THURSDAY, DECEMBER 25, 1879

INDIAN ENTOMOLOGY

Descriptions of New Indian Lepidopterous Insects, from the Collection of the Late Mr. W. S. Atkinson, M.A., F.L.S., &c. Part I. *Rhopalocera*, by W. C. Hewitson, F.L.S.; *Heterocera*, by Frederic Moore, Assist. Curator, India Museum. With an Introductory Notice by Arthur Grote, F.Z.S., &c. 4to, pp. 1-88, with Three Coloured Plates. (Calcutta: Published by the Asiatic Society of Bengal, 1879.)

THE hot valleys of the Himalayan regions of our Indian Empire have always justly had especial interest from an entomological point of view. The number of peculiar and apparently strictly endemic, forms of insects already known from this region is great, and principally in the larger species, for even now we know less of the smaller insect-forms of North India than we do of many other less familiar districts not under the advantage of British rule. Indeed, with a few notable exceptions, much of the knowledge we now possess is not precisely of modern origin. The somewhat numerous military expeditions to, and across, the Himalayas, undertaken within the last quarter of a century, and the great recent extension of tea and cinchona plantations in these regions, have not resulted in a corresponding increase in materials for a Himalayan insect-fauna. In some respects it may be said that we are likely to know more of the entomology of the Lake region of Africa, or of the Amazons region of South America, than of a vast and varied district, for the most part under the government of our own countrymen, and of a commercial importance second (to us) to no other. Still, important and wonderful discoveries have been made of late years, but they are perhaps eclipsed by the acknowledged existence of forms discovered long ago which would have become almost traditional were it not that the "types" exist in collections, and that they were duly described and delineated with infinite care in works that are no longer modern. As a summary, then, to the foregoing short introduction to a notice of a modern work on Indian Entomology, it may be briefly stated that a great deal of our knowledge was initiated before the present generation, and has not since been adequately supplemented.

But, as before-mentioned, there have been notable exceptions, and of these the most notable exists in the fruits of the labours of the much-lamented and talented Mr. Atkinson, an entomologist who, before he left this country for India, had acquired a training in entomological pursuits that his keen powers of observation enabled him to use to the best advantage in the intervals of official duties during a long residence in our Eastern Empire. For a very faithful sketch of Mr. Atkinson's career in India, the introductory notice at the commencement of the part of the book now under consideration, from the pen of Mr. Arthur Grote, suffices so far as it goes, and nothing is more to be regretted than the melancholy *finale*. Mr. Atkinson left India on three years' leave, for the purpose of scientifically working out the results of his labours, and died almost suddenly in Italy, before having had time to unpack his stores; and science lost the benefit of what could not have been otherwise than one of the finest original works on Indian entomology that has appeared, or probably ever will appear.

The collections remain (but more or less dispersed); the MS. notes possibly remain also, but they have not been made use of; the more important personal knowledge was buried with its possessor. The collections passed nominally into the hands of the late Mr. Hewitson, but the larger and scientifically more important portions ultimately went to Germany.

So far this notice has been introductory and historical; it remains to refer more particularly to the book. At the outset nothing strikes one as more to be deplored than that Mr. Atkinson himself could not have recorded the results of his labours. In that case we should, without the slightest doubt, have had a complete list of the species observed by him, with copious biological, and comparative faunistic, notes. As it is, we are compelled to put up with a bare mechanical description of the new species, with only a few words on biology, added by Mr. Grote from his long experience in India. The few new butterflies are described by Mr. Hewitson, and this part was probably the last work done by him, the proofs having been corrected on his death-bed. The far more numerous and more important *Heterocera* were confided to the care of Mr. Frederic Moore, by Dr. Staudinger of Dresden, who became their possessor. It would have been impossible to find a more competent entomologist for this task; there is certainly no one who possesses a more exhaustive knowledge of Indian lepidopterous insects. We believe Mr. Moore has commenced, and will finish, the undertaking in the most thoroughly conscientious manner, and this first part treats mainly upon the *Bombyces*, a group in which North India is superabundantly rich, and which Mr. Moore has very closely studied.

If, then, we find fault with the work it is not with especial reference to Mr. Moore (its principal author), but rather to the system pursued, one which is especially the attribute of writers on exotic Lepidoptera, and which will continue so long as lepidopterists are without a general and intelligible generic guide. We find numerous species referred to genera as described by Walker, Felder, &c., and new genera based on characters compared with these. We ask, would it be possible for any entomologist to identify a vast majority of Mr. Walker's generic (or specific) descriptions without referring to the types? and if not, what, from a scientific point of view, is the use of them at all? In the case of Felder ("Reise der *Novara*") it is somewhat different, but the importance is equal. Had that author lived there is little doubt that full and comparative descriptions would have been to hand; as it is, we have little more than an extensive series of beautiful and accurate figures with names applied to them, or with a few words of diagnosis. If our lepidopterists will consent for a few years to an interruption in this interminable and eminently unsatisfactory work of bare "descriptions," and combinedly commence and continue an exhaustive illustrated generic synopsis, they will earn for themselves more fame hereafter than they appear to foresee. Their present system of working only tends daily to render the subject more complicated.

The plates in Part I. of this work are of the greatest excellence so far as they go, and the colouring appears

to warrant the extreme praise of not being overdone. But we confess to being more pleased with certain parallel plates on the Lepidoptera of the Dutch Indies that have recently appeared in the *Tijdschrift voor Entomologie* (the publication of the Entomological Society of the Netherlands). Our English plates of butterflies and moths too often remind us irresistibly of the sheets of figures of these insects (often beautifully executed) that appear in the shop-windows to be utilised as "scraps," or in any way the purchasers may think fit. That in the majority of cases they serve to identify the species is probable, but they lack the slightest delineation of structural details other than those shown in the general outline of the body and wings. The figures of moths are innocent of legs, innocent of neural details, innocent of palpi (unless these organs be more than usually prominent), and equally innocent of other indications that are now often considered of importance.

Many of the species here described and figured have their evident palæarctic analogues; but, in the absence of a complete list of those found by Mr. Atkinson and other Indian observers, it is impossible to form an idea as to the general nature of the Himalayan lepidopterous fauna.

R. McLACHLAN

MINERAL DEPOSITS

Die Lehre von den Lagerstätten der Erze; ein Zweig der Geologie. Von Dr. Albrecht von Groddeck. 8vo. pp. 350. (Leipzig, 1879.)

IN this volume the phenomena characteristic of mineral deposits are concisely treated in a manner suited for students' use. The descriptive matter is arranged under three heads, the first dealing with the forms of lodes, beds, &c., and their relations to the containing walls or "country" rocks, the second with the contents, or more particularly, with the distribution in the deposits themselves of such contents in the shape of valuable minerals; while the third is a "system of mineral deposits" arranged under different sub-sections, such as original and reconstructed deposits, beds stratified and massive, veins and other deposits filling cracks and hollows, &c.; each particular case being referred to a so-called type bearing a special name. The fourth and final section contains a theory of the origin of mineral deposits in general.

Of the matter contained, much is reproduced from the late Dr. B. von Cotta's "Lehre von der Erzlagerstätten," the last edition of which was published in 1861, the remainder being for the most part derived from papers by various authors that have appeared for the last twenty years, in different German journals, devoted to geological and mining matters.

The principal novelty is the arrangement of the third part, and this is not very satisfactory, the fifty-six types making up the "System" being based partly on structural and partly on topographical considerations, the grouping being too artificial to be of any real geological value. Thus, for example, deposits of chromic iron ore in serpentine are said to belong to the "Wooded Peak" type, because an occurrence of this kind has been reported from a place bearing that not very distinctive name in New Zealand; the famous old mines of Chessy and Monte-catini are examples of the Mednorudjansk type, whose "characteristic" is given as follows: "Pyritic ores . . . in unstratified (*massigen*) rocks oftenest Diorite Gabbro and Olivine rocks (serpentine)." This particular deposit, named as the type perhaps better known as the Nishne Tagilsk malachite mine does not, however, occur in unstratified rocks, but in a mass of chloritic, argillaceous, and talcose schists, inclosed in upper Silurian limestones; the author having been led into a mistake by not properly looking up his authorities, the account relied upon being one published in a German journal twelve or thirteen years ago.

In another case, the Tellemarken-Cornwall type, the characteristic is "Lodes in sedimentary rocks, preponderating contents quartz and copper ores in varying proportions, less common are barytes, carbonates, and silicate of zinc, tin-stone, galena, &c." The examples given of this type appear to show that the copper ores of Tellemarken are not in veins in stratified rocks, but in quartz strings in granite dykes, a tolerably common class of occurrence in Scandinavia, and about as much unlike the ordinary type of Cornish lode phenomena as can well be imagined.

Many other examples might be adduced of the incongruities arising from the author's method of classification.

The accounts of the different districts are very disproportionate in value, especially in non-German countries. Thus Cornwall is dismissed in a page and a half, reproduced from Cotta's work, and the whole of the carboniferous limestone lead regions of Central and Northern England are included in a word or two about Derbyshire and Cumberland, the Silurian districts of Wales not receiving any notice. Iron ores are still more capriciously treated, the thin, stratified, spathic and clay band ores of Westphalia taking the first place, while the mighty deposits of Styria are allowed eight lines. No mention is made of either Mokta-el-Hadid, Hodbarrow, or any other of the great mines in the Furness, Ulverstone, or Whitehaven districts, Sommorostro or any other of the Bilbao mines; and, generally speaking, the great sources of supply to the iron-smelters in Western Europe are conspicuous by their absence. Against this we have to set tolerably complete notices of the iron ores of the United States, derived for the most part from Dr. Wedding's Pennsylvanian Exhibition Report.

The work being primarily intended for the use of German students may perhaps account for the circumstance that in the references only German writers are noticed, and this is so completely carried out, that in the few cases where an English or American authority is named, the titles of their works are not given. This is the more to be regretted, as the use of original memoirs might in some cases have prevented the appearance of errors in the text, obviously due to the second-hand sources of information usually relied upon by the author. The careful study of a single good memoir, such as that of the late Prof. Axel Erdmann on the Dannemora Mines, for example, would probably be of more value as a means of preparing a student for recording original observations, than the most complete knowledge of the types of the very artificial system contained in the work.

H. B.

OUR BOOK SHELF

The Climate of Eastern Asia. By Dr. H. Fritsche, Director of the Imperial Russian Observatory at Peking. Pp. 210, Maps 18. (Printed at the *Celestial Empire* Office, Shanghai.)

IN this memoir Dr. Fritsche has very fully gathered together the various meteorological observations which have been made in Eastern Asia up to the present time, and discussed them in such a way as to cast additional light on the laws of meteorological phenomena ruling in that part of the globe. With the aid of the fresh information obtained from the observations of the past dozen years which it may be remarked have been made with instruments generally of improved quality and at known heights above sea-level, he has made several important rectifications on the isothermal and isobaric lines of Eastern Asia; and stated with more adequate emphasis than has been done heretofore the extraordinary climatic influence of that enormous mass of unbroken land practically destitute of lakes and of the cold arctic currents which wash its eastern coasts.

In winter, atmospheric pressure is high on the continent, and the general movement of the atmosphere being from north-west and north, intensely cold air-currents set in southward from the arid wastes of the interior, and are carried into lower latitudes than in any other quarter of the globe. Hence the mean temperature of January in the territory of the Amoor is 18°·0 lower than that of the eastern coast of North America in the same latitudes; and even at Canton, which is just within the tropics, the temperature sometimes sinks to freezing and snow falls. On the other hand, in summer atmospheric pressure is low on the continent, and the prevailing winds being south-east and south the cold ocean currents flowing along the coast from the north powerfully affect the climate in moderating the summer-heat for some distance inland. Dr. Fritsche's isothermals show that this influence is much greater than is usually indicated on isothermal charts. An extremely interesting comparison of climates is made by an elaborate discussion of their monthly and annual absolute maxima and minima of temperature, but the conclusions would have been more valuable as well as more telling if the methods of observation had been uniform throughout. Indeed, in dealing with extreme temperatures, want of uniformity of observation frequently lays a complete arrest on all discussion.

Dr. Fritsche places in a striking light the influence on climate respectively of the warm waters of the Gulf Stream and of the colossal dry continent of Asia. In January the difference between the mean temperature of the North Pole and that of the equator is, according to Dove, 106°·0. Now, since Western Europe, which is the same distance from Eastern Asia that the equator is from the Pole, has a January temperature 50°·4 higher than that of Eastern Asia, it follows that the influence of the distribution of land and water on the mean temperature of January is nearly a half of that occasioned by latitude.

An elaborate comparison of Buchan's charts of isobaric lines for the coasts and islands of Eastern Asia with recent observations is made, with the result of an average error of one millimetre (0·040 inch). Much, however, remains to be done in settling this important physical datum of the climate of Asia; and it can only be satisfactorily accomplished by the substitution of mercurial for aneroid barometers where such are used, a more accurate determination of the heights above sea-level, and the establishment of additional meteorological stations in eastern and northern Siberia.

Report on the Pathological Histology of Epizoötic Pleuropneumonia. By Charles S. Roy, M.D. (London: published by the British Medical Association, 1879.)

AMONG the many infectious diseases which domestic animals are subject to, pleuropneumonia of cattle is one of serious importance to this, and indeed to every country. Owing to the facility with which infection spreads, the comparatively long duration of the malady, and the high mortality of the affected animals, an epidemic outbreak of this disease inflicts heavy losses on the holders of live stock and on the community at large as the consumers of articles of food derived from cattle. Every contribution to elucidate its intimate pathology, is, therefore, of value, not only in furthering a better understanding of this particular malady, and thus probably enabling us to grapple more successfully with its prevention, but also in throwing light on infectious diseases in general.

The British Medical Association, by the assistance of grants, which it bestows with laudable liberality in all cases where they are deservedly needed, has for some years been foremost in promoting the advancement of the various branches of medical science, and it has in a similar manner enabled Dr. Roy, at the suggestion of Dr. Burdon Sanderson, to carry out an important investigation into the anatomy of pleuropneumonia. To enumerate all the details of this investigation would be more than is possible in a short notice like this, and, probably more than is customary in this journal, but some of the more important results may be here briefly mentioned.

In the earlier stages of the disease the lymphatics, especially those of the sub-pleural plexus and of the connective tissue separating the individual lobules of the lung tissue, are found very much distended, being filled with an exudation which at first is chiefly fibrinous, but later on becomes crowded with cells of various sizes. The lung-tissue itself is the seat of an inflammatory process, which is chiefly characterised by the "absence of uniformity"; in some parts it is similar to what is known to pathologists as lobular pneumonia, in others it resembles croupous pneumonia. In this respect the pleuropneumonia does not differ from the lung affection in many other infectious diseases.

Dr. Roy states that in some parts of the lung there is also a hypertrophy of the muscular tissue of the parenchyma, and illustrates this with a drawing, viz., Fig. VII.; but to this we must take exception, for this figure illustrates merely the structure of a normal infundibulum, very distinct as such by its epithelium and muscular tissue.

As the morbid process advances, large sections of the lung tissue become involved in the inflammatory change, and amongst them the bronchi themselves and the lymphatic trunks leading into the bronchial lymphatic glands. No distinct evidence of the presence of minute organisms in the affected parts could be obtained.

That the malady involves, to a great extent, the lymphatics of the lung, Dr. Roy learned by first making a special investigation into their distribution in the normal lung of cattle, and as the result of this investigation several important facts were ascertained: the individual lobules possess a certain independence from one another both in their blood- and lymph-vessels; the subpleural or superficial lymphatics form a stellate plexus for each lobule; the efferent branches of this plexus join the peribronchial and perivascular lymphatics. In this last respect the lung of cattle differs from that of many other animals, for in these latter there exist special vessels leading from the subpleural plexus through the ligaments of the lung to the root of this organ.

The Report is accompanied by ten lithographed drawings illustrating very capitally the more striking features of the morbid process. We should have liked, however, to see their number increased by several additional drawings showing the distribution of the lymphatics of the normal lung.

E. KLEIN

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 Temperature of the Air at Various Levels

In a treatise recently published at Prague,[1] the author, Mr. Schlemüller, proposes to establish a formula, by which the temperature of the atmosphere at any level above the surface of the earth could be calculated, a similar calculation giving also the height of the atmosphere.

Mr. Schlemüller's train of reasoning is about this :—

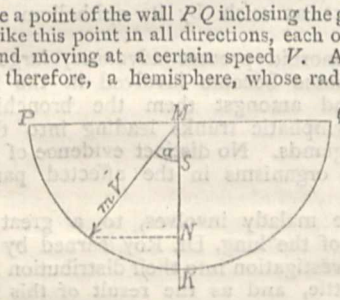
The temperature of a gas is dependent on the *vis viva* of the motion of its molecules. Now, the molecules of the air moving *upwards* are gradually *losing* their *vis viva* by the action of gravity, whereas, in moving *downwards* they *gain* velocity by the same action. It is, therefore, evident that the molecules must have more *vis viva* in the lower strata of the atmosphere than at higher levels, that is to say, the temperature of the atmosphere must *decrease* as the height *increases*.

