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THURSDAY, NOVEMBER 16, 1871

NEW WORKS ON MECHANICS

Lehrbuch der Mechanik in elementarer Darstellung mit Uebungen und Anwendungen auf Maschinen und Bau-Constructionen. Von Ad Wernicke. Vol. I. (Braunschweig, 1871. London: Williams and Norgate.)

Lehrbuch der physikalischen Mechanik. Von Dr. Heinrich Buff. Vol. I. (Braunschweig, 1871. London: Williams and Norgate.)

An Elementary Course of Theoretical and Applied Mechanics. By Richard Wormell. Second Edition. (London, 1871. Groombridge and Sons.)

WERNICKE'S work is intended for pupils in the Prussian industrial schools (*Gewerbeschulen*). The first volume treats of Statics and Dynamics, leaving Hydromechanics for the second. According to the preface, students reading this work should be acquainted with elementary mathematics, including co-ordinate geometry, while a knowledge of the differential calculus is not required. From an English point of view, it is not desirable to draw the line between co-ordinate geometry and the calculus. Even in our universities, not twenty per cent. of the students are acquainted with co-ordinate geometry. It is to be regretted that the proportion is so small; that it is so, is due to the present preposterous system of classical education, that relic of the middle ages which is the bane of our schoolboy days. Almost all English students, however, who learn co-ordinate geometry, generally study both the differential and integral calculus before commencing mechanics. Now intelligent pupils like a text-book of mechanics in which they find scope for exercising all their mathematical knowledge; hence it would appear that for English purposes the line is drawn either too high or too low.

As to the manner in which Wernicke has executed his task, it would be hard to speak too favourably; and notwithstanding the point we have raised, we should hail an English translation as a valuable addition to our standard works on mechanics. One of the best features in the book is that it presents theoretical and practical mechanics not as two distinct subjects, but in that degree of combination which naturally belongs to them.

The first volume of Wernicke's work consists of 500 octavo pages, and is divided into three parts. Part I. discusses the Kinematics of a mathematical point, the inquiry being principally confined to space of two dimensions. The symbol j is here and throughout the work used to denote an acceleration: for example, jx is the acceleration parallel to the axis of x. This notation (unfamiliar to English readers) has obvious advantages when the more appropriate language of the differential calculus cannot be employed. About fifty examples, many of a practical character, are appended to Part I. Among them is found (Ex. 31) a problem virtually requiring the integration of x^n. The solution given is necessarily roundabout and cumbrous, owing to the restraint which the author has imposed upon his use of mathematics. It may, indeed, be questioned whether a student who is not acquainted with the integral calculus could really profit by a solution which is merely the integral calculus ground down and spoiled.

Part II. is upon the Mechanics of a material particle. We notice here small points in the diagrams which must be useful to the learner. Thus, in a figure where the length of a line is denoted by a symbol, the extremities of a bracket indicate the extremities of the line. Those who use the black-board in teaching will appreciate the advantage of this detail. Take, for example, Fig. 54, which refers to motion in an ellipse about a force in the focus. In this part and the examples appended, the usual proportions relating to the statics and dynamics of forces applied at a single point will be found.

The third part, which treats of the mechanics of a rigid body, occupies four-fifths of the volume. Chap. I. discusses the Composition and Equilibrium of Forces in space; some of the examples require a good deal of honest numerical work, others are well-known questions not involving friction. Chap. II. is on the Centre of Gravity; in this we do not notice much that is unusual, except the excellence of the illustrations. The examples contain problems on the centre of gravity of various useful areas and volumes, the theory of the arch, and many other subjects.

In Chap. III. we have a treatise upon Friction. We miss here an actual description and discussion of a series of experiments from which the laws of friction are established. This omission is to be regretted, because the laws are only approximate, and it is important for the pupil to have materials presented to him from which he can form his own estimate of their correctness. Intelligent pupils would have been pleased to find how true the laws are on the whole, and interested in noting the discrepancies. No good opportunity for introducing and discussing the results of experiments should have been lost in a work of this kind. With this exception, the force of friction has been treated in a manner worthy of its importance; we find its effect upon the various mechanical powers, upon toothed wheels and brakes, and in many other cases, treated in an excellent manner. Chap. IV., on the Motion of a rigid body, very properly commences with the exquisite kinematical theorems of Poinsot. D'Alembert's principle follows, and also a table of moments of inertia, which will be found a useful aid in recollecting these troublesome quantities.

Chap. V., on Elasticity and Rigidity, is certainly the best chapter in the book. Problems connected with the deflection of a beam are among the most interesting questions of mechanics. We have here an exceedingly careful discussion of this subject, not too much encumbered with formulæ. A large number of examples thoroughly worked illustrate this chapter. Every teacher of applied mechanics will find these examples invaluable; they are far better than those on the same subject in any other book with which we are acquainted.

Finally, in estimating the merits of this work, we must recollect that it is a manual for class instruction; it is not, nor does it profess to be, a comprehensive and original treatise, like the great work of Weisbach.

Buff's work, of which the first volume is before us, is of somewhat different character to that of Wernicke. It bears the same marks of painstaking thoroughness which characterise the better class of German works on science.

The illustrations are also unusually good in both books, but while Wernicke's is professedly a mathematical treatise, the work of Buff leans more to the physical aspects of mechanics. There is, however, considerable reference to mathematics in Buff, in fact, he makes free use of the calculus when necessary.

The book consists of thirteen sections:—Section I. is on Rest and Motion; Section II. on Movement in Space and Time: this contains, in addition to the usual theorems on the motion of a point, a useful article on harmonic motion. Section III. introduces the Composition of Movements; in this will be found a discussion of experiments upon the trajectory of the bullet from the needle-gun. Section V. commences the subject of Mechanical Work; we are glad to see in this book the principle of work receives that prominence which it unquestionably deserves. Section VII., on Friction, discusses, among other subjects, Pambour's experiments upon the friction of railway carriages. Section IX., upon the Efficiency of Machines, is admirable, the theory being properly proportioned to the experiments. We find here a full discussion of the subject, without that deluge of formulæ which is so often repulsive to those in search of distinct physical conceptions. Section X. contains what is familiar to us by the term Mechanism; Section XII. is the most complete account of Centrifugal Force which we have met with in any work; we have here a physical explanation of the permanent axes, of precession and nutation, of the mode of finding the masses of the heavenly bodies, and of various other matters. Section XIII., upon the Motion of the Pendulum, is a collection of interesting subjects, among them Foucault's pendulum, and a far better account of Cavendish's experiments than is to be found in any English book on mechanics. We are also a little surprised to find the weighing scales treated in this section. The arrangement is novel, and though doubtless much might be said in favour of it, yet we think, on the whole, it is not convenient.

We cordially recommend Buff's treatise to the notice of teachers of natural philosophy.

Mr. Wormell's book, which appears to have been specially intended for the London University examination for B.A. and B.Sc., contains practical and experimental illustrations, in addition to the usual matter. We should gladly welcome a thoroughly good work on the general plan which has been adopted by Mr. Wormell, but the book before us ought to receive careful revision before it is placed in the hands of students. We shall indicate some of the points that we have noticed which require correction. We do so in the belief that a future edition of the work might be made really valuable, and supply a much felt want. Some of the errors are common to this work and other text-books. We can, therefore, only accuse Mr. Wormell of reproducing them, but we cannot allow this excuse on every occasion.

On page 14, we find as follows:—"Any two forces F', F' applied at a point M may be transferred parallel to themselves to any other point M' in the line of direction of the resultant."

This proposition, if true, would assert that the attractions of the earth and sun upon the moon might be transferred to any heavenly body in space which happened to be in the line of direction of the resultant of the forces. The geometrical proof of the composition of parallel forces (p. 33) is meaningless, until the proposition referred to has been properly stated. This blunder is extremely common, it arises from enunciating as a property of forces what is really the definition of a rigid body.

On page 112 we find the following passage:—

"1. When the materials composing the surfaces in contact remain the same, the friction varies as the pressure. Suppose, for example, that a block of wood, having a hole bored in it, rests on a plane inclined at the angle of repose, if lead be poured in the hole, *the screw may be turned so as to incline the plane at a greater angle without causing the body to slide*. By increasing the pressure we increase the friction."

This is very bad; the statement we have italicised in the second paragraph is entirely erroneous. So serious an error would be quite inexcusable even in one of those for whose use the book has been written.

We should have liked to have seen more experiments upon the mechanical powers cited. A student who reads (p. 94) that in the three sheave pulley-block the power is one-sixth of the load, will naturally be surprised when he finds by trial that the power must be one-fourth of the load; nor can we find a single word in the book which would enlighten his difficulty. We should also have expected that the author would have replaced the antiquated and useless pulley systems which only exist in manuals, by some compact and useful machines like the differential pulley.

Such are some of the points which we consider to require careful revision before Mr. Wormell's book can be pronounced suitable for the use of students.

OUR BOOK SHELF

Contributions to Botany, Iconographic and Descriptive. By John Miers, F.R.S., F.L.S. Vol. 3, containing a complete Monograph of the Menispermaceæ. Sixty-six litho plates. (London: Williams and Norgate, 1864—1871.)

Mr. Miers's long-promised Monograph of the Menispermaceæ forms the third volume of his valuable "Contributions to Botany." The intimate acquaintance of this veteran botanist with South American plants, and his long study of this particular family, extending over more than twenty years, render his observations peculiarly valuable to all systematic botanists. Although in some important particulars Mr. Miers combats the views of such high authorities as the authors of the "Flora Indica," and those of the "Genera Plantarum," he adduces reasons for his dissent, which will, at least, need careful consideration from all who hereafter write on these plants. Mr. Miers retains, with some modifications, his views of the structure of the different organs in this order published in the Annals of Natural History in 1851, and classifies the genera which constitute it into seven tribes, on characters dependent mainly on the structure of the fruit, and on the position of the cotyledons relatively to the radicle, whether incumbent or accumbent. The establishment of sixty-four distinct genera in the order, instead of the thirty-one admitted by Bentham and Hooker, may be open to criticism, but several of them contain only single species now for the first time described, which appear to be altogether aberrant types of the order. Good plates are always valuable; and we have here sixty-six, drawn on stone by the author himself, containing careful dissections to illustrate the salient characters of the genera and more important species. This concluding volume of Mr.

Miers's "Contributions to Botany" is no less valuable than any of its predecessors as a record of laborious and conscientious devotion to science. A. W. B.

An Elementary Treatise on Statics. By J. W. Mulcaster F.R.A.S., Military Tutor. (London: Taylor and Francis.),

THIS is a good book without any of that attempt at cramming, too common now in our elementary text-books. It is calculated to give the reader a good grasp of the elements of Statics. It goes over the usual ground, states and proves the principles well and clearly, and contains in each chapter a numerous and excellent series of examples. These examples consist of "graduated and classified groups of problems, each involving distinct statical principles." These, the author says, he finds, and our experience entirely agrees with his, make "an impression on the student's mind otherwise not attainable with problems indiscriminately taken." We gather from the book that it is the production of a good and practical teacher. J. S.

LETTERS TO THE EDITOR

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

The Aurora Borealis of Nov. 9 and 10

As the magnificent display of Aurora on the evening of the 10th was witnessed here under very favourable circumstances, and as several of its phases were of unusual occurrence, an abridged account may not be uninteresting.

The Northern Lights were first noticed at about 7.30 G.M.T., the appearance being that of a pale white light, which gradually rose from the N.N.W., until it completely enveloped the Great Bear, but was not sufficiently strong to hide even the faint star near Mizar. Towards 8.40 the auroral mist assumed the more definite form of three broad white bands, stretching across the sky from E. to W., the uppermost band lying just below Vega and Pollux.

At the same time a bank of dense black cloud rose from the N. horizon to the height of η Ursæ, and shot forth dark streamers as far as the upper arch of light, The streamers E. and W. were brighter than the central part, and waves of light moved slowly and at regular intervals from these brighter parts of the horizon, mingling together at the centre of the arch.

At 9.10 a very bright streamer made its appearance.

Up to this time the display had been colourless, but at 9.20 it assumed a greyish tinge, and had extended by 9.25 as far as β Cassiopeiæ.

At 9.30 the western extremity of the arch was of a bright red colour, whilst only a slight appearance of redness was visible in the E.

The aurora then became wonderfully brilliant, and the rapidity of the changes surpassed anything that had been seen here for years. Flashes of light were succeeded by waves, and these in their turn by small detached clouds, which travelled rapidly across the sky. At 9.45 the waves and streamers seemed to converge to a point slightly S.E. of β Andromedæ.

In the square of Pegasus a curiously-formed cloud, in the shape of an enormous bird, suddenly appeared and disappeared several times, sending forth each time streams of light E. and W., as if from its outstretched wings.

At 10 the auroral light was strongest, and then the waves, moving rapidly from the N., appeared to return for a short distance on their path when they had passed a few degrees S. of the zenith, like waves breaking on the sea shore.

At 10.30 two distinct arches of light, the upper one passing through β Andromedæ, the lower one near Polaris, intersected each other E. and W. at an altitude of about 20°.

At 10.40 all colour had disappeared in the west, but a very brilliant red streamer stretched from the E. nearly to the Twins. About this time a thick cloud of elliptic shape was formed between the points N.W. by N. and W. Beneath this cloud was a pale auroral glare, and from its upper side a mass of broad dark streamers rose towards Polaris. At the E. end of the cloud a very broad streamer moved gradually westward, and shortly afterwards a similar streamer formed near the W. and moved in the same direction.

At 10.45 α Arietis was the centre, towards which the new violet-coloured streamers and the waves and flashes tended.

The last-mentioned cloud was then replaced by another similar in form, but situated farther from the E., its outer streamers of a yellowish green colour meeting in Cassiopeia.

