it moves towards the disc in consequence of the excess of pressure. The force is therefore a force of the old school—a case of *vis à tergo*, a shove from behind.

The advocates of the doctrine of action at a distance, however, have not been put to silence by such arguments. What right, say they, have we to assert that a body cannot act where it is not? Do we not see an instance of action at a distance in the case of a magnet, which acts on another magnet not only at a distance, but with the most complete indifference to the nature of the matter which occupies the intervening space? If the action depends on something occupying the space between the two magnets, it cannot surely be a matter of indifference whether this space is filled with air or not, or whether wood, glass, or copper, be placed between the magnets.

Besides this, Newton's law of gravitation, which every astronomical observation only tends to establish more firmly, asserts not only that the heavenly bodies act on one another across immense intervals of space, but that two portions of matter, the one buried a thousand miles deep in the interior of the earth, and the other a hundred thousand miles deep in the body of the sun, act on one another with exactly the same force as if the strata beneath which each is buried had been non-existent. If any medium takes part in transmitting this action, it must surely make some difference whether the space between the bodies contains nothing but this medium, or whether it is occupied by the dense matter of the earth or of the sun.

But the advocates of direct action at a distance are not content with instances of this kind, in which the phenomena, even at first sight, appear to favour their doctrine. They push their operations into the enemy's camp, and maintain that even when the action is apparently the pressure of contiguous portions of matter, the contiguity is only apparent—that a space *always* intervenes between the bodies which act on each other. They assert, in short, that so far from action at a distance being impossible, it is the only kind of action which ever occurs, and that the favourite old *vis à tergo* of the schools has no existence in nature, and exists only in the imagination of schoolmen.

The best way to prove that when one body pushes another it does not touch it, is to measure the distance between them. Here are two glass lenses, one of which is pressed against the other by means of a weight. By means of the electric light we may obtain on the screen an image of the place where the one lens presses against the other. A series of coloured rings is formed on the screen. These rings were first observed and first explained by Newton. The particular colour of any ring depends on the distance between the surfaces of the pieces of glass. Newton formed a table of the colours corresponding to different distances, so that by comparing the colour of any ring with Newton's table, we may ascertain the distances between the surfaces at that ring. The colours are arranged in rings because the surfaces are spherical, and therefore the interval between the surfaces depends on the distance from the line joining the centres of the spheres. The central spot of the rings indicates the place where the lenses are nearest together, and each successive ring corresponds to an increase of about the 4,000th part of a millimetre in the distance of the surfaces.

The lenses are now pressed together with a force equal to the weight of an ounce, but there is still a measurable interval between them, even at the place where they are nearest together. They are not in optical contact. To prove this, I apply a greater weight. A new colour appears at the central spot, and the diameters of all the rings increase. This shows that the surfaces are now nearer than at first, but they are not yet in optical contact, for if they were, the central spot would be black. I therefore increase the weights, so as to press the lenses into optical contact.

But what we call optical contact is not real contact.

Optical contact indicates only that the distance between the surfaces is much less than a wave-length of light. To show that the surfaces are not in real contact, I remove the weights. The rings contract, and several of them vanish at the centre. Now it is possible to bring two pieces of glass so close together, that they will not tend to separate at all, but adhere together so firmly that when torn asunder the glass will break, not at the surface of contact, but at some other place. The glasses must now be many degrees nearer than when in mere optical contact.

Thus we have shown that bodies begin to press against each other while still at a measurable distance, and that even when pressed together with great force they are not in absolute contact, but may be brought nearer still, and that by many degrees.

Why, then, say the advocates of direct action, should we continue to maintain a doctrine founded only on the rough experience of a pre-scientific age, that matter cannot act where it is not, instead of admitting that all the facts from which our ancestors concluded that contact is essential to action were in reality cases of action at a distance, the distance being too small to be measured by their imperfect means of observation?

If we are ever to discover the laws of nature, we must do so by obtaining the most accurate acquaintance with the facts of nature, and not by dressing up in philosophical language the loose opinions of men who had no knowledge of the facts which throw most light on these laws.

And as for those who introduce æthereal, or other media, to account for these actions, without any direct evidence of the existence of such media, or any clear understanding of how the media do their work, and who fill all space three and four times over with æthers of different sorts, why the less these men talk about their philosophical scruples about admitting action at a distance the better.

If the progress of science were regulated by Newton's first law of motion, it would be easy to cultivate opinions in advance of the age. We should only have to compare the science of to-day with that of fifty years ago, and by producing, in the geometrical sense, the line of progress, we should obtain the science of fifty years hence.

The progress of science in Newton's time consisted in getting rid of the celestial machinery with which generations of astronomers had encumbered the heavens, and thus "sweeping cobwebs off the sky."

Though the planets had already got rid of their crystal spheres, they were still swimming in the vortices of Descartes. Magnets were surrounded by effluvia, and electrified bodies by atmospheres, the properties of which resembled in no respect those of ordinary effluvia and atmospheres.

When Newton demonstrated that the force which acts on each of the heavenly bodies depends on its relative position with respect to the other bodies, the new theory met with violent opposition from the advanced philosophers of the day, who described the doctrine of gravitation as a return to the exploded method of explaining everything by occult causes, attractive virtues, and the like.

Newton himself, with that wise moderation which is characteristic of all his speculations, answered that he made no pretence of explaining the mechanism by which the heavenly bodies act on each other. To determine the mode in which their mutual action depends on their relative position was a great step in science, and this step Newton asserted that he had made. To explain the process by which this action is effected was a quite distinct step, and this step, Newton, in his "Principia," does not attempt to make.

But so far was Newton from asserting that bodies really do act on one another at a distance, independently of anything between them, that in a letter to Bentley which has been quoted by Faraday in this place, he says:—

"It is inconceivable that inanimate brute matter should, without the mediation of something else, which is not material, operate upon and affect other matter without mutual contact, as it must do if gravitation, in the sense of Epicurus, be essential and inherent in it. . . . That gravity should be innate, inherent, and essential to matter, so that one body can act upon another at a distance, through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it."

Accordingly, we find in his "Optical Queries," and in his letters to Boyle, that Newton had very early made the attempt to account for gravitation by means of the pressure of a medium, and that the reason he did not publish these investigations "proceeded from hence only, that he found he was not able, from experiment and observation, to give a satisfactory account of this medium, and the manner of its operation in producing the chief phenomena of nature." *

The doctrine of direct action at a distance cannot claim for its author the discoverer of universal gravitation. It was first asserted by Roger Cotes, in his preface to the "Principia," which he edited during Newton's life. According to Cotes, it is by experience that we learn that all bodies gravitate. We do not learn in any other way that they are extended, moveable, or solid. Gravitation, therefore, has as much right to be considered an essential property of matter as extension, mobility, or impenetrability.

And when the Newtonian philosophy gained ground in Europe, it was the opinion of Cotes rather than that of Newton that became most prevalent, till at last Boscovich propounded his theory, that matter is a congeries of mathematical points, each endowed with the power of attracting or repelling the others according to fixed laws. In his world, matter is unextended, and contact is impossible. He did not forget, however, to endow his mathematical points with inertia. In this some of the modern representatives of his school have thought that he "had not quite got so far as the strict modern view of 'matter' as being but an expression for modes or manifestations of 'force.'" †

But if we leave out of account for the present the development of the ideas of science, and confine our attention to the extension of its boundaries, we shall see that it was most essential that Newton's method should be extended to every branch of science to which it was applicable—that the forces with which bodies act on each other should be investigated in the first place, before attempting to explain *how* that force is transmitted. No men could be better fitted to apply themselves exclusively to the first part of the problem, than those who considered the second part quite unnecessary.

Accordingly Cavendish, Coulomb, and Poisson, the founders of the exact sciences of electricity and magnetism, paid no regard to those old notions of "magnetic effluvia" and "electric atmospheres," which had been put forth in the previous century, but turned their undivided attention to the determination of the law of force, according to which electrified and magnetised bodies attract or repel each other. In this way the true laws of these actions were discovered, and this was done by men who never doubted that the action took place at a distance, without the intervention of any medium, and who would have regarded the discovery of such a medium as complicating rather than as explaining the undoubted phenomena of attraction.

(*To be continued.*)

* Maclaurin's Account of Newton's Discoveries.
† Review of Mrs. Somerville's "Molecular Science," *Saturday Review*, Feb. 13, 1869.

THE TROGLODYTES OF THE VEZERE*

II.

We have now examined the succession of prehistoric periods, from the beginning of the quaternary epoch, under the threefold aspect of stratification, palæontology, and archæology. We have thus obtained three series of dates, which do not always agree very strictly. They coincide only in the latest date, which marks the commencement of the modern epoch, and only approximate in the more ancient dates ; but that is sufficient to enable us to arrange the following table, as a summary :—

	Stratigraphical Dates.	Palæontological Dates.	Archæological Dates.
Quaternary Epoch	Low level of the valleys undisturbed	Mammoth Age	Hatchet of St. Acheul
	Middle level	Intermediate Age	Moust er point
	Upper level	Reindeer Age	Solutré point
Modern Epoch	Recent soil	Present Fauna	Polished hatchet

II.—*Successive Stations of the Troglodytes of the Vézère*

We now possess the facts necessary to enable us to assign a place in chronology to the Troglodytes of the valley of the Vézère. There is not one polished hatchet to be found in their numerous stations ; all their industry belongs to the epoch of hewn stone. They were therefore anterior to the modern epoch. They were acquainted with the mammoth ; they fought him ; they ate him ; they even sketched him ; they also knew the gigantic cave lion, and the cave hyena. Nevertheless, in their most ancient station—at least, the oldest with which we are acquainted, that of Moustier—the extinct species are already very rare. Our Troglodytes, therefore, do not date from the first quaternary period or Mammoth Age ; but their station at Moustier belongs incontestably to the age which we have called intermediate, and which preceded the Reindeer Age.

Their other stations range from epoch to epoch until the end of the Reindeer Age ; they therefore helped to destroy the ancient fauna. They did not, it is true, witness the disappearance of the last survivor, the mammoth, for some few rare vestiges of that animal are met with in the most recent caves of the Vézère, but at some leagues distance, at Excideuil, where MM. Jules and Phillippe Parrott have discovered a palæolithic cave in which was no trace of the extinct species, and in which even the reindeer was becoming rare.