If we know the velocity of an air-molecule at the surface of the earth, we can easily calculate the maximum height to which it can move when going up vertically. This height is the height of the atmosphere. At the upper limit of the atmosphere the molecules have no velocity at all, the temperature is there at the absolute zero. (It must be remembered that the author treats of an atmosphere not exposed to radiation.)

Now, these ideas are not new, as the author himself admits on page 9 of his treatise. He has, however, added to them two new suppositions of his own, and to these we shall confine our attention.

First, the author supposes that at any temperature of a gas the molecules have a certain velocity, which is *equal* for all of them, that is to say, the molecules move in all possible directions, but altogether at the same speed. This is, of course, a hypothesis, which can neither be proved nor refuted ; it is, however, admissible. The other supposition of the author, however, is quite erroneous, and so the results arrived at by means of it are also valueless. Mr. Schlemüller supposes that the molecular velocity of gases has not been calculated rightly as yet, and he therefore proposes to correct the error. His own words are as follows :—

"Let M be a point of the wall PQ inclosing the gas. The molecules will strike this point in all directions, each of them having a mass m, and moving at a certain speed V. All the striking forces form, therefore, a hemisphere, whose radius is equal to



mV, the wall PQ being the basis of it. The acting componen of the striking force is evidently $MN = mV \cos \alpha$. All the possible components $mV \cos \alpha$ represent, therefore, ordinates of the hemispherical surface mentioned before, taking PQ as a basis."

As there is no preference for any of the directions, the mean striking force acting on the wall PQ will be measured by the mean value of all $mV \cos \alpha$, viz., by the ordinate of the centre of gravity of the hemispherical surface. As, however, this centre of gravity is situated at half the length of the radius MK from PQ, the mean value of the striking force will be $mu = \frac{mV}{2}$[2] or $u = \frac{V}{2}$ and $V = 2u$, that is to say, *the mean component of the molecular velocity taken at a right angle to the wall PQ is equal to half the actual velocity.*"

"Considering all this, we shall be able to establish a relation between the molecular velocity, the volume, and the mass of a gas inclosed in a cubical vessel. We shall follow the method indicated by Joule,[1] and introducing into the calculations throughout the mean value $\frac{V}{2}$, instead of V we get for V double the ordinary value, viz. :—

$$V = 2\sqrt{3gP_0V_0(1 + \alpha t)}$$

g being the acceleration of gravity, P_0 the normal pressure, V_0 the volume of one kilogramme of the gas at 0° C. (32° F.), $\alpha = 0,00365$ the coefficient of dilatation, t the temperature in Centigrades above the freezing-point."

It seems that Mr. Schlemüller is not aware of the fact that Clausius fully twenty-two years ago published a very elaborate treatise,[2] in which he calculated the molecular velocity, supposing the molecules *to have equal velocities, but to move in all possible directions.* Now these are exactly the conditions supposed also by Mr. Schlemüller, and yet Clausius has found, just as Krönig before him—

$$V = \sqrt{3gP_0V_0(1 + \alpha t)}$$

instead of Mr. Schlemüller's double value.

In another way Briot[3] has found the same result, whereas according to the theory published by the late Prof. Maxwell,[4] the molecular velocity is—

$$V = \sqrt{\frac{8}{\pi} gP_0V_0(1 + \alpha t)}.$$

There are thus pretty many calculations published already, all of them, according to Mr. Schlemüller, being wrong, and even *very much* wrong (viz., by 100 per cent.).

It can be shown, however, that the fault is Mr. Schlemüller's, and not Krönig's, Clausius's, Briot's, or Maxwell's. Mr. Schlemüller, according to his own statement, accepts the calculation given by Krönig (which he ascribes to Joule), simply replacing the value V by $\frac{V}{2}$. Now, in Krönig's final formula the value V^2 occurs, and this value is arrived at by a double step. First, it is shown that the force with which a molecule strikes the wall is proportionate to its velocity V; secondly, the *number* of strokes occurring in one second is shown to be also proportionate to the value V. Thus the final result is found to contain the value V^2. If the molecules are supposed to move in all possible directions, it might perhaps be admissible to make the mean striking force of a molecule proportionate to the *mean normal component* $m\frac{V}{2}$, (being the mean value of all $mV \cos \alpha$) but it is quite wrong to replace V simply by $\frac{V}{2}$, when the *number* of strokes is calculated. If a molecule of a gas contained in a cubical vessel is moving in the direction of one side of the vessel, it will strike one of the walls $\frac{V}{2a}$ times per second, V being the velocity and a the length of the vessel's side. If, however, the molecules move in all possible directions, it would be quite erroneous to suppose that the mean number of strokes per second will be $\frac{\frac{1}{2}V}{2a}$, viz., that V can be replaced simply by $\frac{V}{2}$. But that is exactly what Mr. Schlemüller does. The problem is not very easy indeed, and certainly not so simple as Mr. Schlemüller seems to think. The elaborate calculations of Clausius and Maxwell are a sufficient proof of that.

Mr. Schlemüller, having thus found his value of V, proceeds to calculate the decrease of *vis viva* of a moving molecule corresponding to a given increase of elevation above the surface of the earth, or, in other words, he calculates the decrease of temperature towards the higher regions of the atmosphere. The result found by him is a fall in temperature of 1° Centigrade to every 175·611 m. or 1° F. to 106·7 yards. Calculating further the height of the atmosphere, viz., the height which can be reached by a molecule starting at a given speed from the surface of the

[1] Der Zusammenhang zwischen Höhenunterschied, Temperatur und Druck in einer ruhenden nicht bestrahlten Atmosphäre, sowie die Höhe der Atmosphäre. Von W. Schlemuller. (Prag: Dominicus, 1880.)

[2] By a misprint the original has $\frac{mN}{2}$

[1] For we ought to know the formula for the molecular velocity was first given by Krönig.

[2] This paper was also published in the *Phil. Mag.*, 4th series, vol. xiv. p. 108.

[3] "Théorie mécanique de la Chaleur," chap. ix. § 141.

[4] *Phil. Mag.*, 4th series, vol. xix. p. 22.

earth, and going vertically upwards, Mr. Schlemüller finds the height of an atmosphere

Of pure oxygen	... ...	43,360m., or 27 miles
Of pure nitrogen	... ...	49,360m., or 31 miles
Of watery vapour	... ...	76,980m., or 48 miles

These results are, indeed, fair approximations to the ordinary values.

At the end of his treatise the author gives some formulæ which are destined to serve for the measurement of heights by means of the barometer and thermometer.

On p. 10 there is a curious statement. Supposing the air or gas to be inclosed in a vertical "narrow tube," the author thinks that the molecules will be able to make vertical movements only, and he introduces, therefore, into his calculations the mean value of the vertical components of their velocity, viz., $\frac{V}{2}$. The result is that, according to Mr. Schlemüller, the temperature in a narrow vertical tube, open at top and bottom, increases four times faster towards the bottom than in the free atmosphere. What the author considers to be a "narrow tube" he shows on p. 12, where he applies his rule to a pit or well (!). It is not too much to say that a perpetuum mobile might be constructed on that principle.

Mr. Schlemüller's formulæ for measuring heights might be perhaps accepted by some who would take the numerical results given by the author as a sufficient proof of his theory. It is, however, impossible that a theory resting on false assumptions should give correct results, and the coincidence of the results given with data derived from other sources is only apparent. First these data themselves are so varying that it is not very difficult to produce a number approaching pretty closely to some of them; on the other hand, the results calculated from a theory which supposes an atmosphere not exposed to radiation *ought not* to coincide with data derived from the *actual* atmosphere, which is far from fulfilling the conditions supposed by the theory.

L. HAJNIŠ

Prague, December 3

Alternative Interpretation of Sensation

THE curious optical phenomena which form the subject of Mr. Ackroyd's letter (NATURE, vol. xxi. p. 108) have their analogues, as many have probably observed, in other orders of sensation. When travelling by railway, or indeed in any closed vehicle, I have often noticed that, if passing objects be shut out from view, it is possible with a little effort to mentally reverse the direction of the train, so that if sensation only were concerned, there would be no doubt as to this reversed motion. Another example of this choice of interpretation is also afforded by the sensations of motion, but in a slightly different way. Standing low down by the water, on a moving steamer or on a bridge over a rapid stream, we can at will either *feel* that we are moving through the water or that we are stationary while the water is flowing by. The same, or at any rate a very similar, choice is presented when the clouds are scudding over the moon's disk; we can either see the moon travelling behind unmoving clouds, or the clouds passing rapidly across the moon.

It would appear from the above facts that we have in certain cases the power of selecting from the experiences which have been associated with a given set of sensations that one which we wish the sensations to convey. It is difficult to see how this can be explained without admitting a certain amount of freedom of will, as the sum of our previous experience, including the sensation itself, is the same, whether we choose to go backwards or forwards, to stand still or to move on.

FRED. D. BROWN

Science Schools, South Kensington, December 16

Curious Incubation

INDIAN birds avail themselves largely of natural heat in incubating; as breeding-time generally begins in March, the hot weather is generally well on by the time the eggs are laid, and as the temperature of the air is never below a minimum of 98° – 100° during the day, the eggs are but little sat upon except during the night, and so rest and duty are combined judiciously.

On one occasion I collected birds' eggs, and, until I could blow them, I used to place them in a drawer of my office table, and there they would lie for two or three days until I had leisure. One day, while writing, I heard strange sounds from this drawer, and opening it found a young crow (*Corvus splendens*) emerged from its egg. On a second occasion I similarly found a young myna. I tried hard to rear these strange hatchings, but failed.

One day I saw a kite's nest in the top of a fan palm, and sent up a native to bring down the contents, which turned out to be eggs. In a spirit of mischief I placed them, without saying anything to any one, under a hen which was sitting upon ducks' eggs, and awaited the result. Two days after, my fowl-man came to me with a long and solemn face, and asked permission to address me. That accorded, he mysteriously whispered, "My lord, a great wonder has occurred in the fowl-house; a marvel has happened; devils have been hatched in the fowl-house." Then began a *tableau* of descriptive acting which I cannot reproduce. "Did not I place ducks' eggs under that hen, and, my lord, have not ducks flat feet like this (flattening and extending his hand), and noses like this (compressing his thumb and index-finger); have they not, my lord?" On my solemnly assenting, he proceeded: "But these devils, my lord, have feet like this (clawing all his fingers), and noses like this (hooking his thumb and index together at his own nose)? Oh! my lord, what shall I do?" "Well, let me see these devils," I replied, sympathisingly; and we walked off to the fowl-house and found the hen sitting dazed beside her basket, in which were five recently-hatched kites. The *finale* was tragical, for the poor hen abandoned both her eggs and the kites, and the latter would have died had I not had them replaced in their nest. As it was, the ducks' eggs were abandoned.

R. F. HUTCHINSON

THE GEOLOGY OF THE HENRY MOUNTAINS[1]

THE Henry Mountains are a group of five peaks, ranging in height from 7,000 to 11,000 feet above the sea, which rise out of the table-land, now so well known to all students of physical geography, to which the American geologists have given the name of the Colorado Plateau.

They are situated in Southern Utah, and are crossed by the meridian of 110° 45′ and the thirty-eighth parallel.

They stand close upon the northern bank of the Colorado, which flows past their base in a cañon 1,500 feet in depth.

Mr. Gilbert's account of the geology of these mountains is specially interesting to the student of physical geology, on account of the explanation it contains of the machinery by which their uplift was brought about. His views have certainly the merit of novelty, and at the same time the evidence in their favour, if not quite conclusive, carries with it considerable weight.

All previous speculation on the subject of mountain-building may be grouped under two heads. Nearly all mountain ranges have a central axis or core of crystalline rock. By the older geologists this crystalline mass was looked upon as intrusive, and it was believed that the violent injection of a huge body of molten matter had lifted up the stratified rocks through which it forced its way, and shouldered them off on either side, giving them a dip coinciding in direction and approximately in amount with the slopes of the chain. A section across a mountain chain would show, according to this view, an anticlinal arrangement of the bedded rocks with a body of intrusive rock in the centre, and it was the intrusion of this central mass that was believed to have caused the upheaval. The force, then, which according to this view, raised mountains to their present elevation, was of the nature of a *thrust acting vertically upwards*.

Never, perhaps, did any theory collapse more completely than this when it came to be subjected to the test of examination in the field. As mountain chains were one by one investigated by geologists, the anticlinal arrangement of their rocks which this theory required was found to be more and more conspicuous by its absence. Marked peculiarities of structure were indeed found to be so universally present in mountain chains, that no range of hills was deemed worthy of that title

[1] "Report on the Geology of the Henry Mountains." By G. K. Gilbert. (Washington, 1877.)

unless it possessed them. But these characteristic structures were vastly different from the simple anticlinal tilting which the earlier speculators had believed to be the typical arrangement of the beds in a mountain chain. It was found that the rocks had been folded into a number of very sharp troughs and arches whose axes ran roughly parallel to the trend of the chain. The radii of some of the curves were measured by miles, while in other cases the beds had been puckered up into minute and complicated convolutions. Frequently the arches had been canted over, and inversion of the beds had been produced. Slaty cleavage had been largely developed, the planes of cleavage having the same general bearing as the axes of the range. Faulting had taken place on a large scale, and the rocks were often jammed and mashed together till a state of confusion that defied description had been produced.

No single thrust acting vertically upwards could have brought about such results as the repeated folding, the inversion, the cleavage, and the smashing; but everything pointed to powerful pressure acting in a horizontal direction which had wrinkled up a vast thickness of strata into mighty folds, and sometimes jammed them together till they became little better than a mash of shattered and ruined rock. The crystalline core was in some cases nothing more than the result of intense metamorphism; and where it was intrusive, there was every reason to think that the molten or pasty rock had been driven up through fissures by the squeezing which the rocks had undergone; in fact, so far from the crystalline centre being the cause of the upheaval, its presence was only one of the results which almost necessarily followed from the way in which that upheaval had been brought about.

All the facts then seemed to show that mountain chains had not been uplifted by a force acting vertically upwards, but had been ridged up by a *squeezing force acting horizontally* on a very thick mass of strata.

That denudation carved into shape the mass as it rose was soon realised, but we are here concerned only with the early stages in the genesis of a mountain chain.

Now one point of great interest in the geology of the Henry Mountains, is that they seem at first sight to form a striking exception to the law of arrangement, perhaps we might more properly say disarrangement, which prevails so widely in mountain chains. They might also, to a casual observer, seem to supply a case where the structure assigned by the earlier geologists to mountain ranges, and which has been looked for in vain so often, does really exist.

Careful investigation, however, shows that neither of these suppositions would be true.

The structure of the Henry Mountains is simple when compared with the complicated foldings and disturbances so characteristic of mountain chains. In the case of each of these mountains the strata are arranged in dome-shaped fashion dipping outwards in all directions from the centre. The strata of the plateau from which they rise are all but horizontal; around the base of each mountain the beds bend up and "rise, slowly at first, but with steadily increasing dip, till an angle of 45° is reached. The dip then steadily diminishes to the centre, where it is nothing." In some cases the beds slope away from a single centre, in others a great arch is made up by the confluence of a number of smaller domes.

Widely different as this arrangement is from the complicated contortion and disturbance usually met with in mountain chains, the Henry Mountains furnish no exception to the broad generalisation that mountain chains always exhibit intense convolution and smashing of their rocks. For the Henry Mountains are in no sense a mountain range. They are a group of peaks, each of which is an isolated individual; they show little or no tendency towards a linear arrangement; "they would prove perfectly intractable in the hands of those geologists who draw parallel lines through groups of volcanic vents by way of showing their trend. They are as perfectly heterotactous as they could be made by artificial arrangement."

In the case of several of the Henry Mountains the centre of the hill is seen to be occupied by a core of intrusive trachyte, from which intrusive sheets and dykes are given off. Reasoning from analogy Mr. Gilbert believes that in those cases where no such core can be seen, there still is one present under ground, but as yet uncovered by denudation. The upper surface of these cores is arched, and seems to run parallel to the bedding of the overlying rocks. It certainly looks as if we had here a case when strata originally horizontal had been bent up into a dome by the injection from below of a mass of molten rock. And this is the explanation adopted by Mr. Gilbert, but his views differ widely from those which the earlier geologists would have maintained had they been acquainted with these mountains. The earlier speculators gave to their intrusive masses a wedge-shaped form, representing them as broadening downwards and extending to the lowest depths to which geological speculation ventured to penetrate. The intrusive cores of the Henry Mountains, on the other hand, are represented by Mr. Gilbert as bounded on their under side by a horizontal plane and as resting on horizontal strata. They have, in fact according to him the shape of a huge plano-convex lens, with its flat face downwards; the curved surface is however rather a portion of an oblate spheroid than a sphere, for the trachytic masses are somewhat flattened on the top; some of them too are oval rather than circular in plan. To an intrusive mass of this shape he gives the name of a laccolite, from λάκκος, a cistern, and λίθος, stone.