At 11 the only colour visible was the violet in the W.

At 11.5 a point S. of γ Pegasi was the centre of motion.

At 11.15 the dark streamers were sharply defined, but extended only a few degrees above the cloud. Ten minutes later the stars below Vega and Ursa minor were completely hidden, and then from 11.25 to 12.15 the aurora gradually died away, leaving only a faint white glare on the N.W. horizon. S. J. PERRY

Stonyhurst College Observatory

ON Friday evening, Nov. 10, I was fortunate enough to witness a brilliant display of the Aurora Borealis, which, if it did not surpass, certainly rivalled, that of Oct. 24, 1870.

At 9h. 20m. G.M.T. the whole sky was literally covered with auroral streaks to within 30° of the southern horizon, all apparently converging to a point near α Andromedæ. The streaks were of a white colour, having a slightly blueish tint (probably caused by the mass of intervening air), and their form, to within 15° of the point of convergence, was perfectly straight. The radial point was shown by an irregular mass of auroral light, from which bright streaks were spread out in every direction, those to the south being much shorter than the streaks to the north or west. The appearance of the sky at the time was that of the outstretched wing of an enormous bird. At 9h. 22m. a rich crimson glare was visible in the S.W., dividing the constellations Pegasus and Cygnus, and at 9h. 25m. a resplendent beam of white light 2° in width was conspicuous in the N.E.; its length was about 50°, and it was nearly parallel in direction with a line joining the stars α Capella and β Aurigæ, but 3° to the left of them. It remained visible for 5m.

At 9h. 25m. 30s. a white luminous meteor (apparently one of the "Leonides") shot swiftly across the constellation Pisces, having a brightness = Sirius, duration 0·5sec., and length of path 10°, left no train or sparks.

At 9h. 32m. the constellation Perseus was overspread by a luminous glare of a reddish colour (known to dyers by the appellation of "ruddy brown,") and which did not disappear for about 10m. At 9h. 34m. the crimson glow reappeared in the S.W. between Cygnus and Pegasus, thereby completing a gorgeous arch about 15° in width, extending from the S.W. to the N.E. horizon, passing over the constellations Cygnus, Lacerta, Perseus, Auriga, and Orion. This crimson belt divided the sky into two halves, that on the north being full of auroral streaks, two columns of which were very conspicuous in the north, passing over Ursa Major and extending nearly to the zenith. A small dark cloud lying horizontally across them divided them into two parts, each of which was distinctly visible.

At 9h. 40m. the streaks had entirely disappeared, being replaced by a diffused auroral glare, similar in appearance to the sky before dawn; but at 10h. the streamers reappeared with equal brilliancy. The radial point had now moved to 2° below β Andromedæ, and was now clearly pointed out by an irregular curve, or hook, about 4° or 5° in diameter, which, although observed at different times during the evening, was never completely formed, as 90° or 120° were always wanting to form a complete circle.

At 10h. 23m. a curious phenomenon presented itself. A small irregular patch of crimson light, about twice the diameter of the moon, appeared over β Trianguli, which slowly, and gradually expanded, but after a lapse of about 30s. (when about 15° in diameter), its colour changed to the ordinary bluish white of the aurora, the phenomenon lasting altogether about 2m. At 10h. 25m. a broad *greenish* white band appeared in the N.E.

By this time the centre of convergence had reached β Trianguli, thus showing apparent progressive motion towards the *east* at the rate of about 15° per hour (which is the rate of the rotation of the earth upon its axis). It is worthy of notice that in the auroral displays of October 1870 the same stars formed the radiant, and its motion was in the same direction.

At 10h. 37m. a beautiful crimson beam appeared in Auriga (in the same position previously occupied by the white streak at 9h 35m.) Its length was about 40°, and at 10h. 50m. a gorgeous *triple* streak was visible in the same position, which presented the appearance of a broad crimson ribbon, with a border of *white* on each side. In about five minutes it faded out of sight.

At 11 o'clock the auroral light was again diffused over the whole northern sky, bounded on the south by a bright milky arch extending from the E. to the S.W. by S. horizon, visible for ten minutes.

At 11h. 30m. only a few faint streamers, and at 12 o'clock the arch was again visible to the S.E., but aurora very faint.

During the progress of the display the peculiar undulatory phases noticed last year were particularly observed. The waves of light seemed to chase each other in rapid succession along the radiating streaks, coming into collision at the point of convergence. The semicircular masses surrounding this point appearing as if they occupied a *fixed* position in the sky, and becoming visible to the eye only as the intermittent waves reached them, somewhat analogous to the waves of the ocean dashing against a rock and breaking over it in a mass of white foam.

In conclusion may I venture to suggest the application of photography to auroral phenomena; and perhaps some of your readers might *practically* answer the query, "Can a photograph be taken of an auroral display?"

ROBERT MCCLURE

342, Argyle Street, Glasgow, Nov. 11

THERE was a brilliant display of Aurora Borealis here on the evenings of Thursday and Friday, November 9 and 10—especially the latter night. Towards 7 o'clock a hazy light began to spread itself over the northern sky, near the horizon, not unlike a brilliant twilight. At 8 P.M. two arches were quite distinct, the upper one being well defined, with its apex passing through the head of Ursa Major. Gradually streamers began to pass from this, and by 9h. 15m. the scene was simply gorgeous. I do not remember ever seeing the streamers so expanded—more like flames, nor possessing such intense whiteness, so much so, that the evening was almost as light as if the moon had been shining. After proceeding from the upper arch, their course was most rapid to the zenith—apparently passing at times behind clouds, then suddenly emerging—where a magnificent whirling motion was formed, which kept changing in true Protean fashion. A grand, though somewhat dingy, red haze next appeared in the west, which gradually ascended towards the zenith, when it disappeared. Meanwhile flashes of light, resembling summer lightning, darted upwards from about 45° from all directions, and not least from the south—the N.W. heavens assuming a muddy green colour. About a quarter-past ten P.M. the aurora gradually diminished, especially the upper arch, and streamers from it. Then the lower arch began to give off streamers, but these were short and, of short duration, though of considerable brightness. The display of Friday, if it fell short of those of October 23 and 24, 1870, in point of brilliant colours, surpassed them in some respects—*e.g.* extent of streamers, and brilliancy of light. Barometer corrected and reduced 29·472: Temperature 32.°

THOMAS FAWCETT

Blencowe School, Cumberland

THERE was a very bright Aurora here last night: the streamers were white, with a red glow in some places. At about ten there was that beautiful and rare phenomenon—a "corona" of streamers converging at the zenith. The barometer was about 29·6. This morning is fine, with the barometer rising.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, Nov. 11

THERE have been two magnificent auroral displays on the nights of the 9th and 10th inst. That on the 9th commenced at 10 o'clock, and continued with little interruption until 12.45; and last night from 9.40 until 12 o'clock. Both displays were in the north and north-west, and at times the streamers reached the zenith, but I did not observe them to pass beyond that point. The colours were varied; at one time of a beautiful crimson, at another a greenish white. Last night's display was the most interesting, but not so brilliant as that of the previous night. The aurora made its first appearance by an undefined redness in the north; it then gradually developed into a crimson, and assumed the shape of a vertical pillar, the upper part tapering to a clearly defined point, within a few degrees of the zenith. It remained in this shape and position for two minutes, and then faded away. At 10.15 there appeared, at about 10 degrees above the horizon, a peculiar lightness, like the edge of a dark horizontal cloud illuminated by the hidden moon, but I could distinctly discern some stars below the illuminated *stratum*, which proves that the *cloud* was transparent; the stars could not, however, be seen through the lightness. At 10.40 there were three distinct streamers shooting up from this light, emanating from separate parts, but all in the north and north-west. They then assumed an easterly movement, the right hand streamer before disappearing being in the north-east. The centre one of these was of a very light colour, approaching a faint or whitish green; the others were crimson. At 11 o'clock I saw an exceedingly brilliant *patch* undefined in the north-east; by this time some clouds, stratified horizontally, rose from the northern horizon and passed into the light part of the heavens, which seemed to influence the display by intensifying the streamers, which were shooting up, at this time, to the zenith. At 11.30 I saw six beams start across east and west, of a whitish colour with dark spaces between, and the southern one in the zenith. The northern streamer now disappeared, but the *auroral twilight* was still visible, although gradually fading, and by 12 o'clock all was darkness. I did not continue my observation beyond this hour, the temperature not being conducive to personal comfort.

I may remark that with the exception of the few clouds which rose last night, both nights were perfectly cloudless, and the milky way shone with uncommon splendour. A portion of this band of stars at one time looked grand, as one mighty streamer ran along its course, some of the largest stars being visible through the intercepting redness.

I hope that some of your correspondents will give particulars of any magnetic disturbances which may have occurred on the nights of the above displays.

JOHN JEREMIAH

43, Red Lion Street, Nov. 11

P.S.—I have been informed that the white horizontal light mentioned in my communication of the 11th inst. was visible at 7.30 on the night of the 9th, but no streamers were seen until the time stated by me.

On Saturday night, at 7.45, I saw in the north-western sky a slight auroral redness, but it did not last more than two minutes.

Nov. 13 J. J.

Nov. 10th, 11 P.M.—I have just witnessed a most magnificent display of Aurora. I first saw it at 9.30. Here is an account of it. The bearings given are magnetic.

9.30 P.M.—On the W. was a deep crimson glow of the richest possible colour, about 50° broad and 60° high. From W.N.W. to N. the sky was filled by a mass of white light, pulsating in long horizontal masses moving upwards. At 9.36 they were moving, not very uniformly, at the rate of 33 waves per minute. From the N. to the E. extended a bright horizontal bend of steady white light, marked with vertical lines and having jagged edges. Suddenly from the centre of it shot up a vertical white streamer 3° or 4° wide; this remained stationary for a few minutes and then gradually faded away.

At 9.38 a fan-shaped mass of white light appeared at N.N.E. At 9.45 a band of white light extending from the horizon to a height of about 20°. From the centre of this streamed upwards a kind of waving flag of intense red light, about 20° broad and reaching to the zenith. At N.N.E. the fan was gone and a bright horizontal band of white light marked with vertical lines had taken its place. It was almost 40° long and 30° high. At 9.50 there appeared an arch of white light about 10° thick. The centre was about 60° high, white, the ends were on the horizon at E.N.E. and N.W. This vanished and was replaced by a horizontal white band, about 60° long and 10° high, the lower edge being about 20° above the horizon. Out of this presently rose four beautiful white streamers. At 9.52 an intensely bright red light was observed at W. At the N.E. were a few patches of white light. At the N.N.E. appeared about ten vertical white streaks for a minute or so. They were 15° high and filled a horizontal space of about 20°. At 9.53 a rather fine meteorite fell. At the N.W. was a red stream about 30° broad and 80° high, while at W.S.W. was a mass of red light. At 9.55 the mass of white light at E.N.E. threw out a number of jets of light in shape like the streams of water from the rose of a watering can. At 10 P.M. the arch which had vanished reappeared, reaching from W.N.W. to E.N.E. It glowed with a deep white light, which was motionless, except that at 10.2 I observed two downward waves. At 10.3 a long streamer grew out of it. At 10.5 the right-hand end was tossed up into the form of a haycock. At 10.8 a glow spread upwards from the centre of the arch, and filled the upper part of the sky. At the same time a slight patch of red light reappeared in the W. The sky to the S. was lighted up with the reflection of the white light in the N. The reflected light seemed to have a faint reddish tinge.

By 10.10 nothing was left except the arch, and between 10.10 and 11 that also vanished.

The stars could be seen distinctly through the aurora. When the light was at the brightest I could see the figures and hands of a large watch, but could not distinguish the figures one from another. Thermometer 30·5 F.; Barometer 29·69 inches.

Pixholme, Dorking, Surrey J. E. H. GORDON

Structure of Lepidodendron

PROFESSOR DYER has already discovered one of the many new facts with which he has yet to become familiar, and hastens, in a straightforward manner, to acknowledge the circumstance; but I must again remind him that this, along with many other facts, was described in No. 129 of the Proceedings of the Royal Society. Professor Dyer further says: "Suppose the transverse septa separating these cells absorbed, *as probably eventually they would have been*, and the rows of cells become scalariform vessels." But I can assure him, as a question of fact, that these cells do *not* become so changed; consequently his conclusion that the central cells and the investing vessels are but parts of "one central structure" becomes negatived. The separation of these two structures *increases* with age instead of *diminishing*.

