THURSDAY, OCTOBER 12, 1882

A HISTORY OF COAL MINING

A History of Coal Mining in Great Britain. By Robert L. Galloway, Author of "The Steam-Engine and its Inventors." (London: Macmillan and Co., 1882.)

THIS unpretentious little volume of 273 pages contains a vastly greater amount of information of a useful and varied character than might at first sight be expected, and its author has evidently taken pains to collect the whole of his data from authentic and original sources. He has also succeeded to an eminent degree in welding them together into a concise, clearly written, and intensely interesting narrative. The twenty-three chapters into which the work is divided partly serve the purpose of marking more or less distinct epochs in the history of mining, partly pave the way for introducing accounts of inventions which have owed their origin to its ever-growing necessities. Prominent among these are the railway and the steam-engine, both of which were born and fostered amongst the coal-mines of Great Britain more than a hundred years before they began to revolutionise the world.

It would appear from Mr. Galloway's account that coal first began to be used as a fuel in some localities about the beginning of the thirteenth century. Much objection was raised against its introduction into London on the plea that its smoke was an intolerable nuisance. This opposition was continued for nearly two hundred years in some quarters, but was at last obliged to give way before the growing scarcity of timber. Towards the beginning of the fourteenth century many shallow collieries were opened out in the neighbourhood of Newcastle-on-Tyne, but little is known about the progress of our subject during the course of the fifteenth century. There is enough to show, however, that the demand for coal went on increasing. In a petition presented to the Council by the Company of Brewers in 1578 we find that corporation offering to use wood only in the neighbourhood of Westminster Palace, as they understand that the Queen findeth "herscalfe greatley greved and anoyed with the taste and smoke of the sea cooles." Another author writing in 1631 says that "within thirty years last the nice dames of London would not come into any house or room when sea coals were burned, nor willingly eat of the meat that was either sod or roasted with sea coal fire."

Soon after the commencement of the seventeenth century the use of coal for domestic purposes as well as for washing, brewing, dyeing, &c., was general and complete. The mines were still shallow, and they were drained by means of horizontal tunnels called adits, water-gates, &c. Already attempts had been made to sink some of them under the water-level and to raise the water by machinery. In the year 1486-7 the monks of Finchdale Priory expended a sum of money at one of their collieries on the Wear "on the new ordinance of the pump" and on the purchase of horses to work it. Underground fires and noxious gases began also to appear about this time. The miners' tools consisted of a pick, a hammer, a wedge, and a wooden shovel. The coal was raised to the surface in some cases by means of a windlass, in others, as in the mines of the east of Scotland, it was carried up stairs on the backs of women called coal-bearers. In the year 1615 the fleet of vessels called the coal-fleet, which carried the produce of the northern collieries—one-half to London the remainder to other destinations—numbered four hundred sail. Many foreign vessels also, especially French, carried away cargoes of coal to their respective countries. Twenty years later the coal-fleet had increased to six or seven hundred sail, and was already regarded as "a great nursery of seamen."

After the shallower seams were worked out the real difficulties of mining began. It became necessary to deepen the shafts and to greatly enlarge the area worked from each, and both of these circumstances entailed a more or less complete change in the character of the operations. Then it was that the great battle between inventive genius on the one hand and natural forces on the other hand began in earnest. The necessity for an improved means of transporting the minerals gave birth to the railway—probably about the beginning of the seventeenth century.

"Up till the year 1767 all the railways in the kingdom were constructed wholly of wood, with the exception of the employment of small bands of iron to strengthen the joints of the rails. But wooden rails were liable to rapid deterioration, and the demand for iron at Coalbrookdale happening to be slack in this year, it occurred to Richard Reynolds, one of the partners, that rails of cast-iron might be employed with advantage. A small quantity were accordingly cast as an experiment. They were four inches in breadth, an inch and a quarter in thickness, and four feet in length, and were laid upon and secured to the previously existing wooden rails. They were found to improve the railway so much that the same course was pursued with all the railways at the works. Between this period and the end of the eighteenth century considerable progress was made in the substitution of iron for wood in railway construction."

The inroads of water were first dealt with by means of buckets, then chain-pumps, then ordinary pumps. Horse-power was the common prime-mover, since wind-power was unreliable, and water-power could only be employed under exceptionally favourable circumstances rarely to be met with. As many as fifty horses were employed in raising water at some collieries. At the beginning of the eighteenth century Capt. Savery tried to introduce his fire-engine for raising water, but failed to do so.

"It was at this juncture" (1710), says our author, "that the miners had put into their hands the most wonderful invention which human ingenuity had yet produced—the Newcomen steam-engine, commonly called the 'atmospheric engine'; a machine capable of draining with ease the deepest mines; applicable anywhere; requiring little or no attention; so docile that its movements might be governed by the strength of a child; so powerful that it could put forth the strength of hundreds of horses; so safe that, to quote the words of a contemporary writer, 'the utmost damage that can come to it is its standing still for want of fire.'"

Towards the end of the seventeenth or beginning of the eighteenth century Sir Humphry Mackworth invented and successfully applied the process of coffering out or damming back water in shafts and sinking pits by means of a water-tight lining now called *tubbing*. He also constructed a railway at his colliery at Neath in Glamorganshire as early as 1698, but after it had been in use for eight years it was declared to be *a nuisance* by the grand jury at Cardiff, and part of it, which crossed the highway between Cardiff and Neath, was torn up and the rails cut in pieces.

Up to the beginning of the eighteenth century the air-currents which ventilated the mines were induced solely by natural causes. It was, however, customary to guide the current into the required channels by means of *stoppings*. As soon as the supply of air was found to be inadequate a new shaft was sunk. Fire-damp was now met with in considerable quantities in the deeper mines, and explosions, which destroyed many lives, began to take place. The first calamity of this kind on the Tyne occurred in 1705, when thirty lives were lost. In 1732 attempts were made in the North of England to produce artificial ventilation by the use of fire-lamps or furnaces, and these appliances were soon afterwards introduced into the collieries of the Tyne. Many disastrous explosions occurred during the eighteenth century and early in the present one, and some remedy was loudly called for. As early as 1733 flint and steel were being used for lighting in the Whitehaven mines, but it appears to be doubtful whether the steel-mill had then been invented. It is certain, however, that it had come into existence in 1753, when its inventor, Spedding, was referred to under the name of Prospero, in a poem in which Dr. Dalton calls it—

> "That strange spark-emitting wheel
> Which, formed by Prospero's magic care,
> Plays harmless in the sulphurous air,
> Without a flame diffuses light,
> And makes the grisly cavern bright."

The steel-mill was at the best a treacherous friend, and our author recounts the various incidents which led to its detection as such, and its abandonment. He also traces minutely the various steps which led to Sir Humphry Davy's splendid invention of the safety lamp in the end of the year 1815, and he gives what appears to be an impartial analysis of the claims put forward by, and on behalf of, George Stephenson to be the original inventor of a similar lamp at the same time.

"The discovery which Sir Humphry Davy had made, that explosion would not pass through small apertures and tubes, was only a stepping-stone to still higher achievements; and before the close of the year 1815 he gave to the world the *wire-gauze* lamp. This was the last, the most splendid, the crowning triumph of his labours—the 'metallic tissue, permeable to light and air, and impermeable to flame.'"

We must now, however, draw our review to a close without having so much as mentioned many another interesting topic which we hoped to have touched upon—such as the perseverance of Sir Robert Mansell, Vice-Admiral of England, in substituting coal for charcoal in glass making; the romantic struggles of Dud Dudley, son of Lord Dudley, against what seemed to be a relentless fate in his partially successful endeavours to effect the same change in iron making--but we can confidently recommend the reader to the original volume, where he will find much to interest him, much, it may be to profit him, and, we are sure, not a little to amuse him.

GARIEL'S "ELECTRICITY"

Traité Pratique d'Électricité, comprenant les Applications aux Sciences et à l'Industrie. Par C. M. Gariel. (*Premier fascicule.*) 200 pp., 140 figs. (Paris: Octave Doin, 1882.)

M. GARIEL, Professor of Physics at the École des Ponts et Chaussées, and better known in this country as the courteous and energetic secretary of the "Association Française," gives us in the above work the first instalment of an extensive book which will not be completed before next year. This first instalment is introductory to the whole subject, and deals with so much of elementary theory as the author deems requisite to give a firm grasp on his subject. Not rejecting mathematics, the author prefers to keep the mathematical treatment of his subject in the background. Nevertheless, he makes good use of algebraical footnotes, and by these and other evidences it may be judged that a firm scientific grasp will be maintained upon the various branches too often treated in a loose and unscientific manner.

Dismissing at the outset the notion that the work is intended for preparing for examinations, the author chooses from old and new the material that will best serve his purpose. It is very satisfactory to find modern notions, both in electrostatics and in electromagnetics, rapidly taking hold of the leading electricians of France. The treatise of M. Mascart first showed them how far electrostatics had advanced in the hands of Green, Gauss, Faraday, Thomson, Clausius, and Maxwell, beyond the achievements of Coulomb and of Poisson. The text-books of MM. Mascart and Joubert, and of MM. Jamin and Bouty, testify to the extension of this salutary influence. And now in the work of M. Gariel we have evidence of the same progress. For example, M. Gariel breaks free from servitude to the consecrated term "*tension*," so often misused as a synonym for potential, electro-motive force, and we know not what; but he uses it, not however in Maxwell's sense as denoting the mechanical stress along the electric lines of force, but as the electric force outside a closed conductor, or as the equivalent of $-4\pi\rho$. The ideas of Faraday on the nature of statical induction are evidently in M. Gariel's mind, though we think he does not give anything like an adequate attention to the subject of specific inductive capacity, which, though of immense practical importance, is passed over almost without mention. Indeed the faults of the book, if such we may call them in a work of such high scientific accuracy, are faults of omission rather than of commission. The contact-theory of voltaic action is very slightly sketched on p. 107; and on pp. 112–115 there is a discussion of the phenomenon of the variable state (*i.e.* of the gradual rise and fall in the strength of currents at making and breaking circuit), in which all allusion to the self-induction of the circuit is omitted, and which would probably lead a reader to draw the conclusion that the reason why the current did not at once attain its full strength was on account of bad conductivity of some part of the circuit. The portion devoted to Ohm's law is fairly complete; but we think the custom of bringing all resistances to a "reduced length" in the antiquated fashion of Pouillet is better honoured in the breach than in the observance. Amongst the newer topics introduced, and not often found in such treatises, we find Jamin's researches on laminated magnets, the thermo-electric effect discovered by Bouty between a metal and its salt, the so-called internal-current galvanometer of Conrad Cooke, and other matters. Many of the drawings are new and suggestive, though some of them (for example, the Ruhmkorff's coil on p. 189) are not quite on the level of the usual excellence of French scientific illustrations. We have serious fault to find only with one minor point; M. Gariel gives in detail the researches of Wheatstone, Fizeau, and Guillemin on the (supposed) "velocity of electricity," without letting his readers know that the apparent velocity of an electric wave which these observers essayed to determine, is a very different thing from the velocity of electricity itself, to which no man can assign any definite value whatever, and which may be infinite or infinitesimal. We congratulate M. Gariel and wish his work success.

LETTERS TO THE EDITOR

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

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

The Recent Magnetic Storm and Aurora

THE following particulars of the magnetic storm of October 2, and of the aurora which accompanied it, may be of interest.

At 21h. 40m. G.M.T. on October 1, a sudden disturbance of the magnetic declination and horizontal force commenced, and the motions were rapid, though not exceptionally large, until about 6h. 50m. on October 2, when a large decrease of declination and horizontal force took place. From about 6h. 50m. to 7h. 20m. the declination diminished 1°, and the horizontal force about 1-70th part. The motions were active till 11h., less so till 14h. or 15h., when the disturbance ended. There was much activity between 9h. and 10h.

Both earth-current traces showed a sudden commencement of disturbance at 21h. 40m., just as in the case of the magnetic registers, the times of greatest activity, and the time of cessation of disturbance being also coincident. As is usually the case, earth-currents were more active along the north and south line, than along the east and west.

As regards the aurora, a bright arch extended along the north horizon to an altitude of 20° from 6h. 48m. to 7¼h., and remarkable outbursts of streamers were noted from 6¾h. to 7¼h., and from 9h. 8m. to 9h. 25m., corresponding closely in point of time with the more active parts of the magnetic disturbance. Patches of phosphorescent light were seen in various parts of the southern sky between 7h. and 7h. 36m., and ruddy light (principally near Arcturus) was observed between 6¾h. and 7¼h.

In connection with this magnetic disturbance it is to be remarked that a large spot was on the central meridian of the sun on September 30, having been first seen near the east limb on September 25. It increased considerably in size as it passed across the disc, and its dimensions on September 30 were:—length, 108″; breadth, 65″; area of whole spot (in millionths of the sun's visible hemisphere), 990; of umbra, 215. There was a line of smaller spots following it 128″ in length, with an area of 520, and a spot of considerable size near the equator, forming, on October 1, with the large spot, three spots visible to the naked eye. The large spot was nearly in the same position on the sun's surface as the great spot of last April, its heliographic longitude being 51°, and latitude 22° S., whilst the position of the great spot on April 10 was long. 65°, lat. 29° S., and at its next return long. 52°, lat. 29° S. W. H. M. CHRISTIE

Royal Observatory, Greenwich, October 9

AN aurora of unusual form appeared here this evening at 7.8 p.m. My attention was attracted by a patch of light in the south-west about 10° above the horizon, and about 6° in diameter. On looking to the north, I saw the usual streamers and bright light indicating an aurora; presently another patch of light, similar to the first, appeared in the south-east, and then others between these two, forming a continuous arch lying, as near as I could judge, in the diurnal path of the sun in midwinter. The arch had a sharp outline below, and from the brightest portion of it extended short streamers, towards the zenith; the colour was a greenish white. In a few minutes the continuous arch disappeared, leaving the brightest portions, which disappeared and reappeared alternately in patches until 7.40, when the last rather suddenly died out.

The light in the north was not particularly bright, nor were the streamers so continuous or numerous as usual, but that in the south showed up most brilliantly against the black sky near the horizon, so much so that the appearance was as if a dark cloud of circular outline was coming up from the south, and cutting off the lower portions of the auroral light. GEO. M. SEABROKE

Temple Observatory, Rugby, October 2

THE aurora of Monday, the 2nd instant, was succeeded by another on the following night at 11 p.m. It assumed the form of pale streamers issuing from a point in the horizon about north by east, and uniting in a similar way directly opposite in the south, like the meridian lines marked on a globe. The streamer crossing the zenith was the brightest. A. PERCY SMITH

Temple Observatory, Rugby, October 6

THE communication below is from a lady. I was on the road from Hilton to this town (and several miles distant from the residence of my correspondent), when I observed the great display she alludes to. I also saw the white clouds or nodes, and at the moment I thought it was a lunar rainbow, similar to one I described in vol. xx. of British Association Reports (1850), but upon considering that the moon had not then risen, and turning round I saw the grand appearance.

St. Ives, Hunts., October 6. J. KING WATTS

A most splendid and beautiful aurora borealis was visible for a long time yesterday evening, October 2 in this town, commencing at 6h. 40m. The weather had been precarious all day. In the early morning there was a thick white fog, the wind being south-west. The wind afterwards changed from that point to the north-east, then in the afternoon to the north. The sky had been much overcast, and some slight showers of rain fell at intervals. The wind then suddenly changed to the west, for a short time, and then back to the north, gently driving the clouds away to the south-east. The aurora then became visible, and was most gorgeous and brilliant, throwing up incessantly various coloured streamers, and many flashes of white light, which passed several degrees beyond the zenith. When the moon arose shortly after 9 p.m. the appearance was still in existence, and was very singular and impressive. During the display and until the aurora had finally disappeared, two large white clouds or nodes were visible, one being similar to a large lump, and the other streaming, and of great brilliancy, in the opposite direction, and they continued so for some time after the aurora had finally disappeared. ANNE GIFFORD

Over Cambs., October 3

I SEE in NATURE (p. 548) notices of an unusual aurora that was seen on the evening of October 2. The following observation may be of interest. At 5.30 p.m. that evening, while it was still quite light, I noticed a band of "mare's tail" cirrus extending from the horizon about north-east, through the zenith, to the horizon about south-west; the texture of the cloud—which I may mention somewhat resembled the backbone of a fish—indicated that it was one of the highest sorts of cirrus. The sky at that time was unusually clear of other cirri; and this rib attracted my attention by its unusual length in isolation. Perhaps further observations may tend to show that these high clouds owe something of their arrangement to electrical causes.

Cheltenham, October 6 W. LARDEN

IT may be worth mentioning that the aurora on the evening of the 2nd inst. was observed at sea on board the Guion s.s. *Arizona* in about Lat. 51° N. and Long. 28° W., or about 700 miles west of Cape Clear. I first noticed it soon after 7 p.m. (ship's time), but the most brilliant display which I saw was between 12 and 12.15 p.m. (G.M.T.), when sheets of light resembling the folds of a curtain passed rapidly across the northern sky. The light was colourless, with occasional flashes of crimson. H. MELLISH

Hodsock Priory, October 9

Newton, Wollaston, and Fraunhofer's Lines

IN most of the current treatises on spectrum analysis, on the spectroscope, and on optics generally (Lloyd's works being exceptions), injustice is done to Newton's care, and scientific insight in his optical experiments, when Wollaston's discovery of the dark lines in the solar spectrum is alluded to, by most positive statements to the effect that Newton never used the slit, or that Wollaston was the first who ever made observations on the pure spectrum.

That the statements are erroneous may be seen by a comparison of the following extracts from Wollaston's paper in the *Philosophical Transactions* for 1802, p. 378, and Newton's "Opticks" edition of 1704.

Wollaston concludes from his experiments that "the colours into which a beam of white light is separable by refraction, appear to me neither 7, as they usually are seen in the rainbow, nor reducible by any means (that I can find) to 3, as some persons have conceived, but that by employing a very narrow pencil of light, four primary divisions of the prismatic spectrum may be seen with a degree of distinctness, that, I believe, has not been described nor observed before." He describes the experiment as follows :—

"If a beam of daylight be admitted into a dark room by *a crevice* 1·20*th of an inch broad*, and received by the eye at a distance of 10 or 12 feet, through a prism of flint glass *free from veins* [italicised by Wollaston], held near the eye, the beam is seen to be separated into the four following colours only, red, yellowish, green, blue, and violet." He then describes four lines marking these divisions, together with two others for which he does not offer any explanation.

Compare with this Prop. 4 of Book I. of the "Opticks," which is "To separate from one another the heterogeneous rays of compound light." Newton, after showing at some length why he uses a lens to "diminish the mixture of the rays," describes Experiment 11, p. 47, as follows :—

"In the sun's light let into my darkened chamber through a small round hole in my window-shutter, at about ten or twelve feet from the window, I placed a lens, by which the image of the hole might be distinctly cast upon a sheet of white paper. . . . Then immediately after the lens I placed a prism, by which the trajected light might be refracted either upwards or sideways." The "oblong image" thus formed he received upon paper placed "at the just distance where the rectilinear sides of the image became most distinct." By varying the size of the hole, he made "the mixture of the rays in the image to be as much or as little as I desired." For this purpose he caused the breadth of the image to be sometimes sixty or seventy times less than its length.

"Yet *instead of the circular hole, 'tis better to substitute an oblong hole shaped like a long parallelogram, with its length parallel to the prism.* For if this hole be an inch or two long, and *but a tenth or twentieth part of an inch broad or narrower;* the light of the image will be as simple as before, or simpler, and the image will become much broader, and therefore more fit to have experiments tried in its light than before."