His theory of the genesis of a laccolitic mountain is as follows:—Lava was pumped up through a chimney or fissure and at a certain point in its upward course spread itself out between two adjoining beds in the form of an intrusive sheet; by farther additions of lava from below the sheet is thickened, the overlying strata are more and more arched, till at last they are bent up into a dome.

Of course this involves the stretching of the overlying strata; in the case of one of the domes it is calculated that there must have been an extension of 300 feet in three miles. Mr. Gilbert has shown that this elongation is rendered possible by the fact that at the time of their flexure the beds were loaded by a crushing weight; directly the tension exceeded the limits of cohesion, and a fissure was torn open, or rather directly a fissure would have been torn open had the bending taken place at the surface, the weight of the pile of strata overhead crushed together the walls and closed the rent. That a cover of rock, perhaps 7,000 feet, and possibly 11,000 feet in thickness, would tend to this result is clear enough, but that it did not always prevent rupture is shown by the numerous dykes associated with the laccolites. Mr. Gilbert has attempted to show by mathematical calculation that at a given depth the overlying strata could not be lifted if the area of the laccolite falls short of a certain value. His method involves certain assumptions which render it somewhat unsatisfactory, and his conclusion seems to be inconsistent with the explanation he gives of the formation of a laccolitic mountain; for according to him the first step in that process is the production of an intrusive sheet. This in itself involves the uplifting of the beds above, and his calculations show that no uplifting could take place till the sheet had reached a certain size.

The failure, however, to solve by mathematical methods a problem of this difficult nature by no means implies a rejection of the theory. A much more important matter is the examination of the evidence by which the existence of these peculiarly shaped bodies of intrusive rock is supported. Mr. Gilbert has evidently seen enough to satisfy himself on this point, and we

are quite willing to put every confidence in the statements of so accurate and skilful an observer; at the same time we cannot help feeling some regret that he has not been a little more explicit in his description of the sections which lay open the characteristic form of the laccolite. The horizontal base and the undisturbed state of the underlying strata are the first points on which we wish to be thoroughly assured. It is stated that "in five instances one side of the dome of strata has been washed away, exposing the core of trachyte to its base, and showing undisturbed strata beneath." We do not doubt the statement, but we should have been better satisfied if these cases had been described more in detail in the special account of the separate mountains. The views of the Marvine laccolite in Figs. 43 and 44, if we understand them aright, do seem to be conclusive on the point of the horizontal base; but the evidence would have been more convincing if these plates had been explained at greater length in the text. In fact, the one fault we have to find with the book is the difficulty of understanding the illustrations; they are not striking from an artistic point of view; in some the letters of reference are so indistinct that they can be found only with the utmost difficulty, and we confess that by some we have been fairly beaten; we should, for instance, very much like to know which is the laccolite in Fig. 33.

Again, the evidence for the parallelism between the upper surface of the laccolite and the bedding of the overlying rocks, has hardly been brought out with sufficient distinctness; after a comparison, for instance, of Figs. 25 and 26, an invidious critic might have something severe to say about the proportion which the part of the laccolite actually seen bears to that which is admittedly theoretical.

But we have made these remarks in no captious spirit; we wish merely to express our fear that the acceptance of Mr. Gilbert's ingenious speculations may be hindered by a lack of detail in the statement of the evidence he brings forward in support of them.

Assuming Mr. Gilbert's theory to be sound and good, it is not likely that the Henry Mountains are the only ones constructed on the laccolitic type. Mr. Gilbert is inclined to class under this head a number of mountains in the western territories, grouped together under one type by Dr. A. C. Beale, in a paper in No. 3 vol. iii. of the *Bulletin* of the United States Geological Survey. We cannot say that there is anything in Dr. Beale's description which would lead us to assign these mountains to the laccolitic group; and in one case, that of the Elk Mountains, the careful account given in the Report for 1874 of the Geological and Geographical Survey of the Territories, seems to show that they form a normal mountain range ridged up by horizontal pressure.

There is one problem which has been always more or less of a puzzle to the student of volcanic phenomena, on which Mr. Gilbert's speculations may possibly throw considerable light: we mean the formation of pit-craters. Mr. Scrope showed how these singular depressions had probably been blown out by one single explosion of unusual violence, and Mr. Judd has suggested their connection with intrusive sheets. If we suppose a rapid accumulation of lava in a laccolitic mass, and a sudden development within it of steam of high tension, we shall have exactly the conditions suitable for producing one of those explosions which there is every reason to think have been the cause of pit-craters.

The work contains a long and elaborate chapter on "Earth Sculpture," which space will not allow us to do more than mention, and concludes with a chapter on Economics, in which the author insists with almost pathetic earnestness, that the Henry Mountains, full of interest as they are for the geologist, can never be put to any profitable account commercially, unless possibly in parts for grazing. Nature would seem here to have laid herself out to frame a district which should have attractions for no one but the student of pure science.

A. H. G.

FINNIC ETHNOLOGY

A DECIDED stage in the progress of Finnish studies is marked by the sumptuous work on "Finnish Crania," recently published by the native ethnologist, Gustavus Retzius.[1] Continuing the investigations of his father, Anders Retzius, this distinguished anthropologist has at last been enabled to arrive at some definite conclusions both as regards the type itself and its geographical area. The elder writer was a warm advocate of what may be called the Finno-European theory, which is still popular amongst a certain school of fearless anthropologists, and which, since the discovery of the Cuneiform writings, has received a fresh impulse and a wider extension. This is not the place to discuss the angry question of the Finno-Ugrian relations to the Accad language and civilisation of Babylonia. But many enthusiasts will probably be disappointed to hear that the younger writer abandons his father's position, and deals a severe blow to the doctrine of a former wide-spread diffusion of the Finnish race over the greater part of Central and Western Europe. The laborious attempts of many ingenious philologists to discover traces of Ugrian affinities in the Italic and Teutonic tongues, and even to remove the Etruscan from the Aryan to the Ural-Altaic family, can scarcely be regarded as at all successful. On the other hand, a few ancient skulls presenting certain traits characteristic of the same race, together with some hatchets and other stone implements picked up here and there analogous in form to those often dug up in Finland, offered far too flimsy materials to supply a solid basis for such a vast superstructure. Hence it is not perhaps surprising that in the light of further investigation and more serious research the theory should prove to be somewhat visionary.

History had already pointed out that during the ascendency of the Goths from the Baltic to the Euxine the Finns were found nowhere to the west, but only to the east and north of that line; in fact in their present homes on the Volga, in Finland, round about the great Russian lakes, and more recently along the southern shores of the Gulf of Finland. It might doubtless be argued that at this period the race had farther west been already absorbed by the Slavs and Teutons of Aryan stock, intruders from Asia. But no reliable data can be appealed to in support of this position. The authenticity of the stone hammers and other objects of Oriental form said to have been found in France and elsewhere is now questioned, while the philological argument never gets beyond the purely etymological stage.

Hence Gustavus Retzius adopts the view now fast gaining ground, that instead of being the aborigines of Western and Central Europe, the Finns are amongst the most recent arrivals from Asia. Their own traditions point to the Altai region as their true home; the national usages and the spirit of the popular songs embodied in the great epic, the Kalevala, are all Asiatic rather than European, and the uninterrupted stream of their migrations westwards may still be clearly followed from their most advanced outposts in the Scandinavian peninsula through Finland, along the Volga and Kama valleys, over the Urals, and up the Obi basin to the probable cradle of their race in the Sayan highlands.

The narrower, though scarcely less interesting question of the position of the Finnic branch in the Ural-Altaic family is still surrounded with difficulties, which seem to be intensified rather than removed by the conclusions of M. Retzius. While the Finnish language is no doubt fundamentally connected with those of the other members of the group, the physical features of the race present

[1] "Finska Kranier." Skildrade af Gustaf Retzius, Stockholm, 1878.

many striking deviations from the ordinary Mongol standard. The elder Retzius had long ago distinguished four more or less marked ethnical groups in Finland itself, apart altogether from the intruding Swedes, Russians, and other foreigners. These, however, are now reduced to two only, which a careful investigation of the materials supplied by archæology, tradition, the Norse Sagas, the old national songs and philology, combined with an extensive study of a vast number of crania and living subjects, have enabled the younger writer to fix with some approach to precision.

Of the two, the Tavastian and the Karelian, he regards the latter as the genuine national type, in this differing from the commonly received opinion. The Karelians, occupying the country more to the east, are of slighter build, but better proportioned and taller than the Tavastians, of a light brown complexion, with longer head, narrower and less heavy features, long, straight, and pointed nose, dark hazel eyes, chestnut or dark hair falling in ringlets over the shoulders, open and animated expression, though still with a serious cast. The Tavastian, on the contrary, is of a much more solid, compact, and coarse build, middle size, light or ashy complexion, but always lacking the rosy tints peculiar to the Teutonic peoples, with straight silken hair of a flaxen colour, and often yellow at the tips, broad square head, short snub nose, dilated nostrils, slightly oblique greyish blue eyes, sullen and unsympathetic expression.

This description obviously corresponds far more closely with the common Mongoloid type than does that of the Karelians. Yet in the writer's opinion the latter are the true descendants of Illmarinen, the hero of the Kalevala, and the scene of his exploits is laid in the region still occupied by them. The Tavastians he regards as a distinct ethnical element of doubtful affinities, though allied on the one hand with the Esthonians of the Baltic provinces, on the other possibly with the Lapps of the Arctic regions.

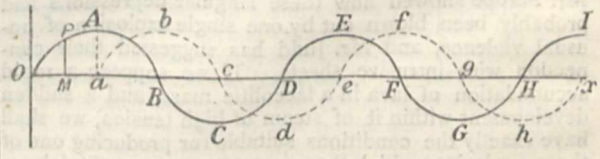
The question, as already remarked, has been advanced one stage; but much remains to be done before we can expect to see all the difficulties removed by which it is surrounded. Meanwhile it seems impossible to agree with M. Retzius, that the Karelians, rather than the Tavastians, represent the true Finnish type. Both have, no doubt, largely absorbed foreign elements. But if both are alike branches of the Mongolo-Tatar family, as has been hitherto supposed, and as their speech appears to place beyond question, it follows that of the two the Tavastians must be regarded as the nearest to the common stock. The Karelians are, of course, much the finer race, both physically and intellectually, and national prejudice may, therefore, feel inclined to regard them as the purer branch. But, ethnologists will probably be disposed to look on the improvements as due rather to a greater absorption of foreign elements, Teutonic or Slav, if not Lithuanian. They occupy a country which may well have been peopled by some of these races before their arrival, whereas the dreary lacustrine region of Tavastland must have been all but destitute of inhabitants previous to its occupation by the advanced wave of Finnish migration.

A. H. KEANE

RESEARCHES ON TELEPHONE VIBRATIONS

DR. RUDOLPH KONIG, the well-known constructor of acoustical apparatus, has recently brought before the Physical Society of Paris a research of the highest interest, upon the difference of phase which exists between the vibrations of a transmitting and a receiving telephone. In a paper published more than two years ago, Prof. du Bois-Reymond discussed the conditions which determine the intensity and the phase of different sounds transmitted telephonically; and from theoretical considerations deduced the conclusion that sounds of low pitch suffered greater loss by transmission than shrill ones, and that every simple vibration was retarded in phase by a quarter of an undulation. The former of these actions would produce an alteration in the timbre of the voice as received at the end of the line: the latter effect would remain unappreciated by the ear, since the retardation of phase was the same for waves of all periods. More recently Helmholtz has attacked the question in a paper in the *Annalen* of Wiedemann ("Telephon und Klangfarbe"), and, with a theoretical treatment of the question based upon somewhat deeper analysis, has deduced the results that all sounds are weakened by transmission in almost a constant proportion irrespective of their pitch, and that the difference of phase between the vibrations of transmitter and receiver are very small. Dr. König has endeavoured to put these conflicting speculations to the test of experiment, and with marked success.

It may be well, perhaps, to indicate the elementary considerations which led du Bois-Reymond to predict the existence of this hitherto unobserved difference of phase. The currents by which sounds are carried from the transmitter to the receiver in the Bell telephone are induction currents, excited in a coil of insulated wire by the vibrations of the iron diaphragm in front of the permanent magnet which serves as a core. The intensity of these induced currents is greatest when the vibrating diaphragm is moving with the greatest velocity. But the maximum *velocity* of the diaphragm does not occur at the moment when the *displacement* of the diaphragm is greatest. To non-mathematical readers this fact may be explained by reference to the movements executed by a simple pendulum. As the pendulum swings backwards and forwards the "bob" comes absolutely to rest at the moment when its displacement to one side or the other is the greatest, and it moves with the greatest velocity when it passes through the "point of rest" mid-way between its two extreme positions. Mathematically, the matter is equally simply stated. The displacement of a body executing a simple harmonic motion is determined by an equation of the form $u = a \cos \frac{2\pi t}{T}$, where the values of u pass through a regular series of maximum and minimum values as t increases. These successive values are geometrically represented by the heights of the ordinates of the well-known harmonic curve or *sinusoid*, the distances along the horizontal axis O x being proportional to the times. Thus the telephone diaphragm originally at rest begins to move towards the magnet under the influence of the voice. The displacement, which at the origin is nothing, increases until at A it becomes a maximum. Owing to its elasticity the diaphragm flies back, and passing rapidly through its point of starting suffers a displacement in an opposite sense. These movements are graphically represented on the harmonic



curve by the passage of the curve across the axis at B to its minimum or greatest negative displacement at C, the curve recurring from the point D. Now the equation which represents the *velocity* of the moving point will be obtained from the equation of the displacement by differentiating with respect to time. This gives us an equation of the form—

$$\dot{u} = -\frac{2a\pi}{T} \sin \frac{2\pi t}{T} = \frac{2a\pi}{T} \cos\left(\frac{2\pi t}{T} + \frac{\pi}{2}\right),$$

which is, neglecting the constant coefficient of amplitude, geometrically represented by another harmonic curve of identical form, but shifted on so that it begins at a point *a*, or a quarter of the length of the curve o o from the origin. In this second curve the heights of the ordinates represent the varying velocities of the diaphragm, the velocity being nothing at *a* when the displacement at A is a maximum, and being at a maximum at *b* when the diaphragm in flying back passes through its point of rest or has no displacement. Now of these two curves the former corresponds in phase to the movement of the diaphragm of the transmitting telephone, while the second curve corresponds to the variations of velocity, and therefore of the current transmitted, and consequently also corresponds to the motions of the diaphragm of the receiving telephone. Hence it is easy to understand that there exists a difference of phase of one-quarter of an undulation between the movements of the diaphragms of the transmitting and receiving telephones, which will be either a retardation or an apparent acceleration of phase according to the sense in which the transmitted currents traverse the coil of the receiving telephone. These considerations apply only to the telephone of Bell or its modification by Gower, in which the vibrations of the transmitting diaphragm generate the current. They do not apply to the transmitters of Edison and Hughes, which merely regulate the current. In these instruments the strength of the current is proportional to the *displacement*, not to the *velocity*; hence there is no retardation of phase.

The memoir of Helmholtz, which, by introducing certain considerations respecting the mutual inductive actions exercised upon one another by the individual turns of wire in the coil of the telephone, arrived at a somewhat different conclusion, and was principally devoted to the question of the timbre of the transmitted sounds. The previous researches in physiological acoustics of this distinguished physicist had shown that differences of phase affecting individual tones of a compound "clang" do not produce any effect which the ear can detect. This important law the present writer has, however, shown elsewhere to be true only when one ear receives the sound, and to hold no longer in the case of binaural hearing. The equations of Helmholtz indicated the unexpected result that the difference of phase between the vibrations of transmitter and receiver was a quantity so small that practically it might be altogether disregarded, and he arrived at the conclusion that all sounds were transmitted by the telephone with an equal proportionate degree of intensity independent of their pitch, and therefore with unaltered timbre. Here again, however, the writer of this article has shown that the relation between the thickness and diameter of the vibrating diaphragm affects the distribution of the magnetism induced in it by the magnet, as to whether it is lamellar or radial in character, and that this distribution has influence on the timbre of the sound emitted by the receiving telephone, the notes of higher pitch being better given by the disk in whose magnetisation the lamellar distribution preponderates, while the lower ones are better given with a preponderating radial magnetisation. The whole question of timbre of the emitted sounds requires further careful study.