* Continued from p. 272.

Thus the Troglodytes of Perigord have existed in the two last periods of the quaternary epoch, from the decadence of the mammoth to the disappearance of the reindeer. It is impossible for us to measure the immense number of ages in which they lived, but we can have some idea of it by studying their stations in connection with the level of the Vézère.

Since the Moustier Cave has ceased to be inhabited it has so often been flooded by the Vézère that it has been entirely filled with alluvial earth. This layer of earth, nearly two metres in thickness, does not contain either bones or flint. It has covered the layer which was formerly the inhabited soil, in which man has left the tokens of his industry and the remnants of his feasts. This proves that the mouth of the cave was within reach of frequent floodings, and that consequently it was at a level hardly above that of the river. Now, at the present day, it is situated twenty-seven metres above the lowest watermark ; the depth of the valley is therefore considerably increased since the epoch of the Moustier Troglodytes. On the other side, the station of La Madelaine, which is one of the most recent, perhaps *the* most recent of the valley, is very slightly above the level of the largest present floodings. We may hence conclude that the valley of the Vézère was very much then what it is now, and that since the epoch of La Madelaine the level has become lowered to the extent of a few metres only.

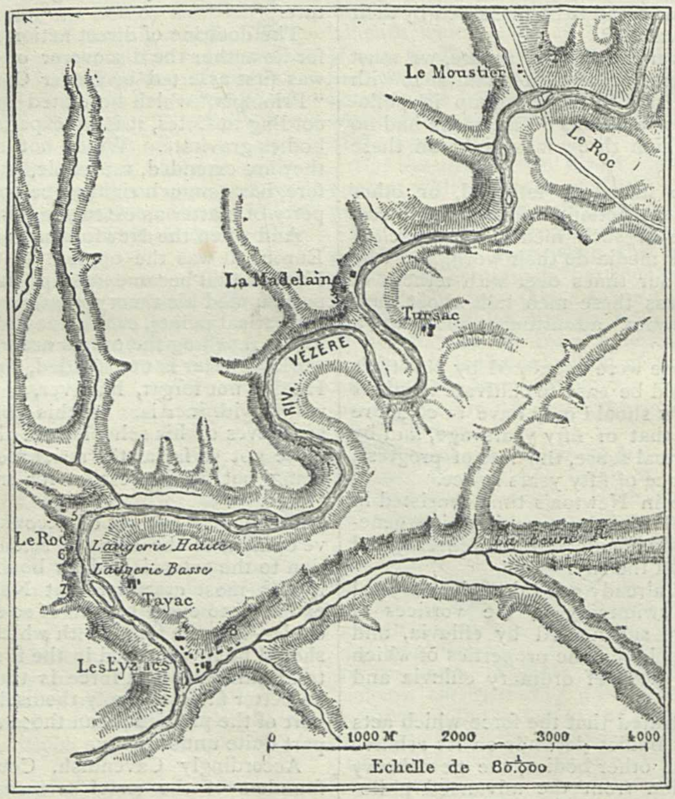

Fig. 8.—Map of the quaternary stations of the Vezère. 1.—Moustier cave. 2.—Moustier shelter. 3.—Shelter of the Madelaine. 4.—Shelter and burying-place of Cromagnon. 5.—Shelter of Upper Laugerie. 6.—Shelter of Lower Laugerie. 7.—Cave of the Gorge d'Enfer. 8.—Cave of the Eyzies.

Thus this depression of twenty-seven metres, due to the action of the waters, was effected almost entirely under the eyes of our Troglodytes, and from that time, during the whole length of the modern epoch, that is in hundreds of centuries, it has made very little progress. Judge from this how many human generations must have come and gone between the epochs of Moustier and La Madelaine.

It is easy to see that in such an immense lapse of time the manners and industry of this people must have undergone notable changes. We shall have no trouble in proving this by the study of their different stations in succession.

All those of the stations that are known up to the present time are grouped on both banks of the Vézère in a very circumscribed space. From Moustier, which is up the river, to Eyzies, which is down, the distance is but eight kilometres as the crow flies ; it is nearly double when you follow the windings of the valley. Between these extreme stations we see succeeding each other, on the right bank, those of the Madelaine, Upper Laugerie, Lower Laugerie, the Gorge d'Enfer, then, on the left bank that of Cromagnon, very near the Eyzies (see the map).

Some are really habitable caves, others are simply shelters under the rocks, with large openings towards the valleys. But these distinctions have no chronological importance. It is not by the nature of the habitations, but by the nature of the *debris* they contain that we can estimate their relative antiquity. The stations at Moustier are evidently the oldest, that of Cromagnon is less ancient, but evidently belongs, like the preceding, to the intermediate age. Upper Laugerie, the Gorge d'Enfer, belong to the Reindeer Age; and finally Lower Laugerie, the Eyzies, the Madelaine, form a last group, and bring us to the end of the quaternary epoch.

The Moustier Troglodytes were quite uncivilised. They did not know how to fashion bones and horns; they only understood working in stone. Carved flints abound in their stations, but, with the exception of an arrow-point, rather carefully cut, all these flints are of very rough workmanship. The distinguishing weapon of the Moustier Troglodytes, that which characterises this station and epoch, is the lance or spear-point which we have already described (see above, Figs. 3, 4, and 5).

This powerful flint, with an arched point, sharp at both edges, wide enough to make large wounds, thin enough to penetrate easily into the flesh, constituted a much more terrible weapon than the hatchet of Saint Acheul. Fastened to the end of a spear, it could put to death the most gigantic mammalia. Vestiges of the mammoth, of the huge cave lion, and of the cave hyena have been picked up at Moustier. But the principal human food at that time was first the horse, then the aurochs; the reindeer came third. The weapons of the chase were more suited to attack the enemy that resisted than the game that fled. They neglected those lighter shafts that bring down birds and smaller quadrupeds. Fishing was also neglected and probably not known. There is not a single fish-bone or bird-bone in the Moustier stations.

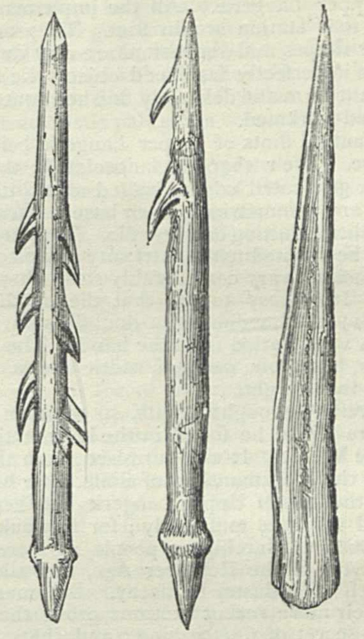

FIG. 9. FIG. 10. FIG. 11.

Fig. 11.—Point in deer horn, without barbs (Gorge d'Enfer). Fig. 9.—Arrow with bilateral barbs. Fig. 10.—Harpoon with unilateral barbs.

The men of Cromagnon, less ancient than those of Moustier, had considerably advanced. Their implements were less massive, more numerous, more varied, and, above all, better finished. They had not the Moustier point, but they had a kind of flint poignard. They wore shell ornaments, and their numerous scrapers seem to indicate that they prepared skins for clothing. Their principal food was still the horse, but they had a great variety. We find in the *débris* of their repasts, besides the reindeer, which was beginning to be plentiful, bones and teeth of aurochs, wild boar, stag, wild goat, wolf, fox, spermopile, hare, and even of a bird belonging to the Crane genera. They consequently hunted small game as well as large animals; but they were still ignorant of fishing.

FIG. 12.—The Mammoth, carved on ivory. (Engraving from the Madelaine.

Among these remains of animals we still find the mammoth and the great cave lion; likewise a large bear, which might well be the *Ursus Spelæus.* We must likewise remember that the reindeer had not begun to multiply rapidly, that it was less plentiful than the horse; we are therefore still in the intermediate age. But, on arriving at the following stations, we enter definitely the Reindeer Age; henceforward the vestiges of this animal will be more abundant than those of all the others put together.

The finest works in flint of the Valley of the Vézère are those of Upper Laugerie. All the implements, all the weapons of that station are in flint. They are innumerable; their shapes and dimensions are very varied. Side by side with imperfectly fashioned objects we find others whose elegant form and delicately finished contours reveal accomplished workmen.

These beautiful flints of Upper Laugerie belong to the Solutré type. Their shape is lanceolated; they are not thick; their graduated edges, jagged with little notches, are regular and symmetrical; their base is often fashioned so as to facilitate putting on a handle. They are evidently destined to be adapted to the extremity of a piece of wood. Their dimensions vary considerably; the shape is much the same. It is easy to see that the small ones are arrow-points; the medium size doubtless furnished the darts which were hurled from the hand. The largest are lance-points, but their want of width shows that those lances were rather light.

These carefully-wrought points, so common at Upper Laugerie, are not to be found in the later stations of the valley of the Vézère. It was surmised, from this circumstance, that the workmanship of flints, after having progressed till the time of Upper Laugerie, had then declined. This caused surprise, and justly; for it would be astonishing if such an intelligent people, as were evidently the Troglodytes of the Reindeer Age, had allowed their main branch of industry to decay. But many objects found in their more recent stations prove that they had not lost the secret of fine carving; and that, if they no longer wrought the points of Upper Laugerie, they no longer needed them.

A great progressive stride had been accomplished. They had learned how to shape the deers' horns, and the bones of animals. It was with those substances, more pliable than flint, less hard, no doubt, but quite solid enough to fabricate darts and arrows of a longer flight and a greater precision. Then, when these modes of workmanship were once known, the bones and horns of deer were used to manufacture a vast number of tools and utensils of every description.

But, for all that, the reign of flint was not over. On the contrary, the varied assortment of cut flints was greater than ever; to those which served as weapons and implements were now added a multitude of small tools destined to use for working the deer-horn.

We have here arrived at an important evolution of industry. Up to that time there had only been simple industry, or as it were primitive, utilising the original substance direct. Now we come to progressive industry. Tools were manufactured whose sole use was to fabricate others.