For the purpose of comparing the simpler light with the more compound, he used also a hole of the shape of an isosceles triangle, whose base was "about the tenth part of an inch, and its height an inch or more" (the width of which, therefore, at a quarter of an inch from the vertex, would be one-fortieth of an inch). The refracting edge of the prism was parallel to the perpendicular of the triangle. The images would therefore be "equicrural triangles," "a little intermingled at their bases, but not at their vertices."

He is very emphatic as to the precautions in making the experiments. He was always careful to have the image in the position of minimum deviation—all foreign light must be carefully excluded from the chamber. The lens must be good—the prism being made of "*glass free from bubbles and veins*," with its sides truly plane and its polish elaborate." "The edges also of the prism and lens, so far as they make any irregular refraction, must be covered with a black paper glued on." "It's difficult to get glass prisms fit for this purpose."

He did not, as is sometimes supposed, always receive the images on paper, for in Expt. 4, Prop. ii., p. 22, he says: "I looked through the prism upon the hole."

That with good prisms, and the great variety of experiments which he must have tried, he did not see the dark lines by looking through the prisms, seems remarkable. It may possibly be explained by the fact that in the very class of experiments in which he was most likely to discover the lines (and in which Wollaston actually discovered them), he found himself obliged to rely on the observation of an assistant. This is mentioned on p. 92 in Prop. iii. of the second part of Book I. The proposition is "To define the refrangibility of the several sorts of homogeneal light, answering to the several colours." In this he says: "I delineated therefore in a paper the perimeter of the spectrum" . . . "and held the paper so that the spectrum might fall upon this delineated figure, and agree with it exactly, *whilst an assistant, whose eyes for distinguishing colours were more critical than mine*, did by right lines drawn across the spectrum note the confines of the colours."

ALEXANDER JOHNSON

McGill College, Montreal, Canada, September 19

The Spectroscope and Weather Forecasting

I MUCH regret that Prof. Smyth should have taken the word prognostic, applied to the rain-band as a depreciatory epithet, when it was only intended as a term of classification. In common parlance any particular "look" of the sky is called a prognostic, and it is a natural extension of the idea to call the "look" of the sky absorption a spectrum prognostic also.

The question at issue is this. Assuming that the rain-band is a quantitative measure of the amount of vapour in a section of the atmosphere, why is it of more use in forecasting than the numerous sky and other prognostics which also indicate an excessive amount of vapour, as, for instance, sweating walls, or a soft sky. Like them, it precedes rain in certain cases, and for the same reason; like them, it fails in numerous cases where rain falls without being preceded by excessive vapour quantity; and, like them, it cannot compare in forecasting value with synoptic observations over a large area, which correlate moist currents with isobaric lines.

But there is one case in which the rain-band may give valuable information—when we have a vapour-laden upper current over a dry surface wind. This often occurs in winter, with a warm south-west current over an area of frost and an east wind. In practice this almost invariably makes itself visible by the long converging stripes of cirrus which so often precede a rainy thaw, but still cases may occur when no cirrus is formed, or it is otherwise invisible. Here is a case in point. One spring morning in London there was a thick fog, with a south-west wind. About 1 a.m. the wind shifted to east, the pavement remaining white and dry; when, to my surprise, the ordinary spectrum of a fog was crossed by a strong rain band. Two hours afterwards a few big drops of rain fell, which soon ceased, and the wind returned to the south-west.

The 8 a.m. chart showed London to be then on the northern edge of an anticyclone, with a small secondary cyclone over Devonshire; this moved on during the day, bringing rain with it, which soon passed.

We can now estimate the different values of the several indications. Cirrus, if there is any, tells that a moist south-west upper current has set in, but not if it is specially vapour-laden. The rain-band tells us simply that there is an abnormal amount of vapour somewhere, and roughly measures it; by inference, from the dryness of the ground, we know that the vapour must be overhead; in very rare cases the band would speak before the cirrus, and in any case would show unusual vapour, which the cirrus could only suggest by looking softer than usual. On the other hand, the spectroscope would be silent in numberless cases where cirrus would indicate rain correctly, and neither could tell their story till the vapour-bearing current had set in.

The forecaster, who used synoptic charts, would know that a damp south-west wind always blew over the north-east wind in front of a cyclone, and in a case like this could say that as the secondary approached, the moist upper current would set in some hours before it arrived, and would be so far ahead of any prognostic; but he would have no means of saying if the current was extra vapour-laden or not.

But in most cases a knowledge of the fact would be but of little service to him. Suppose that in this case there was rain at Plymouth, cirrus or rain-band at Portsmouth, and blue sky over fog in London, the knowledge of this rain-band would not help him much, for he knows by his chart that rain has already set in.

What he does want to know is whether the cyclone will move northwards, eastwards, or southwards. This no prognostic can tell him; the only known clue to a cyclone path is got from a knowledge of the movements of isobaric lines. In this instance the rain in London was, I think, correctly forecast, but unfortunately such a simple case rarely occurs in this country.

Thus we see that a knowledge of the amount of moisture in any current is of only secondary importance to synoptic forecasting, so that if we may welcome the rainband as an addition to our old stock of prognostics, there is little ground for hoping that it will be of further service than them.

All that Prof. Smyth claims for the spectroscope is to act as a gauge of pure vapour quantity, but it seems probable that its employment may be still further extended. There are strong grounds for believing that an air spectrum may vary not only with the amount of pure vapour, but also with the size, aggregation, and physical condition of the condensed vapour suspended in it. For instance, take the so-called rain-lines. These may appear either alone, or with a rain-band of any intensity; so that if the band is due to pure vapour only, the lines must depend on some other condition. Again in sunset tints we have a natural spectroscope whose colours certainly are the product of both the quantity and quality of the total moisture suspended in the air. I have made a large number of observations on the lurid, coppery, yellow, green, and red skies, which form such a large portion of all weather lore, but without decisive results; for sunset spectra are too complicated and too fleeting to be unravelled by a small instrument. They certainly seem to differ, but their spectra are not so marked as their appearance to the naked eye.

But even supposing that this idea is completely verified, and that the spectroscope can be used as a new weapon of research to discover the still unknown nature of clouds, and that we are ever able to say that such and such an absorption spectrum belongs to such and such a kind of sky, there are no grounds for believing that we can ever regard these spectra otherwise than as a new set of sky prognostics, or that as such they will be of more use in forecasting than those already known.

What the use of any prognostics is in forecasting, and how they are related to synoptic charts, and how isobaric lines map out the shape of rain areas, are other sides of the great problem of weather forecasting, which cannot be discussed here.

Some may differ from Prof. Smythe as to the forecasting value of the rain-band, but all will appreciate the singular skill with which he has surmounted the practical difficulties in the way of making it a quantitative measure of atmospheric vapour.

21, Chapel Street, S.W. October 2 RALPH ABERCROMBY

The Comet

WHEN observing the comet this morning, with 7½ inch aperture and powers of 70 and 150, I at once noticed that the nucleus was far from circular, the length being carefully estimated at 45″ and the breadth at 15, while the measured "Position" of the maj. axis was (96°–276°); this was also the supposed direction of the tail, which had ceased to be visible in the increasing twilight.

At 6h. om. G.M.T. the place of the comet was

$$\text{R.A.} = 10\text{h. } 27\text{m. } 3 \pm 5 \text{ secs.}$$
$$\text{N.P.D.} = 100^\circ\ 36'\ 30'' \pm 10''.$$

These places, taken with the equatorial, were confirmed by measures of the not far distant star α Leonis. They differ considerably from the calculated place given in the Dunecht Circular, No. 60. WENTWORTH ERCK

Sherrington House, Bray, Co. Wicklow, October 9

"Note on the History of Optical Glass"

THE writer of the article in a recent number of your journal, entitled "Note on the History of Optical Glass," has fallen into some historical blunders and anachronisms, which are the ground of my addressing you. My grandfather was born in 1738, and would therefore have been but twenty years of age at the date when he is said to have made the acquaintance of the elder Guinand, then sixteen, in Switzerland. It is almost certain that he never was there, at any rate not as an "illustrious savant," engaged in telescopic experiments. His sister's memoirs present a blank at this exact date, but it is evident that if he travelled at the time when he withdrew from the Hanoverian military service, it was in the character of an obscure young musician. It is just barely possible that there may be some foundation for the story now given—and if so, I should be glad to learn it—but a totally mistaken colour has been given to it by drawing on the future. What follows is still more erroneous. Dollond (the elder) was at this period at the zenith of his fame as an optician; Faraday was not born, and Herschel was an ex-bandsman; yet we are told that he "returned the following year with Dollond and Faraday." It is probably something more than a mere coincidence that about sixty years later the son of that Herschel, the son of that Dollond, and Faraday, were associated in treating with the son of that Guinand for the glasses manufactured by the latter. Apart from this, I submit that hardly anything new is contributed in the "Note." All, and more than all, which it contains will be found in the *Biographie Universelle*, under the name GUINAND, where also is mentioned the Swiss rencontre, but with the name *Droz* in lieu of "Herschel and Utzschneider." According to the *Biographie*, Guinand was born "about 1745," and died in 1825. It was in 1821 that the Astronomical Society was instigated to make inquiries (conducted by my father) regarding Guinand's optical glasses. J. HERSCHEL

A "Natural" Experiment in Complementary Colours

ABOUT two miles above Ormeim, in the Romsdal (Norway) is the well-known Slettafos, an imposing cascade formed by the impetuous Rauma, which here plunges through a deep rocky ravine. Fascinated by the scene, I stood watching the foaming water for some time, and all at once noticed a most beautiful and delicate rosy pink tint colouring the foam and spray in the ravine. The water, where not broken up, was of a green colour, and the pink tint was at once explained as its complementary. But the point of special interest to me was that this pink colour was not visible except on those parts of the spray and foam which were in the shade of the gorge. In the full light these appeared, as usual, white. The result above described is an excellent illustration, afforded by nature herself, of the advantage of toning down the brightness of the white surface, upon which we wish to evoke a complementary tint, until it no longer exceeds that of the exciting colour—the green in this case.

CHAS. T. WHITMELL
H.M. Inspector of Schools

9, Beech Grove, Harrogate, September 11

Animal Intelligence

IN the article on animal intelligence (NATURE, vol. xxvi. p. 523), Mr. Morgan seems to me to have inverted the real process in the case of what he calls "isolation," for he says: "I believe such abstract ideas to be impossible for the brute. I believe them to be the outcome of the use of language." The process of abstraction here alluded to is the conception of a quality apart from the things that possess that quality, as whiteness or edibility.

I watched a little child just able to walk alone, on a railway platform. It went up to a square box, and after staring at it for a few seconds, slowly passed its hand over the top, front and sides, and then along the edge, clearly testing the sense of sight by that of touch. It then did the same with the small wheel of a luggage barrow. It was obviously too young to be able to speak, but I think we may safely assume that it got a notion of what we call "square" and "round." Now a dog can readily acquire a somewhat similar experience, by finding a barrel to be less easy to stand upon than a square box. So far they are much alike; the child, however, certainly exhibited a greater inquisitiveness than a dog is likely to do.

It is obvious that a dog can receive just the same impressions as a child through the senses, so that automatic appreciation of the difference between roundness and squareness is common to both; but, whereas, the dog, as I believe with Mr. Morgan can never get beyond that stage, a child, if not an infant, can make the difference an *object of thought* or a mental abstraction, even without having a word to express it; just as an adult experiencing a new but uncomfortable sensation, can think of it, and coin a term to express it, say, "all-overish-ness;" or again, as one can *feel* indignant or benevolent, and at the same time think about such states without necessarily giving expression to them. If words were necessary, as Mr. Morgan seems to think, then a deafmute, who had never been taught to speak, could never rise higher than a brute, because he cannot *picture* "justice" or "edibility." But if we recognise the power to abstract the conception of roundness, justice, edibility, &c., *then* can be felt the want of symbols to represent them; just as a concrete thing, say, a tree, needs the word "tree" to stand for it. Instead, therefore, of considering abstract ideas as an "attempt to conceive a reality-in-thought answering to certain of our symbols," I would completely reverse the process, and make speech itself as the outcome of our power of making abstractions *objects of thought, i.e.* not only can we be conscious of what is white, as a dog also can, but we, and we alone, can be conscious of whiteness; and just as the symbol "white" is invented to stand for the concrete, so "whiteness" is the symbol invented to stand for the abstract. GEORGE HENSLOW

Drayton House, Ealing

An Insect Attacking a Worm

MR. E. LAWRENCE's letter in this week's NATURE reminds me that, walking, now many years ago, on a very hot and bright summer's day, I saw a huge earthworm crawling across the hard-beaten and sun-baked highway. What has brought *you* forth at such a time? I asked, and speedily got my answer. For, coming nearer, I found the larva of some beetle holding on obstinately by the poor worm's tail. I had not leisure to wait the result; and indeed, although here memory does not help me, I may have interfered on behalf of the worm, and so failed to witness anything corresponding to Mr. Lawrence's interesting experiences.

Even although such encounters as that witnessed by him may be but rarely visible, I venture to believe that earthworms very often fall victims to predaceous larvæ. Those of the Caribidæ and other predacious beetles are common enough, that of the well-known ferocious being, the "rove-beetle" (*Staphylinus olens*), for example. The singular pointed tail-appendage of its larva, supposed to assist locomotion, may have a more important use. Turned to an acute angle with the body, it may effectually help the larva to hold its place in a worm-hole against the efforts of its prey to escape from its jaws. And only when the captured worm is very powerful may it be able to come to the surface of the ground, dragging its relentless foe along with it. Such, indeed, was the worm I saw, which had thriven well in the rich meadow-land bordering the Portobello Road, near Edinburgh, copiously irrigated with town sewage, and famous for its fertility. It was the largest I remember ever to have seen, to the best of my belief at the time not less than a foot long, while its assailant might be about an inch only, more or less WILLIAM SWAN

Ardchapel, Dumbartonshire, October 6

YOUR correspondent, Mr. Edwin Lawrence, is mistaken in supposing that the worms of England enjoy immunity from attacks such as he witnessed at Laqueville. I saw, in North Devonshire, in the last week of July, 1882, an incident precisely like that which he narrates. The insect I should judge from his description was identical. What particularly impressed me was its enormous strength, for the earth-worm, which was a large specimen of its kind, must have had at least twenty times the bulk of its adversary, and yet the insect, seizing upon the middle of the body, dragged it by main force a distance of three or four inches. It was cunning as well as strong; for when it found that the corpse, dragged loopwise from the middle, met with considerable resistance from the stiff wiry grass, it seized hold of the head, brought it round over the middle, and endeavoured to drag the worm lengthwise between the opposing stalks. I watched the attack for some time, and then removed the insect with my stick to a distance to see if it would find out the worm again, but in doing so I unfortunately injured it. When I first saw it the worm could still crawl, though feebly, but at the end of the attack it was quite motionless. HERBERT RIX

Science Club, Savile Row, W.

MR. WALLACE, of Tynron, Dumfriesshire, related to me an incident which he was witness to, a few months ago, so similar to that related by your correspondent, Mr. Lawrence, that I called his attention to the communication of the latter. The worm Mr. Wallace observed, was attacked by the same kind of caterpillar-like animal, the difference being that after much twisting and wriggling, about two-thirds of the worm broke away and escaped, leaving one-third in the enemy's possession, upon which it seemed to settle down for the purpose of a meal.

J. SHAW

Chiasmodon Niger and Notacanthus Rissoanus

IF the "singular fish of a deep black colour, with small eyes, and a most *abyssal* physiognomy," noticed by Prof. Giglioli (NATURE, vol. xxv. p. 535) had been a *Chiasmodon*, that learned ichthyologist would doubtless have recognised it, and not suggested that "it may be allied to *Malacosteus*." But in addition to the two specimens of *Chiasmodon niger* referred to by Mr. Johnson (NATURE, vol. xxvi. p. 453), it may interest ichthyologists to learn that a third specimen has been found off the New England coast (on the Le Have Bank). Like the others previously known it had engorged a fish several times larger than itself. The specimen is now in the U.S. National Museum. *Chiasmodon*, it may be added, is not at all related to the Gadidæ, as has been supposed by Messrs. Günther and Johnson, but is a true Acanthopterygian fish and the type of a peculiar family—the *Chiasmodontidæ*. [In Dr. Günther's "system" it belongs to the heterogeneous family *Trachinidæ*.]

With respect to the *Notacanthus rissoanus*, for which a new generic name has been proposed by Prof. Giglioli, permit me to state that prior designations have been suggested. In fact the genus has now received five names, viz.: (1) *Campylodon*, Günther, prov. name, 1861 (not of Fabricius, 1878, and not defined); (2) *Polyacanthonotus*, Bleeker, 1875; (3) *Zanotacanthus*, Gill, 1876; (4) *Paradoxichthys*, Giglioli, 1882; and (5) *Teratichthys*, prov. name Giglioli, 1882. THEO. GILL

Smithsonian Institution, Washington, September 18

PROFESSOR HAECKEL IN CEYLON[1]

VI.

IN his walks through the Singhalese village, of which he preserves so many pleasant memories, Prof. Haeckel was particularly struck with the comparative rarity of the weaker sex, especially of girls between 12 and 20 years of age.

"The greater number of children playing in the streets were boys. Girls are early accustomed to remain inside the huts and employ themselves in household work. Besides this, they develop very young, being often married at 10 or 12 years old, and old women at 20 or 30. Grandmothers of 25 to 30 are very frequent. A further significant fact is the permanent disproportion of male and female births among the Singhalese. The average is 10 boys to 8·9 girls. This fact is connected, to some extent at least, with the curious institution of polyandry. In spite of the efforts made by the English Government to suppress this custom, it maintains its ground, especially in the more remote districts of the Island. It is not unusual to find two or three brothers with one wife in common, and ladies may be found the happy possessors of 10 or 12 husbands. These complicated family arrangements form the theme of many extraordinary stories; but it is very difficult to distinguish fact from fable on the subject. . . .

"The Singhalese have a passion for music and dancing, and practise both arts according to a standard of taste very different from our own. Their principal instruments are the drum and the tom-tom, vigorously belaboured with wooden drum-sticks; besides these, they have reed-pipes, and a very primitive stringed instrument of one string. My evening calm was often broken in upon by the din of these ear-splitting instruments, and if I followed the sound to its source I was sure to find, in front of a fire under a palm tree, a group of ten or a dozen naked brown fellows, gaily painted with white, yellow, or red stripes, and indulging in the most extraordinary antics. A circle of spectators stood round, and followed the grotesque performance with devout attention.

"At Christmas time (the Buddhist New Year) these evening 'devil-dances' are more frequent, and partake

[1] Continued from p. 503.

somewhat of the nature of a religious ceremony. The principal performers are fantastically adorned with coloured feathers and decked with horns and a long tail, to the immense delight of the youthful portion of their audience. Whole troops of these demons parade the village with musical accompaniments throughout the day, the nightly revels being sometimes extended into somewhat unseemly orgies.

"The chief of the neighbouring village, Dena-Pitya, organised a special Buddhist festival on December 19, to which I was invited as the guest of honour, and escorted in grand procession. Ten or twelve old close-shaven priests of Buddha in yellow robes received me under the shade of a gigantic sacred fig tree, and led me to the sound of marvellous singing within the flower-decked temple. Here I was shown the great image of Buddha and the wall-paintings (scenes from the life of the God) were explained to me. Then I was conducted to a chair of state placed under the shade of a banana in front of the temple, and the actual performance began. A band of five tom-tom beaters and as many pipers set up a noise which would have wakened the dead. Then two dancers upon stilts executed a series of wonderful evolutions. While they were proceeding, the chief's daughters, well-grown, black-haired girls of from 12 to 20 years of age, offered cocoa-nut shells filled with toddy or palm wine, and sweetmeats and fruits for refreshment. A long speech was addressed to me by the priest of which, unfortunately, I did not understand a word; but I imagined the subject of it to be the honour which I had done him by my visit. The same idea was pantomimically expressed by a band of ten naked, painted, and bedizened devil-dancers, jumping and whirling round my throne like madmen. When I was at last permitted to break up the sitting and return to my bullock-cart, I found it full of the finest bananas and cocoa-nuts placed there as a parting present from my friendly entertainers. . . .