The experiments which M. König has executed entirely confirm the *à priori* reasoning of du Bois-Reymond as to the existence of a difference of phase. Instead of using two vibrating diaphragms, Dr. König takes two tuning-forks accurately tuned to unison, each of them being placed in front of the magnet of a telephone whose disk has been removed, and which are united in the usual manner by wires. The first of the forks being set into vibration with a violin-bow, the second immediately begins to vibrate. The phase of each of the forks is next observed. This has been done in several ways: firstly, by direct comparison of each fork in turn with the vibration-microscope; secondly, by applying the well-known optical method of Lissajous, compounding together the two vibrations rectangularly by throwing a ray of light on to small mirrors attached to the two forks, and reflected from one to the other and then on to a screen. The figure thus produced exhibited unmistakably a difference of phase of an exact quarter of an undulation. A further experiment on compound tones was made with the same general arrangements; two forks, differing by three octaves, being made to take up, one as transmitter the other as receiver, sounds whose higher vibrations were eight times as rapid as the fundamental tone. Here again the difference of phase experimentally found for the higher tone was one quarter of a vibration.

Incidentally two very important facts have been observed by Dr. König. In experimenting he found that a tuning-fork, vibrating in front of the magnet of a telephone *whose circuit is closed*, comes to rest in a much shorter time than the same fork vibrating freely away from the telephone; also that this weakening of the sound is greater in proportion as the distance of the fork from the pole of the magnet is smaller, and also is greater for small amplitudes of vibration than for large ones. These results are not without interest in their bearing upon Mr. Edison's recent attempt to construct a dynamo-electric machine, in which the moving parts should be attached to a large vibrating tuning-fork instead of to a rotating axis. Doubtless the inventor's idea was to get rid of the friction accompanying rotation; for, as the vibrations of the tuning-fork are very nearly simple harmonic motions, and as the simple harmonic motion is the only type which can be propagated without loss by friction through a body, the motions of whose parts are coincident in phase, it might be anticipated that there would be less waste of energy in a "harmonic" engine than in a rotatory one. The important fact however remained behind that by far the greatest part of the work of driving a dynamo-electric machine was not spent in overcoming friction, but in doing the work of moving closed conductors across a magnetic field, a work which, to produce an equal amount of current, requires equal power, whether the motion be one of rotation or of "harmonic" vibration. Many years ago Foucault demonstrated the reality of this resistance to motion by spinning his gyroscope between the poles of an electromagnet; and with a Gramme machine, and also with a Holtz machine, the increased effort necessary to sustain rotation when work is being done is a familiar fact. Dr. König has now demonstrated the existence of a similar phenomenon in the case of the vibrations of the tuning-fork, which comes much sooner to rest when it is doing electrical work than when it is doing no work.

SILVANUS P. THOMPSON

ON THE EOCENE FLORA OF BOURNEMOUTH

ON several previous occasions these columns have called attention to the eocene plant remains obtained at Bournemouth. The Palæontographical Society has undertaken their publication, but as this must be spread over many years, it may not be undesirable to note from time to time the principal additions to the flora as they come to light.

The specimens which I have collected this year may reach about a thousand. Among the more important are two from the marine beds east of Boscombe. One is a portion of the stem of a cactus measuring two feet three inches by three inches, showing eighty bosses of spines cleared from the matrix. A section which I have made of this presents a flattened ellipse in which the pulp is replaced by sand and the woody stem has sunk down to the lower side, though still preserving the characteristic radiating structure. The cuticle is now thin and glossy black, and bears the spines, varying from two to a dozen on each boss, arranged in the usual spiral

order. Heer described similar spines from Bovey as those of a palm, notwithstanding that the regularly spiral arrangement of the clusters is perfectly shown in Mr. Fitch's drawings.

The second of the specimens is the largest of several branches with leaves, of a Sequoia-like conifer, which abounds in the higher beds east of Bournemouth Pier, yet has not been found in those west of it. The foliage and branching might be almost equally taken for *Sequoia gigantea*, *Araucaria Cunninghami*, *Creptomeria japonica*, or *Arthrotaxis selaginoides*. The stem is slightly curved and does not branch for ten inches, but then forks into six slightly diverging branchlets, each some six inches long. Two of these terminate in swollen buds which would perhaps have borne cones, and another ends in a compact cluster of budding needles without any swelling, and might have produced the male flower. This branchlet, and the great number of others that have been formed with it, were evidently shed from the trees exactly as they are seen to fall from the similar conifers at Kew. Nothing beyond branches clothed with leaves have been found, and we have only the peculiar Araucaria-like swelling of some of the terminal buds to guide us. On the other hand, branches very strongly resembling these have been found by Baron Ettingshausen at Häring with Sequoia cones attached. I think however that this resemblance to Sequoia should not at present have too much value attached to it, because both genera appear to have lived contemporaneously, perhaps from Oolitic times, until the present day.

Ettingshausen has detected what he considers the flower and a scale of Sequoia among the specimens just obtained from the Lower Bournemouth beds, so that the view I put forward that some of the coniferous twigs associated with Bovey ferns were identical with *Sequoia Couttsiæ* of Bovey is somewhat confirmed. It is again most fortunate that I was able last year to obtain a twig of one of the commonest Alum Bay conifers, formerly referred to Taxites, Cupressites, &c., with the peculiar fruit of Podocarpus, recognised by Dr. Carruthers, attached to it, and it now seems probable that there are several distinct podocarps in our eocenes.

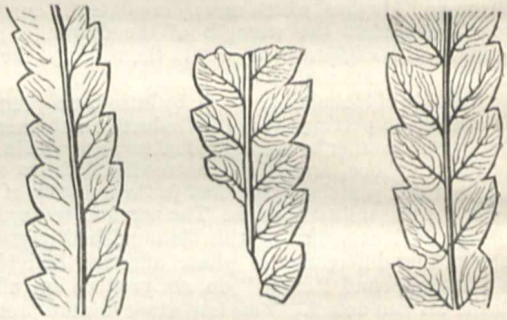
The remains of palm obtained this year are few but instructive. I was fortunate in obtaining from a small isolated patch of clay imbedded in sand, the spathe of a palm; a slab ten inches square covered with over twenty fruit stalks; and about eighteen inches of the upper part of the broad pinna of a feather palm. There is hardly room to doubt that these all belong to the same species, and its accurate determination in that case is a matter of almost certainty.

One exceptionally large fossil dicotyledon was obtained. This is a peltate, bluntly lobed leaf fifteen inches long from the foot of the leaf stalk to the tip, and ten inches across, and is considered by Ettingshausen to be near Cecropia.

Another striking specimen is not only a perfectly new, but one of the finest ferns yet discovered. My attention was called to it by a lady, who was watching my work and whose quick eye caught sight of the unusual venation even before I did, and we gradually brought to light an almost perfect palmate pinna, large enough to occupy a plate in the monograph now being published by the Palæontographical Society. The position of the sori bodering each lobe is distinctly traceable, and this character with its membranous texture and very slender rachis place it almost unmistakably in Adiantum,[1] while the anastomosing veins further define it as belonging to the sub-genus Hewardia, now confined to tropical America. I am the more pleased with this discovery since small mutilated fragments had already attracted my attention and been figured, without our possessing any satisfactory clue to their identity. I have named it *Hewardia regia*.

[1] Or possibly Lindsæa, sub-genus Schizoloma.

While on the subject of ferns, I am pained to have to refer again to a statement I made in this paper with respect to the well-known eocene representative of *Osmunda javanica*. The Rev. Prof. Heer cannot take the expression of an opinion different to his own, in the spirit in which it is meant, however courteously it may be expressed, and I regret that I have hitherto had the misfortune to feel compelled to differ from his conclusions upon almost every subject. In a footnote to a small pamphlet entitled "Die Aufgaben der Phyto-Palæontologie," which was only accidentally brought under my notice, he replies in a manner which renders further discussion impossible. He affects to suppose that I, a much younger man, would venture to differ from him without having reasons founded on new and positive data to justify my doing so. I select one of the instances in which he thinks proper to tell me I do not speak the truth, not because this one is more easy of proof, but because it immediately concerns my present work for the Palæontographical Society. I have accurately traced the figure of what he calls *Pecopteris lignitum*, the figure of his *Dryandra rigida*, and a piece of a fossil Osmunda from Bournemouth. They are so like each other and unlike anything else that nothing need be added. Heer's voluminous work



Dryandra rigida, Heer (Skopau). *Aspidium lignitum*, Heer (Skopau). *Osmunda lignitum* (Bournemouth).

has certainly not tended to simplify the determination of this particular fossil. He had described it as *Aspidium lignitum*,[1] *Dryandra rigida*,[2] and *Pecopteris lignitum*,[3] supposing it to be a Hemitelia, and not until two years after Stur[4] had proved it to be an Osmunda, does it appear in one of his works, without further explanation, as *Osmunda lignitum*.[5] Yet the fossil agrees with the well-known *O. javanica*, which ranges from Kamschatka to Java, so exactly, and in such minute particulars (as detailed in the second part of our monograph upon ferns, in course of publication) that it seems impossible to excuse such a series of mistakes. With unexampled carelessness he has permitted the lithographer, in every one of the works quoted, to distort and make the leaf an impossible one by colouring the lower pair of veins as if they were the margins of the leaf. Having decided, in his own mind, in describing the flora of Bovey Tracey, that this Osmunda was a tree fern, he connected with it, stems, young shoots, and what he calls rhizomes, which never belonged to it, the latter resembling the stem of the Australian grass tree. Two very characteristic statements are founded on this erroneous belief, one that "in the shade of the forest throve numerous ferns, one species of which (*Pecopteris lignitum*) seems to have formed trees of imposing grandeur," the other, that *its* stems with those of Sequoia "certainly contribute the greatest amount of lignite." The real facts are that this was not at all an arborescent fern, and that no vestiges even of the trunks of

[1] "Beitrag zu näher. Kenntn. d. Sächs-thüring. Braunkfl." (Pl. ix. Fig. 2)
[2] *Idem.* (Pl. x. Fig. 15.)
[3] *Phil. Trans.* vol. cliii. p. 1047, 1861.
[4] O. Grutschreiberi, *Stur. Jahrbuch k.k. geol.-Reichsanstalt*, vol. xx. p. 9.
[5] *Jahrbuch der k. ungar.-geol. Anstalt*, vol. ii. 1872.

tree-ferns have ever been found in English eocenes. In the same way on the evidence of three seeds, which he supposes to be grape stones, and some cactus spines, we read that "the trees of the ancient forest were evidently festooned with vines, beside which the prickly Rotang-palm twined its snake-like form." Indeed, in addition to the error he committed in calling them miocene, all Heer's determinations of the Bovey Tracey plants require revising.

The Alum Bay leaf bed, familiar to geologists for twenty or thirty years, appears at last to have almost given out, for the leaf bearing pipe-clay is washed away to such an extent that a fortnight's stay scarce yielded a dozen of the commoner leaves. The unusual rainfall has also nearly obliterated the Hempstead section, and the face of the hill resembles a glacier of mud, which has carried trees and bushes, in place of rocks, into the sea. A lady, my brother, and myself had the misfortune to select that route home, returning from Gurnet Bay when darkness was coming on. The only passage over the deep and perfectly soft mud streams lay through the dead brushwood which fringed them. The tide was high on one side, and up the escarpment on the other lay mud and brushwood of the most impenetrable character, while with a tide still rising and darkness increasing, it appeared as hopeless to attempt to retrace our steps as to press on.

The following, from my note-book, has even less connection with fossil leaves, but the experience may be of use to geologists visiting the district.

At Alum Bay a large area of weathered chalk, usually supposed inaccessible, can be explored without much danger, for it is almost everywhere possible to descend to the sea-level between the Needles and the beacon on Freshwater Down. The face of the cliffs is traversed by numerous faintly marked tracks, which it is difficult to suppose could ever have been of service except to smugglers, for the shore line is rocky and not used by fishermen. Those who appreciate the bolder coast scenery of our white chalk will be repaid by climbs even of 500 or 600 feet, to the perfect solitude of the water's edge. If accompanied by ladies, a rope will be found a proper precaution and useful in lessening the exertion to them. One of the easiest ways is directly under the beacon, and there is a path down into Scratchells Bay, just inside the railing of the fort, whence at low tide the second of the Needles can be reached.

At Bournemouth we had a rather narrow escape. I foresaw that during this year's digging unusual caution would be necessary, owing to the heavy and saturated state of the cliff. I was obliged, however, to go through some fifteen feet of sand to reach a lower bed from which I expected to get pinnæ of *Goniopteris Bunburyi*. I had dug out a piece of this bed from end to end; a distance of about twenty feet by three or four feet wide; and the cliff above this narrow excavation consisted of some fifteen feet of vertical coarse sand, capped by indurated ironstone, and a thick black clay bed, above which the cliff sloped away at an angle. To expose a little more of the leaf bed we ventured at one point to slightly undermine the verticality of the cliff, before replacing the sand and clay we had dug out. During a pause for lunch sand fell twice upon the leaf bed cleared for work and was shovelled off. On a sudden loose pieces seemed to be falling all along the face of our pit, and with no more warning than an impulse to throw ourselves out of danger, huge boulders of clay and ironstone tore by—which from their weight were afterwards immovable to us—our excavation was completely filled in, and our tools still lie buried under the *débris*. I was helplessly buried for a few minutes up to my shoulders in sand, anticipating another slip, which fell soon after I was extricated.

J. STARKIE GARDNER

RECENT EXPERIMENTS ON RADIATION

EXPERIMENTS on radiation have a twofold interest. Accurate measurements of the increase of radiation due to an increase of temperature have of course a great theoretical value, but in addition to this, there is the practical question of a possible measure of temperature by means of the radiation of a body. It is this practical question with special reference to the temperature of the sun which seems chiefly to induce experimenters to study the subject with improved methods. It has led at any rate Mr. Rossetti to furnish a most valuable contribution to the study of radiation.[1]

Newton was the first to give a formula connecting the quantity of heat radiated by a body with the temperature of the body; but his formula was not sufficiently accurate, and has been replaced by another first given by Dulong and Petit. But Dulong and Petit's formula also breaks down when the difference of temperature between the radiating body and the inclosure is large.

Mr. Rossetti, trying to improve on Dulong and Petit's formula, deduces from his experiments the following for the radiation of lampblack:—

$$y = a\,T^{2}\,(T - \theta) - b\,(T - \theta),$$

where y is proportional to the thermal effect of the radiation, a and b are constants, and T and θ are the temperatures of the body and the inclosure, as measured on the absolute scale. This formula seems certainly to be as far superior to Dulong and Petit's as this latter was to Newton's. The last term generally is but small compared to the first, and Mr. Rossetti believes it to be due to the effect of the surrounding air, although we do not quite see how this can be. The following experiments prove how accurately the formula may be made to represent the facts. The constants a and b were obtained by measuring the radiation of a Leslie's cube filled with water or mercury, and gradually heated up to 300°. A piece of copper foil covered with lampblack was then heated in a flame of alcohol. The temperature of the flame lies between 390° and 400°; and two numbers obtained by means of the above formula were found to lie between these limits. The radiation of a red hot copper sphere was then determined, and its temperature independently measured by means of a calorimeter. The temperatures obtained by the two methods were 762°·1 and 763°·6 respectively.

In order to find the temperature of the copper sphere account was of course taken of the emissive power of copper as compared with lampblack. For this purpose, Mr. Rossetti has invented an ingenious method to determine this emissive power of various metals at the temperature of the Bunsen flame. That a formula obtained by means of experiments made between 0° and 300° C. should give such accurate results for a temperature of 760° is already a good proof for the usefulness of the formula, but Mr. Rossetti has pushed his verification even further. A cylinder of oxychloride of magnesium was heated in a flame of coal-gas and oxygen. The temperature was found to be about 960°, and in a flame it was found to be 2,167° and 2,397° in two experiments. Platinum melted easily in the flame, and hence the temperature could not have been far wrong.

Before Mr. Rossetti can apply his formula to determine the sun's temperature, he has to determine the absorptive effect of our atmosphere; but we shall not enter here into this part of the question. The sun's *effective temperature* is the temperature he would have, if he had the emissive power of lampblack. Mr. Rossetti finds this effective temperature by his formula to be a little below 10,000° C. Taking account of the fact that the sun himself is surrounded by an absorbing atmosphere, and accepting some data given by Secchi for the amount of this absorption, the temperature of the photosphere is found to be above 20,000° C.

[1] Reale Acc. dei Lincei (3) II. 6 Jan. 1878.

Prof. Langley's observations[1] were chiefly made with the view of shewing that the low estimates of the solar temperature which have recently been made on the basis of Dulong and Petit's formula must be wrong. Prof. Langley compared directly the heat and light received by the sun with that received by the hottest luminous source he could find. He chose the mass of liquid steel obtained in the Bessemer process. The result was that the solar heat radiation was at least eighty-seven times as strong as that of the liquid mass. It is impossible to compare this result directly with the values obtained by Mr. Rossetti; but a rough idea of a fair agreement may be obtained. Mr. Rossetti found the solar radiation to be about forty times as strong as the radiation of a lampblack body in the hottest oxyhydrogen flame he could obtain. Taking account of the emissive power of iron, we find that the radiation of the molten steel must have been a little more than half that of a black body in the oxyhydrogen flame which is possible. Prof. Langley also compared the intensity of light sent out by his two sources, and naturally found a much larger difference. We do not agree with Prof. Langley's remark that the solar light radiation is a more trustworthy indication of the total difference between the sum of all degrees of radiant energy than the heat. In fact the heat radiation is the only correct indication of the total radiant energy.