In all ages flint had been employed as an instrument of workmanship. From the commencement of the Stone Age it had been used to cut the horn, to make pikes, clubs, handles of lances or darts. The idea of making use in the same manner of the bones of animals was not new either, for in the ancient station of Cromagnon were found some dart-points of deer-horn, and even some pieces of ivory. But the characteristic feature of the epoch on which we are entering was the creation of special tools which were not necessary for the wants of life, and which were destined to facilitate and perfect the fabrication of useful implements. From that time commenced that division of labour which, in a future day, was to increase a hundredfold the power of man and subject all nature to his sway.

The workmanship in deer-horn was already pretty far advanced in the station of Gorge d'Enfer. We find there a complete assortment of objects in this substance—lances, darts, arrows, bodkins, needles, hunting marks, account registers, &c. These articles are pretty well wrought, but without ornaments, and the darts are of the simplest shape. They are conical points, without any barbs. (See Fig. 11.)

The invention of barbs is worthy of attention. These recurring points no doubt rendered the blow more dangerous; the projectile remained fixed in the flesh, and the wounded animal could not get rid of it as he fled through the bushes. But this was probably not the principal object of the barbs. Placed in a regular series on both sides of the arrow (see Fig. 9), they sustained it in the air like wings; they increased the flight and the precision of the aim, and this innovation suggests a certain knowledge of experimental physics. The barbs are generally provided on one side with one or more openings, which are supposed to be destined for the reception of poison. The barb of the arrows and the ornamentation, more or less artistic, are the two distinguishing marks of the stations of the latest epoch. These are three in number—the Eyzies, Lower Laugerie, and the Madelaine. They resemble each other closely, and it is probable that they were nearly contemporary.

III. *The Society of the Troglodytes*

The caves of the Troglodytes were situated near the Vézère, without any special aspect, excepting perhaps that they were never open to the north.

They lived in them the whole year round. This is proved by the remains of their food, for they ate the reindeer fawn of every age. An examination of the teeth of these young animals, of their bones, of their horns in different stages of growth, enables us to determine the number of months they had lived, and consequently the season of the year in which they were killed. Hence we may aver that our Troglodytes had a fixed residence, in other words, that they were not nomads.

When they went out fishing or hunting they closed the mouth of their caves to prevent the entrance of carnivora. A single bone, found at the Madelaine, has the trace of a hyena's teeth. This animal may have once by accident gained an entrance. The hyena was rare at that epoch, but wolves and foxes were numerous, and if they did not come and gnaw the bones scattered all over the floor of the cave, it was because the latter was carefully closed. As there is no vestige of a stone door at the approach to our caves, the Troglodytes, doubtless, closed their doors with palisades.

There have certainly been found, in the three stations of the latest epoch, a certain number of stones in granite, sandstone, or quartz, rounded and polished nearly smooth with friction, presenting on side a very regular depression in the form of a little cup, and resembling little mortars. From this has arisen the supposition that the Troglodytes ground corn for food; but all concur in proving that they did not understand agriculture. It is much more probable that they used their mortars to triturate poisons or colours.

Hunting was their chief resource and occupation. The remnants of bones accumulated on the floor of their caves prove that they hunted animals of every size, from the small bird to the mammoth. This old giant of the early quaternary age still survived, but he was becoming very rare.

Here is the representation of a piece of ivory discovered in 1864, at the Madelaine, by MM. Ed. Lartet, de Verneuil, and Falconer. On this surface, an engraved drawing represents the mammoth, with his head erect, his brow concave, his great tusks bent, his small eye, his long trunk, his tail elevated, and his long mane. In a word, precisely like the mammoths in flesh and bones, which a perpetual frost has preserved to our own days on the banks of the Lena. (See Fig. 12.)

The Troglodytes of the Reindeer Age had rarely an opportunity of encountering the mammoth. They more frequently hunted the aurochs, the horse, the ox; and it was doubtless for hunting these large animals that they still had some large spears, armed with flint, differing little from those of Moustier. But nearly all their weapons were light, and the deer-horn points replaced the flint points of an earlier epoch.

The bow had become the predominant weapon, for henceforth nothing resisted man; all fled before him, and hunting was no longer a struggle but a chase. There were two kinds of arrows: the little pointed arrow, not barbed, for small animals and birds, and the large dart with two sets of barbs, which was principally used in hunting the reindeer. Light spears, terminating in a flattened point, darts with conical points, and long sharp poignards, which gave, when necessary, the finishing blow, completed the hunting equipment. I was nearly forgetting the rallying whistle. It was a reindeer's phalange, pierced near one end, with an oblique hole which did not go right through, and only penetrated to the medullary canal. By blowing on this hole as on a drilled key, one can, even to this day, extract shrill sounds.

(*To be continued.*)

THE NEW HYDROCARBON GAS

THE new hydrocarbon gas produced by Mr. Ruck's process certainly promises to realise the conception that has long floated in the minds of scientific men of turning the exhaustless store of heating power to account that lies ready to hand in water. Mr. Ruck appears literally, by the successful development of his invention, to have set the Thames on fire. At this present time, at the Battersea water-works, on the banks of the old river, near to Battersea Park, both light and heat may be seen and felt in the process of evolution from the decomposition of the water of its stream, and further light is added to the gas first produced by a very simple and uncostly extension of the process, until the illuminating power is raised to the intensity requisite for artificial lighting during the dark hours of the night. The Battersea water-works are now lit experimentally by this new form of gas, an apparatus having been erected there to test and prove the efficiency and value of the method.

Mr. Ruck's hydrocarbon gas, it should be at once understood, differs entirely from the so-called "air gases" that consist mainly of air impregnated with the vapour of some form of naphtha or petroleum, in the fact that its base is essentially a gas. The heating gas, which is the form first generated, is true honest hydrogen mingled with a little taint of carbonic oxide, and a small and practically unimportant percentage of carbonic acid; and the apparatus by which this heating gas is produced is remarkably ingenious and simple. Ordinary steam is brought through a pipe from one of the boilers of the engine house, and this steam is poured through a horse-shoe-shaped tube that passes through the red heat of a fierce coke furnace. In this tube it is superheated, or raised to a temperature which disposes its constituents, the oxygen and hydrogen, to dissolve their intimate alliance, and in that state it is passed on into retorts, also contained in a lower region of the same furnace, which are packed full of coke and fragments of iron. The steam is discharged into the interior of these retorts out of its own conducting pipe, so that it has to traverse their entire length amidst the masses of heated metal and coke, and during its journey it ceases to be steam. The oxygen attaches itself to the iron, and forms scales of black rust, and the hydrogen passes on free, with only a commingling with carbonic oxide and carbonic acid formed by the action of the disengaging oxygen upon the coke packing of the retort, and with certain sulphurous vapours that also issue from the coke. In this impure state the gas issues from the retort, and is carried to a purifying chamber containing oxide of iron, which at once clears it from all the sulphur compounds, and it is then stored in a gas reservoir of ordinary form. In this state it is the "heating gas;" that is, gas supereminently suited for all purposes where heat, without light, is required, as, for instance, for gas stoves of whatever kind, or for boiling water, and generating steam. When the gas is taken from this reservoir, and discharged through an ordinary burner, it burns with the pale colourless hydrogen flame, streaked with a few lines, of yellow scintillations, and of the characteristic pale green colour of incandescent carbonic oxide.

At the present time, with coals quoted in the London markets at 52*s.* per ton, this part of the affair, the production of a heating gas out of water, at the cost of a very simple apparatus, a very small consumption of fuel, and with a demand for an incredibly small application of manual labour, seems to be the one that is most deserving of thought and attention. In the practice of the manufacture at the Battersea water-works, by the expenditure of one ton of coke for the interior of the retorts, and of two tons of coke for the support of the heat of the furnace, 133,000 cubic feet of gas are produced, that, to say the least of it, is quite equal for all purposes of heating to coal gas in ordinary use, and that is as chemically enduring and perfect for storing in gasometers and for transmission to unlimited distances through pipes. In a direct experiment with the gas, tried by the writer, one quart of cold water was boiled in four minutes and a half by a jet of flame issuing from an orifice one-eighth of an inch in diameter, and under a pressure of three inches of water, without any arrangement for the concentration and protection of the flame from chill and draughts. There was no provision on hand to measure the exact consumption of the gas, but the man who was engaged in the Laboratory estimated it at about five cubic feet per hour. Now the cost of this gas at the works is found to be 7*d.* per 1,000 cubic feet. In this experiment, therefore, the result was something like converting seven gallons of water at a temperature of 38° Fahrenheit, into boiling water for 1*d.* One thousand cubic feet at a cost of 7*d.* would boil about 50 gallons of cold water. At the works at the present time the steam is supplied independently from the boiler of the engine room. But this does not need to be taken into consideration, because the waste heat of the retort furnace is more than enough for the production of the steam, and in ordinary circumstances will be used, as a matter of course, for the purpose.

When it is desired to use the gas for lighting purposes, it has to be further prepared and manipulated. The "heating gas" from the gasometer is made to bubble through a reservoir containing rectified petroleum at a specific gravity of about 0·680. It then passes at once into the pipes for circulation and consumption, and issues from these burners a very excellent gas, equal in illuminating power to 16½ candles with a consumption of 5 cubic feet an hour in an Argand burner. The cost of the gas in this form is a trifle less than 1*s.* 8*d.* per 1,000 cubic feet, and the saving in the manufacture over ordinary coal gas with coals costing 26*s.* per ton, is estimated to be 40 per cent.—in exact figures 1*s.* 8*d.* per 1,000 cubic feet against 2*s.* 4*d.* per 1,000 cubic feet. One thousand cubic feet of the heating gas require a gallon and a half of the petroleum to convert them into illuminating gas, but they are considerably increased in volume by the conversion—133,000 cubic feet of "heating gas" become 165,000 cubic feet of "illuminating gas" after it has been passed through the petroleum. Arrangements have been made for the purchase of several millions of tons of crude petroleum at a price which will represent a cost of 6*d.* a gallon after rectification.