. . . "One of the most lovely of the coast lagoons (or *gobbs*) within an easy distance of Belligam, is that called Boralu-Wewa. I am indebted for the pleasant days I spent there to my good friend the Arachy, or second headman of Belligam. He owned a large tract of land close to the lake, planted partly with different fruits, partly with lemon grass, on which he employed from 30 to 40 labourers. The road to Boralu turns off before Dena Pitya, in a north-easterly direction, now passing through lovely palm woods or luxuriant jungle, then across light green paddy fields or marshy meadows, where black buffaloes lie in the mud, and pretty white herons seek their prey. After several miles of this, we come to the lovely lagoon of Boralu, the road sometimes skirting its shores, sometimes making wide detours. The banks are covered with the most luxuriant vegetation, and the background is composed of thickly-wooded hills. A little island covered with trees lies solitary in the midst of the lake. The numerous tongues of land projecting from the shore far into the water give a peculiarly varied charm to the scene; but its principal attraction lies in its intense loneliness and the entire absence of human cultivation. The impression is not destroyed by the carriage-road along the shore, for this is quite concealed by a thick growth of shrubs on either side. The lagoon and its vicinity are rich in animal life. I never visited it without finding the great green lizard (*Hydrosaurus salvator*) six or seven feet long, sunning itself on the banks, and once I was startled by a huge serpent twenty feet long (*Python molurus*). Unfortunately the monster slipped off the rocks into the water before I could take aim at him. A more exciting chase was afforded by the apes, whose chatter was to be heard on every side. I shot several fine examples of the yellow-brown 'Rilawa' (*Macacus sinicus*) and of the great black 'Wanderu' (*Presbytis cephalopterus*). But swimming birds were more enticing still to the sportsman, and I secured many species of water-hens, herons, ibis, flamingoes, pelicans, &c. They came flying over the lagoon in large flocks towards sundown, seeking their nightly quarters; I once brought down half a dozen in a quarter of an hour. The thick brushwood of the banks, with its lovely golden cup-shaped cassia-flowers and purple melastoma, harbours many smaller birds. . . . Besides birds, apes, bats, lizards, &c., I once shot a great porcupine more than three feet long (*Hystrix leucura*). Butterflies and beetles also abound in great varieties. The marshy meadows near the lagoon are often covered with gigantic examples of insectivorous pitcher-plants (*Nepenthes distillatoria*). The elegant pitchers, six inches long, covered with a closely-fitting lid, were sometimes full of captive insects. Brilliant-hued *Ampelidæ* and lovely honey-suckers (*Nectariniæ*) sport among the blossoms with the humming-birds that they resemble. . . . A saunter round the lake leads through the most beautiful part of the forest. In some places the tangle of creepers, *Aristolochia*, *piperacea*, wild vines and pepper plants, *bauhiniæ* and *bignonia*, are so intertwined among the branches of the trees that only a few gleams of light can straggle through them, and no progress is possible without the aid of the knife at every step. I often sat for hours with my sketch-book open before me trying to seize one of these forest views; but I scarcely ever succeeded, owing to the difficulty of knowing where to begin; or when I had begun, how to reproduce such bewildering luxuriance of foliage. The Arachy cultivated lemon grass upon the rounded hills that surrounded his garden; from this very dry grass a simple process of distillation extracts a fragrant and much prized perfume. The whole neighbourhood is penetrated with the scent. The workmen who are occupied with the distillation and with the cultivation of the bananas live in about a dozen scattered huts clustered under the shade of bread-fruit and jak trees; groups of slender areca and cocoa palms, with here and there kittuls and talipats spreading their feathery crowns high over the level of the forest mass, betray the hiding-place of the little bamboo huts. My visits to them, and my intercourse with their friendly inhabitants taught me almost to envy their simple and natural mode of existence. They are all pure Singhalese, cinnamon-coloured and delicately formed; their clothing is limited to a narrow white cloth round the loins. The bright pretty boys were eagerly glad to help me in collecting birds and insects, while the graceful black-eyed girls twined garlands and adorned my ox cart with flowers. At evening time, when the swift-footed bullocks had been harnessed to the cart, and I had taken my place by the Arachy, our rapid start was a special delight to the children, and as we rolled along the lovely banks of the lagoon we were usually followed by a swarm of twenty or thirty gay little creatures, shouting and waving palm leaves, or pelting us with flowers. . . .

"The most distant excursion that I undertook from Belligam at the close of my stay there was to the southernmost point of Ceylon, the far-famed Dondera Head. The town of Matura lies a couple of miles to the west on the shores of the Blue Sand river (Nilwella Ganga). The road from Belligam to Matura is the continuation of the lovely avenue of palm trees which leads from Galla to Belligam, and affords the same variety of luxuriant and beautiful scenery. Arrived at Matura, a town which has lost much of its prosperity since the time of the Dutch dominion in Ceylon, I refreshed myself with a cold bath and did ample justice to the English luncheon provided by my friends. Thus fortified I determined to lose no time in setting off on the proposed expedition, in company with the chief Ilaugakuhn, the most distinguished Singhalese on the whole island. He is, in fact, the last male descendant of the ancient line of Kings of Candy, and resides in a handsome palace at Matura, near the mouth of the river. A month previously he had paid me a visit at Belligam, and presented me with several rare and beautiful birds.

My visit to Matura was made at his request, and the reception he gave me was kind and flattering in the extreme. He insisted on driving me to Dondera. His carriage, a well-appointed English phæton, was drawn by two fine horses of Australian breed. A handsome black Tamil in a red turban and silver-laced livery, ran before us all the way. . . .

"The long blue peninsula of Dondera Head, with its forests of cocoa palms, is visible on the road from Matura long before it is reached. It is the most southerly point of Ceylon, lying at 5° 56′ N. latitude. For more than 2000 years the temples erected on this spot have been the object of pilgrimages, only second in fame to those to Adam's Peak. Thousands of pilgrims and devotees flock here every year, and the temples have been dedicated alternately to Buddha or Vishnu, according as the native Singhalese or the Malabar invaders had the upper hand. Three hundred years ago, the chief temple was an Indian building of the first rank, so large, that from the sea it appeared a considerable town; its numerous pillars and statues were richly decorated with gold and precious stones. In 1587 all this magnificence was destroyed by the Portuguese, who carried off the rich spoils of the interior of the temple. The enormous extent of the building may be estimated by the ruins which remain. In one corner a very large Dagoba has been left standing close to several ancient and colossal Bo-gas or sacred fig-trees. The ruins of a smaller temple are to be seen on the narrow tongue of land which forms the extreme southern point of Dondera Cape. They consist of octagon pillars of porphyry, rising in lonely desolation from the granite rock, and washed by the foaming surf which surrounds it. At low tide I collected many curious marine animals in the natural basins among these rocks, and sat for a long time lost in thought upon this, the most southerly point I had ever reached. It was late in the evening before we returned to Matura. The following day (January 19) was dedicated to a long marine excursion. The chief, Ilaugakuhn, had placed a capital sailing canoe at my service, and my trip extended a long way to the south of Dondera Head. It was glorious summer weather, and the north-west monsoon blew so strong that it was all my boatmen could do to keep the canoe from capsizing. Our speed was almost equal to that of a powerful steamer. No better illustration could have been found of the ease with which the narrow Singhalese canoes cut through the waves, or rather, glide over their crests. As the island receded from our gaze, we had a lovely view of the blue mountain masses, crowned by Adam's Peak, rising from the palm forests of the plains.

"After about four hours of this rapid sailing we became aware of a broad bright streak on the surface of the ocean, extending in the direction of the monsoon, from north-west to south-east, and about a mile wide. I pronounced it at once to be a pelagic stream or current, one of those narrow ocean [illegible] which frequently occur both in the Ocean and the Mediterranean Sea, and which owe their origin to the amalgamation of large shoals of marine animals. As we drew nearer, my surmise proved correct, and I was rewarded with an extraordinarily abundant and interesting capture. A dense mass of pelagic animals, in endless variety, besides numerous larvæ of worms, star-fish, crabs, molluscs, &c., swam hither and hither, and all the vessels I had with me were speedily filled. I only regretted not to have brought enough to contain specimens of all these zoological treasures, among which were many rare and hitherto undescribed varieties. I returned to Matura late in the evening, richly laden with booty, which would provide me with interesting work for many years to come. It was a pleasant reminiscence of the fifth degree of north latitude. My Singhalese were so skilful in taking advantage of the monsoon, that we returned almost as quickly as we had gone, and landed safely at the mouth of the River Nilwella. The view of this delta from the sea is very picturesque, and both banks of the river are thickly wooded. I went up the stream in a canoe on the next day, and was filled with fresh wonder at the unexampled luxuriance of the forest vegetation.

"A melancholy task awaited me on my return to Belligam. I had to bid farewell to the spot on which I had spent six of the happiest and most interesting weeks of my life. The impression of this parting is as vivid in my mind as if it were still to come. The familiar room which had served me for parlour, bedroom, and study, for laboratory, museum, and painting-room, with all the pleasant memories that had centred in it, was empty and bare. In front of the house, under the great teak tree, stood the two bullock-carts laden with my thirty chests of specimens, &c. Beyond the garden-gate were ranged row upon row of the brown villagers watching the departure of the stranger who had been so great an object of curiosity and amazement to them all these weeks. I took leave personally of the two chiefs and of all the more important inhabitants of the village. Good old Socrates, with sorrowful mien, produced for the last time the best of his bananas and mangoes, annonas and cashu-nuts. For the last time Babua climbed my favourite palm to offer me one more draught of sweet, cool cocoa milk. Hardest of all was the parting with my faithful Ganymede. The poor lad wept bitterly, and earnestly begged me to take him with me to Europe. It was in vain that I sought to persuade him, as I had often done before, that this was impossible, and that he could not live in our icy climate and beneath our grey skies. He clung fast round my knees, and assured me that he was ready to follow me anywhere without hesitation. I was obliged at last to disengage myself almost by force, and mount my vehicle. As I waved a last adieu to my dark-skinned friends, I had all the feeling of Paradise Lost—'Schoner Edelstein! Bella Gemma!'"

THE SANITARY INSTITUTE

ONE of the first objects which the Sanitary Institute of Great Britain has set itself to accomplish is the diffusion throughout the country of such information as shall lead to increased knowledge concerning the laws of health, and to an improvement in the conditions under which people live. Amongst the means by which it is sought to attain this object at each annual congress, is the delivery of public addresses in the several sections. This course was, as usual, followed at Newcastle-on-Tyne, and many of the addresses contained matter of much interest.

Dr. Embleton as a resident in the borough visited by the Institute, referred to such measures as had been adopted in Newcastle to secure greater cleanliness of air and water. He deplored the manner in which air was still contaminated by the products of the combustion of coal in the large manufacturing districts; he vividly described the conditions resulting from the constant inhalation of the solid and gaseous matter contained in smoke, and having reference to some of the principal local trades, he explained how hurtful from an economical point of view was the diffusion into the atmosphere of the valuable, unburnt, and therefore wasted carbon, the carbonic acid and oxide, the sulphurous acid, and the fumes of hydrochloric acid, of lead, copper, arsenic, and other vapours. Looking hopefully into the future, and anticipating that with the growth of knowledge in matters relating to health, there would also come a material increase in the duration of human life, he sought to give some estimate of the normal length of the life of man. Accepting the rule laid down by Buffon and Fleurens that the full term of normal life is dependent upon the age at which growth is completed, he pointed out that according to Dr. Quain, the epiphyses of the long bones of the extremity in man are not perfect as regards their ossification until the age of from 23 to 25 years. At that age natural growth is finally completed, and Fleurens, multiplying this age by 5, brought man's normal age to some 125 years. Dr. Farr has been less hopeful, and has regarded the natural term of human life as at about 100 years, whereas he has shown that the actual mean age at death under existing circumstances is slightly under 41 years. Man, according to Dr. Embleton, is himself greatly to blame for his short existence, and he urged his hearers not to go away contented, merely because health officers were now devoting all their time to the removal of conditions inimical to life, but rather themselves to attend to the sanitation of their bodies, their houses, and their surroundings.—Mr. Henry Armstrong, Medical Officer of Health for the City, gave a somewhat detailed history of Newcastle, from a health point of view. Having regard to the many difficult sanitary problems to be dealt with, he urged that it was necessary to remember the extreme antiquity of the borough, and in estimating what had been done, to compare the present with the more remote past. In the thirteenth and fourteenth centuries, epidemics, which lasted from one to three years, occurred in the borough. In the time of James I. so little regard was had to cleanliness, that the "dunghill" within the castle precincts "had increased to such a size and bigness, that it was in length 98 yards, the depth of it was 10 yards, and the breadth of it 32 yards," some 27,000 tons of filth having thus been allowed to accumulate. In the seventeenth century the Great Plague was one of eleven epidemics; it alone caused 7000 deaths, and it led, by the almost complete desertion of the town and port, to a ruined trade and wasted treasury. Even in 1853, at the date of the then prevailing cholera epidemic, it is reported that the town so abounded in narrow yards, lanes, and "entries," that in one district alone there were streets exceeding a mile in length, which had an average width of some four feet only. Since then, rapid progress has been made; good water, improved sewerage, and better dwellings have been provided, and although much remains to be done in an ancient city which is in certain parts so crowded as to prevent that proper movement of air about dwellings which is necessary to health, yet the reduction of the yearly death-rate per 1000 by ten in as many years, and the diminution in the same time of typhus to one-fifth of its prevalence in the period immediately before, are matters of congratulation, and tangible results of good work effected.—Prof. Henry Robinson, in dealing with the question of house sanitation, pointed out that not one quarter of the dwellings of all classes—high or low, rich or poor—are free from dangers to health, due to defects with respect of drainage, water, or ventilation, and he gave a summary of the rules which should everywhere be laid down to secure entire disconnection between the interior of houses and the public sewers, basing his remarks in this connection on the model series of bye-laws issued by the Local Government Board. Mr. Robinson's estimate of the proportion of unhealthy houses is, we fear, below the mark, and in towns it is probable that the houses of the well-to do exhibit greater sources of danger than those of the poor, and this by reason of the number of pipes passing from cisterns, baths, sinks, lavatories, &c., directly into the drains. By means of these direct connections sewer air can, notwithstanding water-traps, easily make its way into dwellings, and the more numerous they are, the greater the danger. Dealing with the question of sewer-ventilation, Prof. Robinson urged the necessity for frequent ventilating-apertures in the course of the public sewers, and in considering the best method of effecting this, he objected to the construction of ventilating shafts in connection with dwellings, deeming it desirable that the ventilation of the main sewer should be accomplished independently of the ventilation of house drains. On the question of water-supply, Prof. Robinson pointed out, as we had already done in commenting on Capt. Galton's address, that chemical analysis could not be regarded as alone sufficing for the determination of the wholesomeness or otherwise of a water-service, especially in the case of rivers liable to contamination by animal organic matter, and he laid it down as a rule that the only way to insure perfect safety was to exclude all waters which were not altogether free from the possibility of pollution. The view held by Mr. W. G. Laws on sewer ventilation differed entirely from those of Prof. Robinson. He advocated the extension upwards of the soil-pipe of houses in such a way as to convey a current of sewer air through the house drain to a point above the roof, and hence he objected to the existence of a trap in the course of the house drain to the sewer. There is one fatal objection to this system, and that is, that if the slightest failure occurs in the plumber's or mason's work, the foul air from the sewer makes its way into the houses, a result which has often ensued, and this with fatal consequences. By the adoption of the principles laid down in the Model Byelaws, and which received Prof. Robinson's commendation, a current of fresh air instead of foul air would constantly pass through the house drains, and this is the result which architects should aim at securing. How far the "gas chimney" advocated by Mr. Laws would answer, it is difficult to say, but we would point out that as yet the Legislature has given no powers to enable authorities to make use of dwellings for the purposes of the ventilation of public sewers.—Mr. E. C. Robins, F.S.A., drew the attention of the Congress to the admirable work on the exclusion of sewer air from houses, which has recently been published by Dr. Renk, of Munich, and which deals with this important question in much detail, and in a thoroughly scientific spirit. One very important question is raised by Dr. Renk, namely, whether the mere inhalation of air from sewers is ever provocative of specific forms of disease. He is inclined to the opinion that the particular matter of infection cannot pass into the human system by means of the superincumbent air alone. Doubts as to this have been raised before, but the emanations from sewers are largely composed of aqueous vapour, which must be regarded as capable of holding infective matter in suspension, and Dr. Frankland, in his paper before the Royal Society, has shown that in the process of the breaking of minute bubbles on the surface of flowing sewage, liquid particles capable of conveying infective solid particles are largely transported into the surrounding air.—Mr. James Leman contributed a useful paper summarising the conditions under which it is desirable as far as possible to separate rainfall from sewage with a view to securing an efficient method of sewage disposal. The adoption of the so-called "separate system" has unquestionable advantages as regards towns which are so circumstanced that it becomes imperative to reduce, as far as possible, the amount of liquid to be dealt with at the outfall, but it can never be absolutely carried out, for it is nearly everywhere necessary to admit into the sewers such rain-water as that which falls on the surface of roads and which is liable to be contaminated, and also to make provision for the occasional flushing of sewers during storms.—Dr. Bartlett, F.C.S., communicated an interesting paper on the influence of suspended matter on health. He detailed at some length a series of failures to procure specimens on the one hand, of the infectious matter of the various contagia, and, on the other, of the particles which swarm in the air emanating from sewers and other sources, and which give rise to unwholesome conditions of air. He next described how resort was had to the peculiar and beautiful waste product of the smelting furnace, slag-wool, as a medium through which to filter air, and how by its means floating particles composed of living organic matter, consisting in part of cells or corpuscles of animal origin had been found in air which had been vitiated from certain sources, and how by means of the discovery the sources of evil were detected and hence done away with. Dr. Bartlett holds a strong opinion against the probability of finding specific disease germs in any form by which our present powers of observation can recognise them, but he is equally impressed with the indications afforded by the results of some of his experiments as to the noxious influence of animal organisms, including, perhaps, the specific matter of the various contagia and of tubercle, which are often contained in impure air.

Capt. R. T. Hildyard drew attention to the influence for good which might be exerted by medical men if, in the course of their private practice, they had more regard to the sanitary conditions under which their patients were living.—The Hon. J. A. R. Russell brought gether a large amount of carefully-prepared meteorological and other statistics to show how climate improved with slight elevation. In a series of conclusions to which his observations had led, he pointed out how the ranges of temperature, yearly, monthly, and diurnal, were less at certain elevations than in lower sites, and he regarded it most desirable that every house should be built on arches or on piers admitting of ventilation above the ground level, and that in country districts no house should be considered habitable of which the floor is on a level with or below the ground.—Miss Yates, Hon. Sec. to the Bread Reform League, pointed out the advantages of wheat-meal bread over white bread, both as regards its nutritive properties and otherwise, and urged its general use as a means of promoting national health, especially amongst the classes depending on bread as their main article of food.