Another interesting contribution to the study of radiation was lately made by Mr. Nichols.[2] Mr. Nichols heated a platinum wire to successive degrees of incandescence by an electric current, and compared the intensity of the luminous radiation in different parts of the spectrum with the incandescence of another platinum wire kept at a constant temperature by means of an electric current. There is a great experimental difficulty in determining the temperatures of the wires, and Mr. Nichols had to content himself with measuring simply their increase in length. Matthiessen's formula will give an approximate idea of the real temperature, but it must be left to future measurements to decide how far Matthiessen's formula can be applied to high temperatures. The chief part of Mr. Nichols' work consists therefore in finding the luminous radiation of platinum, not on an absolute scale, but in terms of an incandescent platinum wire of fixed but unknown temperature. In order to reduce his measurements to an absolute scale Mr. Nichols compared the radiation of his standard with the luminous radiation of the sun, and then employed Lamansky's measurements of the heating effects of different parts of the solar spectrum. The solar spectrum is however a bad medium of comparison, owing to its discontinuous character. There is, for instance, such a strong atmospheric absorption near D that the radiation of the region near D is seriously weakened; which weakening is entirely dependent on atmospheric conditions, and therefore makes comparisons taken at different times illusory. Thus the final curves obtained by Mr. Nichols for the absolute radiation of platinum wire at different temperatures show a discontinuity near D which is evidently produced by the above-mentioned cause, especially as Mr. Nichols did not use sunlight, but light reflected from clouds.

Mr. Nichols also tries to deduce from his experiments the fact that platinum a little below its melting point has a much larger absorbing power than at ordinary temperatures. The whole argument rests however on the assumption that the temperature of a platinum wire is the same as that of a lampblack body when the relative intensity of red and blue light given out by the lampblack body is the same as that given out by the platinum wire. That is to say, Mr. Nichols assumes that the emissive power of platinum is the same for rays of all refrangibilities. But it is evident from Mr. Nichols' own measurements that the temperature of a petroleum flame (used by Mr. Nichols) determined in this way is found much too high. It does not require a large correction in this temperature to bring the value of reflective power of platinum at the temperature and by Mr. Nichols to the same value as that found by Provostaye and Dessains for ordinary temperatures. In the memoir of Mr. Rossetti, an idea of which we have tried to give above, this reflecting power of platinum is directly measured at a temperature of the Bunsen flame, and was found to be strikingly in accordance with the number given by Provostaye and Dessains.

ARTHUR SCHUSTER

[1] Proceedings of the American Academy.

[2] "Ueber das von glühendem Platin ausgestrahlte Licht," E. L. Nichols. Göttingen: E. A. Huth.)

NOTE ON A CONSOLIDATED BEACH IN CEYLON

A SOMEWHAT interesting consolidated beach exists on the west coast of Ceylon, a few miles to the north of Colombo. The writer had only one opportunity of visiting and examining for a short time this formation: but there are certain features in connection with it that cannot fail to be of interest, however short the examination may be. The beach extends continuously in almost a straight line for about four or five miles, and is manifestly in process of formation at the present time, as some portions of it are so soft that they can be easily crumbled in pieces by the hand, whilst others are much harder than gneiss, and can only with the greatest difficulty be fractured by means of a heavy hammer. Between these extremes are all gradations of hardness, and the ordinary shells of the coast may be found in almost every part of the beach more or less firmly embedded in the rock. The highest part of the formation is just within reach of the waves at high tide; but it is difficult to ascertain with any degree of accuracy how far it extends into the sea, on account of the difference between high and low tide being only about two feet. The beach is seen at a glance to be composed chiefly of a faint brownish-coloured rock, with frequent strata of black material of very varied thickness and irregular shape. An examination of specimens shows that the brown rock is composed almost entirely of quartz fragments, and that it possesses only a low specific gravity (2·91), whilst the darker portions are extremely heavy as well as extremely hard. Several specimens gave a specific gravity of 3·9, 3·93, 3·94, the dried sand, freed from its carbonate of lime by means of dilute hydrochloric acid, possessing a specific gravity of 4·32. A microscopic examination of this sand and also of sections of the rock showed that the chief constituent, and that which gave it its dark appearance, was magnetite, corundum in various forms being also present, with here and there a fragment of quartz. One noticeable point was that the fragments of the harder constituents were in nearly every case hardworn, and rounded, whilst the quartz showed traces of recent fracture in the shape of sharp edges and angles. The size of these fragments varies very considerably, those of magnetite ranging from ·005 inch to ·02 inch, whilst those of quartz are much larger, frequently reaching ·04 inch. The corundum fragments are intermediate in size and rounded in form. It must be remembered that these specimens were taken from only one part of the formation, near the centre of its length and about the limit of high tide. In other positions the fragments will, no doubt, vary very much, the size depending in a great measure on the power of the current to carry them along the coast and up the beach. It was a matter of regret to the writer that he was not able to inspect carefully both extremities of the reef, and examine fragments from many different portions of it. The cementing material of the beach is carbonate of lime, no doubt from the coral reefs along the coast, as there is no limestone rock in the neighbourhood or along the course of the Kelani River, which debouches to the south of the reef. It is not known whence the magnetite and corundum have been derived, except that they have

possibly come from the degradation of the gneiss rocks occurring along the coast. Although corundum is comparatively abundant in the interior of Ceylon, it has never been found in its matrix, but always either in pocket holes in streams, or in drift, intermixed with rounded pebbles of quartz. The character of the rivers in the neighbourhood of the coast apparently precludes the possibility of fragments of corundum being carried down to the sea.

A closer examination of the structure of the beach reveals the fact that the heavier particles are frequently deposited in extremely thin strata, transverse sections of which exhibit the most beautiful curves. Examples of this are seen in Figs. 1 and 2, which are half the natural size, the light parts representing quartz, the dark ones

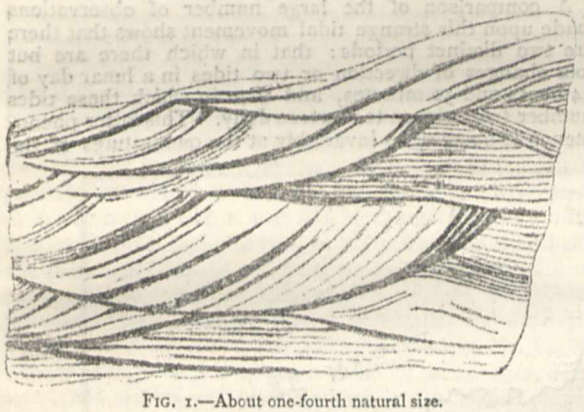


FIG. 1.—About one-fourth natural size.

magnetite. The explanation of this is apparently simple. When the quartz fragments of which the larger portion of the rock is formed have become consolidated, depressions will be formed by the heavy particles of magnetite under the influence of the waves, very much after the manner in which pocket holes are formed in the rocky beds of nearly all the mountain streams in the island. (It was in these pocket-holes that the earlier sapphires were nearly always found.) When once commenced this scouring process would go on as long as the water was sufficiently agitated to keep the fragments of magnetite in motion. Their superior weight would have a tendency to keep them in the hollows they had formed, and the carbonate of lime in the water would fix them in position as soon as they were left undisturbed by the waves. The succeeding waves

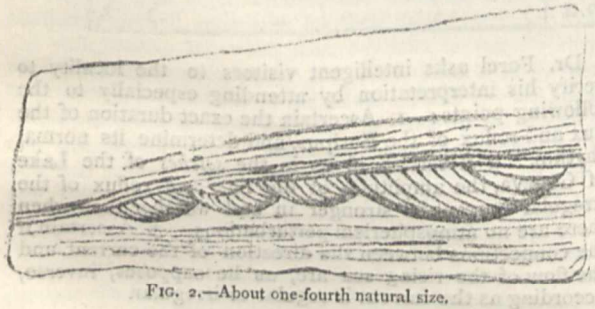


FIG. 2.—About one-fourth natural size.

hat reached the hollow would fill it chiefly with quartz fragments which would become cemented together, and the process of scouring would go on as before.

It may be noticed in explanation of the very beautiful skein-like appearance of Fig. 2, that when once a stratum of magnetite had become consolidated, it would be much less liable to be removed by the scouring process than the neighbouring quartz, on account of its superior hardness, and therefore the original shape of the basin has been retained, whilst other basins, represented by the dark lines, have been formed above it, differing only slightly in shape from the original one. Some portions of this beach are quarried for edging and coping stones which are sent to Colombo.

R. ABBAY

ON THE POTENTIAL DIMENSIONS OF DIFFERENTIATED ENERGY[1]

IN his great work, which appears to be but little known in England, "Ueber die stille Bewegung hypotetischer Körper," Prof. Hans points out that the dimensions of "ideal" matter may not only differ in degree, but also in kind. He deduces, by means of implicit reasoning from his three primitive "stations," that not only must there be space of 4, 5, 6, &c., dimensions, but also that there must be space of $-1, -3, -5$, &c., dimensions, and that there may be space of $-2, -4, -6$, &c., dimensions. Pursuing Hans's train of thought further, Lobwirmski has quite recently interpreted space of 1·1, 1·2, 1·3, &c., dimensions. Not only has fractional space been thus proved to exist, but the same philosopher has also conclusively shown that if space of $n.\sqrt{-1}$ exists, it has all the properties of angular magnitude; *e.g.* like all partly bounded infinities (*theilweise begränzte Unendlichkeiten*), it is unmagnifiable.

These speculations, which are really rather more hyperphysical than metaphysical, immediately suggest the analogous kinematic considerations, and have led me to examine the potential dimensions of differentiated energy. Before pointing out the main conclusion to which I have been led, let me make quite clear the meaning of the terms employed. "Differentiated energy" is that energy which would survive if all matter were destroyed, and simultaneously re-created in such a manner that all its properties were inverted. By "potential dimension" I mean the dimension which, by reason of the kinetic energy of all other dimensions, is only able to vary according to Lobwirmski's groove (*Kleise*).

Let us start from the idea of what is ordinarily conceived to be a Thing, and imagine the Thing itself (not its measure) to be saturated with the property a, after the manner in which the circle is saturated with the straight line in the spiral watch-spring (*spiralförmiger Haasesprung einer Wacht*). Further, let us suppose a to change in such a way that all previous values of any one attribute other than those dependent on its rate of variation can be arranged in a series, the functionally alternate terms of which, up to a certain number whose value will be given by taking each turn separately, and finding to what amount its a property may, under the influence of the given "groove" exceed the a-property of its immediately antecedent term, represent any convenient converging series. The vigour of this change being, as usual, measured by the degree of matter affected, and also by the index of change in a given time, we have at once the simple relationship

$$a = \begin{cases} \beta \\ \gamma \end{cases}.$$

Accordingly, it is obvious as one of the simplest corollaries from the above, that if we know the present position, mass, direction of motion, and velocity of a given piece of matter, we should be able within certain limits to calculate its chemical composition.

As an example of the application of this let us suppose that the earth's satellite M has the mass C; let its direction of motion at *any* given time q be N. Let its rectangular co-ordinates, at the same time, measured from the absolute zero of position, be m, n, and p. Let O be its velocity, and H an arbitrary constant. We have, substituting in the above equation—

$$M = C_m N_n O_p H_q,$$

which has, at least, no closer resemblance to any other body than it has to caseine.

A. V. NUDELN

[1] The correspondent who has received the above letter has forwarded it to us for publication. We are not aware that the general scientific opinion in Germany is in consonance with the results reached in the letter.

A TIDAL PROBLEM

THE so-called *seiches*, or alternate flux and reflux of water in the Lake of Geneva and other bodies of fresh water, have, as our readers know, formed the subject of an interesting study during the past decade by Dr. F. A. Forel, of Morges, near Geneva. Small local tides are constantly noticeable there, the difference between ebb and flow varying from a few centimetres to 2 metres. Their cause is to be traced to the wind, variations in atmospheric pressure at the extremities of the lake, &c. Dr. Forel, as the result of his investigations has established a formula by means of which the duration of a local ebb and flow can be determined—not only for the Lake of Geneva, but for any lake—when its average depth and its length are known. The following is the formula $T = 2\frac{2L}{\sqrt{gh}}$, in which L denotes the length of the lake, h its average depth, and g the acceleration of gravity. This formula gives for the Lake of Geneva, which has a length of 73 kilometres, a duration of tide of 13 minutes; a figure coinciding with the fact.

The law thus established by M. Forel has recently received an interesting application in solving a problem which has puzzled travellers and philosophers for over 2,000 years, viz., the explanation of the currents in the narrow straits of Euripus, where the famous five-arched bridge of Egripo joins the Island of Eubœa to the mainland of Greece. The currents sweeping below the bridge are so violent that mills are kept in operation by them, but they are noted for the changes in direction which occur from four to fourteen times daily. Tradition relates that Aristotle, in despair at his inability to explain this phenomenon, threw himself from the bridge into the water.

A comparison of the large number of observations made upon this strange tidal movement shows that there are two distinct periods: that in which there are but four changes of direction or two tides in a lunar day of 24 hours and 50 minutes, and that in which these tides number from eleven to fourteen daily. This latter phenomenon is observable invariably at the quadratures of the

moon. M. Forel, in his explanation, shows that the regular ebb and flow twice a day in the former period is due to the tidal movement of the Ægean Sea, which is then at its maximum. The increase in the number of tides daily becomes manifest, however, when the tidal force of the Ægean is at its minimum, viz., at the quadratures, and must be owing to some other force more powerful than the minimum but less powerful than the maximum force of the Ægean tide. This force is found in the local tides or *seiches* of the Gulf of Talanti to the north of the straits, which is so shut in by land that it can practically be regarded as subject to the same laws as the lakes of Switzerland and other countries. This basin is 115 kilometres long, and is from 100 to 200 metres in depth. Applying these figures to M. Forel's formula, the ebb and flow in the Gulf of Talanti would be for 100 metres, 122 minutes; for 150 metres, 100 minutes; for 200 metres, 86 minutes. The eleven to fourteen currents observable daily at Euripus during the quadratures last from 103 to 131 minutes. This shows so striking a conformity with the theory advanced by the Swiss *savant*, that we can but consider this problem, which so vexed the ancients, as fairly solved.

Dr. Forel asks intelligent visitors to the locality to verify his interpretation by attending especially to the following points:—1. Ascertain the exact duration of the flux and reflux of the Euripus, and determine its normal rhythm. 2. Ascertain if, as in the *seiches* of the Lake of Geneva, the amplitude of the flux and reflux of the irregular current is stronger in bad weather than when there are no atmospherical perturbations. 3. Ascertain if the connections between the direction of the current and the flow of the rising sea are, as he supposes, inverse, according as the current is regular or irregular.

NOTES

THE great osteological collection which Dr. Barnard Davis, F.R.S., has accumulated during a long life devoted to anthropological pursuits is well known, both in England and abroad, as the richest and most valuable ever formed by a private individual, exceeding, as it does, in variety and rarity of the specimens all the public collections of this country and most of those on the Continent. It contains about eighteen hundred specimens of skulls and skeletons of various races of men, the value of

which is greatly increased by an excellent catalogue, called "Thesaurus Craniorum," in which each is fully described, and all known particulars of its history recorded. We believe that, at one time, Dr. Davis contemplated leaving the collection to the College of Surgeons; but considerations for the interests of his family do not appear to have justified this arrangement, and he has now offered it for the sum of 1,000*l.*—which, considering its extent, and the labour and time taken in its formation, must be considered very moderate. Upon this becoming known to the Council at their meeting on December 11, through a communication of Prof. Flower, we learn from the *British Medical Journal*, it was the unanimous feeling of all present that the opportunity of acquiring it upon the terms offered by Dr. Barnard Davis should not be lost. It was referred to the Museum Committee to consider and report whether the necessary sum could be provided out of the College funds, or whether it was desirable to seek for aid from other sources; for the latter alternative several liberal offers were at once made by individual members of the Council. We feel sure that all who are interested in the scientific progress of the country will have great satisfaction in knowing that the Council of the College have thus promptly stepped forward to save this noble collection from dispersion or expatriation; and that, if it should be thought that the College funds cannot judiciously be taxed at the present time, the country will as promptly respond to an appeal for such a truly national purpose. The Hunterian Museum, thus enriched, would more than ever become the great centre of osteological and anthropological research and instruction, and in the hands of Mr. Flower we may be sure that this collection would be so arranged, developed, and studied as to be rendered in the highest degree available for the advancement of knowledge. It is an opportunity which must not be let pass.