Some rather severe experiments have been already tried to test the power of the illuminating gas to retain its full charge of carbon after travelling through long distances of delivery at low temperatures, and the report of the testing engineers is that so far the experiment was eminently satisfactory, and that there was no perceptible loss of illuminating power. Experiments on this point, however, and also upon the arrangements that will best enable the heating gas to be turned to account, are still in progress, and will afford ground for further notice in due time.

The furnace and retorts which are at work at Battersea are very compact, occupying about the space of an ordinary well-packed steam engine of 20 or 30 horse power. These retorts however are only in use for about two hours out of the twenty-four to supply the works with illumination, and it is estimated that they would be quite large enough to supply illuminating gas for the consumption of a small town of about 4,000 inhabitants. As regards the most important bearing of saving of manual labour it is found to amount to dispensing with the services of 29 labourers out of every 30 who are required in the old process of coal distillation. The charge of coke and iron which is now in the retorts yielding the gas at Battersea has not been changed, or renewed, for several weeks. The iron in the retorts is in the form of old chain, for the convenience of withdrawal, and seems to cover itself with thin black scales. The carbon in the interior of the retort is removed entirely by the gas as it is gradually converted in the process of manufacture into carbonic acid and carbonic oxide.

It may, perhaps, be well to remark that a process for the manufacture of "water gas" was presented by M. Gillard some fourteen years ago, in which superheated steam was decomposed in retorts by the action of incandescent charcoal; the carbonic acid, so formed, issued from the retort with the hydrogen, and was afterwards removed in a special purifier. Lighting power was secured by heating platinum wire in the flame. The distinctive features of Mr. Ruck's process are—the decomposition of the superheated flame by coke and iron, which remain long periods in the retorts without change; the removal of sulphur products by oxide of iron; and the carbonising for illumination by passing the hydrogen through rectified petroleum.

HUNTERIAN LECTURES BY PROF. FLOWER

Lectures I. II. III.

In considering the various formations which compose the earth's crust, it is unnecessary, whilst speaking of the mammalia, to refer to rocks lower than those of the secondary formation, for no palæozoic mammals are known. Respecting the value of palæontology in supporting or disproving the various theories at present in vogue regarding the origin of life, the details of the course will supply evidence of value. The amount of "the imperfection of the geological record" will be demonstrated in the classes considered. The extreme unlikelihood of any aërial animals being preserved in the fossil state is scarcely realised by many, nor is the smallness of the extent of the surface of the earth which has been examined. An accidental discovery like that in the upper oolite, of an extremely small deposit containing numerous marsupial remains, has done more to throw light on the subject than many more painstaking researches over larger fields. These facts being taken into consideration, it is clear that if it can be shown that the examination of fossil remains indicates only a tendency towards the filling of the gaps between existing groups, the tendency will be strongly in favour of evolution; but if it brings to light nothing but types which are entirely new, the doctrine of special creations will be supported. Prof. Huxley has been able to show many of the transitions between reptiles and birds, and Prof. Marsh's new discovery of *Odontornis* is an important addition. It is among mammalia that in the present state of our knowledge there are the greatest gaps. The relations of the Cheiroptera are indeterminable, and so are those of the Edentata; not much is known of the Cetacea as regards their affinities, though they may be near the seals on the other hand. The Ungulata constitute a group in which the considerable gaps between existing types are almost completely removed by the study of fossil forms. Taking first the Perissodactylata, in the Pliocene, Equidæ abounded in America as well as in the Old World. Tapirs and Rhinoceroses were equally abundant; these are the remnants of a large group which is probably becoming extinct, as it is indicated by the fact that the species are becoming less numerous. A little further back we find Hipparion with rudimentary side toes. In the Miocene and upper Eocene, Anchitherium and Palæotherium represent the group, though the latter is peculiar in its teeth. Fossil Rhinoceroses have larger teeth and no horn, some possess incisors, and the other teeth less specialised. The Tapir stands much by itself, and an ancient type containing Lophiodon and Hyracotherium seems to be now unrepresented. Again, among the Artiodactylates, *Chœropotamus* and *Hyopotamus* as far back as the Eocene are the most generalised, and from them as we ascend in the series the differentiation towards existing types becomes more and more evident. Among these later forms the North American *Oreodon*, which has been obtained in such great numbers, tends to the ruminants, but possessed upper incisors and canines. The Miocene of France and Germany affords very similar evidence. It is also interesting to note that the further we go back, the more do the individuals of the Perissodactylate group approach the Artiodactylates, but as yet no connecting link has been obtained. The Proboscidia, animals first appearing in the Miocene, approach in the older forms to the Ungulata, and Prof. Marsh's newly discovered Dinoceras seems to help to fill the gap.

In reviewing the various strata which are found to contain remains of mammalia, those of the quaternary or post-pliocene period are rich in species not far removed from existing forms. In most countries where limestone rocks exist, caverns are found containing large numbers of bones, such as those of Kirkdale, Liege, and Gibraltar, the last having been lately explored by Mr. Busk. Those of the Wellington Valley in Australia have afforded numerous remains of marsupials, showing that those animals have been located there for a considerable period. Again from the Pampas of South America many of the valuable skeletons which enrich the collection of the College of Surgeons have been obtained. The Miocene formation is particularly interesting from the richness of its fauna. *Dinotherium* and *Mastodon* being obtained in South France, as well as at Pikermé in Greece, where they are associated with *Hipparion*, the giraffe and others. Belonging to the same formation are the strata of the Siwalik Hills of India, which abound in hoofed animals, and have been so well worked out by Dr. Falconer. The peculiar mammalia of the territory of Nebraska, at the foot of the Rocky Mountains, belongs to the same age. In the Eocene period lived the animals so fully described by Cuvier, *Palæotherium*, *Anoplotherium*, &c. Besides in the Paris basin, similar strata occur at Hordwell, in Hants, and at Binstead, Bembridge, and Headon, in the Isle of Wight. In the London Clay of Sheppey *Hyracotherium* and *Lophiodon* are found.

Early in this century, it was supposed that mammalia were not present in the secondary rocks; but this was shown to be incorrect. In 1847, Prof. Plieninger discovered in some Triassic sand he was sifting a minute tooth with double fangs, probably belonging to some marsupial animal, which he named *Microlestes*. Prof. Owen considers it to be related to *Myrmecobius*. Similar teeth from the Rhaetic beds have been discovered by Mr. C. Moore, of Bath. An equally minute Triassic tooth was found by Mr. Boyd Dawkins at Watchet, in Somersetshire, and from its slight resemblance to that of *Hypsiprymnus* it has been named

Hypsibrymnopsis. Among the coal fields, probably of the Trias Age, in North Carolina, the late Prof. Emmons obtained the lower jaws of three insectivorous or carnivorous animals, with the following dental formula—i. 3, c. 1, p.m. 3, m. 7, and, as Prof. Owen has pointed out, this large development of the molar series approximates it to *Myrmecobius.* A peculiarity of these jaws, as of all others from the secondary formations, is that a long groove runs along their inner side in the position of the mylo-hyoid groove of recent mammals; this is only a result of arrested development round Meckel's cartilage, and it does not indicate—as has been supposed by some—reptilian affinities, there not being any signs of more than two centres of ossification. So early as 1812, a man working in the Lower Oolite of Stonefield found a perfect lower jaw one inch long. This was taken to Mr. Broderip and Mr. Buckland; Cuvier also had an opportunity of seeing it, and called it an opossum. Dr. Blainville thought that it was reptilian, and called it *Amphitherium.* Owen clearly proved that it was marsupial, the angle being inflected. The dental formula is i. 3, c. 1, m. 12, and the shape of the teeth indicates an insectivorous or carnivorous diet. *Phascolotherium*, another genus from the same slates, has the formula i. 3, c. 1, m. 7, which, if it had one more incisor, would be like that of the opossum. Higher up in the secondary formation, in the Purbeck, Mr. Brodie obtained several small jaws from Durdlestone Bay, near Swanage. Mr. Beccles thoroughly explored this bed, and very valuable results have been obtained, more than forty jaws, nearly all lower, of twenty-four species belonging to ten genera, having been described by Owen.

NOTES

By five decrees of the French government, dated February 13, the working of the French observatories has been thoroughly reorganised, and if the new system is faithfully carried out, we have no doubt it will be productive of good results. The management of the government observatories is entrusted to a body of astronomers responsible to the Minister of Public Instruction, and consisting of titular astronomers (*astronomes titulaires*), associate astronomers (*astronomes adjoints*), and assistant astronomers. This *personnel* is distributed among the various observatories according to the requirements of the service, and the special resources offered by each establishment for the researches of observers. The staff of the observatory of Paris consists of a director, six titular astronomers, ten associate astronomers, and several assistants. A responsible secretary is attached to the establishment. The Paris observatory has a scientific council, composed of the director, the various chief astronomers of the service, and of six councillors of the observatory, chosen from among scientific men eminent in mathematics, astronomy, or physics, and of whom four at least must belong to the Academy of Sciences or to the Bureau des Longitudes. These are to be nominated by decree, in accordance with the advice of the Council, and upon the proposal of the Minister. The Council is to meet once a month, and every year, at Easter, the directors, the councillors, and the chiefs of the various scientific establishments, meet in general assembly with the Minister of Public Instruction. The directors and the titular astronomers are appointed by the President of the Republic, acting according to the advice of the General Assembly. The salaries of the titular astronomers vary from 6000 to 8000 francs, those of the associate astronomers, divided into three classes, from 3,500 to 6,000 francs, and those of the assistant astronomers, also divided into three classes, from 1,000 to 3,500 francs. These salaries do not strike us as being particularly liberal. By a second decree, M. Le Verrier has been made Director of the Paris Observatory; the Councillors of the Observatory are, MM. Belgrand, Fizeau, Vice-Admiral Jurien de la Gravière, Janssen, Tresca, Daubrée; and Members of Council, MM. Yvon Villarceau, Wolf, Gaillot, and Rayet. M. Marie Davy is appointed Director of the Meteorological Observatory of Montsouris, and M. Stephan of the Observatory of Marseilles.