W. C. WILLIAMSON

Encke's Comet

IT may interest those who possess small telescopes to know that this comet is now within the range of instruments of moderate apertures. On November 10 I had a very satisfactory view of it, with a 4″ equatorial by Cooke; no signs of a nucleus were observed, but there appeared to be a slight condensation of light on the *following* side of the comet. THOS. G. E. ELGER

Bedford, Nov. 11

The Science and Art Department

IN your last number there appears a letter signed "Henry Uhlgren," which, among other interesting statements, contains the following: Referring to Mr. Forster's statement in the House of Commons that there was no foundation for the report that "the Examiners after having made their reports had the papers returned to them, with an instruction to reduce the number of successful candidates, as an intimation had been given by a right hon. gentleman that the amount of the Grant due upon those papers must be reduced 20,000*l*.," Mr. Uhlgren states: "But previous to that a provincial local secretary, hearing the rumour, wrote to ask the Department if it were true, and received a reply saying it was true, and that instead of the amount being 20,000*l*. it was 40,000*l*. (the Department's letter can be produced.)" Premising that the amount of the whole vote for payments to teachers on results in science (which was to be reduced by 40,000*l*.) was 26,000*l*., may I ask for the production or publication of this extraordinary official letter? X

ECONOMICAL ALIMENTATION

IN glancing over the recent issues of the *Comptes Rendus*, one cannot but fail to be struck with the practical importance of many of the communications contained therein, a large proportion of which bear special reference to the Siege of Paris. In nearly every branch of science there is some endeavour made to supplement and improve our knowledge in matters such as were then of the greatest importance, and the members of the *Académie* have come forward eagerly to aid, by advice and precept, in overcoming the misery of a prolonged siege. Unfortunately, but little could be done, even by such men as Fremy, Dumas, Chevreul, and others, against the insuperable difficulties which presented themselves; but nevertheless Paris owes much to her men of science who contributed many services of value, at a time when these were most needed. The manufacture and employment of nitro-glycerine in mines and shells, were successfully accomplished at a crisis when the stock of gunpowder was running terribly short, and the supply of some other reliable explosive was rendered imperative. Hitherto nitro-glycerine had been regarded as a most dangerous combustible, liable to explode at the slightest concussion, and yet we hear of its employment in shells against the Prussians, thundered forth from guns of the heaviest calibre, without one single instance of its premature explosion being recorded. Again the question of ballooning, although not perhaps very far advanced by the deliberations of the *Académie*, has, at any rate, been more satisfactorily solved than at any previous period, and Paris has been certainly the first to employ these frail and romantic contrivances in a practical every-day manner, and thus to render the words, "*par ballon monté*" familiar to the ear as a household phrase. In matters of surgery, as in those of a sanitary nature, sound advice was not wanting, and even the abstract calling of the soldier, —the philosophy of his manner of fighting—formed the theme of much scientific discussion.

But the most interesting, perhaps, of all the subjects with which the *Académie des Sciences* busied itself, was that of seeking an economical means of alimeniation for the inhabitants of Paris during the siege. Given certain limited sources of supply, a fixed amount of suitable organic matter, and the problem was how to use the same to the fullest and most profitable degree. Of sheep and oxen there was but an exceedingly limited provision in proportion to the very populous state of the city, and although corn and wine were said to be in abundance, there is no doubt the authorities were from the first sorely troubled by the vague estimates that were published of these comestibles.

As a suitable manner of economising corn, M. Gauldrée called attention to the method in vogue among the Romans of parching and bruising the grains, which in this state may be made to yield an excellent and highly nutritious soup or porridge. The corn is carefully sifted by hand, browned without charring, until it breaks when taken between the teeth, and then ground in any available mill; it is mixed with cold water, boiled for thirty minutes, and seasoned as desired. So economical was this preparation, that at the public kitchens, established in certain quarters of Paris, it was possible to dispense one portion of *bouillie romaine* together with a small modicum of wine for the amount of five centimes.

A proposition to manufacture artificial milk, brought forward by M. Gaudin, seems worthy of some notice. That gentleman estimated that 500,000 litres per day of milk could be prepared in Paris at an exceedingly trifling cost, which should have all the nutritious qualities of good milk, and which should, besides, be neither unpleasant of taste or smell. An emulsion at a very high temperature is made of *bouillon de viande* prepared from bones, fat, and gelatine, and when cold, a product is obtained resembling in taste stale milk of a cheesy flavour; the components of ordinary milk are all present, the gelatine representing the casein; fat, the butter; and sugar, the sugar of milk. For admixture with coffee, chocolate, soup, &c., the milk is said to be by no means disagreeable.

Many propositions were brought forward to economise the blood from the abattoir, the plan suggested by M. Gaultier of mixing it with flour in the manufacture of bread being perhaps the best and simplest, as the fibrine and albumen, so rich in nitrogen—of which the alimentary properties are well known—are in this way utilised to the highest degree. Less inviting is the proposal of M. Fud to consume he carcases of animals that died of typhus, rhinderpest, and other diseases, the flesh in these instances being, so asserts M. Fud, capable of use as food, if only cooked in a suitable manner.

More important, however, than all, is M. Fremy's attempt to bring forward osseine as an article of food. Osseine is essentially different from gelatine, which has recently been asserted by chemists—erroneously, so M Fremy thinks—to be not only unnutritious, but positively injurious to the human system. Leaving, however, the question of gelatine on one side, M. Fremy proceeds to advance the qualifications of osseine as an alimentary substance. Although gelatine and osseine are isomeric, in the same way as starch and dextrine are isomeric, they have not the same properties. Gelatine, unlike osseine, does not exist in organism, but is produced by chemical transformation resulting from the action of water and heat upon the bony tissue; gelatine, moreover, is completely soluble in water, while osseine is not so. For these reasons the two substances would doubtless be different in their alimentary capacities, and deductions drawn from the influence of one upon the human system ought not in any way to prejudice the other. Of course, says M. Fremy, osseine cannot be expected to fulfil the same duty as a complete aliment; such, for instance, as bread, or meat, but must be employed in conjunction with some other suitable material. In the same way gluten, which is simply flour freed from starch, oil, and soluble substances, would alone be powerless to support life and health. If regarded in the same light as fibrine, casein, and albumen, and associated with other bodies, osseine would be found a valuable aliment. White meat, calf's head, neatsfoot, &c., contain much bony tissue, and their nutritious qualities are incontestable.

Of this osseine, then, bones are said to contain 35 per cent., the mode of separation being simply to slice the bone very thinly, and to treat the same with dilute hydrochloric acid; hard white bones, free from fat, are most suitable, and some care and attention in manipulation is of course necessary, so that the product may be perfectly sweet and free from any taint or unpleasant odour. For if disgust is once aroused against this kind of food, as indeed against any other for that matter, no amount of pushing or puffing can force it into the public market. Should, therefore, any trace of acid be perceptible after preparation of the osseine, it is recommended that the product be treated with an alkali of some kind, for example, lime or carbonate of soda, but this must obviously be done with due care and discretion. The cost of this aliment is about one franc per pound, whereas gelatine of good quality costs from four to five francs.

As regards the best method of cooking or curing, M. Fremy recommends the swelling of the mass with hot water, and then boiling for about an hour, when the tissue becomes soft and pliable; it may be seasoned in the cooking, or may be allowed to cool and then kept for thirty-six hours in brine. If eaten warm with admixture of some fat and vegetables the osseine is decidedly palatable. Owing to its large constituent of nitrogen it is extremely nutritious, and, furthermore, forms a comestible not liable to become putrid.

It is right to mention that on some of the points enumerated by M. Fremy, exception is taken by M. Dumas and others, who are not so confident of the real value of osseine as an alimentary substance, those gentlemen maintaining the injurious nature of gelatine; M. Chevreul, however, confirms to some extent M. Fremy, and states that osseine is decidedly more nutritious than gelatine.

Other measures for improving the alimentation of Paris were taken during the siege, but these for the most part present little novelty. Mr. Wilson's plan for salting the carcases intact, and thus preserving the meat in an almost fresh condition, was resorted to, that gentleman bringing his personal staff from Ireland to afford assistance just at the instant of closing the gates of the metropolis. The assistance of M. Georges, whose plan of preserving meat is both original and peculiar, was likewise obtained; this invention, which has been practised it is said with much success in America, is adapted more particularly for the curing of mutton rather than beef, and consists in treating the meat in a bath acidified with hydrochloric acid, and afterwards in a solution of sulphite of soda. In this condition, after further sprinkling with sulphite of soda, the flesh is packed in tins and soldered down; the sulphite of soda acting upon the hydrochloric acid gives rise to sea salt and sulphurous acid, thus ensuring the perfect preservation of the meat.

H. B. P.

THE TEMPERATURE PRODUCED BY SOLAR RADIATION

SIR ISAAC NEWTON determined the intensity of solar radiation by observing the increment of temperature of dry earth on being exposed to the sun. In the latitude of London at midsummer, dry earth acquires a temperature of 150° in the sun at noon and 85° in the shade, difference about 65° Fah. This difference Sir Isaac Newton regarded as a true index of the intensity of solar radiation; hence his celebrated demonstration proving that the comet of 1680 was subjected to a temperature 7,000 times higher than that of boiling water (212° × 7,000 = 1,484,000° Fah.).* The comet when in its perihelion being within one-third part of the radius of the sun from his surface, we have to add the diminution of temperature, 0·44, attending the dispersion of the rays in passing through the solar atmosphere and the remainder of the stated distance from the sun. Accordingly, the demonstration showing that the comet of 1680 was subjected to a temperature 7,000 times higher than that of boiling water, establishes a solar temperature exceeding 2,640,000°; and if we add 0·21 for the retardation of the rays in traversing the terrestrial atmosphere, it will be found that the temperature deduced from the experiments with incandescent radiators, and our actinometer observations, differs scarcely $\frac{1}{5}$ from that roughly estimated by the author of the "Principia." In order to comprehend fully the merits of the method of determining solar intensity conceived by his master mind, let us imagine an extended surface of dry earth, one half of which is shaded, the other half being exposed to the sun. Dry earth being a powerful absorbent and radiator, and at the same time a bad conductor, the central portion of the supposed surface evidently cannot suffer any loss of heat by lateral radiation; while the non-conducting property of the material prevents loss by conduction laterally or downwards. Consequently, no reduction of temperature can take place excepting by radiation in the direction of the source of the heat. Removing the shade, during an investigation, it will be found that, notwithstanding the uninterrupted radiation of the exposed substance upwards, the intensity will gradually increase until an additional temperature of about 65° Fah. has been acquired. Indisputably, this increase of temperature is due to unaided solar radiation. Evidently the accidental interference of currents of air need not be considered. Besides, if the dry earth is confined within a vacuum, such interference may be entirely obviated. It is scarcely necessary to point out that the generally-adopted mode of measuring the sun's radiant heat by thermometers, is in direct opposition to the principle involved in the method under consideration. The meteorologist, in place of preventing the bulb from radiating in all directions and guarding against loss of heat by convection, puts his thermometer on the grass, or suspends it on a post, one half of the convex area of the bulb receiving the sun's radiant heat, while the other half is permitted to radiate freely, the whole being exposed to the radiation from surrounding objects and to the refrigerating influence of accidental currents of air, in addition to the permanent current produced by the ascending heated column above the bulb. This explains the cause of the perplexing discrepancies in meteorological records. The extent of the diminution of intensity of solar radiation occasioned by cold air acting on the bulb, and by the latter radiating freely in all directions, is demonstrated in the most conclusive manner by the result of observations made with the instrument described by Père Secchi in

* Sir Isaac Newton has been criticised for comparing the temperature to that of red-hot iron, "a term of comparison indeed of a very vague description," it is said in "Outlines of Astronomy." This criticism is far from being correct, since the demonstration clearly shows what is meant by the term red-hot, viz. a temperature 3·5 times that of boiling water. The reference to red-heat, exceeded "two thousand times," was evidently intended to furnish some adequate notion of the inconceivably high degree of temperature involved in the computation.

TABLE A.—*Showing the Temperature produced by Solar Radiation at Noon, for each degree of Latitude, when the Earth is in Aphelion. Northern Hemisphere :—*

	Latitude.	Solar intensity at Noon.	Latitude.	Solar intensity at Noon.	Latitude.	Solar intensity at Noon.	Latitude.	Solar intensity at Noon.	
	Deg.	Fah.	Deg.	Fah.	Deg.	Fah.	Deg.	Fah.	
Equator	0	65·30	24	67·20	49	64·95			
	1	65·45	25	67·19	50	64·77			
	2	65·60	26	67·18	51	64·58			
	3	65·75	27	67·17	51·28	64·48	... ...	... ...	Greenwich.
	4	65·89	28	67·14	52	64·38	72	58·69	
	5	66·02	29	67·10	53	64·17	73	58·31	
	6	66·15	30	67·05	54	63·96	74	57·92	
	7	66·27	31	66·99	55	63·74	75	57·52	
	8	66·39	32	66·93	56	63·51	76	57·10	
	9	66·49	33	66·87	57	63·28	77	56·67	
	10	66·58	34	66·80	58	63·04	78	56·24	
	11	66·66	35	66·73	59	62·79	79	55·79	
	12	66·73	36	66·66	60	62·53	80	55·32	
	13	66·80	37	66·58	61	62·25	81	54·84	
	14	66·87	38	66·49	62	61·96	82	54·35	
	15	66·93	39	66·39	63	61·65	83	53·84	
	16	66·99	40	66·27	64	61·34	84	53·32	
	17	67·05	41	66·15	65	61·03	85	52·78	
	18	67·10	42	66·02	66	60·72	86	52·23	
	19	67·14	43	65·89	66·30	60·57	... ...	... ...	Arctic Circle.
	20	67·17	44	65·75	67	60·41	87	51·68	
	21	67·18	45	65·60	68	60·09	88	51·11	
	22	67·19	46	65·45	69	59·76	89	50·52	
	23	67·20	47	65·30	70	59·42	90	49·91	North Pole.
Tropic of Cancer	23·30	67·20	48	65·13	71	59·06			

TABLE B.—*Showing the Temperature produced by Solar Radiation of the Earth's orbit; also the gradual* DIMINUTION *of Temperature during the first half, and the gradual* INCREMENT *of Temperature during the second half-year :—*