THE following translation of a Chinese placard regarding the highly immoral practice of consuming cow's milk is sent to the *Foochow Herald* for publication:—"Strictly refrain from eating cow's milk! Man should not rob the beasts of their food. Moreover of all beasts the cow is the most useful and meritorious. Men who do not discriminate between mankind and beasts are worse than senseless. Those who sell milk darken their consciences for gain, and those who eat cow's milk foolishly think they are benefiting their bodies. Men who take medicine should first carefully investigate and find out its nature. Why do not those who eat cow's milk consider and inquire into its origin? For instance, men beget children, and while the children are small they depend upon milk for their nourishment; so it is also with beasts. But when men buy milk to eat, do they not do injury to the life of the calf? And is there not bitter hatred and distress in the minds of both cow and calf? Beasts cannot speak: how then are they able to tell the man that, in eating the milk of beasts, his body becomes like that of birds and beasts? But if men wish to take strengthening medicine, there are numberless other articles in the world that are beneficial; and what necessity then is there for taking cow's milk? Besides this, the death and life of men have their fixed number and limit, and this cow's milk cannot lengthen out and continue the life of man. Since, then, all know the truth—that it cannot do this, all ought to act with loving and benevolent spirit. Especially all who receive this exhortation should keep from eating milk. The children of those who cause their families to refrain from eating milk will be preserved to grow up; they also will thus lengthen out their own lives, and will escape from evil in time of fatal epidemics. If such persons be able also to exhort others, who are ignorant of first principles, to leave off the eating of milk, their descendants shall surely prosper. Published by the Hall of Good Exhortations. The Xylographic blocks are deposited in the Ung Ling Kóh."

AN important discovery has just been made in the neighbourhood of Elbœuf, Seine-Inférieure, by M. Noury. He has found a multitude of pre-historic implements in the siliceous sands which form the sub-soil of the Seine valley, between Elbœuf and Rouen. In a single locality he collected more than 400 among bones of large quaternary mammals. These implements are said to belong to the palæolithic age; they consist of cut flints forming axes, cores, punches, and hammers of various dimensions.

WITH reference to the discovery of a jade scraper at Geneva, referred to in NATURE, vol. xxi. p. 163, Prof. Max Müller writes to the *Times*:—"Scrapers or cutting instruments made of real jade are very rare, in Switzerland and elsewhere, but I have myself seen several beautiful specimens—among the rest, one found by Dr. Uhlmann, of München-buchsee, whose collection of lacustrine antiquities, all taken out by his own hand from one and the same small lake, the Moossee-dorfsee, is perhaps the most authentic and most instructive collection in the whole of Switzerland." Prof. Müller does not see any difficulty in believing that the early "Aryan" immigrants into Europe brought with them and preserved, "from generation to generation, so handy and so valuable an instrument as a scraper or knife, made of a substance which is *ære perennius*." On the same subject Mr. B. M. Westropp sends the opinion of M. Desors, as follows:—"We cannot share the opinion which attributes extensive commercial relations to the tribes of the age of stone. In support of this opinion are cited the hatchets of nephrite (jade), of which numbers are found at Concise and other stations of that epoch; and as this stone now comes to us from the East, it has been inferred that the tribes of the remote period in question trafficked with Asia. But it should be remembered that the greater part of the hatchets which are assumed to be nephrite may very well be only varieties of indigenous rocks, proceeding from siliceous veins in the serpentine, and whose depository might be found, according to M. de Mortellet, in the higher Maurienne. It seems to us very difficult to admit that so distant a commerce should have been restricted to the exchange of certain stones, which, after all, are not very superior to common silex, while the East might have furnished objects of far greater utility, particularly metals."

ONCE more the New York correspondent of the *Daily News* telegraphs of Mr. Edison's success in electric lighting. "Mr. Edison," we are told, "has perfected an electric lamp of extraordinary simplicity, costing only 25 cents, with which he proposes a general illumination of the village of Menlo Park on New Year's Eve. He has discovered that a steady brilliant light is obtained by the incandescence of mere carbonised paper better than from any other known substance. Strips of drawing paper in horse-shoe form are placed in a mould and baked at a very high temperature. The charred residuum is then attached to the platinum wires and hermetically sealed in a glass globe from which the air has been exhausted. This attached to a wooden stand, or ordinary gas fixtures, is the whole lamp. No regulating apparatus is required, the flow of electricity being automatically increased and diminished at the central generating station. A single generating machine of simple construction, and applicable for domestic use, supplies about fifty lamps. The cost of the power is not stated. The quantity of electricity supplied to each householder is measured by the deposit of copper particles in an electrolytic cell."

M. A. GUYARD claims to have discovered another new metal of the platinum group which he names uralium, from the Ural Mountains, whence the ore is procured. There have been quite a flood of similar announcements lately. We have now gallium, davyum, mosandrum, neptunium, decipium, phillipium, nor-

vegium, scandium, ytterbium, holmium, "X," thulium, and uralium. Chemists will have to keep as narrow a watch on these minor elements as our astronomers do upon the minor planets, or we shall not know where we are.

In a paper on the destruction of obnoxious insects, by Prof. Hagen, of Harvard, in which he describes some experiments that had been made by Mr. J. H. Burns and others, he comes to the following conclusions:—1. That the common house-fly is often killed by a fungus, and that in epizootics a large number of insects which live in the same locality are killed by the same fungus. 2. That the fungus of the house-fly works as well as yeast for baking and brewing purposes. 3. That the application of yeast on insects produces in them a fungus which becomes fatal to the insects. 4. That, in the experiment made by Mr. J. H. Burns, all potato-beetles sprinkled with diluted yeast died from the eighth to the twelfth day, and that the fungus was found in the vessels of the wings. He admits that further experiments are necessary to find out the most convenient method of application.

Woolwich is taking a step ahead in the use of the electric light, a number of tradespeople in that suburb being now supplied by Messrs. Siemens, who have set up for that purpose three of their most powerful machines. Power is supplied from the steam-engines of Messrs. Rose and Mellish's establishment on the river bank, when the day's work is over. The lights are maintained from 6 P.M. till midnight.

A correspondent sends us the following account of the recent severe weather at Mulhouse; it is contained in a letter from Mr. Alfred von Glehn:—"I must give you some description of the fearful weather we had last Friday (December 5). No one here ever remembers such a day. On Thursday night it began to rain, the thermometer being about 8° below freezing, then came lightning and thunder, and then the most terrible wind got up, with driving snow; it lasted all night and next day. It blew a hurricane, thermometer about 20° F. below freezing, and all the time the snow fell so thick that you could not see a yard before you. I really hardly know how I got to the works; one could hardly breathe, and at certain open places one could hardly stand, and I saw people have to turn back and take refuge in shops. No trains could run; one was stopped between here and Bâle, and the people had to come back as best they could on foot. A goods train was snowed up between here and Cernay, and was only got out on Sunday. Two factory chimneys were blown down, and numberless smaller accidents occurred. We had to allow the workmen who live in the country to start for their homes at three o'clock in the afternoon, as at night it would have been impossible for them to find their way. Everywhere in the streets stood carts abandoned by their owners, as the horses could not move them. One train was got ready for Strassburg, with four engines, but it stuck just outside the station, and could go no farther. The next day the weather was fine and cold. Sunday night the thermometer fell to 40° F. below freezing, and at 12 o'clock in the middle of the day with a bright sun stood at 0° F. This morning it went down to 51° F. below freezing, and when I went to the works it was only a few degrees less. The air is fortunately still, and as there has been bright sunshine everything is wonderfully beautiful. Skating is unfortunately out of the question, owing to the masses of snow. Sledges are to be seen on all sides, even the cabs are mostly sledges, and those who have horses are to be envied, as the roads are in a splendid state."

The *Derry Journal* of the 10th inst. states that on the previous Saturday, at about 11.30 P.M., the inhabitants of Stranorlar, county Donegal, and for many miles around, were startled with a strange and unusual sound. It resembled the noise produced by the falling in of a large building, and in some cases the commotion was so powerful that chairs and other household articles were seen to move. The phenomenon is believed to be a slight convulsion of earthquake, and much resembled distant thunder. Mr. Thomas Watson, of Derry, writes that a similar disturbance was noticed at exactly the same hour at Barons Court, the seat of the Duke of Abercorn, in county Tyrone, and was sufficiently intense to cause the candelabrum in one of the large rooms to shake very perceptibly, the noise at the same time being very loud, and of a nature that puzzled those who heard it to explain. It seems to have been in some way connected with an earthquake wave which appears to have taken the direction almost east and west.

In a recently-received report from Guayaquil, it seems that the bad season of 1878 had a most serious effect upon the produce of the soil in that country. The cocoa crop (*Theobroma cacao*) was the smallest on record, though the high prices obtained for this article in the European markets have in some degree compensated for the loss. The coffee crops gave even a worse result, as during the last months of the year it was found necessary to import coffee from Central America for home consumption. The quality of the coffee produced in Guayaquil during the year was very inferior. The rice plantations having been almost entirely under water, owing to the heavy rains, for a long period during 1877 and 1878, the production of this article of food (of which, in the coast provinces of the Republic alone, 5,000 quintals per month are consumed) was very limited. The cotton plantations were also destroyed by the same cause. The failure of the above-mentioned crops left a large number of men free to attend to the collection of india-rubber and ivory nuts. The export of the former during 1878 was a little below that of the preceding year, owing doubtless to the scarcity of the trees producing it, and the difficulties of bringing it down to the coast from the inland forests, where it is gathered, each year made more distant from the ports of embarkation owing to the continued wanton destruction of the trees. The quantity of ivory nuts gathered and exported by far surpassed all previous years.

The *Pharmaceutical Journal* of December 20 contains a valuable report on the botany of the Kuram and Hariab districts, by Surgeon-Major J. E. T. Aitchison.

A number of papers on the hymenoptera and coleoptera of the United States, by Messrs. E. Norton, C. A. Blake, and Dr. Horn, are in course of publication in the *Transactions* of the American Entomological Society of Philadelphia.

From the *American Naturalist* we learn that Thos. G. Gentry is engaged in a work on the fertilisation of plants by insects, based on observations made in Pennsylvania and New Jersey, and that Prof. O. S. Jordan is preparing a work on the Fishes of North America.

A favourable report was presented at the last meeting of the Eastbourne Natural History Society.

In a recent volume of the *Ann. de l'Obs. Roy. de Bruxelles* (September, 1879, 84 pp.) M. Fievez gives a comprehensive bibliography of works, treatises, and notices on spectroscopy. An index facilitates the search for any particular point relating to the subject.

The Russian Technical Society will hold an exhibition of the latest Russian and foreign technical machines, apparatus, instruments, and inventions, from December 15 until May 15 next, at St. Petersburg.

A paper of great value on the Geology of the Lower Amazons, by Mr. Orville A. Derby, read before the American Philosophical Society, has been issued in a separate form.

THE *Transactions* of the Cumberland Association for the Advancement of Literature and Science for 1878-9, is a volume of 340 pages, edited by the Rev. J. Clifton Ward. Among the numerous excellent papers contained in the volume are the following:—An ethnological paper by Mr. R. S. Ferguson, entitled "The Formation of Cumberland;" "Our Summer Visitors," a local natural history article, by Mr. T. Duckworth; an interesting paper on the Dipper (*Cinclus aquaticus*) by Mr. William Duckworth; "The Entomology of the District," by Mr. George Dawson; "The Great Lake, Lagoon or Bay of Triton," by Mr. B. A. Irving; "List of Cumberland Birds in the Carlisle and Keswick Museums," by Mr. George Dawson and the Rev. J. Clifton Ward.

PHYSICAL NOTES

SOME useful observations on the action of safety valves on boilers have been recently communicated to the Vienna Academy by Herr von Burg (November 13). Among other things it is proved that the authoritative directions given in different countries as to the size of safety valves are not at all adequate, and are based on erroneous conceptions. As to the cause of the small amount of lifting of the valve during escape of steam (seldom over ½ mm.), the author at first supposed a vibratory motion of the valve, but further study and experiment led him to the hypothesis that the steam jets, in lifting the valve, do not begin to move from its middle point, but from the periphery of a circle, ρ, out to the circumference of the valve of radius r; so that the pressure of steam on the under surface of the valve is composed of two parts, of which the inner, or *aërostatic*, is produced by the solid steam-cylinder of radius ρ, and the outer or weak *aërodynamic* part, by the external hollow cylinder of $r-\rho$ thickness of wall. The phases of development of steam tension, and other topics, are also investigated.

A SIMPLE method of perforating glass with the electric spark is described by M. Fages in a recent number of *La Nature*. The apparatus required consists (1) of a rectangular plate of ebonite, its size, for a coil giving 12 ctm. sparks, about 18 ctm. by 12; (2) of a brass wire passing under the plate and having its pointed end bent up and penetrating through the plate (not further). This wire is connected with one of the poles of the coil. A few drops of olive oil are placed on the ebonite plate about the point, and the piece of glass to be perforated is superposed, care being taken not to imprison any bubbles of air. The olive oil perfectly accomplishes the object of insulating the wire. One has then only to bring down a wire from the outer pole of the coil, on the piece of glass, above the point of the lower wire, and pass the spark. By displacing the glass laterally, for successive sparks, it is easy to make a close series of holes in a few seconds.

IT has often been queried what might be the reason of the high specific heat of water. Some light has been thrown upon this problem by the recent research of a Russian gentleman of the name of Beketoff, upon the specific heat of the hydrogenium-alloy of palladium, and upon that of the hydrogen in the alloy. The specimen examined by M. Beketoff contained about half per cent. of hydrogenium to ninety-nine and a half of palladium. On examination by careful calorimetric measurements the specific heat of hydrogenium was found to be not less than 5·88; which though probably requiring correction is certainly not greater than the true value. The value should be somewhere about 6·4 by the law of atomic heat of Dulong and Petit.

A VIBRATION micrometer for ascertaining with precision the amplitude of vibrations of tuning-forks and other sounding bodies was recently shown in Paris by M. Mercadier. It is an extremely simple device and can be applied to any vibrating bodies except such as possess very small mass. A small piece of thin white paper bearing one fine black line is affixed to the body whose vibrations are to be measured. If this line is upright, it will, when caused to vibrate, present the appearance of a pale grey parallelogram, the persistence of the visual impression being perfectly definite for the extreme positions of the vibration. To ascertain the amplitude of the vibration, all that is necessary is to measure the apparent width of this minute parallelogram in a direction at right angles to the axis of symmetry of the oscillations. To do this with still greater precision, M. Mercadier proposes to set the line not perpendicular to the direction of the movement, but inclined to it at a small angle, and marks also upon the paper a fine scale of lines parallel to the direction of the movement and distant from one another by equal distances of one millimetre. The width of the narrow parallelogram is thus read off along a straight line, which makes a small angle with its sides, thus giving the quotient of the amplitude sought by the tangent of a small angle. Using this method, M. Mercadier showed that the vibrations of a tuning-fork "interrupter," vibrating automatically under the influence of an electro-magnet, may be regulated so as to be greater or less at will by adjusting to a greater or less distance from the prongs of the fork the electro-magnet which maintains the vibrations.

PROF. TAIT has abandoned the enticing speculation that the thermal conductivity of metals is inversely proportional to their absolute temperature, a conclusion to which his earlier experiments on the conductivity of iron seemed to point. Many metals, indeed, present the opposite case, their conductivity increasing with the temperature.

A MEANS of comparing the intensities of lights of different colours has long been desired. Until quite lately there did not even exist a means of measuring the relative intensity of two lights of the same given colour. M. Gouy has been investigating the latter point by the aid of a particular photometer, and by flames of constant brilliancy produced by the combustion of a homogeneous mixture of coal-gas with air impregnated with saline powders. The photometer resembles in general appearance a two-prism spectroscope, having also an auxiliary collimator with a fixed lamp to serve as a standard light. In place of the usual eye-piece of the instrument a second slit is placed. By this means any one ray can be separately observed, and its intensity compared with the intensity of the same ray from the standard source. M. Gouy states that this slit eye-piece arrangement is capable of such accurate adjustment that each of the two D-lines can be separately examined and its intensity measured.

MARAT, the notorious hero of the first French revolution, the same who met his death at the hands of Charlotte Corday, was the author of several important essays on electricity. This fact, which is not generally known, was recently brought to notice by Mr. A. J. Frost, who is editing the catalogue of the Ronalds Library. Most of Marat's works were written between 1779 and 1785, and several of them were translated into German. Marat was not the only one of the prominent figures of the time who worked in physical science. Arago, though his fame does not rest upon his political achievements, once enacted the chief part in the crowning of the statue of Liberty. "Citizen" Charles was as famous amongst the revolutionists as for his scientific attainments. Robespierre wrote an article on the lightning-conductor for the *Journal des Savants;* and last, but not least, Napoleon Buonaparte on many occasions dabbled in scientific lore, and was the liberal patron of men of science.