The arrangement of the buildings in which the Annual International Exhibitions are held, makes it almost essential for their success that visitors should be able to pass from one side to the other across the gardens of the Royal Horticultural Society. A large body of the Fellows, however, more especially those residing in the neighbourhood, object to the admission of the exhibition visitors, as an infringement upon the privacy of the gardens. At the late adjourned annual meeting there was a very stormy discussion upon the subject, and the report of the Council recommending a continuance of the policy of meeting the views of the managers of the exhibitions was rejected by a large majority. The Council thereupon expressed their intention of resigning; but this, it appears, they have no legal power to do till the expiration of their term of office.

Captain M. F. Maury, the well-known American hydrographer, died on February 1, at Lexington, Virginia, at the age of sixty-six years.

The *Times* announces that the Council of the Royal Society are about to nominate Dr. Hooker as President of the Society, in succession to Sir George B. Airy, who retires from the chair at the Society's anniversary in November next.

It is announced in a "cable" telegram from America to the Astronomer Royal, that a new planet (130) was discovered by Peters on February 18. It is of the eleventh magnitude, and was moving rapidly towards the north. R. A., 10h. 0m., Decl., 13° 40′ N.

Mr. T. M'Kenna Hughes, M.A., of Trinity College, has been elected Woodwardian Professor of Geology at Cambridge, in succession to the late Prof. Sedgwick. Originally there were nine candidates, but most of them retired before the poll, and the real contest lay between Mr. Hughes and Mr. Bonney, a Senior Fellow of St. John's, the numbers at the close being 112 and 105 respectively.

By a resolution of the Board of Trinity College, Dublin, the Natural Sciences have been introduced into the Undergraduate Course. Hitherto a student might select the Natural Science Course for his final examination in Arts, obtaining a senior or junior Moderatorship, according to his answering; now having once passed his "little go," the student may in his third year select for his term Lectures and Examinations, Botany and Zoology; and in his fourth year Physical Geography and Palæontology. For this purpose the following courses of lectures have been arranged:—Michaelmas Term—Prof. Haughton, M.D. F.R.S., lectures on Physical Geography; Prof. E. Perceval Wright, M.D. on Histological Botany; Prof. Macalister, M.D. on Vertebrata. Hilary Term—Prof. Haughton on Palæontology; Prof. Wright on Cryptogamia; Prof. Macalister on Mollusca and Arthropoda. Trinity Term—Prof. Haughton on Palæontology; Prof. Wright on Phanerogamia; Prof. Macalister on Annulosa, Cœlenterata and Polyzoa. In addition, in Trinity Term, Demonstrations are given by the several Professors in Palæontology, Comparative Anatomy, and Botany.

At the Fellowship Examination at Trinity College, Cambridge, in 1874, a Fellowship will be obtainable by adequate proficiency in Natural Science. The Examination, which will take place in the end of September or the beginning of October, will be chiefly in Chemistry, Physics, and Biology, and in the subjects of any papers which may have been sent in. Candidates are invited to send in to the Examiners (care of Mr. Trotter), on or before May 15, 1874, any papers which they may have published containing original observations or experiments, or discussions of scientific questions, or any similar matter in manuscript. The papers may be on any branch of Natural Science which is not strictly medical. They must be accompanied by a statement as to what portions of the matter are claimed as original, and of the sources from which the rest is derived so far as they are not explicitly stated in the paper itself. Candidates will be liable to be examined in the subjects of their papers, and in matters connected with them, or in the branches of science to which they refer. This Fellowship will be open to all Bachelors of Arts, Bachelors of Law, and Bachelors of Medicine of the University, whose standing after their first degree does not exceed three years. Candidates who are not members of the College must send their names to the Master on or before September 15, accompanied by certificates of good character. For further information, apply to the Rev. Coutts Trotter, Tutor of Trinity.

M. René de Brebisson writing under date of February 16 to the Secretary of the Dublin Microscopical Club, mentions that while the smaller collections of Algæ belonging to his late distinguished father, had for some time past been disposed of, yet the large collection of Diatomaceæ was still for sale. This collection contains (1) 8,000 prepared slides, some in fluid, but the greater part by far in Canada Balsam; (2) about 600 tubes and bottles of Diatoms in alcohol ready for mounting; and (3) a collection of Diatoms on mica and some few n paper. These collections contain the types of most of the species described by De Brebisson, Kutzing, Smith, Ralfs, Grunow, W. Arnott, De Notaris, &c. &c. The price asked is 10,000 francs, but possibly for a public collection 8,000 francs might be taken. The collection is well worthy the attention of botanists, and we hope soon to be able to report that it has been disposed of.

The Royal Dublin Society has inaugurated a course of lectures on subjects connected with public health, in the arrangement of which the Dublin Sanitary Association afforded its advice and assistance; the first of the series, being Introductory, was delivered on Saturday, Feb. 22, by Dr. W. Stokes, F.R.S., and the remaining ten will be delivered each Saturday until completed. The Subjects and Lecturers are as follows:—On the discrimination of Unadulterated Food, by Dr. J. Emerson Reynolds. On Meteorology in its bearing on Health and Disease, by Dr. T. W. Moore. On the Geographical Distribution of Disease, by Dr. T. Little. On Zymotic and Preventible Diseases, by Dr. T. Grimshaw. On liability to Disease, by Dr. Alfred Hudson. On Antiseptics and Disinfection, by Dr. R. Macdonnell, F.R.S. The Prevention of Artisans' Diseases, by Dr. E. D. Mapother. On the Contagion Theory of Epidemics, by Rev. Dr. Haughton, F.R.S. On the Construction of Dwelling Houses, with reference to their Sanitary arrangement, by Mr. G. C. Henderson; and on Sanitary Legislation, by Mr. R. O. B. Furlong.

We understand that the delay which has occurred in the issue of the volume of the *Zoological Record* for 1871, has been caused by the illness of one of the contributors to the Invertebrate section. At a recent meeting of the Council of the Zoological Record Association it was determined to issue the portion of the volume already completed (down to the end of the Insecta) immediately, leaving the remaining section until the health of the contributor allows of its completion.

Prof. Giglioli, of Florence, has lately re-examined the skull of the Chimpanzee of East Africa, which was obtained some years ago from the Upper White Nile, and was formerly in the Museum of the School of Medicine of Cairo, and has come to the conclusion that it belongs to a new species which he proposes to call *Troglodytes Schweinfurthii*, after the well-known African traveller of that name.

The Royal Zoological Society of Ireland has just issued its forty-first annual Report. It would appear that the Gardens were visited during 1872 by 147,184 persons, being nearly 20,000 less than 1871; but this is abundantly accounted for by the extreme wetness of the past year. Perhaps the most interesting addition to the Garden during that period consisted of two living specimens of the Climbing Perch of India (*Anabas scandens*); these were presented by Staff-Surgeon Dobson of Calcutta.

We have received from Mr. Roosevelt, the secretary, the third and fourth annual Reports of the American Museum of Natural History, from which we learn that this newly founded national collection, situated in Central Park, New York, is being conducted with an enterprise and discretion which, if continued, will shortly render it worthy of the capital it represents. Frequently during the last year it was visited by more than 10,000 people in one day, and every encouragement is given to students of science. Among the most valuable donations during the last two years is a great Auk, presented by Mr. R. L. Stuart, and a large collection of insects from Madame Verreaux, of Paris.

Prof. Tyndall arrived at Liverpool on the 19th inst., in the *Cuba*.

At Thorn, in Prussia, where he was born in 1473, the four hundredth anniversary of the birthday of Copernicus was celebrated on February 19. Speeches were delivered by several scientific men, and a ball was given in the town hall.

According to the accounts we have as yet seen of the Samos earthquake it was of a remarkable character. It affected chiefly the pretty little capital of Vathy. The shocks were not felt throughout the island, but only on the coast between Kotzika and Pagonda. Nevertheless a counter shock was felt as far off as Smyrna. So far as we can make out, the first shock, which was the strongest, was felt at 1 A.M. Up to Feb. 3, 104 shocks had been felt at intervals, 4 or 5 very strong and threatening.

The Smyrna earthquake was on Feb. 1 or Jan. 31 at night, and was violent. The oscillation is reported as from S.W. to N.E.

The weather in Yanina, in Epirus, up to the beginning of February, had been most remarkable. There had been great rains, and the fruit trees had already yielded fruit. In the neighbouring provinces of Bosnia and Prizrend the fruit trees had also blossomed in full winter, and some had given fruit. The like is reported from Verzin, where plum trees, pears and figs had produced fruit of good quality.

A coal mine has been discovered in the Bagdad district between Yezireh and Zeto. According to the report of M. Mougel, engineer to the viceroyalty, the formation extends over a length of more than four miles with a breadth of from 400 to 450 feet. About 84 tons were got out in the first three weeks.

We have received from Dr. Petermann a beautifully executed map of South-west Germany, with Alsace and Lorraine as they existed before the outbreak of the French Revolution in 1789.

We learn from the *Times of India* that the Bombay Geographical Society has been formally amalgamated with the local branch of the Royal Asiatic Society.

We learn from the *Garden* that an American has made an experiment with the view of ascertaining how far soil is protected from cold by snow. For four successive winter days, there being four inches of snow on a level, he found the average temperature immediately above the snow 14° below zero; immediately beneath, 10° above zero; and under a drift 2 ft. deep, 27° above zero.

PROFESSOR RAMSAY ON LAKES *

II.

III.—*The Waters of the Cambrian and Silurian Epochs and the Lakes of the Old Red Sandstone*

THE lecturer first briefly summarised the reasoning and the conclusions contained in his two preceding lectures on the origin of fresh and salt water lakes, and then proceeded to apply them to explain certain phenomena of the above geological epochs as deduced from the rocks belonging to those periods. He was about to endeavour to prove that certain of the formations included in a table of the stratified rocks were not formed in the open sea as usually supposed, but were formed in great lakes. The small numbers of fossil shells found in fresh-water strata and in some cases their total absence rendered absolute demonstration very difficult. The Cambrian strata, seen in England, in North Wales, Shropshire, and other parts consist of red and mottled sandstones and slates, and contain but few fossils; trilobites and one or two fossil shells have been found, not in the red strata, however, but in blue and grey shades. Above these the Lingula flags (a member of the Lower Silurian) contain fossils in great numbers, and of such creatures as must have lived in the open ocean of that period. In the Upper Silurian, too, fossils are very numerous, and all inhabitants of the sea. But above these, in the Old Red sandstone, the numbers have declined both in genera and species and individuals, and the shells, &c., which remain are small and dwarfed in size. Yet the strata of the Old Red sandstone lie conformably on the Upper Silurian, showing that the passage from the one set of beds to the other was gradual, and the change in the fossils is likewise gradual.