ON THE PERCEPTION OF COLOURS BY THE ANCIENT MAORIS

In an interesting paper on this subject by Mr. Colenso, he gives a great deal of information on this subject, derived from his individual experience during a very long period of dwelling among the Maoris, and that before the country was settled, and by his having travelled very much among them, frequently in parts where no white man had ever been, sometimes on the battle-field, both during and after the fight, ever with them as medical man, often in the confidence of their best head men. The colours of black, white, red and brown were the prized and favourite ones. The purer states, especially of each of these colours were highly valued, to which may be added green and yellow. These several colours and their varying hues comprised nearly all that pertained to their dresses and personal decorations, to their principal houses and canoes. In the olden times a chief's house might truly be called a house "of many colours," which were artistically and laboriously displayed. Each tint or shade of colour bore its own peculiar name plainly and naturally, or figuratively sometimes both. They possessed a fine general discrimination of the various shades and hues and tints; they could give an accurate description of a rainbow, of all its various colours; they noticed the iridescent hues of the feathers of a pigeon's neck, of some shells, and the delicate evanescent tints on the ventral surfaces of many fish. From their general hues alone the Maoris could accurately tell whether far off and to them unknown districts were covered with a vegetation of fern or flax (Phormium) or grasses, but far above all their fine discrimination of delicate hues and shades was correctly shown in their nice distinction of the various tints of the flesh of the several kinds of kumara and taro. Once travelling on the coast, nearly forty years ago, Colenso met an old chief who told him that long ago he had cultivated a variety of the taro, which is called Wairuaarangi, but that it had long been lost. Knowing this sort from having met it in the north, and remembering the delicate and curious pink colour, Colenso tested the knowledge of the chief by asking what colour it was, which he immediately minutely described. They had early succeeded in getting brilliant black and red dyes. The old Maoris had a peculiar bias towards neutral colours. Blue was certainly known to them, and they obtained it from two sources, one mineral, the other vegetable; and they had even distinct names for several shades of blue. Throughout this paper Mr. Colenso criticises and contradicts many of the assertions made by Mr. Stack, from probably an insufficient knowledge of Maori, in a memoir recently published on the colour-sense of the Maoris (*Trans.* New Zealand Institute, vol. xiv. p. 49).

FRIEDRICH WÖHLER

Wöhler is dead. A man, who was born four years after Priestley died, who worked with Berzelius, who was engaged in chemical research when the brilliant genius of Davy was ranging over the whole field of chemical phenomena, who was contemporaneous with Liebig and Graham—this man has but now passed away from our midst.

Wöhler witnessed, and well bore his part in helping on the many great advances which chemistry has made since the science was founded by Black, Priestley, and Lavoisier.

Friedrich Wöhler was born in 1800 near Frankfurt; he graduated as Doctor of Medicine at Heidelberg in 1823, but in place of pursuing the study of the uncertain art of medicine, as he tells us in his "Reminiscences," he determined to devote himself to the more exact science of chemistry. Recommended to Berzelius by Gmelin, Wöhler spent the winter of 1823-4 in the laboratory of the great Swedish chemist.

As we read the Reminiscences of Wöhler's youth—published a few years ago in the *Berichte* of the Berlin Chemical Society—we are ready to exclaim that it was impossible that, with the appliances which he had at his command, Berzelius could accomplish chemical work of any value. A few tables, an oil lamp or two, a large jar of water, basins and flasks—that was nearly all. The ancient Anna cooked in the kitchen, where also stood the sand-bath and the rarely-used furnace; Anna still spoke in these days of "oxidised marine acid gas;" but Berzelius was beginning to think that it might be better to say chlorine.

Five years later we come to a date memorable in the history of chemistry. Hitherto it had seemed as if the boundary which chemists had found it convenient to draw between organic and inorganic chemistry had a real existence in nature; but Wöhler's preparation of urea, in 1828, from constituents of mineral origin, showed that this chemical boundary was as unreal as any other drawn by the too ardent devotees of system; and that, as Graham said, in nature "distinctions of class are never absolute." The artificial barrier broken down, the living science of the chemistry of carbon compounds rapidly grew and overspread the place where the dead wall had been. Wöhler's discovery seemed a small one at the time, but what great fruit has it borne:

> "Walls admit of no expansion,
> Trellis work may haply flower
> Twice the size."

About this time (1830) the reaction led by Dumas against the Berzelian system of classification was growing in strength; in their zeal to overthrow the evils which had arisen from the axiom of the Swedish chemist—that every compound must be built up of two electrically opposed parts—chemists had sought likewise to demolish the conception of compound radicles, which formed so marked a feature of the Berzelian system.

But the classical research of Liebig and Wöhler on "oil of bitter almonds" in 1832, recalled investigators to the true paths of advance. By recognising the existence in a series of compound molecules of a group of elementary atoms—which group they called *benzoyl*—Liebig and Wöhler were able to bring together, and so to explain the properties of compounds derived from this oil, compounds which to the less imaginative chemist appeared to belong to altogether different classes of bodies.

Thus was inaugurated the modern conception of compound radicle, a conception which, being much more elastic than that of the Berzelian radicle which preceded it, and being at the same time sufficiently precise, was destined to lead to that of a replacing value for each radicle, and so to be merged in the wider hypothesis of the chemical equivalency of elementary atoms.

But in other and different fields the influence of the work of Wöhler has also been felt. Called to the Professorship of Chemistry at Göttingen in 1836, for more than forty years Wöhler pursued his investigations into the properties of metals and metallic compounds. Do we not owe to him much of our knowledge of aluminium and of nickel? Was it not he who taught us how to separate cobalt from nickel and from manganese? Did we not learn from him much concerning the properties of chromium, tungsten, tellurium, arsenic, and titanium?

His researches have thrown light on the chemistry of palladium and iridium, of beryllium and yttrium, and largely on the properties of silicon.

In 1833 Wöhler published the "Grundriss der Chemie," a book which is known wherever chemistry is studied, and which has been translated into the English, French, Dutch, Swedish, and Danish languages.

In 1861 the publication of his "Mineral Analysis" enriched analytical chemistry with methods of rare accuracy and general applicability.

Wöhler's translations into German of the *Lehrbuch* and *Jahresberichte* of Berzelius brought those classical works within the reach of every chemist.

But what shall be said of the influence of this great student of nature on others? Many a chemist looks to Göttingen as to the place where he learned what research means.

He has lived long and nobly; he has seen chemistry grow from a feeble plant to a spreading tree, and to that growth he has in no small measure ministered.

M. M. P. M.

PALÆOLITHIC GRAVELS OF NORTH-EAST LONDON

DURING the present spring and summer several new and instructive sections through the beds containing Palæolithic implements have been laid open at and near Stoke Newington. For the first time in my memory sections have been exposed which show the real age of the beds near the valley of the Hackney Brook, together with the older deposits on which they rest. Stoke Newington, Highbury, and Hackney are now so much built over, and where not built over, the surface of the ground has been so much disturbed for market gardening, brick-making, and excavations for sand and gravel, that one might live near the place for a lifetime and never see a section of four feet which would show the true nature of the uppermost deposits.

In NATURE, vol. xxv. p. 460, I described the "Palæolithic Floor" lighted on by me at Stoke Newington. This "floor" is a place where Palæolithic implements and flakes occur in large numbers. They are found about four feet beneath the surface of the ground, and nearly all the examples are as sharp as knives. That this was really a working place where tools were made in Palæolithic times is proved by the fact of my replacing flakes on to the blocks from which they were originally struck Hitherto I have described this "floor" as belonging to the Hackney Brook, and Dr. John Evans, in his "Stone Implements of Great Britain," p. 523, says: "The Shacklewell gravel lies on the slopes of the valley of the Hackney Brook." This in one sense, is really the case, but recent sections show that the Hackney Brook is quite modern, that it has cut its way through the Shacklewell gravels and only slightly disturbed them; in some places it has washed the "Palæolithic Floor" quite away. The "floor" really belongs to the Thames and the Lea, and one part of it occurs at the point of the former confluence of the two streams at four miles north of the Tower of London. It is also older than the "trail" or "warp" of the Rev. O. Fisher which occurs just above the "floor." The "floor" I now find to be by no means restricted to the slopes of the Hackney Brook, for I have seen a good section of it with tools and flakes *in situ* at three-quarters of a mile to the east of the stream and quite removed from its slopes. The present Hackney Brook may possibly follow some old depression left by previous denudation on the north bank and bed of the ancient Thames, but that is all. I have no doubt that the unabraded implement found at the bottom of a sand and gravel pit at Highbury by Mr. Norman Evans ("Stone Implements," p. 525) and compared by Dr. John Evans to the tools from Hoxne, High Lodge, and the cave of Le Moustier, really belongs to the "Palæolithic Floor," for I have an example recently found by myself near the Highbury position, which I know came from the "floor," for I there saw the "floor" in section. The unabraded implements, from their character and position clearly belong to a recent Palæolithic period, and they agree partly with the Le Moustier examples, but the Hackney Brook is far more modern than the most recent of Palæolithic times. At first the evidence seemed to indicate that the men worked on the old banks of the brook; it is now clear, however, that it was on the immensely older banks of the ancient Thames, that the men really fabricated their tools.

As no section through the "Palæolithic Floor" has hitherto been published, the accompanying illustration, Fig. 1, engraved to scale, will give an idea of its nature. The upper part of the illustration shows a section, facing the east, 300 feet long from north to south. It is taken through the gardens between Alkham and Kyverdale Road and south of Cazenove Road—the latter is shown on Stanford's Library Map of London. It is north of, and close to Stoke Newington Common. The south end, nearest the brook, is 83 feet 3 inches above the ordnance datum, whilst the north end is 90 feet 6 inches, showing a rise of 7 feet 3 inches in 300 feet—the heights are my own. Varying at from 4 feet to 6 feet from the surface there is a thin stratum of sub-angular broken flints and other stones seldom more than 4 or 5 inches in thickness, and sometimes obliterated or with only a single thickness of stones. This is the "Palæolithic Floor," and it is indicated in the upper part of Fig. 1 by the letters A, A, A. At 8 feet below the "floor" and about 12 feet from the surface of the ground is a bed of gravel and sand about 8 feet in thickness containing implements of older date; this bed is shown at the base of both the upper and lower sections seen in Fig. 1.

To more clearly show the nature of the "floor," the 60 feet of the upper figure (where marked) is engraved below to a larger scale; B is the 12 feet gravel containing rolled fossil bones and abraded Palæolithic implements; C is fine buff-coloured sand, often full of fossil shells of land and freshwater molluscs, D D D is the "floor," with its numerous unabraded tools and flakes; in the part illustrated, the "floor" is in duplicate. After the men had made their tools on the "floor" where the lower D's occur, a slight flood of water covered up the tools with a thin coating of sand; the men then walked over the newly-deposited material, and made other tools on the new "floor." The two white streaks on the top of the upper "floor" are London Clay mixed with sand. Sometimes the tools and flakes are to be seen in this clay, but of course they were washed into it in Palæolithic times by floods. Above the "floor" is sandy loam and loamy sand; the uppermost part, and sometimes the whole of the material above the "floor," is not water-laid; in other words, it is one form of "trail;" above this "trail," where the darker tint is engraved, is humus, with Neolithic celts and flakes.

When the material above the "floor" is carefully removed, as I have so had it removed for me several times, the surface of the old working place is exposed. The stones are chiefly subangular broken flints, under the average size, the crust sometimes ochreous, at other times grey, quartzite pebbles, pieces of sandstone, a few pieces of quartz, cretaceous fossils, and numerous small grey flint pebbles, with traces of chalk. Intermixed with these stones are large numbers of keen lustrous flakes and many implements, all sharp, and as a rule (not without exceptions) small in size and well made, some so

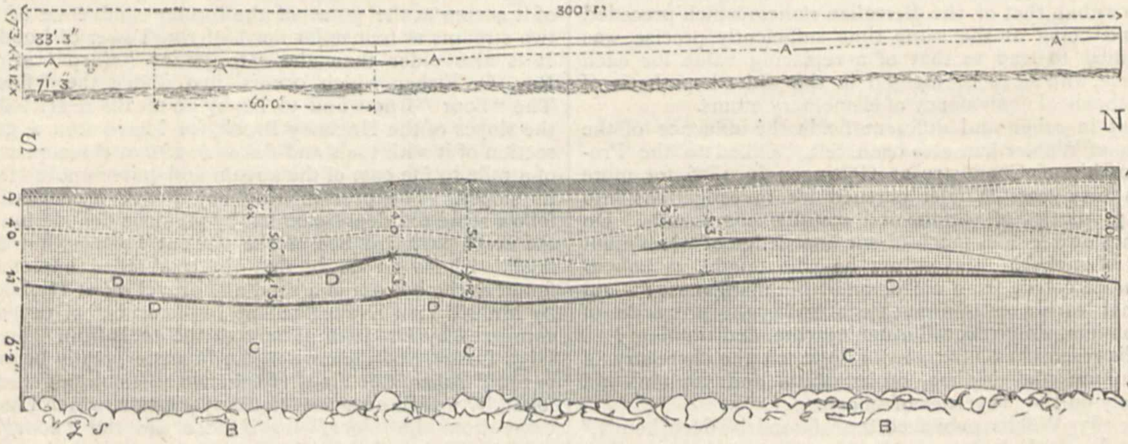

Fig. 1.

exquisitely made as to rival the best Neolithic work. With these tools, fossil bones, mostly broken, belonging to the mammoth, horse, bison, and reindeer, occur with broken tusks, teeth, and antlers of the same and other animals; human bones and teeth I have never been able to light on. I have, however, many times seen such tender things as leaves, small pieces of wood and small crushed branches, generally, especially is this the case with the leaves, very friable. Molluscan remains in immediate contact with the "floor" sometimes occur, and I have seen them both below and above it, and in contact with the bones and implements. Three or four feet below the "floor," shells are sometimes very common. Both under and above the "floor" are occasional seams and blocks of London clay, brought from a short distance to the north-west, where the clay comes to the surface. As a rule there are no very large blocks of flint or other large stones on the "floor." The non-waterlaid covering mass often disturbs the "floor," ploughs it up, and pushes underneath it. The twisting, contortion, and undulation of the material above the "floor" seems to prove that it was laid down by moving ice from the north. This ice-deposited "trail" is full of small whitish pebbles; fixed in the tenacious material at various angles. Abraded and whitened

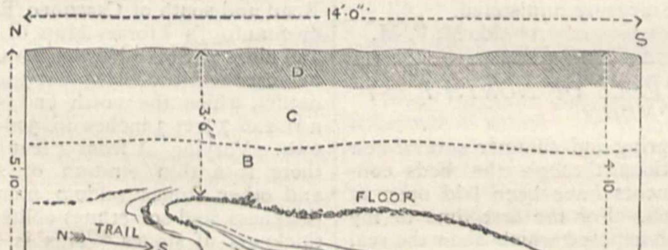

Fig. 2.

implements are also met with in the "trail," examples no doubt caught up from old exposed surfaces by the ice-sheet, and brought from a distance to their present position. No Palæolithic implements occur above the "trail," the "trail" seals up all the relics of the Palæolithic age, and as far as the evidence of north-east London goes, Palæolithic man had quite retired before the "trail" was deposited. When implements are found on the surface, the ground may have been denuded, and the implements exposed.

Fig. 2 is a measured section through the "floor" facing west; on the other side of the section, illustrated in Fig. 1, the "floor" is seen at from 3 feet 6 inches to 4 feet 10 inches beneath the surface, muddy trail, with sand and a few stones, is present at B and C, — D is humus. In the direction of the arrow, from north to south, the "trail" is seen pushing under and upheaving the "floor" with its implements; the Hackney Brook is towards the south, and a flooded brook to the south would hardly upheave the "floor" from the north; A is a mass of London clay and sand brought from a distance and pushed under the "floor" by the advancing "trail" from the north. Where the "floor" has been crumpled and disturbed, the implements show a very small amount of abrasion, when the "floor" is covered by the stratified sand or mud of the river, the tools are all as sharp as on the day they were made.

It fortunately happens that very near the sections here illustrated, viz. at 270 yards west by north from Clapton Railway Station, and just south of Caroline Street (marked on Stanford's map), one or two other cuttings have quite recently been made, these show admirable sections of characteristic "trail." At Fig. 3 a section facing south is engraved to scale, and at Fig. 4 the end of the section is further enlarged to show the "trail" above and the stratification below. The section is 11 feet 6 inches deep, and just reaches the top of the stratum of gravel which contains implements intermediate in age between those of the "floor" above, and those found from 20 feet to 30 feet beneath the surface. The "Palæolithic Floor" on Fig. 4, if present, would be just above the hortozanal bands of stratification, but the "trail" at this spot has swept it away, it however occurs in a perfect state a few yards off. Beginning at the top, the reference-letter, R, is humus; Q, mud belonging to the "trail"; O, "trail"; P, a pocket of London Clay; N, Palæolithic sand and loam crumpled and disturbed by the "trail"; M, dark sand and clays; L, light sand and clay; K, dark sand and clay; J, yellow sand; I, red sand; H, light sand and clay; G, dark sand and clay; F, red sand; E, yellow sand; D, red sand; C, sand, almost white; B, buff sand, sometimes full of the fossil shells of land and freshwater molluscs. These sands represent the sandy margin of the old Thames, now four miles distant from this spot.

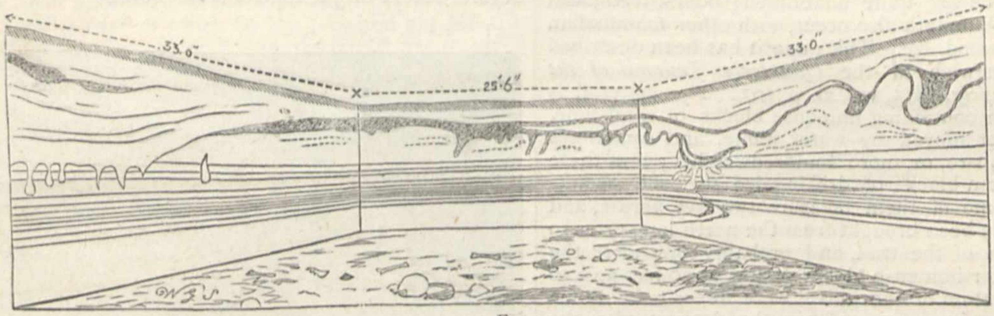

Fig. 3.

Some of the shells found in it by me have been kindly named by Dr. J. Gwyn Jeffreys; the series is probably very imperfect, as the time I have for geological matters is extremely limited, but no doubt the list is typical, as I have many times met with the species hereafter mentioned; other species may be more rare or local.

1. *Corbicula fluminalis*, Müll., extremely common.
2. *Hydrobia marginata*, Mich., not uncommon.
3. *Sphærium corneum*, Linn.
4. *Pisidium fontinale*, Drap.; var. *Henslowana*, Jen.

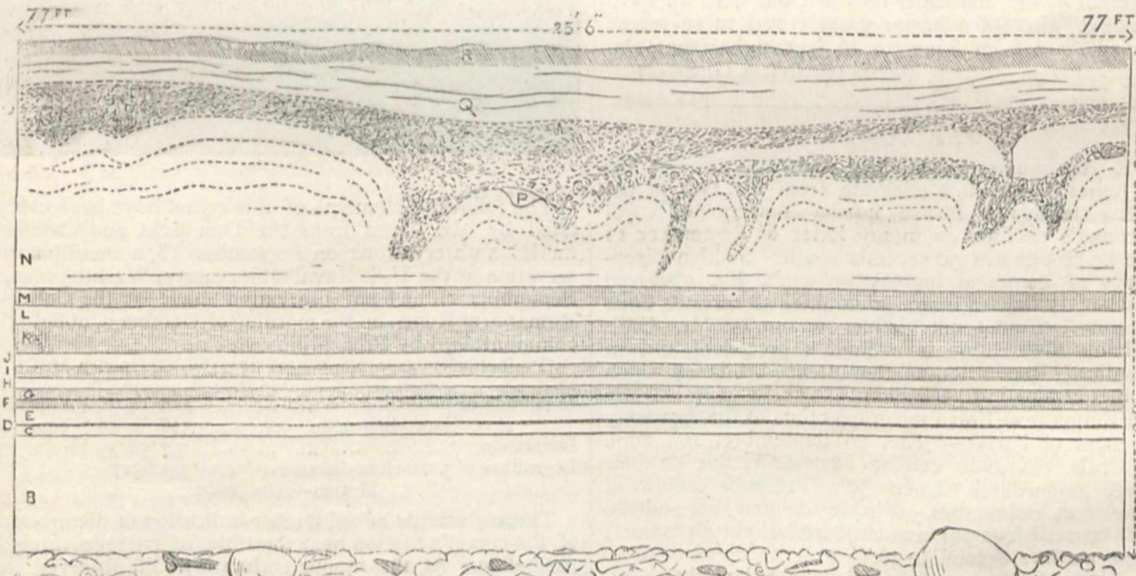

Fig. 4.