DATES.	1st.		5th.		10th.		15th.		20th.		25th.	
MONTH.	Max.	Diff.	Max.	Diff.	Max.	Diff.	Max.	Diff.	Max.	Diff.	Max.	Diff.
	Fah.	Fah.	Fah.	Fah.	Fah.	Fah.	Fah.	[illegible]	Fah.	Fah.	Fah.	Fah.
January	90·72	5·88	90·70	5·86	90·67	5·83	90·62	5·78	90·54	5·70	90·44	5·60
February...	90·28	5·44	90·16	5·32	90·01	5·17	89·83	4·99	89·64	4·80	89·43	4·59
March	89·27	4·43	89·09	4·25	88·86	4·02	88·62	3·78	88·37	3·53	88·12	3·28
April	87·77	2·93	87·57	2·73	87·32	2·48	87·07	2·23	86·83	1·99	86·59	1·75
May	86·32	1·48	86·15	1·31	85·95	1·11	85·76	0·92	85·58	0·74	85·43	0·59
June	85·22	0·38	85·13	0·29	85·03	0·19	84·96	0·12	84·90	0·06	84·86	0·02
July	84·84	0·00	84·85	0·01	84·87	0·03	84·92	0·08	84·99	0·15	85·07	0·23
August	85·22	0·38	85·34	0·50	85·49	0·65	85·65	0·81	85·83	0·99	86·03	1·19
September	86·32	1·48	86·50	1·66	86·73	1·89	86·97	2·13	87·22	2·38	87·47	2·63
October	87·77	2·93	87·97	3·13	88·22	3·38	88·47	3·63	88·71	3·87	88·95	4·11
November	89·27	4·43	89·43	4·59	89·64	4·80	89·83	4·99	90·01	5·17	90·16	5·32
December	90·33	5·49	90·42	5·58	90·52	5·68	90·61	5·77	90·66	5·82	90·70	5·86

TABLE C.—*Temperatures produced by Solar Radiation, June 26, 1871, compared with the Temperatures entered in the Table constructed 1870, for corresponding Zenith distances. Mean discrepancy = 0·26° Fah. :—*

	ZENITH DISTANCES—DEGREES.								
	57	58	59	60	61	62	63	64	65
	Fah.	Fah.	Fah.	Fah.	Fah.	Fah.	Fah.	Fah.	Fah.
Observations June 26, 1871 ...	55·64	55·00	53·83	53·51	53·41	52·76	52·23	51·70	51·27
Table of 1870	55·09	54·60	54·10	53·58	53·05	52·50	51·90	51·40	50·81

his recent work "Le Soleil" (p. 267). "During a great number of observations made at Rome," says the author, "the difference between the two temperatures (that indicated by the thermometer exposed to the sun and that of the surrounding casing), was 12·06° (21·70° Fah.); during days when the sky was clearer, it rose to 14°." Consequently, the highest temperature indicated by the instrument referred to, was 25·2° Fah., against 66·04°, which is the true maximum solar intensity in the latitude of Rome. It will be seen then, that, by exposing the bulb of the thermometer in the manner pointed out, it is possible to reduce the temperature produced by solar radiation to 0·38 of the actual temperature.

It will be proper to observe with reference to the accompanying tables—constructed in accordance with the result of investigations continued winter and summer during three years—that the opinion expressed by the Director of the Roman Observatory, respecting solar intensity at different seasons, is wholly at variance with the facts established by my numerous observations. The question was raised last summer whether the high temperature during the "heated term" would not charge the atmosphere with an additional amount of vapour capable of retarding the passage of the heat rays, thus rendering the figures entered in my tables to some extent unreliable. Accordingly, during the solstice June 26, 1871, the sky being very clear, the actinometer was put in operation for the purpose of ascertaining with critical nicety whether the atmosphere which had been loaded with vapour for several weeks previously possessed any unusual property tending to check the heating power of the sun's rays. The observations were made late in the afternoon under great zenith distance and increased atmospheric depth, in order to subject the heat rays to an additional retardation from the supposed vapours. The result is recorded in Table C, by which it will be seen that the reduction of temperature was only 0·26° Fah., a difference too small to call for any explanation. The result of the observations made during midwinter are equally conclusive with reference to the permanency of solar energy at all seasons. Among others may be mentioned that of January 17, 1871, the zenith distance being 61° 30′, the actinometer remained perfectly stationary at 58·73° Fah., from 12h. 10m. to 12h. 20m. P.M. The table just referred to shows that on June 26, 1871, the actinometer indicated 53·08° when the sun's zenith distance was 61° 30′. Hence during midwinter the temperature proved to be 58·73° − 53·08° = 5·65° higher, for corresponding zenith distance, than during the summer solstice. By reference to Table B it will be seen that owing to the diminished distance between the sun and the earth, the increment of temperature on January 17, ought to have been 5·75°, discrepancy = 0·1° Fah. In the face of such facts it is idle to contend that the temperature produced by solar radiation under corresponding zenith distance and a *clear sky*, varies from any other cause than the varying distance between the sun and the earth. Of course there are many regions in which the sun, in consequence of local peculiarities, but seldom acts with maximum energy. Alaska, for instance, is hardly ever favoured with a full amount of solar heat; nor does Rome, we are now informed by the Italian physicist, receive maximum solar heat excepting during winter, owing, it may be imagined, to the absorptive power of the atmosphere of the Campagna during summer.

Without entering the field of speculation, let us consider that the established diminution of solar heat on the ecliptic, nearly 18° Fah., proves the existence of a powerful retarding medium, and points to the presence of a permanent mass of aqueous matter in the higher regions of the atmosphere; necessary, it may be urged, to regulate terrestrial temperature and render vegetable life possible under the destructive vicissitudes of heat and cold, inevitable in the absence of a permanent regulator. The assumption that the supposed mass of aqueous matter is nearly invariable, and at all times present, can alone account satisfactorily for the remarkable fact that, whenever a clear sun is presented, either by the opening of the clouds or by their disappearance, the actinometer indicates the same temperature, subject only to the variations depending on the sun's zenith distance, and the varying position of the earth in its orbit. The variation of temperature produced by the latter cause is entered in Table B, for every fifth day in each month. This table, an extract from a more elaborate one showing the temperature for every day in the year, the meteorologist will find indispensable to harmonise observations made at different seasons. It may be mentioned that the attempt to construct a curve, the ordinates of which would determine the temperature for different zenith distances, at first met with apparently insuperable difficulty. The result of observations made at different seasons under the most favourable circumstances, failed to produce a regular curve until the change of temperature corresponding with the varying distance between the sun and the earth was determined and introduced in the calculation. This at once harmonised the previously conflicting observations, and rendered the task easy of perfecting the curve, and obtaining ordinates consistent with the observed temperature produced by solar radiation at different seasons and different zenith distance.

Regarding Table A, it will suffice to state that it is based upon our acquired knowledge of the temperature produced by solar radiation at given zenith distances when the earth is in aphelion. Evidently if we know that, for instance, when the sun's zenith distance is 43° the temperature is 60·57° Fah., we know also that this is the temperature at noon on the Arctic Circle, the latter being 43° from the ecliptic at the summer solstice. Again, the North Pole being 66° 30′ from the ecliptic at the same time, we find by referring to the figures entered in the table of zenith distances and temperatures (previously published) that the depth of atmosphere to be penetrated by the rays when the sun is 66°, 30′ from the zenith, is 2·444 times greater than on the ecliptic; and that, therefore, the radiant intensity, as shown in the table, is reduced from 67·20° at the tropic of Cancer to 49·91° Fah. at the pole. Possibly it may be found necessary to introduce a correction for the difference of atmospheric density in the higher latitudes; but at present I deem it inexpedient to complicate the matter by applying a correction which obviously cannot affect the general result.

J. ERICSSON

NOTES

THE Anniversary Meeting of the Royal Society will be held on the 30th inst., when Sir Edward Sabine will deliver his eleventh and last anniversary address. Prof. G. B. Airy, the Astronomer Royal, will be brought forward as his successor.

AT the opening meeting for the session of the Royal Geographical Society, on Monday evening last, the president, Sir H. Rawlinson, announced that, in consideration of Dr. Livingstone's services, Her Majesty's Government had been pleased to grant to his children the sum of 300*l*.

THE following are the lecture arrangements for 1871-72 at the Royal Institution, Albemarle Street:—Prof. Tyndall, F.R.S.: six lectures on "Ice, Water, and Air," on December 28, 30, 1871; January 2, 4, 6, 9, 1872. Dr. W. Rutherford, F.R.S.E.: ten lectures on "The Nervous and Circulatory System," on Tuesdays, January 16 to March 19. Prof. Odling, F.R.S.: ten lectures on "The Chemistry of Alkalies and Alkali Manufacture," on Thursdays, January 11 to March 21. Mr. W. G. Clark, late Public Orator: six lectures on "The History of Dramatic Literature, Ancient and Modern," on Saturdays, January 20 to Feb. 24. Mr. Moncure D. Conway: four lectures on "Demonology," on Saturdays, March 2 to 23. The Friday evening meetings will commence on January 13. The Friday evening discourses before Easter will probably be given by Mr. W. R. Grove, the Archbishop of Westminster, Professors Odling and Humphrey, Dr. Gladstone, Messrs. C. W. Siemens, R. Liebreich, and John Evans, and Prof. Tyndall. Dr. Wm. A. Guy, F.R.S.: three lectures on "Statistics, Social Science, and Political Economy," on Tuesdays, April 9, 16, and 23. Mr. Edward B. Tylor, F.R.S.: six lectures on "The Development of Belief and Custom amongst the Lower Races of Mankind," on Tuesdays, April 30 to June 4. Prof. Tyndall, F.R.S.: nine lectures, on Thursdays, April 11 to June 6. Mr. R. A. Proctor, F.R.A.S.: five lectures on "Star Depths," on Saturdays, April 13 to May 11. Prof. Roscoe, F.R.S.: four lectures on "The Chemical Action of Light," on Saturdays, May 18 to June 8.

THE following Lectures to Women, on the Elements of Physical Science, will be delivered during the ensuing term, in the Lecture Theatre of the South Kensington Museum, by Professors Huxley, Guthrie, and Duncan. Professor Duncan: ten lectures on "Elementary Physiography," commencing on Saturday the 18th November, and ending on the 20th December; Saturdays and Wednesdays at 2.30. Professor Guthrie: fifteen lectures on "Elementary Physics and Chemistry," commencing on Wednesday the 10th January, and ending on Wednesday the 28th February; Wednesdays and Saturdays, at 2.30. Professor Huxley: ten lectures on "Elementary Biology," commencing on Saturday the 2nd March, and continued on Saturdays only at 2.30 P.M., on the 9th, 16th, 23rd March; 13th, 20th, 27th April; 4th, 11th, 18th May.

A CLASS for the teaching of Natural Science has been formed at the College for Women, at Hitchin. Until very recently, classics and mathematics were almost exclusively the subjects brought under the consideration of the students; but a demand for the teaching of Natural Science has arisen, and under the advice of Prof. Liveing, of Cambridge, the subject of Chemistry has been taken to begin with. Prof. Liveing is on the list of lecturers at the College for Women, but in consequence of the weak state of his health—the result of overwork—he is unable to undertake the teaching himself. The actual professor at Hitchin is Mr. Hicks, Natural Science Lecturer at Sidney Sussex College, Cambridge. The lecturer gives one lecture a week, illustrated by experiments; and Mrs. Whelpdale, a lady who has had experience in teaching the subject, also gives supplementary teaching once a week. This lady works under the direction of Mr. Hicks, and acts as a tutor preparing for the lectures. So far as this has been worked, the plan seems to answer exceedingly well. The apparatus considered by Prof. Liveing and Mr. Hicks to be indispensable, has been provided by the college, but the authorities would be glad to make it more complete. Prof. Liveing has kindly promised to lend from Cambridge some of the more expensive things which are not in constant use. It is quite evident, however, that until there is a completely furnished laboratory, with all the appliances requisite for the study of Physical Science, the efforts made for the teaching of such science must be, to a certain extent, partial. It is to be hoped that funds will be forthcoming from some of the friends of the higher education of women to furnish the means for all that is needed in the new college building near Cambridge, to which the College for Women will, in time, be removed.

A BARONETCY has been conferred on Prof. Christison of Edinburgh in recognition of his well-earned position at the head of the profession in Scotland. Prof. Christison already holds the appointment of Honorary Physician to the Queen in Scotland, and is President of the Royal Society of Edinburgh. He has received the honorary doctorate of Oxford, and has been twice President of the Royal College of Physicians of Edinburgh. He has been a professor of the University of Edinburgh since 1822, and is the author of a work on Poisons, which, although written many years since, is still a standard authority; and of a highly esteemed treatise on Materia Medica. Sir Robert Christison is a Crown Member of the General Medical Council, and took a leading part in framing the authorised edition of the *British Pharmacopœia* issued by the Council. Recently, as a mark of especial esteem and respect from his colleagues in the University of Edinburgh and other friends, his bust was sculptured by subscription, and placed in the library of the University—an honour which, according to the *British Medical Journal*, had not previously been conferred on any professor during life.

IN the year 1872 there will be open for competition, at St. John's College, Cambridge, four minor scholarships, two of the value of 70*l.* per annum, and two of 50*l.* per annum, together with three exhibitions of 50*l.* per annum, tenable on the same terms as the minor scholarships, and two of 40*l.* per annum, tenable for four years. The examination of candidates for the above-mentioned scholarships and exhibitions will commence on Tuesday, the 9th of April, 1872. The examination will consist of three mathematical papers and four classical papers. Besides the nine minor scholarships or exhibitions above mentioned, there will be for competition an exhibition of 50*l.* per annum for proficiency in natural science, the exhibition to be tenable for three years in case the exhibitioner has passed within two years the previous examination as required for candidates for honours, otherwise the exhibition to cease at the end of two years. The candidates for the Natural Science Exhibition will have a special examination on Friday and Saturday, the 12th and 13th of April, 1872, in (1) chemistry, including practical work in the laboratory; (2) physics, viz., electricity, heat, and light; (3) physiology. They will also have the opportunity of being examined in one or more of the following subjects—(4) geology, (5) anatomy, (6) botany, provided that they give notice of the subjects in which they wish to be examined four weeks prior to the examination. No candidate will be examined in more than three of these six subjects, whereof one at least must be chosen from the former group. It is the wish of the master and seniors that excellence in some single department should be specially regarded by the candidates. Candidates must send their names to one of the tutors (Rev. S. Parkinson, Rev. T. G. Bonney, and Mr. J. E. Sandys), fourteen days before the commencement of the examination. The minor scholarships are open to all persons under twenty years of age, whether students in the university or not, who have not yet commenced residence in the university or who are in the first term of their residence.