The Old Red strata consist of red sandstones (forming about two-thirds of the whole strata) and a red marl developed in England, in South Wales, Herefordshire, &c., throughout the whole of these strata fossils are very scarce, chiefly occurring in the uppermost and lowermost portion. In the Ludlow rocks, at the upper portion of the Silurian strata, are found fragments of stones and seed vessels of land plants for the first time. Not that land plants did not exist before that period; the lecturer thought they had done so, but that their remains were not preserved in the rocks, inasmuch as they had been formed in the open sea, far from land. But their occurrence in the Ludlow rocks evidently proves that those strata, although truly marine, were formed in the neighbourhood of land, and, as the lecturer believed, in waters more or less land-locked. These passage beds also contain the remains of fish of various genera—Cephalaspis, Onchus, &c. But passing upwards into the beds of the Old Red sandstone, the fish which occur have their nearest living analogies in inland fresh-water areas; *e.g.* the Lepidosteus of the North American rivers, the Polypterus of the Nile, and the recently discovered Ceratodus in the rivers of Australia. Large crustaceans—Eurypterus and Pterygotus—occur higher up in the formation, and in all cases where they are found, and in the majority of cases where fish are found in these strata, shells are not associated with them. Hence from the absence of shells, and their dwarfed forms when they do occur, especially as compared with the underlying Silurian beds, and from the presence of those peculiar kinds of fish, we are entitled to infer that the strata were deposited in inland lakes. Again, examination of a piece of the red sandstone will show it to be composed of a number of minute grains, each surrounded by a thin pellicle of peroxide of iron, to which the red colour of the rock is due, for when this iron is discharged by chemical means the rock remains purely white. All truly marine rocks that we know are in no case coloured red; they are black, blue, green, or yellowish, but never red, and there is no reason why in the sea iron should be deposited as a peroxide. But in certain lakes in Sweden there is a constant deposit of iron oxide; and though this is due to organic agency, still it occurs in lakes, but never in the sea. The Old Red sandstone is not a wide-spread formation, but has more of a local character.

The lecturer then showed by means of diagrams how he conceived that certain areas of the Silurian seas might be isolated and shut off from the ocean by elevation and depression of the land, that the gradual freshening of these inland areas would result in dwarfing and deforming the marine creatures in the waters, and rendering them gradually extinct. The lakes in the north of Europe, which must have been filled with sea-water just after the glacial epoch, are similar cases, for in some of them the marine forms are not yet totally extinct, but have become partly acclimatised, and so the occurrence of a few such forms in these rocks is no conclusive evidence against their being formed in inland and fresh-water lakes, but rather the contrary. At the top of the Old Red sandstone beds land-plants and fresh-water shells occur. In the north of Scotland the Old Red sandstone rocks are well developed, the Grampians at that time standing out of the waters. The bottom bed is a clay with angular boulders, much resembling the "boulder clay" formation, and evidently of glacial origin, and though the lecturer dare not assert that glaciers scooped out the lakes in which the rocks were deposited, still it was very interesting to have evidence of their connection with those lakes. He likewise pointed out that if this theory of the lake origin of certain formations, first suggested by Mr. Godwin Austen, were established, it would open out an entirely new field of geological research by revealing to us the conditions not only of the ancient seas, but also of old continental areas.

IV.—*Salt Lakes of the Permian Epoch*

Prof. Ramsay first explained that it was necessary, in attempting to demonstrate the truth of his assertions as to certain formations having been deposited in inland waters, to commence by considering the conditions of the preceding epoch, and trace the gradual change in the deposits resulting from the changed conditons. He therefore commenced by describing somewhat fully the rocks belonging to the carboniferous formation. The mountain limestone or carboniferous limestone, which lies at the base of the system in the south of England, is a nearly pure limestone, composed almost entirely of encrinites, corals, and other similar marine forms, and attaining a thickness of two or three thousand feet. Above that lies the millstone grit, about a thousand feet thick, likewise marine, but containing the remains of land plants; overlying that are the coal measures, consisting of an alternation of beds of sandstone, slate, coal, and ironstone. In the north of England and Scotland the base of the system consists of alternating beds of limestone, sandstone, and shale, with occasional beds of coal, and above that the true coal measures. The coal was formed by the life and death of land-plants—Lepidodendron, Sigillaria, Calamites, &c., and under every bed of coal is a layer of clay—"underclay," which is nothing more nor less than the ancient soil on which the plants grew, and contains the roots of some of the above plants, *e.g.* Stigmaria, the root of Sigillaria. The remains of the plants accumulated somewhat like existing peat bogs, and were at times submerged and covered with a layer of sediment, and again upheaved and overspread by vegetation. There must have been a large continental area in the latitude in which Britain now stands to furnish the gigantic rivers at the mouths of which many of these coal-measure forests grew.

Above the carboniferous strata lie the Permian seen surrounding some of the Midland coal fields, in a strip from Derbyshire into Cumberland, and forming the base rocks of a portion of the Vale of Eden. The beds lie unconformably on or against the coal measures, implying that a vast lapse of time, sufficient to allow for the denudation of thousands of feet of thickness of strata in some places, took place between the deposition of the two formations. At the base of the Permian strata lie beds of red conglomerate, sandstone, and marl, known on the Continent as *Rothliegende;* and above those lie the magnesian limestone. In the magnesian limestone a considerable number of marine forms of life occur, but compared with the great abundance of those forms in the carboniferous limestone, the fauna seems poor and the individuals are dwarfed; out of 1800 species of shells in the carboniferous genera only 38 genera and 180 species are found in the magnesian limestone. The latter strata also contain some fossil fish in its lower beds (marl slate), of the same genera as those found in carboniferous strata, and some show considerable resemblance to those living forms inhabiting inland fresh-water areas, mentioned in the last lecture. And there are various reptiles found—Labyrinthodont reptiles—which were truly amphibious, and which in some cases have left their skeletons, but far more frequently their foot-marks impressed upon the soft mud of some ancient shore, which likewise shows occasionally rain marks and sun cracks. Some of the reptiles belong to the Protosaurian genus, closely allied to the modern crocodiles or Thecodont saurians, and therefore probably ultimately connected with the land. And a very significant point in regard to the origin of these rocks is their chemical composition, the magnesian limestone consisting of the carbonates of lime and magnesia, often in about equal proportions. Now

* Continued from p. 313.

limestone is formed from the sea-water by the agency of animals, but no creature is known which secretes carbonate of magnesia from the sea waters to make its skeleton, and therefore we may conclude that it was precipitated from chemical solutions; and this could not take place in the open sea, but must have occurred, as in the case of rock-salt in confined inland waters. It is probable that by extensive changes in physical geography, large areas of the ocean were shut off, and in the lakes thus formed, the Permian rocks were deposited, the magnesian limestone being formed by the mixture of the carbonate of magnesia, precipitated by means of evaporation with limestone built up by organic agency. Crystals of gypsum too occur in these rocks, and pseudomorphous crystals of rock-salt pointing to evaporation, and consequently concentration of these salts in the waters of confined areas. A thin pellicle of peroxide of iron surrounds the grains in the sandstone and marl, which gives the red colour to the rocks, and which peroxide was formed by the reduction of the carbonate of iron, carried into the lakes by the rivers, by means of the oxygen of the air. The lecturer had no hesitation in saying that in all those formations which we know to be truly marine, the rocks are never red. So that from the paucity or absence of shells, from the remains of terrestrial or amphibious reptiles, and their foot-prints, from the occasional presence of true land plants (of the same genera, but not the same species, as in the carboniferous rocks), from the chemical composition of the rocks, from the presence of peroxide of iron, and from the presence of chemical precepitates, we are justified in concluding that the Permian rocks were deposited in great salt lakes, though perhaps not salt in every case. And a reflex of the conditions under which they were deposited may be seen in the state of the Caspian Sea (with a marine fauna like the North Sea, though the species are few and dwarfed), and of the salt lakes of Asia.

SCIENTIFIC SERIALS

THE *Lens* for November 1872, contains the following communications: "The preparation of Diatomaceæ," Christopher Johnstone, M.D.: a succinct account of the most usual and approved methods of cleaning Diatomaceous deposits. A short reply of Dr. J. J. Woodward to Dr. Lionel S. Beale; and a memorandum by Chas. Stodder, entitled "Draw-tubes *v.* Deep-eye-pieces." A continuation by Dr. J. N. Danforth of his communication on "the cell," treats of the theories of cell development. H. H. Babcock's "Flora of Chicago and its vicinity," Part IV. completes, we presume, the phanerogamic plants of Part III.; "Microscopical Memoranda for the use of Practitioners of Medicine," by Dr. J. J. Woodward, relates the results of the author's experience on "the Imbibition of the Tissues with Chloride of Gold and Osmic Acid." Prof. H. L. Smith gives a brief notice of the Bailey Collection of Diatomaceæ in the Museum of the Boston Society of Natural History. Dr. J. J. Woodward also advocates the employment of *Frussulia Saxonica* as a test of high-power definition in preference to *Amphipleura pellucida.* S. A. Briggs gives an enumeration of some of the Diatomaceæ of Upper Lake Huron and the Sault. The usual brief notes, with title-page and index, complete this number and the first volume of this American Quarterly Journal of Microscopy.

La Belgique Horticole, gives a short life of Redonté, the celebrated French painter of flowers. A description of a new tea rose, the "Pearl of Lyons," contains a short history of these plants, from which we learn that they were introduced into Europe in 1793 by an Englishman, Mr. Parsons, and reintroduced early in this century by others, Sir A. Hume being one of them. M. E. Morren describes, in a very clear and concise manner, the physiology of the nutrition of plants.