5. *P. amnicum*, Müll.
6. *Unio tumidus*, Phil.
7. *Bythinia tentaculata*, Linn, extremely common, with abundant free opercula.
8. *Valvata piscinalis*, Müll., var. *subcylindrica.*
9. *Planorbis albus*, Müll.
10. *P. complanatus*, Linn.
11. *Limnæa auricularia*, Linn.
12. *L. truncatula*, Müll.
13. *L. peregra*, Müll.
14. *Ancylus fluviatilis*, Müll.
15. *Helix concinna*, Jeffr.
16. *H. nemoralis*, Linn.

Dr. Jeffreys was good enough to add the following note:—"The occurrence of *Pisidium fontinale*, var. *Henslowana*, as well as the *tout ensemble* of all these fossil shells, induces me to believe that they had been thrown up by floods on the banks of a large river such as the Thames." A mile to the west at Highbury, other molluscan genera are represented. A list of the Highbury shells is given by Dr. John Evans—"Stone Implements," p. 524.

I now come to the bed of gravel indicated at B (Fig. 1) and A (Fig. 4). It is found at an average depth of 12 feet, and descends to 20 or 30 feet from the surface; this drift contains, chiefly in its upper parts, lustrous sub-abraded Palæolithic implements of medium age. All these tools have been more or less moved and relaid by the agency of water; none are quite unabraded; bones, teeth, and tusks of the mammoth also occur, with other mammalian remains, driftwood, &c. This deposit has been described by Prof. Prestwich in the *Quarterly Journal of the Geological Society*, 1855, vol. xi. p. 107. The material is remarkable for containing immense blocks of sandstone, probably never moved by water alone, and sometimes weighing one, two, or more hundredweights; that these stones fell from blocks of drifting ice seems extremely probable. Some of them measure two feet across, and they must have been brought from the north long prior to the deposition of the trail, and probably long after the time when other immense blocks found at 20 feet and 30 feet at the bottom of the gravel were deposited. Some show glacial striæ. Generally in the deepest pits, the third and oldest class of implements is found, the examples are rudely made, massive, deeply ochreous in colour, with a thick ochreous crust, the ochreous tint not derived from the matrix they are now in; they are generally very much abraded, indicating transport from a long distance, or long dashing about in water with other stones, but as the three different classes of implements will be illustrated in my concluding note, and proved to be of totally distinct ages, far removed from each other, I need not refer to them at length here.

It commonly happens, that the higher the gravels above the present rivers, the older they are, but here we have an instance where the newer gravels and more recent implements are from 8 feet to 26 feet higher than the old. WORTHINGTON G. SMITH

THE COMET

THE Astronomer-Royal has received, through Sir James Anderson, a telegram from Mr. Gill, in the following terms:—"Please inform Astronomer-Royal that comet's declination in my letter of September 11 should be 56 minutes 30 seconds south. Sudden disappearance of comet at ingress on sun's disc observed September 17 days 4 hours 50 minutes 58 seconds Cape mean time. Comet not visible on sun." Mr. Gill's remarkable observation is without a precedent, and an extraordinary illustration of the intense brilliancy which the comet attained at perihelion.

The Emperor of Brazil telegraphs thus to the Academy of Sciences of Paris:—"Rio, 26 Septembre, 10h. 20m. Note Cruls. Grande comète australe visible de jour observée aujourd'hui. Queue 30°. Présence sodium et carbone. 25 Septembre.—Visible de jour au sud de Rio 18, 19, 20. Vue par moi aujourd'hui de 4h. 10m. à 5h. 40m. matin. Splendide 26."

Mr. Ainslie Common, of Ealing, whose daylight observations on September 17 may have an important bearing on the theory of the comet, has furnished us with the following extract from his note-book on that date:—

		Value.
"10.45.	Found bright comet. S.W. sun.	
10.59.	Comet precedes sun, 6m. 50s., centre to centre	3
11.10.	Comet south, sun's limb, 20R 50D = 18′ 8″...	
11.47.	Comet precedes sun, 5m. 48s. (?)	1
11.58.	Comet south, sun's limb, 16R 60D = 14′ 41″...	
12.0.	Comet precedes sun, 5m. 44s. (good)	3
12.6.	Comet south, sun's limb, 15R 55D = 13′ 45″...	

Clouds came over shortly after this."

Mr. Common has corrected an error in reducing the last micrometrical difference of declination into arc: one revolution = 53″·1. He states that he made an immediate attempt to telegraph to Greenwich and Dun Echt, but the office at Ealing was unfortunately closed.

We have received several drawings from M. Bulard, of Algiers, showing the appearance of the comet as viewed with the naked eye, in one of which the tail is depicted with considerable curvature. Also a sketch of the head as seen in a powerful telescope, exhibiting the system of envelopes rising from the nucleus, which has characterised several recent bright comets (see Figure).

The following elements of this comet have been calculated by Mr. Hind from the Dun Echt and Coimbra meridian observations on September 18, a meridian observation at the U.S. Naval Observatory, Washington, on September 21, and an observation made at the Collegio Romano, at Rome, on the morning of October 2, obligingly communicated by Prof. Millosevich:—

Perihelion passage, September 17·2169, Greenwich M.T.

	° ′ ″	
Longitude of perihelion	276 14 36	Apparent
,, ascending node	346 6 58	equinox
Inclination	37 58 59	Sept. 25.
Logarithm of perihelion distance ...	7·906527	

Motion—retrograde.

These elements afford further indication of disturbance of the comet's motion near the time of passage through perihelion. At the moment when Mr. Gill observed the comet upon the sun's limb, when the distance from the sun's centre was consequently 16′·0, the orbit gives the central distance, as 10′·9, or the comet projected upon the sun's disc. Considering that Mr. Gill's observation was made less than one day previous to the accordant meridian observations at Dun Echt and Coimbra, it is not easy to see how such difference could arise from error of elements, which represent the middle position employed in their determination within a minute of arc.

The following expressions for the comet's heliocentric co-ordinates x, y, z, referred to the equator, are to be used in connection with the X, Y, Z of the *Nautical Almanac*, in the calculation of geocentric positions:—

$$x = r \,.\, [9{\cdot}99521] \,.\, \sin (v + 9^\circ\ 6'{\cdot}2)$$
$$y = r \,.\, [9{\cdot}98774] \,.\, \sin (v + 277\ \ 2{\cdot}4)$$
$$z = r \,.\, [9{\cdot}44252] \,.\, \sin (v + 130\ \ 17{\cdot}5)$$

r being the radius-vector, and v the true anomaly.

[Mr. Gill writes on September 19: "Yesterday and to-day the comet is a brilliant daylight object, and was observed on the meridian by myself with the Transit Circle. We have a whole lot of Alt-Azimuth observations which will be reduced as soon as possible. They were the only kind of observations possible, as the comet was only visible by glimpses through holes in the cloud between September 8 and perihelion."

In a letter addressed on the same day to the Astronomer Royal (with a copy of which he has favoured us) Mr. Gill says: "On Sunday, the 17th inst., the comet was followed by two observers with separate instruments right up to the sun's limb, where it suddenly disappeared at 4h. 50m. 58s. Cape M.T."]

NOTES

PROBABLY some of our readers may have heard that Mr. W. Spottiswoode met with an accident recently. The fact is that on September 30 last he broke his left humerus within the capsule, through the overturning of the tricycle he was riding. He has, we are glad to learn, been carefully attended, and is getting on as well as possible.

A PRIVATE letter to this country conveys the intelligence of the death, on September 11, at Kandy, of Dr. Thwaites, F.R.S., for many years director of the Royal Botanic Gardens, Peeadeniya, Ceylon. We shall defer to a future issue some particulars of his life.

THE death is announced, at the early age of forty-eight years, of the well-known scientific photographer, Dr. D. Van Monckhoven.

WE are glad to learn that a memorial signed by Professors Paget, Humphry, Hughes, Newton, and Moseley, Drs. Michael Foster and S. H. Vines, and Messrs. G. H. Darwin, E. W. Blore, Coutts Trotter, A. Sedgwick, and J. W. Clark, was presented to the Vice-Chancellor of Cambridge University (Dr. Porter) on the 4th inst., representing the desirability of establishing some memorial of the late Prof. Balfour in the University. The Vice-Chancellor, in accordance with this request, has called a meeting of Members of the Senate and others for October 21, at 4.30 p.m., in the Lecture-Room of Comparative Anatomy, in the New Museums, "to take steps to establish in the University a memorial of the late Prof. Balfour."

SOME forty eminent German botanists met at Eisenach on September 16, under the presidency of Professors Pringsheim, Cramer, and Willkomm, and founded a German Botanical Society. The new society has its seat at Berlin, and its object is to form an effective and supporting centre for all efforts in the domain of scientific botany in Germany.

AS is well known, the French Institute is divided into five classes, which meet together once every year. The president of this reunion is chosen in rotation from among the president of each of the five sections. The chair will be occupied this year by the president of the Academy of Sciences, who is styled director, and who happens to be M. Dumas, one of the two perpetual secretaries of the Academy of Sciences. M. Dumas will deliver on this occasion an address which it is stated will be of special importance. This meeting will take place on October 25 next.

M. DUMAS delivered at the sitting of the Academy of Sciences of October 9 an address summarising the works of the International Commission of Weights and Measures. He stated that the commissioners had executed a comparison between the original meter and kilogramme deposited in the Archives, with the new standards. The difference had been proved to be 0·000006m. for the meter, and 0·00001 gram for the kilogramme. The consequence is that a slight correction will be required for the measures taken with the international meter as the comparison between two measures of length can be executed with a precision of one part in ten millions. The new international kilogramme can be used without any correction at all.

Two International Conferences will open in Paris on Monday next. One of these is for the object of settling upon a plan for the protection of sub-marine telegraph cables; the other is to establish throughout Europe the important desideratum of technical uniformity in relation to electricity. England, France, Germany, Austria, the United States, Spain, Denmark, Norway, and Sweden will be represented.

M. GABRIEL DE MORTILLET, Professor of Archæology to the School of Anthropology of Paris, has just published through Reinwald a work under the title of "Le Præhistorique," which may be considered as the first complete manual for the study of the Archæological Museum of St. Germain. M. Gabriel de Mortillet has been attached to this establishment from its foundation by Napoleon III. up to the present time, and is industriously engaged in its completion. The author, who is one of the few living geologists who investigated the formation of glaciers in Switzerland with Agassiz, attempts at the end of his volume to determine how far distant is the epoch when *Homo Sapiens* made his first appearance on the earth, by estimating the rate of progression of blocks which were carried by former ice-fields, and he comes to the conclusion that the space of time that has elapsed since that event took place exceeds 200,000 years.

THE meteorological station on the summit of the Säntis has recently been opened, and this latest Swiss station promises to be of importance with regard to the progress of meteorological science. In its altitude of 2504 metres it is surpassed only by the observatories on the Stelvio (2548 metres), the Pic du Midi in the Pyrenees (2877 metres), and the station upon the Colorado Peak (4340 metres).

THE *Panama Star and Herald* of September 14 gives details of several earthquake shocks which had visited the isthmus during the preceding week, doing much damage, but, fortunately, only causing two deaths. At 3.20 a.m. on Thursday, the 7th, the inhabitants were aroused from their beds by one of the longest and most severe earthquake shocks ever experienced in the city. It was preceded by a hollow, rumbling noise. The motion was wave-like, and proceeded almost directly from north to south. The first and most severe shock must have lasted at least 30 seconds. Extreme damage was done to buildings. A second and milder shock occurred about half an hour after the first. The Pacific Mail steamship *Clyde*, arriving from San Francisco, reported that the earthquake was severely felt on board. Passengers declared that it appeared as if the vessel were lifted bodily from the sea and allowed to fall back. The effects of the earthquake along the railroad were most marked. The stone abutments of several of the bridges were cracked and almost split, and the earthworks sank in half a dozen places. In several places where the direct action of the shock appears to have made itself most strongly felt, the rails were curved as if they had been intentionally bent. The severe shock on the morning of the 7th was followed during the day by several others of less intensity, and at 11.30 p.m. a sharp shock alarmed the whole city, and drove the people from their houses to the squares. Another slighter shock occurred at about three in the morning; but, fortunately, neither it nor its predecessor added further ruin to that already incurred in the city. All the shocks were felt on the islands in the bay, and some houses suffered at Taboga. On the morning of the 7th, at about 3.15, the residents of Colon were aroused by the earthquake shock which has caused so much alarm and damage to the whole isthmus. The duration of the shock was fully 60 seconds, and was so severe that the whole populace rushed into the streets as rapidly as their feet could carry them. About half an hour afterwards another shock was felt, but much lighter than the first. A deep fissure was opened in the earth from the south end of the freight-house for a distance of about 400 feet along the walk leading in the direction of the ice-houses. Many buildings were moved slightly from their foundations, but on the whole remarkably little damage was done. On board the vessels in the harbour the shock was also felt very severely. About 1 p.m. another much slighter shock was felt, and during the succeeding night two more slight disturbances were reported. It may be of meteorological interest to observe that the sea at the time remained calm, the atmosphere quite clear, and the stars and waning moon remarkably brilliant. Soon after, say about 4 o'clock, a slight fog wafted from inland; no rain fell. All day an ominous calm prevailed without rain, with fluctuating barometer and excessive heat. Another slight shock occurred at Panama on the morning of the 9th, a little before 5 o'clock, but fortunately no damage was done. The same shock was lightly felt in Colon and along the railroad track. All day on Saturday no shock was felt, and the night passed quietly. At mid-day on Saturday, there was a marked change in the atmosphere, and, with a refreshing shower which fell, the murky, sultry air of the previous days entirely disappeared. The rumours of a volcanic eruption at Chagres are entirely without foundation. The earthquake was felt there, did some little damage, and opened a few cracks in the ground. The earthquake of the 7th was felt at the Pearl Islands, in the bay. At Donoso, Govea, and Rio Indio a number of shocks were felt, and the people were much frightened. At Miguel la Borda, 35 miles from Colon, in the direction of Bocas del Toro, the tide rose to an unusual height and flooded some of the houses, which are built on the beach almost on a level with the sea. The earth sank in about a dozen places. The Governor of the district writes officially that several boiling springs suddenly appeared, some of which throw hot water to a considerable height. Letters have been received from the towns of La Villa, Chitré, Macaracas, ann Natà, all in the State, announcing that several shocks have been felt, but that the material of which the houses are built—bamboos and adobes—resisted the movements, and they suffered no damage. Two or three slight tremblings were experienced in Panama during the night of the 12th, but they caused no alarm, and many people were returning to their houses.

IN the Photographic Exhibition, which was opened in Pall Mall on Monday, there are several pictures of more than artistic interest. We may mention especially Captain Abney's views taken on the Alps, and showing the great difference in the photographic quality of the light reflected from the sky at high altitudes (9,000 to 10,000 feet), and that reflected at lower levels. Mr. Grant's photographs taken on board Mr. Leigh Smith's yacht *Eira* during her cruise to Franz Josef Land in 1880, are also of interest, as is also Mr. Shadbolt's photograph taken from the car of a balloon at the height of 2,000 feet, showing the streets and houses below.

THE Council of the Statistical Society have again decided to grant the sum of 20*l*. to the writer who may gain the "Howard Medal" in 1883. The subject is—"The best exposition of the experiences and opinions of John Howard on the preservation and improvement of the health of the inmates of schools, prisons, workhouses, hospitals, and other public institutions, as far as health is affected by structural arrangements relating to supplies of air and water, drainage, &c." Candidates are referred to the text and foot-notes of Howard's two works on "Prisons" and "Lazarettos."

BOTANISTS will learn with satisfaction that the Cavaliere d'Amico has succeeded, not without considerable difficulty, in acclimatising a number of foreign plants in Sicily. They are being exhibited at the present moment at the Agricultural Exhibition of Messina, and excite a great deal of interest among the spectators. Amongst them are the tea plant, *Persea gratissima*, *Cinchona succirubra*, *Indigofera tinctoria*, and *Myrica cerifera*. Cav. d'Amico intends to establish a tea plantation of some extent not far from Messina, and it is hoped that Sicilian tea may in a few years become an important article of commerce.

IN a vineyard at Bonn, Phylloxera have recently made their appearance. The necessary precautions were at once taken.

THE eminent Berlin sculptor, Herr Pohle, is now about to complete a bust of the celebrated geographer, Karl Ritter, for the Geographical Society of Berlin.

PROF. SIMON NEWCOMB, of Washington; Lieut. T. L. Casy, United States Army; Ensign J. H. L. Holcombe, United States Navy; and Mr. Julius Ulke, forming the expedition despatched by the Government of the United States to observe the transit of Venus at the Cape, left Plymouth last Friday in the Union Steamship Company's mail steamer *Durban*. Miss Newcomb, daughter of the Professor, the lady member of the expedition, is in London, the epidemic of smallpox at the Cape deterring her from proceeding with her father. Mr. Gill, the Astronomer Royal at the Cape, has expressed his willingness to render the members of the expedition every facility as to the selection of a station by collecting information. It is probable that Beaufort, which is 300 miles from Cape Town, will be chosen, from the fact that in that district there is proverbially a clear sky.

THE Danish astronomers, who have been selected to take observations of the transit of Venus, have left Copenhagen for Santa Cruz.

ON commencing his Winter course of lectures on Comparative Anatomy at King's College, Prof. Jeffery Bell made the following remarks:—"In ordinary circumstances it is well to proceed at once to the work before us, but, during the six months that have elapsed, since I last addressed a class of comparative anatomy from this chair, two heavy blows have fallen on the students of zoological science; the two most remarkable of English workers have been taken away from us, the one full of years and honours, the other the bearer of a glorious promise. I should not be doing my duty if I were not to ask you to pause for a moment on the threshold of your studies to bear witness with me to the regrets which we justly feel at the death of Charles Darwin, and the sense of irreparable loss which is connected with the name of F. M. Balfour. The father of modern zoology, the reformer of all our conceptions as to the workings of nature in the organic world, the assiduous and patient collector of the facts of natural history, the prince of observers and the leader of philosophical naturalists was carried to his grave in our national burying place amid the mourning of tthe whole civilised world; the broad outline of his work is well known to you all. On the treacherous slopes of an ice-bound mountain, away from kindred and friends, save such as his character had won for himself in an Alpine village, and yet always in the minds of those who knew him, Francis Balfour in, as we may be assured a moment of time, yielded up a life of which only thirty years had been spent, and lost to science and society what had promised to be as many years and more of patient and far-seeing investigation, free from prejudice, animated by the most scientific and philosophical of ideas while he himself, urged on by the success of the past, would have sought only fresh fields of victory in the future. It would be useless to point out in detail here, where so many are only beginners, the special services of Prof. Balfour, but you will note that his name will be constantly quoted during this course, as the discoverer of facts which have often thrown unexpected light on the problems of our science, and have always, at least, been of the highest importance, and stated with admirable truth and modesty."