TRINITY COLLEGE, Cambridge, offers one or more of its foundation scholarships, of the value of 80*l.* per annum each, for proficiency in the Natural Sciences. The examination will commence on April 5, and will be open to all undergraduates of Cambridge or Oxford, as well as to persons, under twenty-one, who are not members of the Universities. Further information may be obtained from the Rev. E. Blore, tutor of the college.

THE first course of Cantor Lectures of the Society of Arts for the ensuing session will be "On the Manufacture and Refining of Sugar," by C. Haughton Gill, and will consist of four lectures to be delivered Monday evenings November 27, and December 4, 11, and 18.

AT the late examination for the Natural Science Moderatorship in Trinity College, Dublin, the first senior moderatorship was awarded to Phineas Simon Abraham, the second to Charles B Ball; the junior moderatorships were given to R. D. Purefoy and W. J. Smyly. The subjects for examination were—Comparative and Physiological Anatomy, Zoology, Botany, Physical Geography, and Palæontology.

THE annual general meeting of the Royal Horticultural Society of Ireland was held in Dublin on the 9th of November. The report of the Council was most satisfactory, and the treasurer's account showed a balance on the year to the credit of the society of upwards of 1,060*l*. Of this sum 1,000*l*. was added to the reserve fund. In addition to the usual early Spring, Summer, and Autumn shows it was resolved to hold in October next a grand international fruit show, which we hope will be attended with success.

MR. JOHN RUSKIN has lately presented a valuable collection of minerals and fossils to the High School, Nottingham. Among the former are two hundred metalliferous ores, including some rare specimens from Hungary, a hundred choice silicates, the principal varieties of fluor spar, calcite, and barytes, some agates, and a series of fine gems. The fossils are mainly from the Cretaceous Rocks of Kent and Sussex.

ON Saturday last Sir William Stirling Maxwell was elected Rector of the University of Edinburgh.

THE great Aquarium at the Crystal Palace, of which we recently gave a full description and drawing, was formally opened to the public on Friday evening last by a *soirée*.

THE Session of the Institution of Civil Engineers commenced on the 14th inst., and the annual general meeting "to receive and deliberate upon the report of the Council on the state of the Institution, and to elect the officers for the ensuing year," will be held on Tuesday, the 19th of December. At the same time the members have been reminded of the obligation entered into on election to promote the public and scientific obligations contemplated in the Royal Charter of Incorporation granted to the institution by preparing, or aiding in the preparation of, original communications for reading at the meetings, by frequent attendance at the meetings and occasionally taking part in the discussion, and by presenting to the library copies of reports and scientific treatises not already in the collection. It has also been notified that the qualifications of candidates seeking admission into the institution must in all cases be set forth with the utmost precision and in considerable detail, in order to enable the Council, upon whom the classification involves, and the members, with whom the subsequent election rests, to form a correct opinion as to the nature of the practice, the extent of the experience, and the degree of responsibility of every candidate. The casualties which have occurred among the members of this body during the last three months include the death of Field-Marshal Sir John Burgoyne, G.C.B., &c., honorary member; of Messrs. Joseph Hamilton Beattie, John George Blackburne, Robert Benson Dockray, Albinus Martin, and Josiah Parkes, members; and of Messrs. Arthur Field, Edward Mosely Perkins, and Henry Beadon Rotton, associates. This has reduced the total number of members of all classes from 2,009, at which it stood on the 1st of August last, to 2,000, comprising 14 honorary members, 725 members, 1,056 associates, and 205 students. During the period referred to the ordinary general meetings have been suspended, so that there has been no ballot for new members.

MR. BROTHERS has made a photograph eight inches in diameter of one of Mr. Proctor's star maps, containing nearly fifty thousand stars. The more marked constellations are just distinguishable upon a background, which appears to be shaded with innumerable minute points representing smaller stars. The increase of intensity in the shading is very evident upon certain parts of the picture. The whole represents the heavens as we should see them if the pupils of our eyes were a little more than two inches in diameter.

DR. J. B. PETTIGREW, F.R.S., will deliver a course of twelve lectures on physiological and pathological subjects at the Royal College of Surgeons, Edinburgh.

THE GEOGNOSY OF THE APPALACHIANS AND THE ORIGIN OF CRYSTALLINE ROCKS *

III.

THE direct formation of the crystalline schists from an aqueous magma is a notion which belongs to an early period in geological theory. De la Beche, in 1834,† conceived that they were thrown down as chemical deposits from the waters of the heated ocean, after its reaction on the crust of the cooling globe, and before the appearance of organic life. This view was revived by Daubrée in 1860. Having sought to explain the alteration of palæozoic strata of mechanical origin, by the action of heated waters, he proceeds to discuss the origin of the still more ancient crystalline schists. The first precipitated waters, according to him, acting on the anhydrous silicates of the earth's crust, at a very elevated temperature, and at a great pressure, which he estimated at two hundred and fifty atmospheres, formed a magma, from which, as it cooled, were successively deposited the various strata of the crystalline schists.‡ This hypothesis, violating, as it does, all the notions which sound theory teaches with regard to the chemistry of a cooling globe, has, moreover, to encounter grave geognostical difficulties. The pre-Silurian crystalline rocks belong to two or more distinct systems of different ages, succeeding each other in discordant stratification. The whole history of these rocks, moreover, shows that their various alternating strata were deposited, not as precipitates from a seething solution, but under conditions of sedimentation very like those of more recent times. In the oldest known of them, the Laurentian system, great limestone formations are interstratified with gneisses, quartzites, and even with conglomerates. All analogy, moreover, leads us to conclude that even at this early period life existed at the surface of the planet. Great accumulations of iron-oxyd, beds of metallic sulphids, and of graphite, exist in these oldest strata, and we know of no other agency than that of organic matter capable of generating these products.

Bischof had already arrived at the conclusion, which in the present state of our knowledge seems inevitable, that "all the carbon yet known to occur in a free state can only be regarded as a product of the decomposition of carbonic acid, and as derived from the vegetable kingdom." He further adds, "living plants decompose carbonic acid; dead organic matters decompose sulphates, so that, like carbon, sulphur appears to owe its existence in a free state to the organic kingdom."§ As a decomposition (deoxidation) of sulphates is necessary to the production of metallic sulphids, the presence of the latter, not less than that of free sulphur and free carbon, depends on organic bodies; the part which these play in reducing and rendering soluble the peroxyd of iron, and in the production of iron ores, is, moreover, well known. It was, therefore, that, after a careful study of these ancient rocks, I declared in May, 1858, that a great mass of evidence "points to the existence of organic life, even during the Laurentian or so-called azoic period."‖

This prediction was soon verified in the discovery of the Eozoön Canadense of Dawson, the organic character of which is now admitted by all zoologists and geologists of authority. But with this discovery appeared another fact, which afforded a signal verification of my theory as to the origin and mode of deposition of serpentine and pyroxene. The microscopic and chemical researches of Dawson and myself showed that the calcareous skeleton of this foraminiferal organism was filled with the one or the other of these silicates in such a manner as to make it evident that they had replaced the sarcode of the animal, precisely as glauconite and similar silicates have, from the Silurian times to the present, filled and injected more recent foraminiferal skeletons. I recalled, in connection with this discovery, the observations of Ehrenberg, Mantell, and Bailey, and the more recent ones of Pourtalès, to the effect that glauconite or some similar substance occasionally fills the spines of Echini, the cavities of corals and millepores, the canals in the shells of Balanus, and even forms casts of the holes made by burrowing sponges (Clionia) and

* Address of Prof. T. Sterry Hunt on retiring from the office of President of the American Association for the Advancement of Science; abridged from the "American Naturalist," concluded from p. 34.
† Researches in Theoretical Geology, pp. 297-300.
‡ Etudes et expériences synthétiques sur le Metamorphisme, pp. 119-121.
§ Bischof, Lehrbuch, 1st ed. II. 95. English ed. I. 252, 344.
‖ Amer. Jour. Science, II. xxv. 436.

worms. The significance of these facts was further illustrated by showing that the so-called glauconites differ considerably in composition, some of them containing more or less alumina or magnesia, and one from the tertiary limestones near Paris being, according to Berthier, a true serpentine.*

These facts in the history of Eozoön were first made known by me in May 1864, in the *American Journal of Science*, and subsequently more in detail, February 1865, in a communication to the Geological Society of London.† They were speedily verified by Dr. Gümbel, who was then engaged in the study of the ancient crystalline schists of Bavaria, and who soon recognised the existence, in the limestones of the old Hercynian gneiss, of the characteristic Eozoön Canadense, injected with silicates in a manner precisely similar to that observed by Dawson and myself.‡ Later, in 1869, Robert Hoffmann described the results of a minute chemical examination of the Eozoön from Raspenau, in Bohemia, confirming the previous observations in Canada and Bavaria. He showed that the calcareous shell of the Eozoön examined by him, had been injected by a peculiar silicate, which may be described as related in composition both to glauconite and to chlorite. The masses of Eozoön he found to be enclosed and wrapped around by thin alternating layers of a green magnesian silicate allied to picrosmine, and a brown non-magnesian mineral, which proved to be a hydrous silicate of alumina, ferrous oxyd, and alkalies, related in composition to fahlunite, or more nearly to jollyte.§

Still more recently, in the course of the present year, Dr. Dawson detected a mineral insoluble in acids, injecting the pores of crinoidal stems and plates in a palæozoic limestone from New Brunswick, which is made up of organic remains. This silicate which, in decalcified specimens, shows in a beautiful manner the intimate structure of these ancient crinoids, I have found by analysis to be a hydrous silicate of alumina and ferrous oxyd, with magnesia and alkalies, closely related to fahlunite and to jollyte.‖ The microscopic examinations of Dr. Dawson show that this silicate injected the pores of the crinoidal remains and some of the interstices of the associated shell-fragments, before the introduction of the calcite which cements the mass. I have since found a silicate almost identical with this, occurring under similar conditions in an Upper Silurian limestone said to be from Llangedoc in Wales.

Gümbel, meanwhile, in the essay on the Laurentian rocks of Bavaria, in 1866, already referred to, fully recognised the truth of the views which I had put forward, both with regard to the mineralogy of Eozoön and to the origin of the crystalline schists. His results are still farther detailed in his *Geognost. Beschreibung des östbayerischen Grenzegebirges*, 1868, p. 833. Credner, moreover, as he tells us,¶ had already from his mineralogical and lithological studies, been led to admit my views as to the original formation of serpentine, pyroxene, and similar silicates (which he cites from my paper of 1865, above referred to**), when he found that Gümbel had arrived at similar conclusions. The views of the latter, as cited by Credner from the work just referred to, are in substance as follows :—The crystalline schists, with their interstratified layers, have all the characters of altered sedimentary deposits, and from their mode of occurrence cannot be of igneous origin, nor the result of epigenic action. The originally formed sediments are conceived to have been amorphous, and under moderate heat and pressure to have arranged themselves, and crystallised, generating various mineral species in their midst by a change, which, to distinguish it from metamorphism by an epigenic process, Gümbel happily designates diagenesis.

It is unnecessary to remark that these views, the conclusions from the recent studies of Gümbel in Germany and Credner in North America, are identical with those put forth by me in 1860.

At the early periods in which the materials of the ancient crystalline schists were accumulated, it cannot be doubted that the chemical processes which generated silicates were much more active than in more recent times. The heat of the earth's crust was probably then far greater than at present, while a high temperature prevailed at comparatively small depths, and thermal waters abounded. A denser atmosphere, charged with carbonic acid gas, must also have contributed to maintain, at the earth's surface, a greater degree of heat, though one not incompatible with the existence of organic life.* These conditions must have favoured many chemical processes, which, in later times, have nearly ceased to operate. Hence we find that subsequently to the eozoic times, silicated rocks of clearly marked chemical origin are comparatively rare. In the mechanical sediments of later periods certain crystalline minerals may be developed by a process of molecular re-arrangement—diagenesis. These are, in the feldspathic and aluminous sediments, orthoclase, muscovite, garnet, staurolite, cyanite, and chiastolite, and in the more basic sediments, hornblendic minerals. It is possible that these latter and similar silicates may sometimes be generated by reactions between silica on the one hand and carbonates and oxyds on the other, as already pointed out in some cases of local alteration. Such a case may apply to more or less hornblendic gneisses, for example; but no sediments, not of direct chemical origin, are pure enough to have given rise to the great beds of serpentine, pyroxene, steatite, labradorite, &c., which abound in the ancient crystalline schists. Thus, while the materials for producing, by diagenesis, the aluminous silicates just mentioned, are to be met with in the mud and clay-rocks of all ages, the chemically formed silicates capable of crystallising into pyroxene, talc, serpentine, &c., have only been formed under special conditions.