THE *Revue Bibliographique Universelle* contains short reviews of several botanical works, including that by Grisebach and Engelman, on the geographical distribution of plants, in which the world is divided into twenty-four botanical regions, several of these being, according to the reviewer, unnecessary. Referring to a work by M. Hamilton on the Botany of the Bible, the following occurs:—"Il a joint à chacun de ses articles une photographie prise sur nature, mais malheureusement dans les environs de Nice, et non point en Terre Sainte." Prof. Balfour's Introduction to the Study of Palæontological Botany is considered too deficient in detail and from the fewness of the references to other authors, the incompleteness of the Edinburgh libraries is presumed.

SOCIETIES AND ACADEMIES

LONDON

London Mathematical Society, Feb 13.—Dr. Hirst, president, in the chair. The following papers were read:—Prof. H. G. Smith, on the higher singularities of plane curves, and on systems of linear consequences.—Mr. J. Macleod, on the application of the hodograph to the solution of problems on projectiles.

Geologists' Association, February 1.—Henry Woodward, F.G.S., president, in the chair.—"On the Diprionidæ of the Moffat Shale," by Charles Lapworth, F.G.S. After reviewing the history of investigation among the biserial *Graptolites*, and the antagonistic opinions regarding their internal structure held by different palæontologists, the author stated that a careful decomposition and examination of specimen of *Chinacograptus* from the Moffat Shale, preserved in a state of relief, had forced him to the conclusion that the view of the duplicate nature of the polypary in this genus advocated by Professor Nicholson is substantially correct. The internal characters are identical with those in *Diplograptus.* The diprionidian polypary is in reality composed of two complete monoprionidian polyparies (each with its own cænosarc, virgula, and distinct hydrotheæ), placed back to back and coalescing along their flattened dorsal walls. There is certain evidence that this type of structure obtains among all, or nearly all, of the Moffat *Chinacograpti.* Nevertheless, he was not prepared to deny the accuracy of Professor Hall's interpretation of the internal characters of his *China*(?)*typicalis.* As long as a single doubt remained upon this point, it was argued that it would be unsafe to exclude *Retiolites* and its allies from the *Dipliotidæ*, which might meanwhile be considered as embracing three sub-families, *Diplograptidæ*, *Retiolitidæ*, and a third and intermediate sub-family, of which *C.*(?) *typicalis* is the only known example. The sub-family *Diplograptidæ* will include all those species at present referred to *Diplograptus* and *Chinacograptus.* Now that the type of structure in these two genera is proved to be identical, a new system of classification is necessary. The only remaining characters which can in all cases be employed for the purpose of separation at our command are the form of the polypary and the shape and arrangement of the hydrotheca. It was shown that the different species of the *Diplograptidæ* naturally arrange themselves into five groups, clearly individualised by striking distinctions in these characters. Each of these groups, it was contended, was of sufficient importance to be considered as forming a distinct and separate genus. In this way the genera *Climacograptus* (Hall) and *Cephalograptus* (Hopk.) would rumain untouched, and the author suggested that the generic term *Diplograptus* (M'Coy) should be restricted in future to those species of which *Dip. folium* (His.) is the type, and he proposed two new genera, viz., *Orthograptus*, to include those species resembling *Dip. quadrimucronatus* (Hall) and *Glyptograptus* for those formed after the pattern of *D. tamariosens* (Nich.). The second portion of the paper was devoted to a revision of the genera and species of Diplograptidæ found in the Moffat Shales, and the following new species were described:—*Orthograptus aculeatus, O. Carruthersi, O. fasilicus, O. Pageanus, O. explanatus, O. compactus*; *Glyptograptus gregarius, G. per excavatus, G. modestus*; *Chinacograptus styloidens, C. tubuliferus, C. Longicaudatus, C. Wilsoni, C. antiquus, C. brevicornis, C. mirabilis.*

Zoological Society, Feb. 18.—John Gould, F.R.S., V.P., in the chair.—The Secretary read a report on the additions that had been made to the Society's collection during the month of January, 1873. Amongst these were specially mentioned a pair of Fruit-Bats from Formosa, presented by the Rev. Mr. Ritchie of Takoo, and a tapir from Paraguay, which presented some points of distinction from the ordinary form of the American tapir.—Prof. Newton, F.R.S., V.P., exhibited a print by Adrian Collaert (*circa*, 1580) containing the figure of a bird, cepied in Leguat's "Voyages" (1708), and mentioned by the latter under the name of the "*Géant.*"—Extracts were read from a letter received from Dr. John Kirk, H. B. M. Consul at Zanzibar, respecting a female koodoo, and other antelopes, of which he had obtained specimens for the Society.—Mr. Garrod gave a notice of the death of a kangaroo in the Society's gardens, which had been caused by strangulation of the small intestine, produced by the folding of the elongate caecum round a loop of the small intestine.—A communication was read from Prof. G. J. Allman, F.R.S., containing a report on the *Hydroida* collected during the two expeditions of H.M.S. *Porcupine* in 1869 and 1870.—Mr. W. K. Parker, F.R.S., read a memoir on Ægithognathous Birds, in which it was shown that the peculiar palatal structure of this group was met with in three stages. These might be denominated incomplete, complete, and compound Ægithognathism.—Mr. A. H. Garrod read some notes on the anatomy of the Binturong (*Arctictis binturong*) founded on the dissection of a male specimen of this animal which had recently died in the Society's Gardens.—Mr. E. L. Layard, H.B.M. Consul at Para, communicated some notes on Mr. E. W. H. Holdsworth's recently published catalogue of the birds found in Ceylon.—A communication was read from Mr. H. Adams, F.L.S., containing descriptions of eighteen new species of land and marine shells, the former from Borneo and the Island of Tobago, and the latter from Mauritius, the New Hebrides and the Persian Gulf. Mr. Adams proposed to establish a new sub-genus of *Helix*, under the name *Caldwellia*, for *H. philyrina*, Morel, and some allied species from Mauritius and the Isle of Bourbon.

Chemical Society, Feb. 20.—Dr. Frankland, F.R.S., president, in the chair. The first paper read after the usual business of the society had been transacted, was entitled "Solidification of nitrous oxide," by Mr. Wells. The gas having been previously liquefied by compression in a strong iron vessel, can be caused to solidify by the rapid evaporation of the liquid in a current of air. It somewhat resembles solid carbonic acid in appearance.—A paper on aurin, by Messrs. R. S. Dale and C. Schorlemmer, F.R.S., was then read, giving an account of the authors' investigation of the composition and chemical properties of this dye.—"Researches on the action of the copper-zinc couple on organic bodies, I. on iodide of ethyl," by J. H. Gladstone, F.R.S., and A. Tribe, was read by Dr. Gladstone; and the last communication, "On the determination of ammonia in the atmosphere," was read by the author, Mr. A. H. Smee, Jun. The method employed is to collect and examine the moisture condensed from the atmosphere, on the external surface of a suitable glass vessel filled with ice. The lecture was illustrated by carefully-made drawings of the magnified crystalline forms which are left on evaporating the liquid.

Royal Horticultural Society, Feb. 11.—Annual General Meeting.—Lord Henry G. Lennox, M.P., in the chair.—The Report of the Council stated that there were now 3,572 Fellows on the books. They thought that, notwithstanding that a portion of the Fellows preferred to have the Garden and Society kept distinct from the Exhibition, it was for the interest of the former that the two establishments should work harmoniously. They have accordingly done their best to make arrangements with Her Majesty's Commissioners for the present year. The nature of these arrangements appeared in a letter from the Commissioners appended to the Report. They excited a very stormy discussion, and the further consideration of the Report was referred to an adjourned meeting.

Feb. 12.—Scientific Committee.—Dr. Masters, F.R.S., in the chair.—A letter was read from Col. Jervoise, stating that the two plants of *Agave Americana* which had flowered during the past summer were 23 years old in 1797. The presence of the *Phylloxera vastatrix* on vines about London was stated as having been ascertained without doubt. A discussion then took place on a letter from Major-General Cotton as to the best means of arresting a belt of moving sand which threatens the destruction of Beyrout. General Meeting.—Mr. Wilson Saunders, F.R.S., in the chair.—The Rev. M. J. Berkeley commented on a fine specimen of *Vanda Cathcarti*, which, though a native of the hot valleys of Sikkim, was found to succeed best under a cool treatment. A seed-pod of *Yucca Draconis*, sent by Mr. Wilson Saunders, was noteworthy, because Yuccas rarely fruited in this country.

Feb. 18.—Adjourned Annual General Meeting.—Mr. Wilson Saunders, F.R.S., in the chair.—The consideration of the Report of the Council was resumed. A letter was read from the Commissioners reverting to the subsisting agreement between them and the Society. On the motion of Sir Alfred Slade, the Report of the Council was not adopted. The Council then intimated their intention of resigning, and the meeting again adjourned.

PHILADELPHIA

American Philosophical Society, March 15, 1872.—A paper by Prof. Daniel Kirkwood was read, entitled "On some remarkable relations between the mean motions of Jupiter, Saturn, Uranus, and Neptune."

April 15.—On the Magnetism of Rocks of the Marquette group, by Prof. F. B. Brooks, State Geologist of Michigan. Beds of this formation were shown to possess such an influence on the needle, as to be correctly located by it, even when at considerable depths.—Prof. Pliny E. Chase presented numerous new relations which he had obtained by his method of comparing molar and molecular forces. He showed that the principal maxima of the annual auroral curve follow the principal annual meteoric displays; that all the primary planets are arranged near centres of inertia, or centres of primary or secondary oscillation; that superficial gravity both at Jupiter and at the earth, acting against orbital force for a half-rotation, gives a velocity nearly equivalent to that of a planet revolving at the sun's surface; that solar gravity under the same circumstances gives the velocity of light; that the sun-spot period is governed by the centre of gyration of the planetary system; that polarity is a necessary consequence of a rotating uniformly elastic fluid; that the elasticity of hydrogen is nearly perfect, and that, therefore, its density is, approximately, 54,130,000,000 times as great as that of the luminiferous æther. He also gave several additional physical approximations to the sun's distance, all of which are within the limits of the best recent astronomical estimates.