THE *Annales de Chimie et de Physique* reproduces in its August number a paper relating to the theory of dissipation of energy, read by Macquorn Rankine at the British Association meeting in 1852.

A SERIES of scientific ascents were made on Sunday afternoon from the Place Saint Jacques, in Paris, under the auspices of the Académie d'Aérostation Météorologique. At a height of eight hundred feet photographs of the entire horizon were taken by means of a panoramic apparatus invented by M. Triboulet. In a brief explanation of this, given by one of the members of the Academy, it was pointed out that the experiment was as important from a military as from a scientific point of view, since it would enable an army to ascertain exactly the number and position of their enemies. At another ascent telephonic conversation with persons on the ground was carried on at the height of five hundred feet. The experiments were under the auspices of the Municipal Council of Paris.

THE aurora borealis which was seen in so many parts of England on October 2, was also visible in France from a very large number of places.

M. DUVAUX, the French Minister of Public Instruction, has opened the first superior school for females established in France. It is situated in the city of Rouen, and the regular course of study will begin this year. Many similar establishments are in course of construction in several parts of the country.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis* ♀) from East Africa, presented by Capt. F. W. Schwedler; a Binturong (*Arctictis binturong*) from Malacca; a Common Fox (*Canis vulpes* ♀), British, presented by Mrs. Studholme Brownrigg; two Goshawks (*Astur palumbarius*) from Germany, presented by Dr. Rudolph Blasius, C.M.Z.S.; a Common Raven (*Corvux corax*), two Lesser Black-backed Gulls (*Larus fuscus*) from Scotland, presented by Mr. F. G. Bury; two Greater Sulphur-crested Cockatoos (*Cacatua galerita*) from Australia, presented by Mr. C. Kerry Nicholls, F.Z.S.; a Puff Adder (*Vipera arietans*) from South Africa, presented by Lieut. R. Crawshay; an Ornamented Lorikeet (*Trichoglossus ornatus*) from Moluccas, a Crested Curassow (*Crax a'ector*) from Guiana, two Illiger's Macaws (*Ara maracana*) from Brazil, purchased; two Brazilian Hangnests (*Icterus jamaicai*) from Brazil, deposited; an Australian Fruit Bat (*Pteropus poliocephalus*), born in the Gardens.

CHEMICAL NOTES

AN exceedingly ingenious patent for the manufacture of hydrogen and oxygen has been taken out by M. N. A. Hélouis, of Paris. Wood charcoal is obtained by heating wood in closed vessels: the gas which is evolved is used for heating the retorts in which hydrogen and oxygen are produced, the tar is used for carburetting hydrogen, the pyroligneous acid is employed to decompose sodium sulphite (produced in another stage of the process), whereby sulphurous acid and sodium acetate are obtained. By passing steam over hot wood charcoal, a mixture of hydrogen, carbon monoxide, and dioxide is obtained; the mixed gases are passed into retorts containing heated gypsum, which is reduced by carbon monoxide to calcium sulphide; the escaping carbon monoxide is absorbed by soda solution, giving sodium bicarbonate. Oxygen is obtained by decomposing gypsum (600 parts) by silica (340 parts river sand); the mixture of sulphur dioxide and oxygen which is produced, is passed into caustic soda solution, whereby sodium bisulphite is formed; the residual sulphur dioxide is absorbed by milk of lime. The calcium sulphite produced by the final washing of the mixed gases is decomposed by sodium bicarbonate, giving calcium carbonate and sodium bisulphite; the latter is decomposed, as already described, by pyroligneous acid, and the sulphurous acid produced is oxidised to sulphuric acid in a cylinder containing platinised pumice-stone, by air containing 75 per cent. of oxygen. The calcium sulphide which remains in the oxygen retorts is decomposed by carbon dioxide and steam; the sulphuretted hydrogen produced, after being freed from moisture by passing through a condensing apparatus, is burned with air rich in oxygen, and the sulphurous acid formed is conducted into the leaden chambers of the sulphuric acid manufactory. Air containing 75 per cent. oxygen is obtained by pumping air into a cylinder containing a mixture of 80 parts water and 20 parts glycerine; when the pressure has reached 10 atmospheres, communication is made between the first cylinder and another from which air has been removed; air rich in nitrogen remains in the first cylinder. By repeating this operation, a mixture of 75 per cent. oxygen and 25 per cent. nitrogen can be obtained. Another method of obtaining nearly pure oxygen from air consists in passing the latter into an iron cylinder containing a bag of silk covered with caoutchouc; the dialysed air is then driven by a steam jet into a condenser, and thence passes into a second similar cylinder; this process is repeated several times; a mixture of 98 per cent. oxygen and 3 per cent. nitrogen may thus be obtained, but for most metallurgical or lighting purposes a mixture containing 60 per cent. oxygen is sufficient. Nitrogen escapes from each iron cylinder by a side tube which dips under water. The silk bags used for dialysing air are prepared by washing ordinary caoutchouc with a mixture of carbon disulphide and alcohol (whereby substances are removed which would readily stop the pores of the caoutchouc-covered silk) making into a paste with benzene, and placing a layer of this between two layers of silk.

IN the *Scientific Proceedings* of the Ohio Mechanics' Institute (i. 35) a process is described for melting iridium by heating in a Hessian crucible with phosphorus, and subsequent renewal of the phosphorus by repeated fusion with lime. The metal, in very thin sheets, can be cut by a copper wheel making 2000 revolutions per minute, and having its surface covered with emery, or corundum, and oil. Metallic iridium is nearly as hard as ruby; no steel tools make any impression on it; attempts have been made, with fair success, to use it in place of carbon as the negative pole in the electric arc light.

IT is stated in the *Chemical Review* that recent analyses of the water from the *Holy Well* at Mecca, which is so eagerly drunk by pilgrims, show this water to be sewage, about ten times stronger than average London sewage.

ARTIFICIAL ivory of a pure white colour, and very durable has recently been manufactured by the inventor of celluloid: it is prepared by dissolving shellac in ammonia, mixing the solution with oxide of zinc, driving off ammonia by heating, powdering, and strongly compressing in moulds.

ON THE ALTERATIONS IN THE DIMENSIONS OF THE MAGNETIC METALS BY THE ACT OF MAGNETISATION[1]

DR. JOULE long since discovered that when a bar of iron was magnetised by an electric current, an *elongation* of the bar took place. In subsequent experiments, published in 1847, Joule found that the elongation amounted to about 1-200,000th of the length of the bar for the maximum magnetisation, and that the total elongation was nearly proportional to the square of the actual magnetisation. By placing the bar in a vessel of water stopped with a capillary tube, it was found that the volume of the iron did not augment, and hence Joule concluded that the sectional area diminished in proportion to the elongation. Under longitudinal tension, magnetisation caused a *shortening* of the rod when the tension exceeded 600 lbs. for a rod a quarter of an inch square. Soft steel behaved like iron; but hard steel, under all circumstances, Joule found to shorten slightly when the magnetising current passed

In 1873 Prof. Mayer repeated Joule's experiments with new and delicate apparatus; the elongation of the iron he found to amount to 1-277,000th of its length for the maximum magnetisation. Mayer also found that soft as well as hard steel contracted under magnetisation.

[1] Paper read at the Southampton Meeting of the British Association by Prof. W. F. Barrett, F.R.S.E., Professor of Physics in the Royal College of Science, Dublin.

In the same year I made a series of experiments on the other magnetic metal, nickel and cobalt, and found that whilst cobalt lengthened under magnetisation, nickel appeared to suffer no change.[1] This result is surprising, for nickel more nearly resembles iron and cobalt than steel in magnetic properties, the former having little coercive force, and the latter very considerable retentive power. With entirely new apparatus the experiments were repeated, and a distinct *shortening* of the nickel was now found, cobalt elongating but not so much as iron. This observation is, I believe, new, the fact was first noticed by me on September 9, 1873, but some uncertainty as to the reliability of the apparatus I then used led me to put the matter aside till July, 1876, when the experiments were repeated, and the fact that cobalt elongates and nickel retracts under magnetisation, was fully confirmed.

The multiplying apparatus that was found to yield most satisfactory results was a simple form of optical lever, a mirror vertically fixed over the fulcrum of a lever of the first order, and reflecting a scale at some distance into an observing telescope. The apparatus will be more fully described in the report that will be presented next year; a committee, with a small money grant, having been appointed at a previous meeting of the Association to investigate this and certain other molecular changes accompanying the magnetisation of iron, described by the author at the Bradford meeting of the Association.

The results so far obtained may be summed up as follows:—However often the current traverses the helix around the bar of *cobalt*, the elongation is practically the same after the first current, and amounts to about two-thirds of the elongation produced in an iron bar of the same dimensions. In my measurement the elongation of the iron amounted to about 1-260,000th of its length for the maximum magnetisation; the iron elongated 5 scale divisions, and the cobalt 3, or 1-425,000th of its length. With *nickel*, the retraction on the same scale was 10, or twice the elongation of the iron, or about 1-130,000th of the length of the bar. Reversing the current made no alteration in the results. The index returned promptly to zero on the cessation of the current. The retraction of the nickel was so instantaneous that it was only by noting the scale-reading that any motion could be discovered to have taken place. The helix in all cases was the whole length of the bars.

Inclosing the bars in a vessel of water terminating in a capillary tube (the stem of a mercurial thermometer of extremely fine bore), and surrounding the vessel by a powerful magnetising helix, no motion of the water-level in the capillary tube was noticed with iron and cobalt on the making, breaking, or reversing the current in the helix; with nickel no motion was observed on making, and a barely perceptible, but still definite, fall of the index, equal to about 1-10,000,000th of the volume of the bar, occurred on breaking, which was more clearly seen by frequent interruptions of the current.

The "magnetic tick" is heard loudly with cobalt and nickel, as well as iron, the former giving a very clear metallic click on magnetisation.

I am much indebted to the kindness of Messrs. Johnson and Matthey for the bars of nickel and cobalt (9½ inches long and 1 inch diameter) with which the experiments were conducted, and also to Mr. Gore, F.R.S., for the loan of a longer bar of nickel. Experiments are now in progress to determine the effect of temperatures and longitudinal tensions on the result.

Preliminary experiments show, that raising the temperature of the iron and cobalt bars some 50° C. makes a scarcely appreciable difference in the amount they elongate, whereas, when nickel is heated the same amount, its retraction on magnetisation is, as might be expected, considerably diminished, being about three-fourths of the amount occurring at the temperature of the air. Owing to the short length of the bars, the actual elongation measured was, in the case of the cobalt, only the 1-46,000th of an inch, but a difference of 100,000th of an inch could confidently be measured.

SUNLIGHT AND SKYLIGHT AT HIGH ALTITUDES

At the Southampton meeting of the British Association, Captain Abney read a paper in which he called attention to the fact that photographs taken at high altitudes show skies that are nearly black by comparison with bright objects projected against them, and he went on to show that the higher above the sea-level the observer went, the darker the sky really is and the fainter the spectrum. In fact, the latter shows but little more than a band in the violet and ultra-violet at a height of 8500 feet, whilst at sea-level it shows nearly the whole photographic spectrum. The only reason of this must be particles of some reflecting matter from which sunlight is reflected. The author refers this to watery stuff of which nine-tenths is left behind at the altitude at which he worked. He then showed that the brightness of the ultra-violet of direct sunlight increased enormously the higher the observer went, but only to a certain point, for the spectrum suddenly terminated about 2940 wave-length. This abrupt absorption was due to extra atmospheric causes and perhaps to space. The increase in brightness of the ultra-violet was such that the usually invisible rays L, M, N could be distinctly seen showing that the visibility of these rays depended on the intensity of the radiation. The red and ultra-red part of the spectrum was also considered. He showed that the absorption lines were present in undiminished force and number at this high altitude, thus placing their origin to extra atmospheric causes. The absorption from atmospheric causes of radiant energy in these parts he showed was due to "water-stuff," which he hesitated to call aqueous vapour, since the banded spectrum of water was present, and not lines. The B and A line he also stated could not be claimed as telluric lines, much less as due to aqueous vapour, but must originate between the sun and our atmosphere. The author finally confirmed the presence of benzene and ethyl in the same region. He had found their presence indicated in the spectrum at sea-level, and found their absorption lines with undiminished intensity at 8500 feet. Thus without much doubt hydrocarbons must exist between our atmosphere and the sun, and it may be in space.

PROF. LANGLEY, following Capt. Abney, observed: The very remarkable paper just read by Captain Abney has already brought information, upon some points which the one I am about, by the courtesy of the Association, to present, leaves in doubt. It will be understood then that the references here are to his published memoirs only, and not to what we have just heard.

The solar spectrum is so commonly supposed to have been mapped with completeness, that the statement that much more than one half its extent is not only unmapped but nearly unknown, may excite surprise. This statement is, however, I think, quite within the truth, as to that almost unexplored region discovered by the elder Herschel, which lying below the red and invisible to the eye, is so compressed by the prism, that though its aggregate heat effects have been studied through the thermopile, it is only by the recent researches of Capt. Abney that we have any certain knowledge of the lines of absorption there, even in part. Though the last named investigator has extended our knowledge of it to a point much beyond the lowest visible ray, there yet remains a still remoter region, more extensive than the whole visible spectrum, the study of which has been entered on at Alleghany, by means of the linear Bolometer.

The whole spectrum, visible and invisible, is powerfully affected by the selective absorption of our atmosphere, and that of the sun; and we must first observe that could we get outside our earth's atmospheric shell, we should see a second and very different spectrum, and could we afterward remove the solar atmosphere also, we should have yet a third, different from either. The charts exhibited show:—

1st. The distribution of the solar energy as we receive it, at the earth's surface, throughout the entire invisible as well as visible portion, both on the prismatic and normal scales. This is what I have principally to speak of now, but this whole first research is but incidental to others upon the spectra before any absorption, which though incomplete, I wish to briefly allude to later. The other curves then indicate.

2nd. The distribution of energy before absorption by our own atmosphere.

3rd. This distribution at the photosophere of the sun.

The extent of the field, newly studied, is shown by this drawing (chart exhibited). Between H in the extreme violet, and A in the furthest red, lies the visible spectrum, with which we are familiar, its length being about 4,000 of Ångstrom's units. If, then, 4,000 represent the length of the visible spectrum, the chart shows that the region below extends through 24,000 more, and so much of this as lies below wavelength, 12,000, I think, is now mapped for the first time.

We have to $\lambda = 12,000$, relatively complete photographs, pub-

[1] *Phil. Mag.*, January, 1874.

lished by Capt. Abney, but except some very slight indications by Lamansky, Desains, and Mouton, no further guide.

Deviations being proportionate to abscissae, and measured solar energies to ordinates, we have here (1) the distribution of energy in the prismatic and (2) its distribution in the normal spectrum. The total energy is in each case proportionate to the area of the curve, (the two very dissimilar curves inclosing the same area), and on each, if the total energy be roughly divided into four parts, one of these will correspond to the visible, and three to the invisible or ultra-red part. The total energy at the ultra violet end, is so small then as to be here altogether negligable.

We observe that (owing to the distortion introduced by the prism) the maximum ordinate representing the heat in the prismatic spectrum is, as observed by Tyndall, below the red, while upon the normal scale this maximum ordinate is found in the orange.

I would next ask your attention to the fact that in either spectrum, below $\lambda = 12,000$ are most extraordinary depressions and interruptions of the energy, to which, as will be seen, the visible spectrum offers no parallel. As to the agent producing these great gaps, which so strikingly interrupt the continuity of the curve, and as you see, in one place, cut it completely in two, I have as yet obtained no conclusive evidence. Knowing the great absorption of water vapor in this lowest region, as we already do, from the observations of Tyndall, it would, *a priori*, seem not unreasonable to look to it as the cause. On the other hand, when I have continued observations from noon to sunset, making successive measures of each ordinate, as the sinking sun sent its rays through greater depths of absorbing atmosphere; I have not found these gaps increasing, as much as they apparently should, if due to a terrestrial cause, and so far as this evidence goes, they might be rather thought to be solar. But my own means of investigation are not so well adapted to decide this important point, as those of photography, to which we may yet be indebted for our final conclusion.

I am led from a study of Capt. Abney's photographs of the region between $\lambda = 8,000$ and $\lambda = 12,000$, to think that these gaps are produced by the aggregation of finer lines, which can best be discriminated by the camera, an instrument, which where it can be used at all, is far more sensitive than the bolometer; while the latter, I think, has on the other hand some advantage in affording direct and trustworthy measures of the amount of energy inhering in each ray.

One reason why the extent of this great region has been so singularly underestimated, is the deceptively small space into

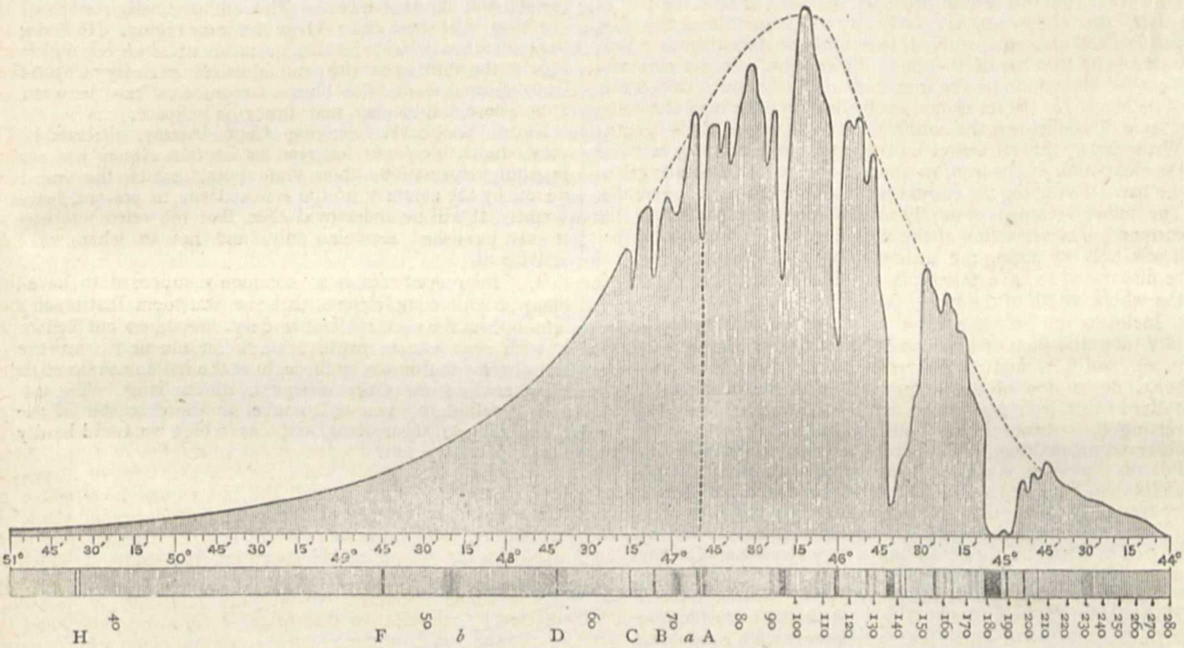

FIG. 1.—Prismatic Spectrum.

which it appears to be compressed by the distortion of the prism. To discriminate between these crowded rays I have been driven to the invention of a special instrument. The bolometer, which I have here, is an instrument depending upon principles which I need not explain at length, since all present may be presumed to be familiar with the success which has before attended their application in another field, in the hands of the President of this Association.