The same reasoning which led me to maintain the theory of an original formation of the mineral silicates of the crystalline schists, induced me to question the received notion of the epigenic origin of gypsums and magnesian limestones or dolomites. The interstratification of dolomites and pure limestones, and the enclosure of pebbles of the latter in a paste of crystalline dolomite, are of themselves sufficient to show that in these cases, at least, dolomites have not been formed by the alteration of pure limestones. The first results of a very long series of experiments and inquiries into the history of gypsum were published by me in 1859, and further researches, reiterating and confirming my previous conclusions, appeared in 1866.† In these two papers it will, I think, be found that the following facts in the history of dolomite are established, viz.: first, its origin in nature by direct sedimentation, and not by the alteration of non-magnesian limestones; second, its artificial production by the direct union of carbonate of lime and hydrous carbonate of magnesia, at a gentle heat, in the presence of water. As to the sources of the hydrous magnesian carbonate, I have endeavoured to show that it is formed from the magnesian chlorid or sulphate of the sea or other saline waters in two ways :—first, by the action of the bicarbonate of soda found in many natural waters; this, after converting all soluble lime-salts into insoluble carbonate, forms a comparatively soluble bicarbonate of magnesia, from which a hydrous carbonate slowly separates; secondly, by the action of bicarbonate of lime in solution, which, with sulphate of magnesia, gives rise to gypsum; this first crystallises out, leaving behind a much more soluble bicarbonate of magnesia, which deposits the hydrous carbonate in its turn. In this way for the first time, in 1859, the origin of gypsums and their intimate relation with magnesian limestones were explained.

It was, moreover, shown that to the perfect operation of this reaction, an excess of carbonic acid in the solution, during the evaporation, was necessary to prevent the decomposing action of the hydrous mono-carbonate of magnesia upon the already formed gypsum. Having found that a prolonged exposure to the air, by permitting the loss of carbonic acid, partially interfered with the process, I was led to repeat the experiment in a confined atmosphere, charged with carbonic acid, but rendered drying by the presence of a layer of dessicated chlorid of calcium. As had been foreseen, the process under these conditions proceeded uninterruptedly, pure gypsum first crystallising out from the liquid, and subsequently the hydrous magnesian carbonate.‡ This experiment is instructive as showing the results which must have attended this process in past ages, when the quantity of carbonic acid in the atmosphere greatly exceeded its present amount.

As regards the hypotheses put forward to explain the supposed dolomitisation of previously-formed limestones by an epigenic process, I may remark that I repeated very many times, under varying conditions, the often-cited experiment of Von Morlot, who claimed to have generated dolomite by the action of sulphate of magnesia on carbonate of lime, in the presence of water at a

* Amer. Jour. Sci. II. xl. 360, Report Geol. Survey Canada, 1866, p. 231, and Quar. Geol. Jour. XXI. 71.
† Amer. Jour. Sci. II. xxxvii. 431. Quar. Geol. Jour. XXI. 67.
‡ Proc. R. Bavar. Acad. for 1866, and Canadian Naturalist, N. S., III. 81.
§ Jour. für Prakt. Chem. May, 1869, and Amer. Jour. Sci. III. i. 378.
‖ Amer. Jour. Sci. III. i. 379.
¶ Hermann Credner; die Gleiderung der Eozoischen Formationsgruppe Nord Amerikas. Halle, 1869.
** That in the Quar. Geol. Jour. XXI. 67.

* Amer. Jour. Sci. II. xxxvi. 396.
† Amer. Jour. Sci. II. xxxviii. 170, 365; xlii. 49.
‡ Proceedings Royal Institution, May 30, 1867, and Canadian Naturalist, New Series, III. 231.

somewhat elevated temperature under pressure. I showed that what he regarded as dolomite was not such, but an admixture of carbonate of lime with anhydrous and sparingly soluble carbonate of magnesia; the conditions in which the carbonate of magnesia is liberated in this reaction not being favourable to its union with the carbonate of lime to form the double salt which constitutes dolomite. The experiment of Marignac, who thought to form dolomite by substituting a solution of chlorid of magnesium for the sulphate, I found to yield similar results, the greater part of the magnesian carbonate produced passing at once into the insoluble condition, without combining with the excess of carbonate of lime present. The process for the production of the double carbonate described by Ch. Deville, namely, the action of vapours of anhydrous magnesian chlorid on heated carbonate of lime, in accordance with Von Buch's strange theory of dolomitisation, I have not thought necessary to submit to the test of experiment, since the conditions required are scarcely conceivable in nature. Multiplied geognostical observations show that the notion of the epigenic production of dolomite from limestone is untenable, although its resolution and deposition in veins, cavities, or pores in other rocks is a phenomenon of frequent occurrence.

The dolomites or magnesian limestones may be conveniently considered in two classes; first, those which are found with gypsums at various geological horizons; and secondly, the more abundant and widely distributed rocks of the same kind, which are not associated with deposits of gypsum. The production of the first class is dependent upon the decomposition of sulphate of magnesia by solutions of bicarbonate of lime, while those of the second class owe their origin to the decomposition of magnesian chlorid or sulphate by solutions of alkaline bicarbonates. In both cases, however, the bicarbonate of magnesia, which the carbonated waters generally contain, contributes a more or less important part to the generation of the magnesian sediments. The carbonated alkaline waters of deep-seated springs often contain, as is well known, besides the bicarbonates of soda, lime and magnesia, compounds of iron, manganese, and many of the rarer metals in solution, and thus the metalliferous character of many of the dolomites of the second class is explained. The simultaneous occurrence of alkaline silicates in such mineral waters, would give rise, as already pointed out, to the production of insoluble silicates of magnesia, and thus the frequent association of such silicates with dolomites and magnesian carbonates in the crystalline schists is explained, as marking portions of one continuous process. The formation of these mineral waters depends upon the decomposition of feldspathic rocks by subterranean or sub-aërial processes, which were doubtless more active in former ages than in our own. The subsequent action upon magnesian waters of these bicarbonated solutions, whether alkaline or not, is dependent upon climatic conditions, since, in a region where the rainfall is abundant, such waters would find their way down the river-courses to the open sea, where the excess of dissolved sulphate of lime would prevent the deposition of magnesian carbonate. It is in dry and desert regions, with limited lake-basins, that we must seek for the production of magnesian carbonates, and I have argued from these considerations that much of north-eastern America, including the present basins of the Upper Mississippi and St. Lawrence, must, during long intervals, in the palæozoic period, have had a climate of excessive dryness, and a surface marked by shallow enclosed basins, as is shown by the widely-spread magnesian limestones, and the existence of gypsum and rock-salt at more than one geological horizon within that area.* The occurrence of serpentine and diallage at Syracuse, New York, offers a curious example of the local development of crystalline magnesian silicates in Upper Silurian dolomitic strata under conditions which are imperfectly known, and which, in the present state of the locality, cannot be studied.†

Since the uncombined and hydrated magnesia mono-carbonate is at once decomposed by sulphate or chlorid of calcium, it follows that the whole of these lime-salts in a sea-basin must be converted into carbonates before the production of carbonated magnesian sediments can begin. The carbonate of lime formed by the action of carbonates of magnesia and soda, remains at first dissolved as bicarbonate, and is only separated in a solid form, when, in excess, or when required for the needs of living plants or animals, which are dependent for their supply of calcareous matter, on the bicarbonate of lime produced, in part by the process just described, and in part by the action of carbonic acid on insoluble lime-compounds of the earth's solid crust So many limestones are made up of calcareous organic remains, that a notion exists among many writers on geology that all limestones are, in some way, of organic origin. At the bottom of this lies the idea of an analogy between the chemical relations of vegetable and animal life. As plants give rise to beds of coal, so animals are supposed to produce limestones. In fact, however, the synthetic process by which the growing plant, from the elements of water, carbonic acid and ammonia, generates hydrocarbonaceous and azotised matters, has no analogy with the assimilative process by which the growing animal appropriates alike these organic matters and the carbonate and phosphate of lime. Without the plant, the synthesis of the hydrocarbons would not take place, while independently of the existence of coral or mollusk, the carbonate of lime would still be generated by chemical reactions, and would accumulate in the waters until, these being saturated, its excess would be deposited as gypsum or rock-salt are deposited. Hence, in such waters, where, from any causes, life is excluded, accumulations of pure carbonate of lime may be formed. In 1861 I called attention to the white marbles of Vermont, which occur intercalated among impure and fossiliferous beds, as apparently examples of such a process.*

* Geology of South-western Ontario, Amer. Jour. Sci. II. xlvi. 355.
† Geology of the 3rd district of New York, 108-110, and Hunt on Ophiolites, Amer. Jour. Sci. II. xxvi. 236.

It is by a fallacy similar to that which prevails as to the organic origin of limestones, that Daubeny and Murchison were led to appeal to the absence of phosphates from certain old strata as evidence of the absence of organic life at the time of their accumulation.† Phosphates, like silica and iron-oxyd, were doubtless constituents of the primitive earth's crust, and the production of apatite crystals in granitic veins, or in crystalline schists, is a process as independent of life as the formation of crystals of quartz or of hematite. Growing plants, it is true, take up from the soil or the waters dissolved phosphates, which passed into the skeletons of animals, a process which has been active from very remote periods. I showed in 1854 that the shells of Lingula and Orbicula, both those from the base of the palæozoic rocks and those of the present time have (like Conularia and Serpulites) a chemical composition similar to the skeletons of vertebrate animals.‡ The relations of both carbonate and phosphate of lime to organised beings are similar to those of silica, which, like them, is held in watery solution, and by processes independent of life is deposited both in amorphous and crystalline forms, but in certain cases is appropriated by diatoms and sponges, and made to assume organised shapes. In a word, the assimilation of silica, like that of phosphate and carbonate of lime, is a purely secondary and accidental process, and where life is absent, all of these substances are deposited in mineral and inorganic forms.

I have thus endeavoured to sketch, in a concise and rapid manner, the history of the earlier rock-formations of eastern North America, and of our progress in the knowledge of them; while I have, at the same time, dwelt upon some of the geognostical and chemical questions which their study suggests. With the record of the last thirty years before them, American geologists have cause for congratulation that their investigations have been so fruitful in great results. They see, however, at the same time, how much yet remains to be done in the study of the Appalachians and of our north-eastern coast, before the history of these ancient rock-formations can be satisfactorily written. Meanwhile our adventurous students are directing their labours to the vast regions of western America, where the results which have already been obtained are of profound interest. The progress of these investigations will doubtless lead us to modify many of the views now accepted in science, and cannot fail greatly to enlarge the bound of geological knowledge.

THE SCOTTISH SCHOOL OF GEOLOGY §

II.

WHILE Hutton fortified his convictions by constant appeals to the rocks themselves, his disciple Hall tested their truth in the laboratory. It is the boast of Scotland to have led the way in the application of chemical and physical experiment to the elucidation of geological history. It was objected to Hutton's theory, that if basalt and similar rocks had ever been in a

* Amer. Jour. Sci. II. xxxi. 402.
† Siluria, 4th ed. pp. 28 and 537.
‡ Amer. Jour. Sci. II. xvii. 236.
§ A Lecture delivered at the opening of the class of Geology and Mineralogy in the University of Edinburgh, by Archibald Geikie, F.R.S., Nov. 6, 1871, concluded from p. 39.

melted state, they would now have been seen in the condition of glass or slag, and not with the granular or crystalline texture which they actually possess. Hall demolished this objection by melting basalt into a glass, and then by slow cooling reconverting it into a granular substance like the original rock. Hutton had maintained that under enormous pressure, such as he conceived must exist under the ocean, or deep within the crust of the earth, even limestone itself might be melted without losing its carbonic acid. This was ridiculed by his opponents, on whom he retorted that they "judged of the great operations of the mineral kingdom from having kindled a fire and looked into the bottom of a little crucible." Hall, however, to whom fire and crucible were congenial implements, resolved to put the question to the test of experiment, and though, out of deference to his master, he delayed his task until after the death of the latter, he did at last succeed in converting limestone, under various great pressures, into a kind of marble, and even in reducing it to complete fusion, in which state it acted powerfully on other rocks. He concluded his elaborate essay on this subject with these words, "This single result affords, I conceive, a strong presumption in favour of the solution which Dr. Hutton has advanced of all the geological phenomena; for the truth of the most doubtful principle which he has assumed has thus been established by direct experiment."

Though they saw clearly the proofs which the rocks afford us of former revolutions, neither Hutton nor his friends had any conception of the existence of the great series of fossiliferous formations which has since been unfolded by the labours of later observers—that voluminous record in which the history of life upon this planet has been preserved. They spoke of "Alpine schistus," "primary" or "secondary" strata, as if the geological past had consisted but of two great ages—the second replete with traces of the destruction of the first. "The ruins of an older world," said Hutton, "are visible in the present structure of our planet." He knew nothing of the long, but then undiscovered, succession of such "ruins," each marking a wide interval of time. Nevertheless, for the establishment of the great truths which Hutton laboured to confirm, such knowledge was not necessary. On the other hand, it was most needful that the significance of that discordance between the older and newer strata which Hutton recognised should be persistently proclaimed. And the Huttonians, in spite of their limited range of knowledge and opportunity, saw its value and held by it.

2. But it was not merely, or even chiefly, for their exposition of the structure and history of the rocks under our feet that the geologists of the Scottish School deserve to be held in lasting remembrance. They could not, indeed, have advanced as far as they did in expounding former and ancient conditions of the planet, had they not, with singular clearness, perceived the order and system of change which is in progress over the surface of the globe at the present day. It was their teaching which first led men to see the harmony and co-operation of the forces of nature which work within the earth, with those which are seen and felt upon its surface. Hutton first caught the meaning of that constant circulation of water which, by means of evaporation, winds, clouds, rain, snow, brooks, and rivers, is kept up between land and sea. He saw that the surface of the dry land is everywhere being wasted and worn away. The scarped cliff, the rugged glen, the lowland valley, are each undergoing this process of destruction; wherever land rises above ocean, there, from mountain-top to sea-shore, degradation is continually going on. Here and there, indeed, the *débris* of the hills may be spread out upon the plains; here and there, too, dark angular peaks and crags rise as they rose centuries ago, and seem to defy the elements. But these are only apparent and not real exceptions to the universal law, that so long as a surface of land is exposed to the atmosphere it must suffer degradation and removal.