EDISON'S telephone has, it is said, been successfully used over a line of 2,000 miles in length. A hunting party in Nebraska were thus enabled to converse with perfect distinctness with their friends in Pennsylvania, *viâ* Chicago and the Western Union Telegraph Company's line.

GEOGRAPHICAL NOTES

THE Neapolitans are preparing to *fête* Prof. Nordenskjöld, who intends staying a short time in Southern Italy before returning overland to Sweden. The *Vega* arrived at Galle on the 16th inst. We have received from Hongkong an account of the reception given to Prof. Nordenskjöld and the officers of the *Vega*, on arriving at that Eastern limit of the British Empire. At the close of an official banquet at Government House, Governor Hennessy congratulated Prof. Nordenskjöld and his staff in the warmest terms. "We behold," he said, "as it were in this remote outpost of Europe, the writing of the last words in the last chapter of heroic maritime discovery." Captain Palander brought down to the drawing-room the actual charts he had used during the voyage, and throughout the evening they were inspected by the Governor's guests with great interest. The charts were Russian ones, and one of the minor results of the expedition has been the establishment of the fact that they are not accurate, inasmuch as a great deal that was put down as land was actually sailed over by the *Vega*. The route was marked in red ink and pencil and showed these inaccuracies. Some specimens of the plants from the region where the *Vega* was so long bound up in the ice and photographs of the natives were also on the drawing-room tables. We understand

Prof. Nordenskjöld, before his departure, received from his Excellency, as a present to the *Vega* expedition, an herbarium of the plants of Hongkong and South China, prepared by Mr. Ford, the head of the Botanical Department of the Colony.

ZANZIBAR advices report that the Abbé Debaize, the French explorer, was on the 13th of June at Ujiji, on Lake Tanganyika. He was waiting for some boats to go to the north of the lake, and meanwhile was examining neighbouring rivers and some points on the lake. At the beginning of September he expected to start for the Uzige country, there to leave a depôt of merchandise under trustworthy men while he proceeded with the rest of his effects to Aruwimi or Stanley river, which joins the Congo, leaving there a second depôt, exploring with his best men the western slope of the Blue Mountains and the region between Lakes Albert and Tanganyika, and then returning to Uzige to despatch reports and explain his further plans.

THE enlarged edition of Whitaker's Almanack for 1880 contains an article on geographical discovery, written in a somewhat perfunctory manner. As instances of the want of proportion observable in it, we may mention the space given to the voyage of the *Isbjörn* to Novaya Zemlya, and Mr. McCarthy's journey across China, the former of which was admittedly unsuccessful, while the latter, which did not occur in the period under review, added nothing whatever to our geographical knowledge. Accuracy hardly appears to be the writer's *forte*, otherwise he would hardly discourse about Mr. E. Colborne Baker's journey in Western China, nor would he turn one of the Portuguese African explorers' names into Ives, not to mention his inability to make up his mind how to spell Thibet.

IN the course of their explorations last year in the unknown highlands of Eastern Perak, a party of Englishmen met with several small settlements of Sakis, presumably the aborigines of the peninsula, who still hold themselves aloof from the Malays. Few of these people have metal or earthenware cooking utensils, but roast their sago in large bamboos. The majority of them speak Malay, with an accent not unlike the Chinese; their own language is described as soft and guttural. Two specimens of these people—a man and a woman—on being measured, were found to be 4 feet 6 inches and 4 feet 1 inch in height, and these appeared to be about the average. The women are said to be not bad-looking, with thick lips and flat noses; their figures are good, though rather inclined to stoutness; and they have remarkably pretty little feet and hands. The dress of both sexes consists of a strip of bark about 9 feet long and 1 foot 6 inches wide, wound round the bodies. The bark used is that of a species of fig, and is very soft and pliable; there are two descriptions of it, obtained from different trees, one of a dirty white and the other of a reddish brown colour.

THE new number of the *Bulletin* of the Société Commerciale de Géographie of Bordeaux, contains an article on Cabul, and from its "Chronique Géographique" we learn that the French Minister of Marine has ordered the Governor of Senegal to send an expeditionary column to the country between the Upper Senegal and the Niger. The object of the column will be to explore the region in order to see by actual survey and examination whether the two rivers can be joined by a railway. The expedition will be accompanied by a skilled topographer.

MR. H. CONYBEARE, of the Bengal Civil Service, has published a carefully prepared report on the Pargana Dudhí, which extends from 25° 52′ 17″ to 24° 21′ 21″ N. lat., and from 82° 59′ 28″ to 83° 28′ 7″ E. long. The first portion deals almost entirely with geographical matters, and furnishes much interesting information respecting the various aboriginal tribes, their language, customs, and style of cultivation, &c.

THE *Hiogo News* states that the Japanese Government has decided upon at once going on with the construction of a railway between Shiwotsu, at the head of Lake Biwa, and Tsuruga, a town at the head of a large bay, which will probably before long become an open port. Some high officials connected with the Board of Works are to proceed to Tsuruga on this business without delay. It is expected that the opening of the line in question will have a most beneficial effect on the trade of the treaty port of Kobe. A large extent of rich country will be opened up to commerce, and it is probable that the whole of the produce of the silk districts to the north of Lake Biwa will be brought to Kobe for shipment to Europe.

ON THE NATURE OF THE ABSORPTION OF GASES

MORE than seventy years ago Dalton made the assertion that gases, when absorbed by liquids (*e.g.*, water), remain only mechanically included in the latter, without losing thereby any property which belongs to them as gases. This hypothesis of the nature of absorption is opposed by a still older one—the chemical—which considers the phenomenon as the consequence of an affinity between gases and liquids, and explains, for example, the absorption of CO_2 and N_2O by water by the formation of H_2CO_3 and HNO. Since the time when these two hypotheses were started, their proof has always been attempted with the aid of the statical method; *i.e.*, by the determination of the proportion in which the absorbed and absorbing bodies maintain their equilibrium under given conditions; or, in other words, by the determination of the coefficients of absorption. Mackenzie, who in this way has lately most thoroughly examined into the absorption of carbonic acid by means of a solution of salt in water, says that it would be presumptuous, on the basis of existing observations, to attempt yet to solve the problem whether absorption is a purely physical phenomenon or whether it belongs rather to the domain of the so-called chemical phenomena.

After these two hypotheses there comes yet a third, set forth by Graham, according to which gases are transformed into the liquid state in the case of their absorption by bodies such as liquids, caoutchouc, or by glowing metals. This hypothesis is supported on the one hand by the circumstance, already remarked by Mitchell, that membranes of caoutchouc are most easily penetrable for those gases which are most readily capable of being rendered liquid and are most soluble; on the other, by two assertions of Graham's—(1) That a body in the form of a liquid penetrates another body more easily than in the form of a gas; and (2) That liquids and such colloid substances as caoutchouc, have no pores at all, and, in point of fact, are, even in the thinnest film, impenetrable, to gases as such. According to Graham, then, it is impossible for a gas to penetrate such a substance without this conversion into a liquid state, which may or should be favoured in some measure by the chemical affinity between the gas and the absorbing substance.

My researches in the domain of diffusion gradually led me to the conviction that a much nearer approach will be made to a solution of the problem of absorption if conclusions are drawn, with reference to the state in which gases exist in these substances from the study of the phenomena of motion, which exhibit them in their diffusion through absorbing substances. Availing myself of the kind invitation of the editor of NATURE, I shall take the liberty of here briefly describing the results which I have in this way obtained. They refer to what takes place in the case of caoutchouc.

The application of the laws of the diffusion of gases through absorbing substances[1] to the phenomena which appear in caoutchouc shows that the quantity of gas which passes through a membrane of caoutchouc in a unit of time is, conditions being equal (*i.e.*, equal surfaces of diffusion, equal thickness of the membrane, and equal difference of saturation on both sides of the membrane) in proportion to the product $D\,S$. D is the *constant of diffusion* of a gas in caoutchouc, and corresponds to the thermometric conductivity of a body in the theory of the conduction of heat. S is the *coefficient of saturation*, and is expressed by the equation—

$$S = A_\theta \frac{p}{76},$$

in which A_θ denotes the coefficient of absorption of caoutchouc for the gas under consideration at the temperature θ, and p the pressure (in centimetres of mercury) under which the gas is. The coefficient, then, is that volume of gas reduced to 0° C. and under 76 cm. of mercury which can be contained in the unit or volume of caoutchouc at the given temperature and under the given pressure. It corresponds to the specific heat of the unit of volume of a substance in the theory of heat.

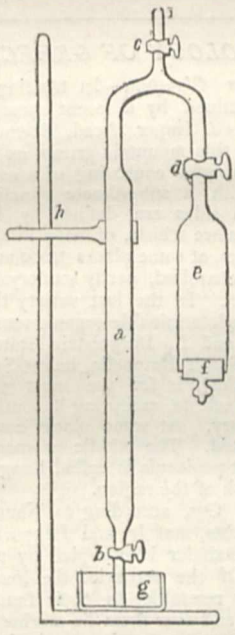
Mitchell and Graham, during their experiments with caoutchouc, have always measured the product $D\,S$ only, which can give us absolutely no explanation of the nature of the absorption of gases, and which has led Graham, as we shall see further on, to false inductions.

In order to determine the constant D, which shall form the basis of our examination, it is necessary to know the coefficient of absorption, by means of which the coefficient of saturation

[1] Wroblewski in Wiedemann's *Annalen*, ii., 481-513.

can then be ascertained. The determination of the coefficient of absorption presupposes, moreover, that the Henry-Dalton law of absorption holds good for caoutchouc as well. That this law is valid is proved by the experiments which I made several years ago on the passage of gases through membranes of caoutchouc,[1] and by means of which I have shown that, at the various differences of pressure between 74 cm. and 2 cm. mercury, the quantity of gas which passes through is proportional to the actual pressure of gas upon the membrane. This relation between the quantity of gas passing through and the pressure is only *possible* in the case of the coefficient of saturation being proportional to the pressure, or, in other words, when the Henry-Dalton law holds good for caoutchouc within the given limits.

The absorptiometer which I have constructed for the determination of the coefficients of absorption, consists of glass throughout. *a* is a tube which is divided into tenths of cubic centimetres, and from which even hundredths of cubic centimetres may be read off; *b*, *c*, and *d* are glass stopcocks; *e* is a space which serves as a receptacle for the caoutchouc, and is closed from beneath by a glass stopper which renders it air-tight when shut. The apparatus stands in a glass trough, *g*, of mercury, and is held



in a vertical position by the holder *h*. Its use is very simple. The membranes of caoutchouc upon which our experiment is to be made, and whose specific gravity has been previously ascertained, is cut into strips of about 10 centimetres in length, and 1·5 centimetres in breadth, dried, weighed, and introduced into the space *e*. The apparatus is first of all put in communication with the Jolly quicksilver air-pump by means of the stopcock *c*, and is pumped empty. Then both the stopcocks *d* and *e* are shut, the apparatus is separated from the pump, a drop of water is introduced at the bottom of the tube *i* above the stopcock *e*, and the gas to be examined enters from above into the space inclosed by the stopcocks *b*, *c*, and *d*. The further working of the apparatus explains itself. If the volume of gas which has been allowed to enter has been measured, and also the pressure under which it is, the stopcock *d* is opened, and after the lapse of from three to twelve hours, the volume of gas and the pressure is again ascertained. The calculation of the coefficients of absorption is made according to the known formula.

I will here remark that the pressure of the gas which remains in the caoutchouc after the apparatus has been pumped free therefrom can only be measured by the hundredth part of a millimetre of mercury, which at the same time is the limit of the power of action of the Jolly pump.

For the experiments, red vulcanised caoutchouc of about one-third of a millimetre in thickness was employed. Its specific gravity at 15° C. was 1·02685.

The coefficient of absorption of the four following gases was ascertained: nitrous oxide (N_2O), carbonic acid (CO_2), hydrogen and atmospheric air.

It was shown that the coefficient of absorption of caoutchouc for gases, within the limits of the examination, are linear functions of the temperature, and that they diminish with an increase of temperature in the case of nitrous oxide and carbonic acid. The coefficient of absorption of hydrogen, on the other hand, grows larger with increase of temperature, and atmospheric air shows a similar tendency. The coefficient of absorption is as follows:—

	At 5° C.	At 10°.	At 15°.
For N_2O ...	1·8229	1·6896	1·5564
,, CO_2 ...	1·1991	1·1203	1·0416
,, H ...	—	0·06121	0·08157
,, Air ...	—	0·09832	0·11710

With the assistance of these values the constant *D* can now be ascertained. For the description of the diffusiometer which I have constructed for that purpose and for the method of observation, I must refer the reader to my paper in Wiedemann's *Annalen*, vol. viii. pp. 29–52.

The experiments showed that the constant *D* amounted to—

	At 12° C.	At 14° C.	
For N_2O ...	56	62	$\times 10^{-8} \frac{cm^2}{sec}$
,, CO_2 ...	54	61	

Nitrous oxide and carbonic acid have thus almost equal constants, a somewhat greater value being accorded to nitrous oxide (being the somewhat specifically lighter gas). The constant for these two gases increases with the temperature, and is at 10° 50 times smaller than *D* for carbonic acid in water,[1] and 300,000 times smaller than the constant of free diffusion for carbonic acid and air at the same temperature and the same pressure.

If the great difference in the coefficients of absorption of caoutchouc for both gases is taken into account, it is at once seen that the constant *D* depends neither upon the chemical nature of the gas nor upon the value of the coefficients of absorption. It can, in this case, depend only upon the physical properties of the gases, and since specific gravity is the principal property in which gases differ from each other in physical respects, the constant *D* must depend upon the specific gravity of the gases. Proof of this is afforded by the determination of the constant *D* for hydrogen gas: it comes to $353 \times 10^{-8} \frac{cm^2}{sec}$. The constants for these three gases is thus nearly in inverse ratio to the square root of the specific gravity of the gases.

If the behaviour of the nitrous oxide is held as normal, it is found that *D* is about 27 per cent. greater for hydrogen than it would be if the constant under consideration were exactly in inverse ratio to the square root of the specific gravity of the gas. The same variation here appears which Graham has observed in the diffusion of gases through plates of graphite. Hydrogen diffused itself through a plate of 0·05 centimetres in thickness—supposing the air to show its normal behaviour—about 9 per cent. quicker than is prescribed by the above relation. A similar variation was observed when hydrogen diffused itself in oxygen or carbonic acid instead of air. Granted that this deviation is in inverse ratio to the specific gravity of the gas, it would, in the case of the aforesaid graphite, amount to about 23 per cent. for hydrogen in comparison with nitrous oxide. The deviation is thus with such heterogeneous bodies as vulcanised caoutchouc and compressed graphite, not only of the same direction, but also of the same order, hence there is no ground for supposing that the gas, in its passage through a non-absorbent porous partition like a plate of graphite, should change its aggregate condition, and since the dependence of the constant *D* of a gas upon its specific gravity can only be considered a sign of the gaseous form of the aggregate condition of the diffusing body, it follows, then, that *gases cannot possibly exist in caoutchouc in a fluid form, and they retain also during their absorption by caoutchouc all the properties which belong to them as gases. Graham's hypothesis of the nature of absorption of gases must certainly, therefore, be regarded as false*, and a greater or less degree of penetrability of the layer for one or other of the gases

[1] Wroblewski in *Poggendorff's Annalen*, clviii., 539-568.

[1] The constant *D* for CO_2 in water is, according to my experiment, about $0{\cdot}000025 \frac{cm^2}{sec}$. It depends neither upon the coefficient of absorption nor upon the coefficient of saturation. On the other hand it depends upon the viscosity of the fluid. If any body, *e.g.*, a crystalloid or a colloid, is dissolved in water, and a more viscous fluid is thereby obtained, the constant *D* decreases. This constant, however, as is shown by my experiments with glycerine in water, cannot be diminished at will by increasing progressively the viscosity of the medium in which the diffusion of the gas takes place. (See Wiedemann's *Annalen*, vol. iv. pp. 268-277, and vol. vii. pp. 11-23.)

has nothing—as Mitchell asserted—to do with its solubility or compressibility. *Just as little practicable is the chemical hypothesis upon what takes place in caoutchouc, and the absorption of gases such as nitrous oxide, carbonic acid, and hydrogen by caoutchouc must be considered as a purely physical phenomenon.* A layer of caoutchouc is, then, to be conceived as a *porous* substance, endowed with powers of condensing as well as of rarefying gases whose porosity is of the same order as the porosity of graphite. The motion of the gas takes place through the pores of the caoutchouc.

It is much to be regretted that Graham's experiments upon the passage of gases through metals were so conducted, that they cannot now be calculated with the help of the laws of the diffusion of gases in absorbent substances. I have been able to calculate only those numbers which, as they are not without interest, I will here communicate. They are the constant D for hydrogen in platinum at bright red heat, and D for carbonic oxide and hydrogen in iron at full red heat.