I may remark, however, that this special construction has involved very considerable difficulties and long labour. For the instrument here shown, platinum has been rolled by Messrs. Tiffany, of New York, into sheets, which as determined by the kindness of Professor Rood, reach the surprising tenuity of less than $\frac{1}{25000}$ of an English inch (I have also iron rolled to $\frac{1}{15000}$ inch), and from this platinum a strip is cut $\frac{1}{125}$ of an inch wide. This minute strip, forming one arm of a Wheatstone's bridge, and thus perfectly shielded from air currents, is accurately centred by means of a compound microscope, in this truly turned cylinder, and the cylinder itself is exactly directed by the arms of this Y.

The attached galvanometer responds readily to changes of temperature, of much less than $\frac{1}{10000}$° Fah. Since it is one and the same solar energy, whose manifestations we call "light" or "heat," according to the medium which interprets them, what is "light" to the eye is "heat" to the bolometer, and what is seen as a dark line by the eye is felt as a cold line by the sentient instrument. Accordingly if lines analogous to the dark "Frauenhofer lines" exist in this invisible region they will appear (if I may so speak), to the bolometer as cold bands, and this hair-like strip of platina is moved along in the invisible part of the spectrum, till the galvanometer indicates the all but infinitesimal change of temperature caused by its contact with such a "cold band." The whole work, it will be seen, is necessarily very slow; it is in fact a long groping in the dark, and it demands extreme patience. A portion of its results are now before you.

The most tedious part of the whole process, has been the determination of the wave-lengths. It will be remembered that we have (except through the work of Capt. Abney, already cited, and perhaps of M. Mouton), no direct knowledge of the wave-lengths in the infra-red prismatic spectrum, but have hitherto inferred them from formulas like the well-known one of Cauchy's, all which known to me appear to be here found erroneous by the test of direct experiment; at least in the case of the prism actually employed.

I have been greatly aided in this part of the work by the remarkable concave gratings lately constructed by Prof. Rowland of Baltimore, one of which I have the pleasure of showing you. (Instrument exhibited.)

The spectra formed by this, fall upon a screen in which is a fine slit, only permitting nearly homogeneous rays to pass, and these, which may contain the rays of as many as four overlapping spectra, are next passed through a rock-salt or glass prism placed with its refracting edge parallel to the grating lines. This sorts out the different narrow spectral images, without danger of overlapping, and after their passage through the prism we find them again and fix their position by means of the bolometer, which for this purpose is attached to a special kind of spectrometer, where its platinum thread replaces the reticule of the ordinary telescope. This is very difficult work, especially in the lowermost spectrum, where I have spent over two weeks of consecutive labour, in fixing a single wave-length.

The final result is I think worth the trouble however, for as you see here, we are now able to fix with approximate precision, and by direct experiment, the wave-length of every

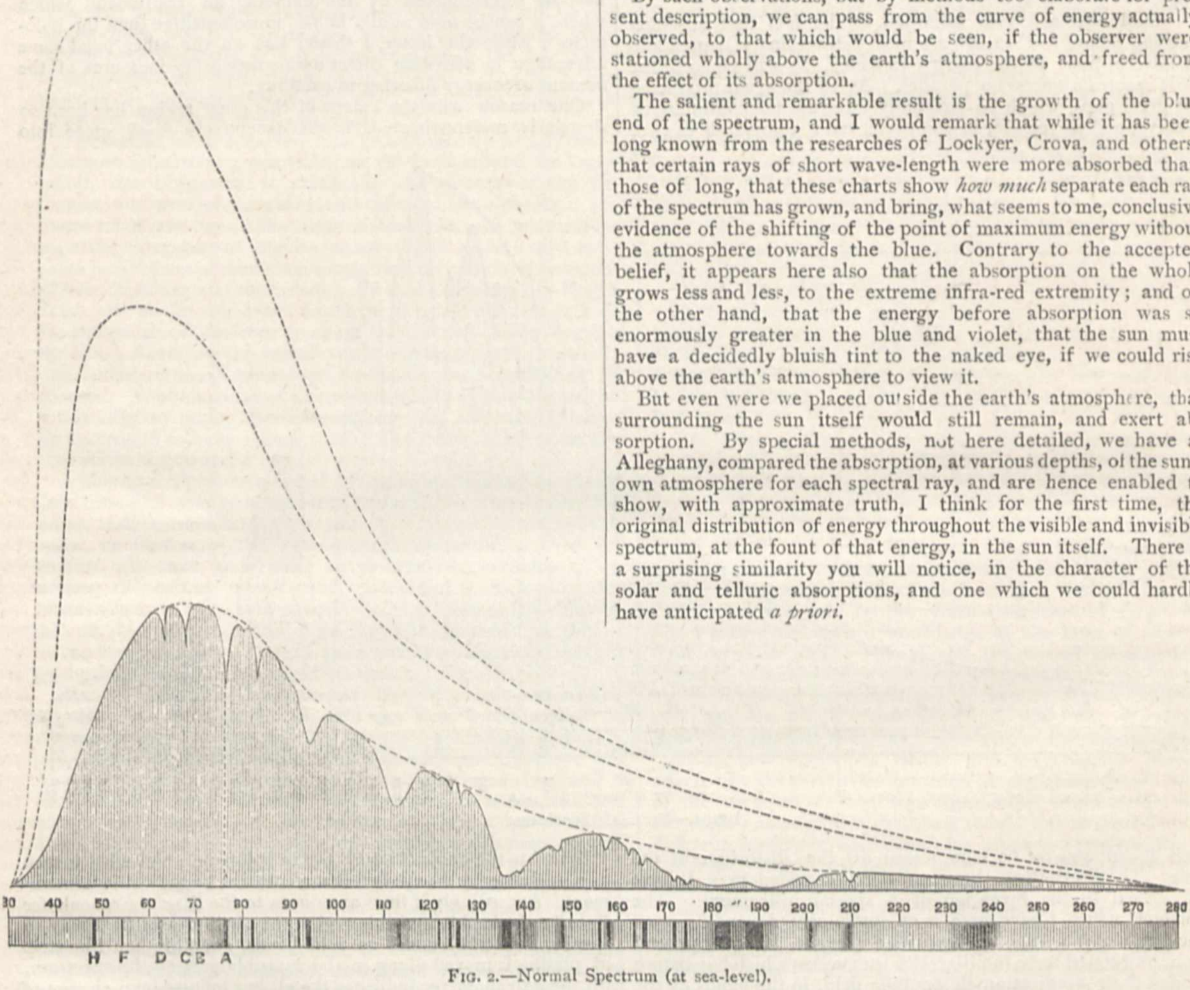

Fig. 2.—Normal Spectrum (at sea-level).

prismatic spectral ray. The terminal ray of the solar spectrum, whose presence has been certainly felt by the bolometer, has a wave-length of about 28,000 (or is nearly two octaves below the "great A" of Frauenhofer).

So far it appears only that we have been measuring *heat*, but I have called the curve that of solar "energy," because by a series of independent investigations, not here given, the selective absorption of the silver, the speculum-metal, the glass and the lamp-black (the latter used on the bolometer-strip), forming the agents of investigation, has been separately allowed for. My study of lamp-black absorption, I should add in qualification, is not quite complete, I have found it quite transparent to certain infra-red rays, and it is very possible that there may be some faint radiations yet to be discovered even below those here indicated.

In view of the increased attention that is doubtless soon to be given to this most interesting but strangely neglected region, and which by photography and other methods, is certain to be fully mapped hereafter, I can but consider this present work less as a survey than as a sketch of this great new field, and it is as such only that I here present it.

All that has preceded is subordinate to the main research, on which I have occupied the past two years at Alleghany, in comparing the spectra of the sun at high and low altitudes, but which I must here touch upon briefly. By the generosity of a friend of the Alleghany Observatory, and by the aid of Gen. Hazen, Chief Signal Officer of the U.S. army, I was enabled last year to organise an expedition to Mount Whitney in South California, where the most important of these latter observations were repeated at an altitude of 13,000 feet. Upon my return I made a special investigation upon the selective absorption of the sun's atmosphere, with results which I can now only allude to.

By such observations, but by methods too elaborate for present description, we can pass from the curve of energy actually observed, to that which would be seen, if the observer were stationed wholly above the earth's atmosphere, and freed from the effect of its absorption.

The salient and remarkable result is the growth of the blue end of the spectrum, and I would remark that while it has been long known from the researches of Lockyer, Crova, and others, that certain rays of short wave-length were more absorbed than those of long, that these charts show *how much* separate each ray of the spectrum has grown, and bring, what seems to me, conclusive evidence of the shifting of the point of maximum energy without the atmosphere towards the blue. Contrary to the accepted belief, it appears here also that the absorption on the whole grows less and less, to the extreme infra-red extremity; and on the other hand, that the energy before absorption was so enormously greater in the blue and violet, that the sun must have a decidedly bluish tint to the naked eye, if we could rise above the earth's atmosphere to view it.

But even were we placed outside the earth's atmosphere, that surrounding the sun itself would still remain, and exert absorption. By special methods, not here detailed, we have at Alleghany, compared the absorption, at various depths, of the sun's own atmosphere for each spectral ray, and are hence enabled to show, with approximate truth, I think for the first time, the original distribution of energy throughout the visible and invisible spectrum, at the fount of that energy, in the sun itself. There is a surprising similarity you will notice, in the character of the solar and telluric absorptions, and one which we could hardly have anticipated *a priori*.

Here too, violet has been absorbed enormously more than the green, and the green than the red, and so on, the difference being so great, that if we were to calculate the thickness of the solar atmosphere on the hypothesis of a uniform transmission, we should obtain a very thick atmosphere, from the rate of absorption in the infra-red alone, and a very thin one from that in the violet alone.

But the main result, seems to be still this, that as we have seen in the earth's atmosphere, so we see in the sun's, an enormous and progressive increase of the energy towards the shorter wave-lengths. This conclusion, which I may be permitted to remark, I anticipated in a communication published in the *Comptes Rendus* of the Institute of France as long since as 1875, is now fully confirmed, and I may mention that it is so also by direct photometric methods, not here given.

If then we ask how the solar photosphere would appear to the eye, could we see it without absorption, these figures appear to show conclusively that it would be *blue*. Not to rely on any assumption, however, we have by various methods at Alleghany, reproduced this colour.

Thus (to indicate roughly the principle used), taking three Maxwell's discs, a red, green, and blue, so as to reproduce white, we note the three corresponding ordinates at the earth's surface spectrum, and comparing these with the same ordinates in the curve giving the energy at the solar surface; we re-arrange the discs, so as to give the proportion of red, green, and blue which would be seen *there*, and obtain by their revolution a tint which must approximately represent that at the photosphere, and which is most similar to that of a blue near Frauenhofer's "F."

The conclusion then is that while all radiations emanate from the solar surface, including red and infra-red, in greater degree than we receive them, that the blue end is so enormously greater in proportion, that the proper colour of the sun, as seen at the photosphere, is blue—not only "bluish," but positively and distinctly blue; a statement which I have not ventured to make from any conjecture, or on any less cause than on the sole ground of long continued experiments, which, commenced some seven years since, have within the past two years irresistibly tended to the present conclusion.

The mass of observations on which it rests must be reserved for more detailed publication elsewhere, at present I can only thank the Association for the courtesy which has given me the much prized opportunity of laying before them this indication of methods and results.

UNDERGROUND TEMPERATURE[1]

II.

E. We now proceed to a Comparison of Results.

THE localities at which definite results have been obtained may thus be classified:—

1. Metallic mines. 2. Coal mines. 3. Wells and wet borings. 4. Tunnels.

1. The mines at Przibram in Bohemia, with a depth of 1900 feet, are in very quartzose rock, and give a very slow rate of increase, viz. 1° F in 135 feet. As all the shafts are in lofty hills, an allowance of $\frac{1}{18}$ may be made for convexity, leaving 1° F. in 126 feet. Quartz is found by Prof. Herschel to have a conductivity of about ·0086.

The mines at Schemnitz in Hungary, with a depth of 1368 feet, give an average rate of 1° F. in 74 feet, the rock being a green hornblende-andesite (in German, *Grünstein-Trachyt*), which is a compact, fine-grained, crystalline, more or less vitreous rock. Prof. Lebour estimates its conductivity as being probably nearly the same as that of Calton Hill trap-rock, which Prof. Herschel found to be about ·0029.

2. The principal results from coal mines are as follows:—

The mines of the Société Cocqueril at Seraing (Belgium), with a depth of 1657 feet, give an average rate of 1° F. in 50 feet. The rock is coal shale. Prof. Herschel found for shale the low conductivity ·0019.

The mines of Anzin, in the north of France, with a depth of 658 feet, gave in the deepest shaft an increase of 1° in 47 feet.

Rosebridge Colliery, near Wigan, with a depth of 2445 feet, gave a mean rate of 1° in 54 feet.

The four following are in the East Manchester coalfield:—

Astley Pit, Dukinfield, with a depth of 2700 feet, gave a mean rate of 1° in 72 feet.

Ashton Moss Colliery, with a depth of 2790 feet, gave 1° in 77 feet.

Bredbury Colliery, with a depth of 1020 feet, gave 1° in 78·5 feet.

Nook Pit, with a depth of 1050 feet, gave 1° in 79 feet.

South Hetton Colliery, Durham, with a depth of 1929 feet, including a bore hole at bottom, gives very consistent observations at various depths, and an average rate of 1° in 57·5 feet.

Boldon Colliery, between Newcastle and Sunderland, with a depth of 1514 feet, and excellent conditions of observation, gives an average rate of 1° in 49 feet.

Kingswood Colliery, near Bristol, with a depth of 1769 feet, and remarkable consistency between observations at various points, gives 1° in 68 feet.

Prof. Phillips' observations in Monkwearmouth Colliery, published in *Phil. Mag.* for December 1834, showed a temperature of 71·2 in a hole bored in the floor of a recently exposed part at the depth of 1584 feet. The surface of the ground is 87 feet above high water, and the mean temperature of the air is assumed by Prof. Phillips to be 47·6. If, as usual, we add 1° to get the soil temperature, instead of assuming, as Prof. Phillips does, that the temperature 100 feet deep is identical with the air temperature at the surface, we obtain a rate of increase of 1° in 70 feet.

3. The following are the most trustworthy results from wells and borings:—

The Sperenberg bore, near Berlin, in rock salt, with a depth of 3492 English feet, to the deepest reliable observation, gave an average of 1° in 51·5 feet. This result is entitled to special weight, not only on account of the great depth, but also on account of the powerful means employed to exclude convection.

Rock salt, according to Prof. Herschel, has the very high conductivity ·0113.

Three artesian well in the chalk of the Paris Basin gave the following results:—

	Feet.		Rate. Feet.
St. Andre, depth of observation ...	830	...	1 in 56·4
Grenelle	1312	...	1 in 56·9
Military School	568	...	1 in 56·2

An artesian well at St. Petersburg, in the Lower Silurian strata, with a depth of 656 feet, gave about 1° in 44 feet.

A well sunk at Yakoutsk, in Siberia, to the depth of 540 feet, disclosed the fact that the ground was permanently frozen to this depth, and probably to the depth of 700 feet. The rate of increase of temperature was 1° in 52 feet.

Of the English wells in which observations have been taken, the most important is that at Kentish Town, in which Mr. G. J. Symons, F.R.S., has taken observations to the depth of 1100 feet. The temperatures at different depths form a smooth series, and have been confirmed by observations repeated at long intervals. The only question that can arise as to the accuracy of the results is the possibility of their being affected by convection.

The well is 8 feet in diameter, with brickwork to the depth of 540 feet, and this part of it is traversed by an iron tube 8 inches in diameter, which is continued to the depth of more than 1300 feet from the surface. The tube is choked with mud to the depth of about 1080 feet, so that the deepest observations were taken under 20 feet of mud. The temperature at 1100 feet was 69°·9, and by combining this with the surface temperature of 49°·9 observed at the Botanic Gardens, Regent's Park, we obtain a rate of 1° in 55 feet. These data would give at 250 feet a calculated temperature of 54·5, whereas the temperature actually observed at this depth was 56·1, or 1°·6 higher; the temperature at 300 feet and at 350 feet being also 56·1. This seems to indicate convection, but it can be accounted for by convection in the 8-foot well which surrounds the tube, and does not imply convection currents within the tube. Convection currents are much more easily formed in water columns of large diameter than in small ones, and the 20 feet of mud at the bottom give some security against convection at the deepest point of observation. It is important to remark that the increase from 1050 to 1100 feet is rather less than the average instead of being decidedly greater, as it would be if there were convection above, but not in, the mud. The rate of 1° in 55 feet may therefore be adopted as correct.

The strata consist of tertiary strata, chalk (586 feet thick), upper greensand, and gault.

The Kentish Town temperature at the depth of 400 feet (58°) is confirmed by observations in Mr. Sich's well at Chiswick, which is 395 feet deep, and has a temperature varying from 58° to 57°·5.

The Bootle well, belonging to the Liverpool Waterworks, is 1302 feet deep, and the observations were taken in it during the sinking. The diameter of the bore is 24 inches, and convection might have been suspected but for the circumstance that there was a gradual upward flow of water from the bottom, which escaped from the upper part of the well by percolation to an underground reservoir near at hand. This would check the tendency to downflow of colder water from the top; and as the observations of temperature were always made at the bottom, they would thus be protected against convective disturbance.

The temperature at 226 feet was 52°, at 750 feet 56°, at 1302 feet 59°, giving by comparison of the first and last of these a mean rate of 1° in 154 feet. The circumstance that the boring

[1] Continued from p. 567.

ceased for six weeks at the depth of 1004 feet, and the temperature fell during this interval from 58°·1 to 57°·0, would seem to indicate an elevation of 1° due to the heat generated by the boring tool. An assumed surface temperature of 49° (only 0°·9 lower than that of the Botanic Gardens in London) would give by comparison with 57°, at 1004 feet, a rate of 1° in 125½ feet, and by comparison with 59°, at 1302 feet, a rate of 1° in 130 feet, which last may be adopted as the best determination. The rock consists of the pebble beds of the Bunter or Lower Trias, and the boring was executed at the rate of nearly 100 feet per month.

The boring at Swinderby, near Scarle (Lincoln), in search of coal, was carried to a depth of 2000 feet, with a diameter at the lower part of only 3½ inches—a circumstance favourable to accuracy, both as impeding convection and as promoting the rapid escape of the heat of boring. The temperature at the bottom was 79°, the water having been undisturbed for a month, and this by comparison with an assumed surface temperature of 50° gives a rate of 1° in 69 feet.

The rocks are Lower Lias, New Red Marl (569 feet thick), New Red Sandstone (790 feet thick), Red Marl, and earthy Limestone.

The following results have been obtained from shallow borings. The first three were made under Sir William Thomson's direction, with a thermometer which could be read by estimation to hundredths of a degree:—

Blythswood bore, near Glasgow, with a depth of 347 feet, gave a very regular increase of 1° in 50 feet.

Kirkland Neuk bore, in the immediate vicinity of the above, gave consistent observations at different seasons of the year from 180 feet to the bottom (354 feet), the rate being 1° in 53 feet. This bore passed through coal which had been "very much burned or charred."

South Balgray bore, near Glasgow, and north of the Clyde, with an available depth of 525 feet, gave by comparing the temperature at the bottom with that at 60 feet a rate of 1° in 41 feet.

Shale extends continuously from 390 to 450 feet from the surface, and the increase in these 60 feet of shale was 2°·02, which is at the rate of 1° in 30 feet. This rapid increase agrees with the fact that shale has very low conductivity, averaging ·0019 in Prof. Herschel's experiments.

The only small bore remaining to be mentioned is that at Manegaon, in India, which had 310 feet available, and gave by comparing the temperature at this depth with that at 60 feet a rate of 1° in 68 feet. The rocks consist of fine softish sandstones and hard silty clays, the dip being 10°.