But Hutton saw, further, that this waste is not equally distributed over the whole face of the dry land, that while, owing to the greater or less resistance offered by different kinds of rocks, the rate of decay must vary indefinitely, the amount of material must necessarily be greatest where the surplus water flows off towards the sea, that is, along the channels of the streams. Water-courses, he argued, are precisely in the lines which water would naturally follow in running down the slope of the land from its water-shed to the sea, and which, when once selected by the surplus drainage, would necessarily be continually widened and deepened by the excavating power of the rivers. Hence he regarded the streams and rivers of a country as following the lines which they had chiselled for themselves out of the solid land, and hus he arrived at the deduction that valleys have been, inch by inch and foot by foot, dug out of the solid framework of the land by the same natural agents—rain, frost, springs, rivers—by which they are still made wider and deeper. "The mountains," he said, "have been formed by the hollowing out of the valleys, and the valleys have been hollowed out by the attrition of hard materials coming from the mountains." This is a doctrine which is only now beginning to be adequately realised. Yet to Hutton it was so obvious as to convince him, to use his own memorable words, "that the great system upon the surface of this earth is that of valleys and rivers, and that however this system shall be interrupted and occasionally destroyed, it would necessarily be again formed in time while the earth continued above the level of the sea."

Although these views were again and again proclaimed by Hutton in the pages of his treatise, and though Playfair, catching up the spirit of his master, preached them with a force and eloquence which might almost have insured the triumph of any cause, they met with but scant acceptance. The men were before their time; and thus, while the world gradually acknowledged the teaching of the Scottish school as to the past history of the rocks, it lent an incredulous ear to that teaching when dealing with the present surface of the earth. Even some of the Huttonians themselves refused to follow their master when he sought to explain the existing inequalities of the land by the working of the same quiet unobtrusive forces which are still plying their daily tasks around us. But no incredulity or neglect can destroy the innate vitality of truth. And so now, after the lapse of fully two generations, the views of Hutton have in recent years been revived, and have become the war-cry of a yearly increasing crowd of earnest hard-working geologists.

While they insisted upon the manifest proofs of constant and universal decay over the surface of the globe, the Scottish geologists no less strongly contended that the decay was a necessary part of the present economy of Nature, that it had been in progress from the earliest periods in the history of the earth, and that it was essential for the presence of organised beings upon the planet. They pointed to the vegetable soil, derived from the decomposition of the rocks which it covers, and necessary for the support of vegetable life. They appealed to the vast quantity of sedimentary rocks forming the visible part of the crust of the earth, and bearing witness in every bed and layer to the degradation and removal of former continents. They showed that the accumulated *débris* of the land, carried to sea, was there spread out on the sea-floor to form new strata, which, in due time hardened into solid rock, would hereafter be upheaved to form the framework of new lands.

Such was the geology of the Scottish School. It was based not on mere speculation, but on facts drawn from mountain and valley, hill and plain, and tested as far as was then possible by the scrutiny of actual experiment. It strove, for the first time in the history of science, to evolve a system out of the manifold complications of nature, to harmonise what had seemed but the wild random working of subterranean forces with the quiet operations in progress upon the surface of the earth, to understand what is the present system of the world, and through that to peer into the history of the earlier conditions of the planet. It taught that the earthquake and volcano were parts of the orderly arrangement by which new continents were from time to time raised up to supply the place of others which had been worn away; that the surface of the land required to decay to furnish life to plants and animals; that in the removal of the *débris* thus produced mountains and valleys were carved out; and that in the depths of the ocean there were at the same time laid down the materials for the formation of other lands, which in after ages would be upheaved by underground forces, to be anew worn away as before. The Scottish School proclaimed that in the inorganic world there is ceaseless change, that this change is the central idea of the system, and that in its constant progress lie the conditions necessary for the continuance of our earth as a habitable globe.

That Hutton and his followers should have seen only a part of the truth, that they did not perceive the full scope which their views would ultimately acquire, that they fell into errors, and attached to some secondary parts of their system an importance which we now see to have been misplaced, is only what may be said of any body of men who, at any time, have led the way in a new development of human inquiry. But, after all allowance is made for such shortcomings, we see that their errors were for the most part on mere matters of detail, and that he fundamental principles which they laboured to establish have become the very life and soul of modern geology

I have spoken of this Scottish School as marking a period of activity which rose into brightness and then waned. It is only too true, that so far as the originality and influence of its cultivators go, Geology has never since held in Scotland the place which it held here at the beginning of the century. Its decay is perhaps to be ascribed chiefly, if not entirely, to the introduction of the doctrines of Werner from Germany. The Huttonians had dealt rather with general principles than with minute details; they were weak in accurate mineralogical knowledge—not that they were ignorant of or in any degree despised such knowledge; but it was not necessary for their object. When, however, the system of Werner came to be taught within these walls by his enthusiastic pupil Jameson, its precision and simplicity, and its supposed capability of ready application in every country, joined to the skill and zeal of its teacher, gave it an impulse which lasted for years. I shall have occasion in a subsequent lecture to speak of this system. It is enough for the present to describe it as a crude and artificial attempt to explain the geological history of the globe from the rocks of a district in Saxony. It required mineralogical determination of rocks, and in so far it did good service, but its theoretical teaching in matters of geology cannot now be regarded without a smile. It maintained that the globe was covered with certain universal formations, and that these had been precipitated successively from solution in a primeval ocean. Of upheaval and subsidence, earthquakes and volcanos, and all the mechanism of internal heat, it could make nothing, and ignored as much as it dared. Werner, the founder of this system, had the faculty of attaching his students to him, and of infusing into them no small share of his own zeal and faith in his doctrines. His pupil Jameson had a similar aptitude. Skilled in the mineralogy of his time, and full of desire to apply the teachings of Freyberg to the explication of Scottish geology or geognosy, as he preferred to call it, he gathered round him a band of active observers, who gleaned facts from all parts of Scotland, and to whom the first accurate descriptions of the mineralogy of the country are due. It is but fitting that a tribute of gratitude should on the present occasion be offered to the memory of Jameson for the life-long devotion with which he taught Natural History, and especially Mineralogy, in this University. His influence is to be judged not by what he wrote, but by the effect of his example, and by the number of ardent naturalists who came from his teaching. He founded a scientific Society here, and called it Wernerian, after his chief—a Society which under his guidance did excellent service to the cause of science in Scotland. And yet in the course of my scientific reading I have never met a sadder contrast than to turn from the earlier volumes of the Royal Society of Edinburgh, containing the classic essays of Hutton, Hall, and Playfair—essays which made an epoch in the history of Geology—to the pages of the Wernerian memoirs, and find grave discussions about the universal formations, the aqueous origin of basalt, and the chemical deposition of such rocks as slate and conglomerate!

Between the followers of Hutton and Werner there necessarily arose a keen warfare. The one battalion of combatants was styled by its opponents "Vulcanists" or "Plutonists," as if they recognised only the power of internal fire, while the other was in turn nicknamed "Neptunists," in token of their adherence to water. The warfare lasted in a desultory way for many years, and though the Wernerian school, having essentially no vitality, eventually died out, and its leader Jameson publicly and frankly recanted his errors, the early Huttonian magnates had one by one departed and left no successors. The Huttonian school triumphed indeed, but its triumph was seen rather in other countries than in Scotland. Here the Wernerian school attracted in great measure the younger men who gathered round Jameson, and when its influence waned there were no great names on the other side to rally the thinned and weakened ranks of Huttonianism. Hence came a period of comparative quiescence, which has lasted almost down to our own day. From time to time, indeed, a geologist has arisen among us to show that the science was not dead, and that the doctrines of Hutton had borne good fruit. But Geology has never since held such a prominent place amongst us, nor have the writings of geologists in Scotland taken the same position in the literature of the science. The great name of Lyell, and others of lesser note, have earned elsewhere their title to fame.

But there is one name which must be in our hearts and on our lips to-day, that of Roderick Impey Murchison. To his munificence, and the liberality of the Crown, we owe the foundation of this Chair of Geology, and to his warm friendship I am indebted for the position in which I stand before you. Of his achievements in science, and of the influence of his work all over the world, it is not necessary now to speak. But on Scottish Geology no man has left his name more deeply engraven. It was he who, along with Prof. Sedgwick, first made known the order of succession of the Old Red sandstone of the north of Scotland; it was he who sketched for us the relations of the great Silurian masses of the Southern uplands; and it was he who, by a series of admirable researches, brought order out of the chaos of the so-called Primary rocks of the Highlands, and placed these rocks in a parallel with the Silurian strata of other conntries. These labours will come again before us in detail, and you will then better understand their value, and the debt we owe to the man who accomplished them.

Sir Roderick Murchison looked forward with interest to the occasion which has called us together to-day. Only a few weeks ago I talked with him regarding it, and his eye brightened as I told him of the subject on which I proposed to speak to you. I had hoped that he would have lived to see this day, and to hear at least of the beginning of the work which he has inaugurated for us in this University. But this was not to be. He has been taken from us ripe in years, in work, and in honours, and he leaves us the example of his unwearied industry, his admirable powers of observation, and his rare goodness of heart.

In the course of study now before us, we are to be engaged in examining together the structure and history of the earth. We shall trace the working of the various natural agents which are now carrying on geological change, and by which the past changes of the globe have been effected. In so doing we shall be brought continually face to face with the history of life as recorded in the rocks—for it is by that history mainly that the sequences of geological time can be established. We shall thus have to trespass a little on what is the proper domain of the professors of botany and of natural history. But you will find that no hard line can be drawn between the sciences. Each must needs overlap upon the other; and indeed it is in this mutual interlacing that one great element of the strength and interest of science lies. From Profs. Balfour and Wyville Thomson you will learn the structure and the relation borne to living plants and animals by the fossils with which we shall have to deal as our geological alphabet. By Prof. Crum Brown you are taught the full meaning and application of the chemical laws under which the minerals and rocks, which we in this class must study, have been formed, and of the processes concerned in those subsequent changes, both of rocks and minerals, which are of such paramount importance in Geology.

And now, in conclusion, permit me to give expression to the feelings which must strongly possess the mind of one who is called upon to fill the first Chair dedicated in Scotland to the cultivation of Geology. When I look back to the times of that illustrious group of men—Hutton, Hall, Playfair—who made Edinburgh the special home of Geology; of Boué and Macculloch, who gave to Scottish rocks and mountains an European celebrity; of Jameson and Edward Forbes, who did so much to stimulate the study of Geology and Mineralogy in this University; and to the memory of Hugh Miller and Charles Maclaren, who fostered the love of the sciences throughout the community here, and to whose kindly friendship and guidance, given to me in my boyhood, I would fain express my hearty gratitude—when I cast my thoughts back upon these recollections, it would be affectation to conceal the anxiety with which the prospect fills me. The memory of these great names arises continually before me, bearing with it a consciousness of the responsibility under which I lie to labour earnestly not to be unworthy of the traditions of the past. And, gentlemen, I feel deeply my responsibility to you who are to enter with me upon a yet untrodden path of the Academic curriculum. It is only experience that will show us how we shall best travel over the wide field before us. In the meantime I must bespeak your kindly forbearance. While I shall cheerfully teach you all I know, and confess what I do not know, I would fain have you in the end to regard me rather in the light of a fellow-student, searching with you after truth, than of a teacher putting before you what is already known. We have now an opportunity of combined and sedulous work which has not hitherto been obtainable in Scotland. We may not rival a Hutton or a Hall; but we may at least try to raise again the standard of geological inquiry here. On every side of us are incentives to study. Crag and hill rise around us, each eloquent of ancient revolutions, and each a silent witness of the revolution in progress now. At our very gates tower on one side the picturesque memorials of long silent volcanoes, with their crumbling lavas and ashes. On the other lie the buried vegetation of an ancient land, and the corals and shells of a former ocean. Everywhere the scarred and wasted rocks tell of the degradation of the solid land, and show us how the waste goes on. Let us then carry into our task some share of the enthusiasm which these daily exemplars called forth in earlier days. Let us turn from the lessons of the lecture-room to the lessons of the crags and ravines, appealing constantly to Nature for the explanation and verification of what is taught. And thus, whatsoever may be your career in future, you will in the meantime cultivate habits of observation and communion with the free fresh world around you—habits which will give a zest to every journey, which will enable you to add to the sum of human knowledge, and which will assuredly make you wiser and better men.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, November 7.—Prof. Newton, F.R.S., vice-president, in the chair. The secretary read a report on the additions that had been made to the society's menagerie during the months of June, July, August, and September 1871, amongst which were specimens of the Tamandua Ant-eater (*Tamandua tetradactyla*), Baird's Tapir (*Tapirus bairdi*), and several other animals of special interest.—A communication was read from Mr. Gerard Krefft, Curator of the Australian Museum, Sydney, N.S.W., containing notes on a rare Ziphioid Whale, which had been stranded near Sydney, and which appeared to be referable to *Ziphius layardi*.—Mr. Gould exhibited and characterised a small but lovely Fruit Pigeon from the Fiji Islands, which he proposed to name *Chrysœna victor*.—Mr. Sclater called attention to the supposed existence of an undescribed animal, of about the size of a Dingo, in the Rockingham Bay district of Queensland, and read a letter addressed to him by Mr. Brinsley G. Sheridan, containing particulars on this subject.—Dr. John Anderson, of Calcutta, communicated a description of a short tailed Macaque from Upper Burmah, supposed to be new, which he proposed to call *Macacus brunneus*.—A communication was read from the Viscount Walden on a new and interesting Falconine Bird, of the genus *Polihierax*, recently obtained by Major Lloyd, in the vicinity of Tongoo, Upper Burmah, and proposed to be called *Polihierax insignis*.—Mr. W. H. Flower, F.R.S., read a memoir on the recent Ziphioid Whales, among which he proposed to recognise the following generic types:—*Hyperoodon*, *Ziphius*, *Mesoplodon*, and *Berardius*. This was followed by a description of the skeleton of *Berardius arnouxii*, founded on a specimen lately transmitted to the Museum of the Royal College of Surgeons from New Zealand by Dr. J. Haast, F.R.S.—Mr. Herbert Taylor Usher read some notes on the habits of the Horned Viper (*Vipera nasicornis*), as observed by him in the vicinity of Cape Coast Castle, Western Africa.—Prof. Newton read a notice of a remarkable peculiarity which he had recently discovered in an Australian duck, *Anas punctata*, viz., that in this species the osseous development of the lower trachea was common to both sexes.—A paper by Dr. J. C. Cox, of Sydney, was read, describing a new Volute and twelve new species of Land Shells from Australia and the Solomon Islands.—A communication was read from Surgeon Francis Day, Inspector-General of Fisheries of British India, containing some remarks on the identification of certain species of Indian Fishes.—Mr. P. L. Sclater, F.R.S., read some notes on Pelicans, being supplementary to a previous paper on the same subject read at a meeting of the society in May, 1868.—A communication was read from Mr. J. Brazier, of Sydney, containing descriptions of eight new Australian Land Shells.—Prof. Newton communicated a paper by Dr. J. Murie, containing supplementary notes concerning the powder-down patches of *Rhinochetus jubatus*.