May 3.—Prof. Rogers described a new form of galvanic battery.—Prof. Lesley described a fault in the Unaka Mountains, on the Nolichucky River in East Tennessee.—Prof. E. D. Cope made some observations on the life of the Wyandotte Cave, Indiana.

May 17.—Prof. Chase exhibited an annual auroral curve, and explained its relations to the periodic maxima and minima of meteoric displays, &c. He then presented a number of tables expressive of recent calculated planetary relationships.—Prof. Rogers explained his manner of obtaining an unlimited supply of electricity from a high-pressure steam jet, not insulated and in all weathers.—Dr. Emerson and Mr. Trego described the destruction of *Abies excelsa*, *Maclura*, and *Thuja* during the preceding winter as far south as lat. 40°.—Prof. Blodget described the meteorology of March 5, 6, and 7, during which a dry cold gale prevailed. In the succeeding spring fruit trees exhibited an inability to blossom as though paralysed.

July 19.—A paper was received from Prof. Cope "On the Tertiary Coal and Fossils of Osino Nevada." The fossils were shown to be *Planorbis* and other freshwater forms; insects (largely *Diptera*) in beautiful preservation, and fishes. The shales resemble the *papier kohle* of Bonn, and contain great numbers of leaves.—Prof. Chase read a paper on "Ætherial Oscillation, the primordial force;" and stated that certain meteorological predictions had been verified, which had been based on his observations of the rainfall at San Francisco.

August 16.—"Descriptions of some new Vertebrata from the Bridger group of the Eocene; second account of new extinct Vertebrata from the Bridger Eocene." In the former, among other new forms, was described *Mesonyx*, a genus of Carnivora or allied form with teeth with only one row of conic tubercles and with flat claws, allied to *Hyacnodon*. Also a genus allied to both Proboscidians and Rodents, without molar teeth, called *Pseudotomus*.—A communication from Prof. Cope was read on his discovery of "*Proboscidia* in the Wyoming Eocene," this order having been previously unrecognised below the Miocene in America. A new genus, *Eobasileus*, was described; dentition, i, 0; c, 1; pm, 3; m, 2, horns on the top of the head. Three species were described, *E. cornutus*, of gigantic size, represented by cranium, scapula, vertebræ, pelvis and femur complete. The horn cores trihedral, the muzzle with two horizontal superior shovel-like expansions. *E. furcatus* with bifurcate nose, with spatulate processes; and *E. pressicornis* with massive feet, flattened horns and high occiput. The tusks were dangerous weapons, a foot long, and sabre-shaped, but the molars were small.

ITALY

R. Accademia dei Lincei, Jan. 5.—Prof. Respighi, in a note upon the solar diameter, proposed to show that the differences of the results in the daily observations of the duration of the meridian passage of the solar disc, ought not to be attributed to real variations in the diameter of the solar disc, caused by the temporary enlargement or diminution of the photosphere, or to variations in brightness arising from the constitution of the photosphere, but rather to the inaccuracies of measurement which inevitably attend such very difficult observations. In observations of the contacts on the solar border by means of the micrometer, there are two principal sources of error, the influence of which may sensibly vary from day to day; they are: (1) The difference of the conditions between the contacts of the west and east limbs. Prof. Respighi observed first by a micrometer in a faintly illuminated field, and secondly in a highly illuminated one: this is apt to introduce an error variable from day to day into the observations of the same person, in proportion to the clearness or transparency of our atmosphere, and will probably become greater when the sky is less clear. (2) From the state of undulation of the solar limb, variable from day to day, there may result a sensible and variable increase of the extent of the disc or diameter of the sun. These influences will not be excluded by the proficiency of the observer, by the use of good instruments, nor by the chronographic registration of the contacts. For the purpose of more thoroughly studying these variations, and investigating their origin, recourse was recently had to the spectroscopic combination of Father Secchi, by which the solar limb or image was obtained, formed by monochromatic or almost monochromatic rays; and from a series of observations made with this apparatus it was found that the solar diameter was less by ·6″ than that given in the *Nautical Almanac*. Hence it has been inferred that by depriving the solar disc or diameter of the influence of the chromosphere its extent is diminished by about 8″ from that obtained by means of the telescope. And therefore it has been inferred that the variations in the solar diameter very probably depend on the variable increase produced on it by the chromosphere, in relation to the extent and intensity of light and the varying state of transparency of our atmosphere. Prof. Respighi, after having shown how the light of the chromosphere could not make any sensible difference to an image of the solar limb or disc, expounded the results obtained from various observations, made by him on the solar diameter by means of the spectroscopic combination alluded to, both with the objective and direct-vision prisms, applied in front of the slit of the spectroscope, using every precaution to exclude the various sources of error. From these observations it results that the duration of the passage of the solar diameter is essentially the same, taking the contacts at the various spectral lines, B, C, D, E, F, and that the measurement agrees very closely with that of the *Nautical Almanac*. The same result is obtained in determining the duration of the passage of the solar-limb by means of the slit of the simple spectroscope. Hence Prof. Respighi concludes that while the difference between the solar diameter, as given by the spectroscope and that given by the telescope alone has not been proved, so the suspected origin of this difference is inadmissible, and therefore also any daily variations in the solar diameter.

VIENNA

I. R. Geological Institute, Jan. 7.—Contributions to a more accurate interpretation of fossil vegetable remains from the salt-stock of Wieliczka (Galicia), by M. Dionys Stur. By dissolving in water pieces of salt from Wieliczka, which included vegetable remains, M. Stur succeeded in getting the latter in a state of preservation and purity which permitted an accurate examination; his very interesting inquiries rectify in many points the determinations made by one of the first authorities in fossil botany, Prof. Unger, who many years ago had given a description of these remains in the first volume of the memoirs of the Vienna Academy. To the most frequent of them belong pine-nuts; besides the one species, *Pinus salinarum* Partsh, described by Unger, Stur discovered two other species: *P. polonica*, which is allied to the existing *P. Massoniana* Lamb, and the larger, *P. Russeggeri*, resembling the *P. rigida* Mill. A very curious fact is noted in connection with these cones; while many of them are perfectly well preserved, many others were found with scales gnawed or bitten off, exactly in the same manner as squirrels (*Sciurus*) demolish the pine-nuts of our forests in order to get their seed corns. Pine-nuts which were not quite ripe are bitten on one side (the sun-side) only, while perfectly ripe nuts are demolished to the basis, which then shows a deceptive likeness with the cupula of an acorn. Indeed the two vegetable remains described by Unger as the cupulæ of *Quercus Saturni* and *Q. limnophila* are but pine-nuts destroyed in the same manner: moreover the oak-apples themselves, mentioned by Unger, have proved to belong to quite different plants. The so-called nut of *Q. glans Saturni* Unger, is the nut of *Carya costata* Sternb, which is also gnawed by a squirrel, whilst the nut taken by Unger for the fruit of *Q. limnophila*, is the fruit of a palm very similar to that of the existing *Raphia tacdigera*, and is named by Stur *Raphia Ungeri*.—K. v. Hauer gave a description of the large quarries in the tertiary limestone of Zogelsdorf in Austria,; in former years they had furnished almost all building stones for Vienna, especially for the famous tower of St. Stephen. Upon the discovery of a very good building stone nearer to the town in the Leitha mountains the quarries of Zogelsdorf decayed, but as soon as the Franz-Joseph railway, which passes very near the spot, made cheap transport practicable, they were reopened by the present possessor, Baron Suttner, and are worked now very extensively.—Dr. G. Stache described an earthquake which was felt in Vienna on January 3, some minutes before 7 o'clock in the evening. In some parts of the town, for instance in the working rooms of the Geological Institute, in the palace of Prince Liechtenstein two shocks were observed, the second tolerably vehement, with a rolling noise. The direction seemed N.W. to S.E.; the duration of the phenomenon was about four seconds.

DIARY

THURSDAY, FEBRUARY 27.

ROYAL SOCIETY, at 8.30.—On Leaf Arrangement: Dr. Hubert Airy.
SOCIETY OF ANTIQUARIES, at 8.30.—Northamptonshire Star-Chamber Proceedings, Temp. James I.: W. H. Hart.
ROYAL INSTITUTION, at 3.—On the Artificial Formation of Organic Substances: Prof. Rutherford.

FRIDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 9.—On Livingstone's Explorations in Africa: Sir H. C. Rawlinson.
QUEKETT CLUB, at 8.
ROYAL COLLEGE OF SURGEONS, at 4.—Extinct Mammals: Prof. Flower.

SATURDAY, MARCH 1.

ROYAL INSTITUTION, at 3.—On the Philosophy of the Pure Sciences: Prof. W. K. Clifford.

MONDAY, MARCH 3.

ENTOMOLOGICAL SOCIETY, at 7.
LONDON INSTITUTION, at 4.—Physical Geography: Prof. Duncan.
ROYAL COLLEGE OF SURGEONS, at 4.—Extinct Mammals: Prof. Flower.
ROYAL INSTITUTION, at 2.—General Monthly Meeting.
CANTOR LECTURES, at 8.—On the Energy of Electricity: Arthur Rigg.

TUESDAY, MARCH 4.

ANTHROPOLOGICAL SOCIETY, at 8.—On the Looshais: Dr. A. Campbell.—Implements and Pottery from Canada: Sir Duncan Gibb, Bart, M.D.—The Venmor Flints: Hodder M. Westropp.
SOCIETY OF BIBLICAL ARCHÆOLOGY, at 8.30.
ZOOLOGICAL SOCIETY, at 8.30.—On the Spiders of St. Helena: Rev. O. P. Cambridge.—On some Marine Mollusca from Madeira: R. B. Watson.
ROYAL INSTITUTION, at 3.—Forces and Motions of the Body: Prof. Rutherford.

WEDNESDAY, MARCH 5.

SOCIETY OF ARTS, at 8.—On Gas-lighting by Electricity, and Means for Lighting and Extinguishing Street and other Lamps: W. Lloyd Wise.
MICROSCOPICAL SOCIETY, at 8.—Notes on the Micro-Spectroscope and Microscope: E. J. Gayer.
LONDON INSTITUTION, at 7.—Musical Lecture.
ROYAL COLLEGE OF SURGEONS, at 4.—Extinct Mammals: Prof. Flower.

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