4. *Tunnels.*—The Mont Cenis tunnel, which is about seven miles long, is at a depth of exactly a mile (5280 feet) beneath the crest of Mont Fréjus overhead. This was the warmest part of the tunnel, and had a temperature of 85°·1 F. The mean air temperature at the crest overhead was calculated by the engineer of the tunnel, M. Giordano, by interpolating between the known temperature of the hill of San Theodule and that of the city of Turin, the former being 430 metres higher, and the latter 2650 metres lower, than the point in question. It is thus calculated to be − 2°·6 C. or 27°·3 F. If, according to our usual rule, we assume the ground to be 1° warmer than the air, we have 28°·3 to compare with 85°·1. This gives a rate of 1° in 93 feet; but, inasmuch as the convexity of the surface increases the distance between the isotherms, a correction will be necessary before we can fairly compare this result with rates under level ground. As a rough estimate we may take $\frac{6}{7}$ of 93, and adopt 1° in 79 feet, as the corrected result.

"The rocks on which the observations have been made are absolutely the same, geologically and otherwise, from the entrance to the tunnel, on the Italian side, for a distance of nearly 10,000 yards. They are not faulted to any extent, though highly inclined, contorted, and subjected to slight slips and slides. They consist, to a very large extent indeed, of silicates, chiefly of alumina, and the small quantity of lime they contain is a crystalline carbonate."

The St. Gothard Tunnel, which has a length of about nine miles, has been subjected to much more minute observation, a skilled geologist, Dr. Stapff, having, under Government direction, devoted his whole time to investigating its geology and physics. He not only observed the temperature of the rock in the tunnel at very numerous points, but also determined, by observations of springs, the mean temperatures of the surface of the mountain at various points, and compared these with an empirical formula for air temperature deduced from the known mean temperatures of the air at Göschenen, Andermatt, Airolo, and the Hospice of St. Bernard. He infers from his comparisons a considerable excess of soil above air temperature, increasing from 2° C. at the ends of the tunnel to 6° C. at the crest of the mountain over the centre of the tunnel. The highest temperature of the rocks in the tunnel was at this central part, and was about 30°·6 C. or 87° F. The soil temperature at the crest above it was about − 0°·6 C., or 31° F., giving a difference of 56° F. The height of the crest above sea-level was about 2850 m., and that of the tunnel at this part 1150 m., giving a difference of 1700 m. or 5578 feet. The rate of increase here is, therefore, about 1° F. in 100 feet; and if we apply the same correction for convexity as in the case of the Mont Cenis Tunnel, this will be reduced to about 1° F. in 87 feet, as the equivalen rate under a level surface. From combining his observations in all parts of the tunnel through the medium of empirical formulæ, Dr. Stapff deduces an average rate of 1° F. for every 88 feet measured from the surface directly overhead. Where the surface is a steep ridge, the increase was less rapid than this average; where the surface was a valley or plain, the increase was more rapid. As this average merely applies to the actual temperatures, the application of a correction for the general convexity of the surface would give a more rapid rate. If we bring the isotherms nearer by one part in 15, which seems a fair assumption, we shall obtain a rate of 1° F. in 82 feet.

Collecting together all the results which appear reliable, and arranging them mainly in the order of their rates of increase, but also with some reference to locality, we have the following list:—

	Depth feet	Feet for 1° F.
Bootle waterworks (Liverpool ...	1392	130
Przibram mines (Bohemia)	1900	126
St. Gothard tunnel	5578	82
Mont Cenis tunnel	5280	79
Talargoch lead mine (Flint)	1041	80
Nook Pit, Colliery (East Manchester coalfield)	1050	79
Bredbury ,, (East Manchester coalfield)	1020	78½
Ashton Moss ,, (East Manchester coalfield)	2790	77
Denton ,, (East Manchester coalfield)	1317	77
Astley Pit, Dukinfield (East Manchester coalfield)	2700	72
Schemnitz mines (Hungary)	1368	74
Scarle boring (Lincoln)	2000	69
Manegaon boring (India)	310	68
Pontypridd colliery (S. Wales)	855	76
Kingswood colliery (Bristol)	1769	68
Radstock ,, (Bath)	620	62
Paris artesian well, Grenelle	1312	57
,, ,, St. André	830	56
,, ,, Military School	568	56
London ,, Kentish Town	1100	55
Rosebridge colliery (Wigan)	2445	54
Yakoutsk, frozen ground (Siberia)	540	52
Sperenberg, boring in salt (Berlin)	3492	51½
Seraing collieries (Belgium)	1657	50
Monkwearmouth collieries (Durham)	1584	70
South Hetton ,, ,,	1929	57½
Boldon ,, ,,	1514	49
Whitehaven ,, (Cumberland)	1250	45
Kirkland Neuk bore (Glasgow)	354	53
Blythswood ,, ,,	347	50
South Balgray ,, ,,	525	41
Anzin collieries (North of France)	658	47
St. Petersburg, well (Russia)	656	44
Carrickfergus, shaft of salt mine (Ireland)	770	43
,, ,, ,,	570	40
Slitt mine, Weardale (Northumberland)	660	34

The depth stated is in each case that of the deepest observation that has been utilised.

F. In Deducing a Mean from these very Various Results, it is better to operate not upon the number of feet per degree, but upon its reciprocal—the increase of temperature per foot. Assigning to the results in the foregoing list weights proportional to the depths, the mean increase of temperature per foot is found to be ·01563, or about $\frac{1}{64}$ of a degree per foot—that is, 1° F. in 64 feet.

It would be more just to assign greater weight to those single results which represent a large district or an extensive group of mines, especially where the data are known to be very accurate. Doubling the weights above assigned to Przibram, St. Gothard, Mont Cenis, Schemnitz, Kentish Town, Rosebridge, and Seraing, and quadrupling that assigned to Sperenberg, no material difference is made in the result. The mean still comes out 1° F. in 64 feet, or more exactly ·01566 of a degree per foot.

This is a slower rate than has been generally assumed, but it has been fairly deduced from the evidence contained in the Committee's Reports; and there is no reason to throw doubt on the results in the upper portion of the above list more than on those in its lower portion. Any error that can reasonably be attributed to the data used in the calculations for the St. Gothard Tunnel and for the numerous deep mines of the East Manchester coalfield, will have only a trifling effect on the rates of increase assigned to these localities.

To obtain an approximation to the rate at which heat escapes annually from the earth, we will first reduce the above rate of increase ·01566 to Centigrade degrees per centimetre of depth. For this purpose we must multiply by ·0182, giving ·000285.

To calculate the rate of escape of heat, this must be multiplied by the conductivity.

The most certain determinations yet made of the conductivity of a portion of the earth's substance are those deduced by Sir William Thomson by an indirect method, involving observations of underground thermometers at three stations at Edinburgh, combined with laboratory measurement of the specific heats and densities of the rocks in which the thermometers were planted. The specific heats were determined by Regnault, and the densities by Forbes. Specific heats and densities can be determined wiih great accuracy in the laboratory, but the direct determination of conductivity in the laboratory is exceedingly difficult, it being almost impossible to avoid sources of error which make the conductivity appear less than it really is.

Prof. Herschel, in conjunction with a Committee of the British Association, has made a very extensive and valuable series of direct measurements of the conductivities of a great variety of rocks, and has given additional certainty to his results by selecting as two of the subjects of his experiments the Calton Hill Trap and Craigleith sandstone, to which Sir William Thomson's determinations apply.

From combining Prof. Herschel's determinations with those of Sir Wm. Thomson, ·0058 is adopted as the mean conductivity of the outer crust of the earth, which, being multiplied by the mean rate of increase, ·000285, gives

$$16330 \times 10^{-10}$$

as the flow of heat in a second across a square centimetre. Multiplying by the number of seconds in a year, which is approximately $31\frac{1}{2}$ millions, we have

$$1633 \times 315 \times 10^{-4} = 41{\cdot}4.$$

This, then, is our estimate of the average number of gramme-degrees of heat that escape annually through each square centimetre of a horizontal section of the earth's substance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The lists of Boards of Studies for the first time include the separate Boards of Physics and Chemistry, and of Biology and Geology, as constituted by the new Statutes. The Woodwardian Professor appears in both Boards. The Physiology Professor, not being yet appointed, only appears in brackets; the same is the case with the Professor of Pathology in the Board of Medical Studies.

The new Statute B having been finally approved, determines that in 1883 and 1884, a sum of between 5000*l.* and 6000*l.* in each year will become available for University purposes from College revenues, subject only to deduction of 40*l.* by each College for each Professorial Fellowship held at the College.

The Professors of Physiology, Pathology, and Mental Philosophy and Logic are to be appointed in such order as the University may think fit, as soon as sufficient funds can be provided conveniently for the purpose from the common University fund, or from other sources. The Professors of Physiology and of Pathology are not to undertake the private practice of medicine or surgery. The stipends are fixed at 800*l.* for these two Professors, and 700*l.* for the Professor of Mental Philosophy.

The appointment of Readers is similarly dependent on the convenient provision of funds. Thus, until the Council of the Senate has published its recommendations, nothing certain can be said as to the objects upon which it will be thought wisest first to expend the new funds accruing. But it must not be forgotten that a considerable amount of the new income will be required to pay the increased stipends of present professors.

Prof. Liveing will lecture on the General Principles of Chemistry this term, and also take practical classes in spectroscopic analysis. Prof. Dewar will lecture on Physical Chemitry, and Tutorial lectures will be given in connection with this course by Mr. A. Scott, Prof. Dewar's assistant. Demonstrations in volumetric chemistry will be given by one of the demonstrators.

Lord Rayleigh will lecture on Electrical Measurements to advanced students; Mr. Glazebrook will give demonstrations on Electricity and Magnetism, and Mr. Shaw on Heat in the Cavendish Laboratory. Mr. Trotter will give an elementary course on Electricity and Magnetism at Trinity College, and also a course on Optics and Light.

Mr. Vines will lecture on the Physiology of Plants, at Christ's College, in connection with practical work, and will also give an elementary course at the New Museums, especially for medical students. The Assistant Curator of the Herbarium, Mr. T. H. Corry, B.A., of Caius College, will give a series of demonstrations on the natural orders of plants.

Prof. Stuart wlll lecture on Mechanism and Applied Mechanics, and the workshops and drawing office will be opened to pupils on October 13. At Gonville and Caius College one or more Entrance Scholarships of values varying from 40*l.* to 80*l.* according to merit of candidates, will be awarded in Natural Science by an examination beginning on Janaary 8 next. They are only open to candidates under nineteen years of age on the first day of examination, and are tenable only for one year, after which a foundation scholarship may be awarded. The subjects are Physics, Chemistry, Biology, and Animal Physiology; two subjects at least are required, Chemistry being essential. Particulars of subjects may be learnt on applicaiion to the Senior Tutor, Rev. A. W. Steel. Scholarships may also be awarded for Mathematics and Natural Science combined.

The examination for Entrance Scholarships at Emmanuel College will commence on January 12. They are tenable in the first instance for two years. The subjects in Natural Science are Chemistry, Physics (including Dynamics and Hydrostatics), Elementary Biology, and Geology and Mineratogy. Candidates may also obtain scholarships for Mathematics and Natural Science combined. Mr. W. Chawner, the tutor, will supply all information.

Mr. A. Sedgwick, of Trinity College, Cambridge, will conduct the classes in Morphology which Prof. Balfour had announced for the present term.

SCIENTIFIC SERIALS

The Journal of Anatomy and Physiology (*Normal and Pathological*), vol. xvi. pt. iv., July, 1882, contains:—Observations in comparative myology, by Dr. Hans Gadow. The first section of this interesting paper is devoted to the important subject of a scientific nomenclature for muscles.—On fat embolism, by Drs. R. Saundby and G. Barling (with a plate).—On Micrococcus poisoning, by Dr. Alex. Ogston.—On the action of saline cathartics, by Dr. M. Hay (D and E series of experiments).—On a variety of pulmonary lobation and its relation to the thoracic parietes, as illustrated by comparative anatomy and abnomalities in the human subject, by Dr. W. Allen.—Prof. Gegenbaur, critical remarks on polydactyly as atavism; translated by Drs. Garson and Gadow.

The American Naturalist for August, 1882, contains—On the compass plant, by B. Alvord.—On the development of the tree toad, by M. H. Hinckley.—On some entomostraca of Lake Michigan and adjacent waters, by S. A. Forbes.—Organic physics, by Charles Morris.—The Editor's table.—Recent lite·

The same for September, 1882, contains—The methods of microscopical research adopted in the Zoological Station in Naples, by C. O. Whitman.—Notes on the habits of the "Savannah cricket frog," by C. C. Abbott.—On the evolution of forms from the Clinton to the Niagara group, by E. N. S. Ringueberg.—On hypnotism in animals, by Dr. W. Prentiss.

The Transactions and Proceedings of the New Zealand Institute for 1882, being vol. xiv., edited by Dr. J. Hector, F.R.S., and published at Wellington, May, 1882, have just reached us. They form a royal octavo volume of over 600 pages and 39 plates.

Among the more important memoirs may be mentioned the following:—On historical incidents and traditions of the Maoris, Part II.—Contributions to a better knowledge of the Maori race, Part IV., and on the fine perception of colour of the ancient Maori, by W. Colenso.—On the causes leading to the extinction of the Maoris, by Dr. A. K. Newman.—Several memoirs on the mollusca of New Zealand, by Prof. Hutton.—On New Zealand crustacea, by C. Chilton.—On the skeleton of *Notornis mantelli*, Py Prof. Parker.—On New Zealand shells and cephalopoda, by T. W. Kirk.—On the Coccidæ of New Zealand, by W. M. Maskell.—On New Zealand crustacea, by G. M. Thomson.—On new Orthoptera and Coleoptera, by W. Colenso.—On the freshwater algæ of New Zealand, by W. Spencer (a very imperfect paper).—On additions to the flora, by T. F. Cheeseman.—On new species of plants from New Zealand forests, by W. Colenso.—On the Alpine flora of New Zealand, by John Buchanan.—On the New Zealand olives, and on recent additions to the flora, by T. Kirk.—On a deposit of moa bones (probably the oldest yet found) near Motanau, North Canterbury, by A. McKay.—Notes on the mineralogy of New Zealand, by S. Herbert Cox.

Berichte über die Verhandlungen der Naturforschenden Gesellschaft zu Freiburg, I.B. Band viii. Heft 1, 1882.—On some actions of coercitive force, by E. Warburg.—Imitation of the phenomena of optically-anomalous crystals by stretched colloids, by F. Klocke.—On the action of unilateral pressure on optically-anomalous crystals of alum, idocrase, and apophyllite, by the same.—Axial images in convergent light in alum, nitrate of lead, pressed gelatine, and quickly-cooled glass, by the same.—On the motion of glaciers, by K. R. Koch and Fr. Klocke (second paper).—On the classification of surfaces according to the displaceability of their geodetic triangles, by H. v. Mangoldt.—On the connection between viscosity and density in fluid, especially gaseous fluid substances, by E. Warburg and L. v. Babs.—On a method of testing micrometer-screws, by K. R. Koch.

Schriften der Naturforschenden Gesellschaft in Danzig, vol. v. Heft 3, 1882.—Pagan remains found in the Weichsel-Nogal delta, by Dr. Marshall.—Communications on amber, by O. Helm.—A case of duplication of the allantois and the external genitals, by O. Meyer.—Proceedings of the West Prussian Botanical-Zoological Society; fourth meeting at Elbing in June, 1881.—On the hygienic significance of drinking water and rational principles for its examination and estimation, by M. Barth.—On Cenomanian petrefactions from the diluvium of the environs of Danzig, by J. Kiesow.—Telegraphic determination of longitude between Danzig and Königsberg, by E. Kayser.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 2.—M. Blanchard in the chair.—Reference was made by M. Dumas to the death of Friedrich Wöhler (who was a Foreign Associate).—M. de Candolle presented a work on the origin of cultivated plants. It treats of 247 species; and of all, except three (viz. two species of *Cucurbita* and the kidney bean), it is possible to say whether they are from the old or the new world. Of 49 species cultivated for more than 4000 years, six or seven are extinct or in course of extinction.—Transit of Venus over the sun, by M. Dumas. The last of the eight missions, that to Florida, under Col. Perrier, left Havre on September 30. M. Dumas gives the complete list. The navy figures prominently. There are three members of the Academy, MM. d'Abbadie and Tisserand, and Col. Perrier; also a nephew of Arago. The eight destinations are: Port-au-Prince, Mexico, Martinique, Florida, Santa-Cruz, Chili, Chubut, and Rio-Negro. Each station will have two equatorials carefully tested. The members have all practised at the Observatory with artificial transits. Most of the missions will use photography. The railway and steamboat companies have given great facilities in transport.—On the shock of imperfectly electric bodies, by M. Resal.—Typographic reproduction of photographs; process of M. Ch. Petit, by M. Marey. Two samples of the process (which is named *similigravure*, but is not described), are given.—Optical communications between Mauritius and Reunion, by Mr. Adams.—The coercitive force of steel rendered permanent by compression, by M. Clémandot. He attributes the effect to the more absolute homogeneity produced by pressure and cooling under pressure. The steel submitted to compression is *soft*, and may be filed, bored, &c.—Researches on the action of the intermolecular ether in the propagation of light, by M. De Klercker. He believes he has, by a purely physical method, established a new theory of the action.—On the treatment of phylloxerised vines with coal tar, *àpropos* of a recent communication of M. Max Cornu, by M. Balbiani.—On the employment of heavy oils of coal in treatment against the winter egg of phylloxera, by M. De Laffitte.—A telegram from Munich (October 2) announced that the experimental transmission of force by an ordinary telegraph wire, between Miesbach and Munich (57 km.), by M. Deprez' method, had fully succeeded. Another telegram (September 26) was received from the Emperor of Brazil about the comet. The presence of sodium and carbon was noted.—Observations of the comets Barnard and Common (1882), at the Lyons Observatory, by M. André.—On a class of uniform functions of two independent variables, by M. Piccard.—Hydrodiapasons, by M. Decharme. One of these is formed of a brass tube of elongated U shape, with a nozzle screwed into the curved part and conducting town water. The upper part of each branch is bent round, so that the free ends are closely opposed. To these ends disks or other pieces may be attached with screws. On passage of the water, a regular vibratory motion occurs, with sound; by attraction if the branch-nozzles have thick edges, by repulsion, if they have thin. The experiment is better if the branches are put in water. The feeling when one touches the instrument is like that of shocks from a weak induction coil.—On the nature of vibratory motions which accompany the propagation of flame in combustible gaseous mixtures, by MM. Mallard and Le Chatelier. They have studied, with the help of photography, the period of accelerated and very irregular velocity (accompanied by sound), which follows a (first) period of slower, silent, and regular propagation, in a tube closed at one end, and having its combustible gaseous contents (bioxide of nitrogen and sulphide of carbon) lit at the other. A vibratory movement is indicated; the amplitude increasing as the last third of the tube's length is neared (where is one of the ventral segments of vibration). A mean pressure of at least 5 atm. is produced for a few ten-thousandths of a second. The mean velocity of propagation is accelerated as the amplitude and rapidity of the vibrations increase.—Action of anhydrous chloride of aluminium on the acetone, by M. Louise.—On the secretory epithelium of the kidney of batrachians, by M. Bouillot.—Cause of the rot of grapes in America, by M. Prillieux. The rot is due to penetration of *Peronospora*, not to *Phoma uvicola*, which is merely developed on the grapes already killed.—M. Daubrée sketched the work of a Committee which has reported to the Minister of Public Works on the means of preventing explosions of fire-damp.—M. Daubrée presented a catalogue of the collection of meteorites of the Museum of Natural History on July 1, 1882, and noted recent acquisitions, &c.

CONTENTS