Anthropological Institute, November 6.—Sir John Lubbock, Bart., F.R.S., president, in the chair. Mr. M. Allport, F.R.S., was elected a corresponding member for Tasmania.—Mr. J. W. Flower, F.G.S., treasurer, read a paper "On the relative ages of the Flint and Stone Implement Periods in England." In this paper, which was illustrated by the exhibition of a series of various kinds of flint implements, the author proposed to show, that having regard to recent discoveries, the arrangement hitherto adopted regarding the Prehistoric Stone period in England as divisible into the Palæolithic and Neolithic was altogether inadequate, and that as well on Geological as on Palæontological grounds the drift period was separable by a vast interval from that of the bone Caves, as the cave period was separable from the Tumulus or Barrow period. The author adduced various reasons for believing that the implements were made and the drift gravel was thrown down long before this island was severed from the Continent, and that thus before that event both countries were inhabited. He also contended, on this and other grounds founded upon recent discoveries, that the implements could not have been transported (if transported at all by fluviatile action) to the places in which they are found by any rivers flowing in the same channels and draining the same areas as now; and he also expressed doubts whether the gravels were transported by river action, and also whether the makers of the implements were contemporary with the Mammalia with whose remains they were associated; the gravel and the fossils having been evidently carried from considerable distances, whereas the implements were made on the spot from stones taken from the gravel. Mr. Flower then pointed out that the works of art found in the caves, as well as the animal remains, differed in many important particulars from those found in the drift, and that those of the Tumulus period differed entirely from those in the caves; that in truth the cave fauna had then quite disappeared, and had been succeeded by one entirely different, including most of our domestic animals, and that for effecting such a change an interval of long duration must be allowed. He also pointed out that the use of bronze was common to both what were known as the Palæolithic and Neolithic periods, and could not be regarded therefore as it usually has been, as distinct from and posterior to both; and, in conclusion, he suggested that the drift period might properly be termed Palæolithic, that of the caves as Archaic, that of the Tumuli as Prehistoric, whilst that of the polished stones might still be known as Neolithic.

Geologists' Association, November 3.—The Rev. Thomas Wiltshire, M.A., F.G.S., president, in the chair. "On the old Land Surfaces of the Globe," by Prof. Morris, F.G.S. The indications of land surfaces to be found in Palæozoic, Mesozoic, and Cainozoic strata were recapitulated. Conglomerates and ripple marks, as well as the great thickness of the oldest sedimentary rocks, the result of denudation, clearly show the existence of land during Cambrian and Silurian times. Though there are indications of vegetable life in Cambrian rocks, the earliest remains of vegetable organisms allied to our present land plants occur in the uppermost Silurian Strata, or passage beds. The Old Red sandstone of Scotland affords evidence of fresh-water origin, and consequently of lakes and land. But in carboniferous rocks we have in the vast accumulations of vegetable remains forming the great coal beds of the world, perhaps the most striking and conclusive proof of land and terrestrial conditions to be found in the geologic record. After noticing the indications of land in the Permian rocks, the Mesozoic reptilia and mammalia, as well as the many other evidences of land surfaces to be met with in the Secondary rocks, were dwelt upon; and a similar review of Cainozoic, or Tertiary, terrestrial indications was followed by an exposition of the upward and onward progress of life, culminating in the present conditions of the globe with a flora and a fauna admirably adapted to the wants of the latest addition to the marvels of the universe, man, whose duty it is, and whose pleasure it ought to be, to study those successive changes, the grand result of which he now enjoys.—A note "On recent exposure of the Glacial Drift at Finchley" was read by Mr. H. Walker. This was a brief notice, and intended as an introduction of the subject, which will be more fully elucidated in a paper by the same author to be read at the next meeting of the association.

Society of Biblical Archæology, November 7.—Dr. S. Birch, president, in the chair. Dr. Richard Cull, F.S.A. read a paper contributed by Mr. Henry Fox Talbot, F.R.S., "On the Religious Beliefs of the Assyrians."—Mr. R. Hamilton Lang, H.B.M. Consul at Cyprus, read a paper "On the Discovery of some Cypriote Inscriptions." After stating that the credit was due to Duc de Luynes of having proved the existence of a Cypriote alphabet, he enumerated the various inscriptions which he had himself discovered, and drew especial attention to one, a bi-lingual inscription in Phœnician and Cypriote, which he first discovered during the excavation of a temple at Idalion. The alphabet, which had been compiled by the Duc de Luynes, consisted of 80 letters, but Mr. Lang felt justified in reducing that number to 51, and exhibited an alphabet which he believed to contain all the Cypriote characters of which we are at present certain. In proceeding he dwelt at some length upon an apparent resemblance between the Cypriote and Lycian alphabets, and stated that they were both derived from the same source, the Lycians having however engrafted upon the ancient forms a great many Grecian Letters, while in Cyprus the character was preserved in its original fulness and power. Mr. Daniel Sharpe had endeavoured to prove that the Lycian alphabet was of Indo-Germanic origin, and so also might be the Cyprian. Mr. Lang alluded to the attempt which had been made both by De Luynes and von Röth to read the Cypriote writing, especially as regarded a word which both gentlemen agreed in rendering "Salamis," and which they considered to be the key to the Cypriote characters. Mr. Lang, on the contrary, gave his reasons for dissenting from this reading upon the testimony of coins, and showed why he thought that the word should be read as "King." The evidence of the bi-lingual inscription before referred to was dwelt upon in confirmation of this reading. A resemblance was further pointed out between the word translated "king" by Mr. Sharpe in Lycian, and that proposed to be read in the same way in Cypriote, and a reading was suggested for the whole of the first line in the Cypriote part of the bi-lingual inscription. Many other points of interest connected with this alphabet were also detailed, and Mr. Lang concluded by observing that in it "we have a child long lost both to the sight and knowledge of the world, and he felt convinced that more extended research would prove that the pedigree of the foundling was of more than usual philological interest and importance."—Mr. G. Smith then read a paper "On the Decipherment of the Cypriote Inscriptions," in which, after alluding to the antiquities discovered by General Cesnola and Mr. Lang, particularly the bi-lingual inscription already mentioned, he went on to detail the discovery of the values of eighteen Cypriote signs from that inscription alone. He further related the discovery of the sounds of twenty other signs by comparison of various texts, together with the reading of the names "Idalium Citium Evagoras," and many others. His conclusions were that the Cypriote language belonged to the Aryan group, and was written with about fifty-four syllabic signs. Diagrams showing case endings of nouns, proper names, and part of the bi-lingual inscription, illustrated the paper. A collection of electrotypes of the Cypriate coins referred to in the foregoing papers was exhibited by Mr. Ready of the British Museum.

Paris

Academy of Sciences, November 6.—A memoir was read by M. A. Mannheim on the properties relating to the infinitely small displacements of a body when these displacements are only defined by four conditions, and one by M. Maurice Lévy on the integration of equations with partial differences relating to the internal movements of ductile solid bodies, when these movements take place in parallel planes.—M. Phillips also communicated a memoir containing a summary of observations made during the last seven years at the Observatory of Neuchatel upon chronometers furnished with spirals with theoretical final curves. —M. P. A. Favre presented a continuation of his thermic investigations upon electrolysis. This paper contains chiefly the results of experiments upon various acids.—General Morin communicated a paper by M. H. Tresca on the effects of torsion prolonged beyond the limits of elasticity.—M. Le Verrier communicated a note on the observation of the flight of meteors of the 12th, 13th, and 14th of this month at the stations of the French Scientific Association.—M. E. Peligot presented a further memoir on the distribution of potass and soda in plants, upon which MM. Dumas and Chevreul made some remarks.—M. I. Pierre presented some observations on the solubility of chloride of silver, with reference to the note on this subject recently communicated by M. Stas.—M. Peligot communicated a note by M. J. Bouis on the determination of hydrochloric acid in cases of poisoning, in which he recommends the heating of the filtered liquids in contact with a plate of gold after the addition of a few fragments of chlorate of potass. The dissolution of the gold indicates the presence of hydrochloric acid, and it is determined by means of protochloride of tin.—M. Berthelot presented a note on the formation of precipitates, in which he commenced the discussion of the phenomena connected therewith, and noticed especially the heat evolved or absorbed during the formation of a solid compound, and the dehydratation of precipitated compounds.—A note by M. F. Cayrol on the Lower Cretaceous formation of Corbières was presented by M. Milne-Edwards. The author compared this formation with that of the Clape, formerly described by him, and stated that it consisted in ascending order of a marly clay containing *Orbitolinæ*, a thick limestone with *Requienia Lonsdalii*, and a second *Orbitolina*-zone, the latter overlain by the Gault.—A note by M. Guido Susain was also read on an improved method of managing the egg-laying of the silkworm moth.—The tables of meteorological observations made at Paris in October was communicated to the Academy.

BOOKS RECEIVED

English.—The Student's Manual of Geology: Jukes and Geikie; 3rd edition (Edinburgh: A. and C. Black).—A Treatise on the Origin, Nature, and Varieties of Wine: Thudichum and Dupré (Macmillan and Co.).—Lights and Shadows of a Canine Life, by Ugly's Mistress (Chapman and Hall).—The Ornithology of Shakespeare: J. E. Harting (Van Voorst).—The Royal Institution; its Founder and its Professors: Dr. Bence Jones (Longmans and Co.).

American.—Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College; No. 4.—Deep-Sea Corals: Count Pourtalès.

Foreign.—Mémoires de la Société de Physique et d'Histoire Naturelle de Genève; Tome xxi.—Nachtrag zum 6 u. 7 Jahresbericht des Vereins für Erdkunde zu Dresden.—Bulletin de la Société Impériale des Naturalistes de Moscou, 1870; Parts 3 and 4.

DIARY

THURSDAY, November 16.

Royal Society, at 8.30.—Considerations on the Abrupt Change at Boiling or Condensing in Reference to the Continuity of the Fluid State of Matter: Prof. J. Thomson.—Magnetic Survey of the East of France in 1869: Rev. S. J. Perry and Rev. W. Sidgreaves.—Action of Hydriodic Acid on Codeia in presence of Phosphorus: Dr. C. R. A. Wright.—Corrections and Additions to the Memoir on the Theory of Reciprocal Surfaces: Prof. Cayley, F.R.S.—On the Dependence of the Earth's Magnetism on the Rotation of the Sun: Prof. Miller.

Linnean Society, at 8.—On the Floral Structure of Impatiens fulva, &c.: A. W. Bennett, F.L.S.—Remarks on Dolichos uniflorus: N. A. Dalzell.—Floræ Hongkongensis Supplementum: H. F. Hance, Ph. D.

Chemical Society, at 8.

London Institution, at 7.30.—The Influence of Geological Phenomena on the Social Life of the People: Harry G. Seeley, F G.S.

SUNDAY, November 19.

Sunday Lecture Society, at 4.—The Gulf Stream, what it does and what it does not: W. B. Carpenter, M.D., F.R.S.

MONDAY, November 20.

London Institution, at 4.—Consciousness: Prof. Huxley, F.R.S. (Course on Elementary Physiology).

Anthropological Institute, at 8.—Anthropological Collections from the Holy Land: Captain Richard F. Burton, F.R.G.S.

Entomological Society, at 7.

TUESDAY, November 21.

Zoological Society, at 9.—On the Osteology of the Marsupialia. (Part III.) Modifications of the Skeleton in the species of Phascolomys: Prof. Owen, F.R.S.—Report on Several Collections of Fishes recently obtained for the British Museum: Dr. A. Günther, F.R.S.

Statistical Society, at 7.45.—The President's Opening Address.—Suggestions for the Collection of Local Statistics: J. T. Hammick.

WEDNESDAY, November 22.

Geological Society, at 8.—On some Devonian Fossils from the Witzenberg, S. Africa: Prof. T. Rupert Jones, F.G.S.—On the Geology of Fernando Noronha: Dr. Alex. Rattray.—Note on some Ichthyosaurian Remains from Kimmeridge Bay, Dorset: J. W. Hulke, F.R.S.—Appendix to a Note on a Wealden Vertebra: J. W. Hulke, F.R.S.

Society of Arts, at 8.—On the Present State of the Through Railway Communication to India: Hyde Clarke.

Royal Society of Literature, at 8.30.

THURSDAY, November 25.

Royal Society, at 8.30.

Society of Antiquaries, at 8.30.

London Institution, at 7.30.—Science and Commerce, illustrated by the Raw Materials of our Manufactures. (I.) P. L. Simmonds.

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