A platinum wire absorbed at red heat 0·17 volumes of hydrogen (taking the average of four experiments). A tube drawn out of the same mass of fused platinum, 0·11 centimetres in diameter, let 489·2 cubic centimetres of gas in the minute pass through a surface of 1 square metre; therefore

$$D = 0{\cdot}00053 \frac{cm^2}{sec}.$$

A tube of malleable iron, 0·17 centimetres in diameter, let 0·284 cubic centimetres of carbonic oxide and 76·5 cubic centimetres of hydrogen through the square metre in the minute. Since one volume of this metal can contain four volumes of carbonic oxide, so is for this gas

$$D = 0{\cdot}00000002 \frac{cm^2}{sec}.$$

Since the coefficient of absorption of this metal for hydrogen was less than four, so is the constant D for this gas greater than $0{\cdot}00000054 \frac{cm^2}{sec}$, whence it follows, if there can be any comparison between these two numbers, that in metals greater constants D belong to specifically lighter gases.

It has lately been asserted by Stefan that the constant D, in both water and alcohol, is greater for oxygen and nitrogen than for carbonic acid, and that the greatest constant pertains to hydrogen. It would be, however, premature to wish to draw from his experiments any conclusions with regard to the nature of absorption of gases in fluids.

Franz Exner has already shown, several years ago, that, on the passage of gases through a lamina consisting of a solution of soap in water, the interchanged volumes of two gases are directly proportional to their coefficients of absorption and in inverse ratio to the square root of their specific gravities. Hence Stefan has concluded that the constant D in fluids is in inverse ratio to the square root of the specific gravity of the gas, and that the gas molecules move by themselves and not in connection with the molecules of the fluid, which would correspond with Dalton's views on the nature of absorption in fluids. Meanwhile, these conclusions are contradicted by the experiments of Pranghe, who has shown that the above-mentioned relation in the case of the lamina is not at all borne out when pure unboiled linseed oil is used. We see from this, then, that what takes place in the case of fluids must be much more complicated, and that we must subject the matter to a much more searching and extended inquiry before we shall be in a position to say anything definite upon the nature of the absorption of gases in liquids.

S. Wroblewski

NOTE ON PREHISTORIC STATIONS IN CARNIOLA[1]

THE most important of these prehistoric stations is the burial-field of Klenik, near Waatsch. During the year 1878 about 250 graves, covered with stone slabs, were opened at a depth of from ½ metre to 2½ metres. They contained skeletons, some remains of burnt corpses, and a great number of various objects. The bronze and other articles are very similar to those found in the well-known cemetery near Hallstadt, in Upper Austria. No Roman remains were met with. Thus there is no doubt of the pre-Roman age of these stations and cemeteries near Waatsch. They may be ascribed with great probability to the Taurisci, a Celtic tribe, known to have worked the salt at Hallstadt, and to have extended from Upper Austria, through Styria and Carinthia, as far as the Julian Alps. Strabo asserts explicitly that the very ancient landing-place Nauportus (now Ober-Laibach) was a settlement of this people, and, according to him, Italian merchandise was brought by carriage from Aquileja over Mount Okra (now Birnbaumer Wald), then by the River Savus to Siscia (now Sissek) and the Danubian districts. Thus it must be admitted that before the reign of Augustus a much-used water-communication existed on the Save and the Laibach between Siscia and Nauportus. The tradition ascribing the foundation of Emona to the Argonauts is an indication of the very remote beginning of this intercourse. Prof. Müllner, of Marburg, has lately offered some forcible arguments to the effect that Emona did not occupy the present position of Laibach, but was at the south end of the Laibach Moor, where Brundorf and Sonnegg now stand.

The graves, with skeletons, at Rojé, near Morants, contain objects referable to the Merovingian Period (fourth to seventh centuries); and a skull from one of them is of the type of those found in the successional sepultures.

[1] From the First Report of the Prehistorical Committee of the Vienna Academy, with 22 plates. By F. von Hochstetter and Ch. Deschmann. (*Proceedings*, Imper. Acad., July 3, 1879.)

GEOLOGY OF GREECE

1. *The Thessalian Olympus.*—In treating of the geology of Greece, as determined by a recent survey, Herr M. Neumayr, in the *Proceed.* Imper. Acad. Sciences, Vienna, July 17, 1879, describes this mountain-group as having a north and south direction, and consisting of a somewhat flattened dome of strata, with a subordinate syncline on the west. The limits on both sides are defined by lines of fracture. The constituent rocks are schists, of many kinds, with enormous intercalated limestones, at some places 3,000 metres thick. These latter are partly saccharoidal, partly semicrystalline, and sometimes nearly compact. In the last variety there are, in some localities numerous indeterminable organic remains.

2. M. Neumayr and L. Burgerstein state that the broad peninsular mass in South Roumelia, below Salonica, known as Chalkidiké (Chalcidica), is for the most part composed of micaceous and other schists, excepting its south-west portion and the Athos promontory. At some places considerable beds of marble are intercalated. The middle promontory of the three terminating the great peninsula is called Longos, and consists of gneiss, the oldest rock of the region.

3. The Island of Cos, according to Neumayr, consists for the most part of schists, marble, and Hippurite-limestone (with Rudistæ). The remainder is occupied by upper tertiary and diluvial deposits. Of the tertiaries the lower pliocene paludina beds strikingly resemble, in their fauna, the analogous Sclavonian deposits, and over them lie marine pliocene beds and rhyolitic tuffs; and eruptive rocks, trachytic in character, are also present. Being the extreme eastern member of the Cycladic-Sporadic series, traversing the Egean, and being connected with the neighbouring volcanic islands, Cos is well adapted to afford an insight into the nature of this submarine mountain-chain, and it yields an indication of the South-Egean basin being a depressed area of diluvial origin. The freshwater pliocene fauna offers interesting materials for the discussion of the upper tertiary freshwater deposits of the Egean region at present known, and of the evolution of the Eastern Mediterranean area. A number of passages have been collected by Prof. Hörnes from the Greek Classics, mentioning "giants' bones," which may point to places where remains of fossil mammals have been found.

NOTES FROM NEW ZEALAND

Wild Pigs and Wekas (*Ocydromus*).—Early in the spring of 1876 I spent several days in fern-collecting and botanising in the Malvern Hills district of Canterbury. Whilst so engaged, in many places I came across fresh pig-tracks and rootings, now and then sighting a boar. On one open hillside, bordered with fagus woods, I found three nests of that curious rail, the weka (*Ocydromus*); each of the nests contained eggs. It seemed remarkable that the nests should have remained unravaged by the wild pigs that were constantly roaming about the neighbourhood. It is highly improbable that the keen-scented swine were not aware of the weka's haunts. The trail of this bird is strong, readily followed by dogs; indeed, dogs take to this pursuit with so much of pleasure and relish that many good sheep-dogs

become unreliable and almost worthless when they enter upon weka-hunting. It is a well-known fact that wekas usually abound in districts infested with wild pigs; they probably find their advantage in feeding on the varied forms of insect life disclosed in the soil upturned by the swine in rooting up ferns, spear-grass, &c.

The Kea (*Nestor notabilis*).—In NATURE, vol. iv. p. 489, I called attention to certain destructive habits developed in the Kea. Since the date when that notice was written the bird has become very much better known to sheep-farmers in the alpine districts. During the past winter sheep were attacked by the kea as far north as the Rangitata River; it is probable these birds came from the district known as the Mackenzie country, as they have been troublesome about Lake Ohou.

A New Zealand Gamekeeper's Return.—Naturalists may read with some interest perhaps the following return of animals killed by gun or trap, on a large estate in the Middle Island; the numbers given do not include animals that have been destroyed by means of poison, or "the bill of mortality" would have been very much heavier.

From January 12, 1879, *to August* 24, 1879

Wild pigs	108
,, cats	18
Rats	1,054
Falcons	10
Harriers (*Circus assimilis*)	790
Wekas (*Ocydromus*)	893
Pukekos (*Porphyrio melanotus*)	5,074
Paradise ducks (*Casarca variegata*)	175
Shags	9
	8,131

Ohinitahi, October 7 T. H. POTTS

SCIENTIFIC SERIALS

Journal of the Asiatic Society of Bengal, vol. 48, Part 2, No. 11, 1879, contains:—S. E. Peal, note on the old Burmese route over Patkai *via* Nongyang (viewed as the most feasible and direct route from India to China), with two maps and two plates.—Louis Schwendler, on a new standard of light, with a plate.—W. T. Blanford, a second note on mammalia collected by Major Biddulph in Gilgit.—Dr. J. Armstrong, Marine Survey Department, on some new species of hydroid zoophytes from the seas and coasts of India, with four plates.—Lieut. R. C. Temple, note on the formation of the country passed through by the 2nd column Tal Chotiali field force during its march from Kala Abdullah Khán, in the Khójak Pass to Lugárí Bárkhan, in the spring of 1879, with a map.—W. T. Blanford, notes on a collection of frogs and reptiles from the neighbourhood of Ellore and Dumagudem.—J. Wood-Mason, preliminary notice of a new genus (Parectatosoma) of Phasmidæ, from Madagascar, with descriptions of two species.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 11.—"On the Reversal of the Lines of Metallic Vapours," No. VII. By G. D. Liveing, M.A., F.R.S., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

The experiments of which the results are here given were all made with the powerful electric current from the Siemens dynamo-electric machine in limestone crucibles.

With sodium carbonate the green pair wave-lengths 4983, 4982 were reversed, showing dark lines in the middle of the bright ones, the less refrangible of the two giving the stronger dark line. The sodium line given by Lecoq de Boisbaudran at wave-length 4670 showed as a diffuse blue band with a *pair* of fine dark lines in it, of which the stronger and more lasting was the less refrangible. The diffuse blue band resolved itself into *two* diffuse lines as the sodium carbonate evaporated, and the measurement of their positions in comparison with a conspicuous titanium line, which lies between them, and was made to show at the same time by introducing a fragment of titanic oxide into the crucible, gave for this sodium pair the wave-lengths 4667, 4664. The red pair, wave-lengths 6160, 6154, were also seen reversed in like manner, but the authors failed to detect any difference in the strength or continuance of the dark lines in this case. The reversals of the red pair first ceased to be visible, next those of the diffuse blue pair, then the dark lines in the green pair, and then those in the yellowish green (5687, 5681). In some cases when a large quantity of sodium carbonate was put into the crucible a curious double reversal occurred. In the middle of an enormous dark expansion of D a bright yellow band appeared, which in turn had a narrower dark band, or a pair of dark lines, in its middle. A similar double reversal of the lithium blue line occurred so far as to show a bright line in the middle of the dark one. Of the two violet lines of potassium the authors observed that the more refrangible remained reversed longer than the other.

In addition to the reversals of calcium lines before observed by them, the authors have noticed the reversal of all the more conspicuous calcium lines of the G group and some others. The finer lines, wave-lengths 4434·3, 4454·5, slightly less refrangible than the strong lines 4434, 4454, were reversed, but only when one of the poles was a bar of iron, instead of carbon. The strong lines just mentioned were expanded so as to cover their neighbours, and all four lines were seen black against the bright background in the positions and of the same relative strengths as when bright.

When strontium chloride was put into the crucible twelve lines besides those before noted were observed reversed. Besides these, many dark bands were observed in the less refrangible part of the spectrum, of which three appear to be identical with bright bands ascribed to strontia, and one with a bright line given by strontium chloride.

Manganese, introduced as sulphate, gave with facility the violet triplet, as dark lines on the continuous background. The bright blue lines of manganese were not, however, reversed until some metallic magnesium was introduced. This brought out the reversal of the lines, wave-lengths 4753, 4783, and 4823, the last being the most easily reversed of the three.

Lead introduced in the metallic state gave a reversal of the violet line, wave-length 4058, which Cornu had previously seen reversed, but this reversal was far better seen, becoming a wide black band when the lead was introduced as an alloy with zinc. Probably the lead vapour was not so rapidly oxidised when mixed with zinc, and a thicker, if less dense, stratum interposed between the arc and the spectroscope. When lead ferrocyanide was used, not only the line above mentioned was reversed, but also, much less strongly, a line near it, wave-length 4062.

With zinc, only the less refrangible two of the three bright blue lines were seen reversed. The very bright lines, wave-lengths 4924, 4911, seen in the spark between zinc poles, were not seen at all in the arc, resembling in this respect the magnesium line, wave-length 4481, and the cadmium lines, wave-lengths 5377, 5336.

When cadmium was put into the crucible the lines, wave-length 5085, 4799, and 4677 were reversed, not the line, wave-length 4415. With a large dose of cadmium the red line, wave-length 6438, was once seen reversed for an instant only.

With silver, besides the reversals before observed by the authors, the line, wave-length 4053, showed a dark line in the middle of its expansion as noticed by Mr. Lockyer, but they could see no reversal of the line, wave-length 4208. Instead of the reversal of this line they observed that a second bright line came out close to it, rather diffuse, and about midway between the line 4208 and the calcium line 4215. This second line coming out near the other silver line gave the appearance of a reversal in the middle of a diffuse line, but besides the measurements made with a micrometer the authors assured themselves of the fact by watching the fading of the second line as the silver evaporated. The use of an alloy of zinc with silver did not alter the appearance of these two lines, or bring out a reversal of either of them. The authors failed to see any line of silver either bright or reversed with wave-length about 4240, as noticed by Cornu. With the carbons arranged vertically and the light viewed through the upper, perforated carbon, silver gave a channelled spectrum as described by Lockyer and Roberts. As this channelled spectrum was not seen with silver in any other arrangement of the crucibles, the authors are led to attribute it to a comparatively cool condition of the silver vapour ascending the carbon tube, a condition of near approach to a state of liquefaction.

Having observed that lines frequently came out with mixtures which were not visible when the separate ingredients were used, they tried a few amalagms. None of these showed any reversals

of the mercury lines. But an amalgam of bismuth gave readily the reversal of the bismuth line, wave-length 4722, and with more difficulty that of the line, wave-length 4119.

Antimony did not appear to give any lines, or none easily distinguishable, in the arc.

With copper the reversal of two lines only were observed, wave-length 5105, 5153.

Iron introduced as metal, or as chloride, in the usual way, gave no reversal; with an iron rod used as positive pole instead of one of the carbons, the authors succeeded in getting the reversal of one line, wave-length 4045, which expanded and showed a fine dark line in its middle; but by passing an iron wire into the arc through the positive carbon, which was perforated, and pushing in the wire slowly as the end burned away, several of the brightest of the iron lines were reversed. The three violet lines, wave-lengths 4045, 4063, 4071, were the first to be reversed. They all expanded before showing reversal, and the order of reversal was that of refrangibility. Besides these seven other of the brightest lines were reversed.

Nickel, whether put into the crucible in the old way, or fed into the arc in small fragments filling a platinum tube which was passed through a perforated carbon pole, gave no definite reversal of any of its lines; nor did cobalt, even when a bar of cobalt was used as the positive pole.

Tin, palladium, and platinum gave no reversals.

It is worthy of remark in regard to the difficulty of obtaining substances chemically pure that the authors found that carbon poles which had been for some hours ignited in a current of chlorine and further intensely heated in the arc, while a current of chlorine was passed through perforations down their axes, still showed in the arc, of course without any crucible being employed, a multitude of lines amongst which the so-called carbon lines and those of calcium and iron were conspicuous.

December 18.—"On the Capillary Electroscope," by G. Gore, LL.D., F.R.S.

This paper contains a description of a modified form of the "Capillary Electroscope," together with full details of its construction and of the circumstances which affect its successful action. Numerous forms of the apparatus were constructed and a variety of solutions employed with the hope of obtaining an instrument capable of being employed for accurate measurements of feeble electromotive forces, but without success. The author is now engaged in examining the behaviour of a variety of liquids in the apparatus, and in completing an investigation of the causes and conditions of the movements. During this examination he has discovered the singular circumstance that in certain cases the mercury moves in an opposite direction to the electric current.

Mathematical Society, December 11.—C. W. Merrifield, F.R.S., president, in the chair.—The following gentlemen were elected members:—Mr. W. Burnside, Mr. J. R. Harris, Dr. W. Jack, Mr. W. J. Curran Sharpe, and Prof. W. Woolsey Johnson, St. John's College, Annapolis, Maryland.—The following communications were made to the Society:—Note on a method of obtaining the q-formula for the sine-amplitude in elliptic functions, by Mr. J. W. L. Glaisher, F.R.S.—Note on a numerical theorem connected with the cubical division of space, by the President.—Notes on Curvature, by Mr. J. J. Walker.—A property of a linkage, by Mr. A. B. Kempe.—Mr. Merrifield's note arose thus:—it is known that if space be cubically divided by three systems of orthogonal and equidistant planes, there must be an infinite number of ways of selecting points of the system, which shall be the corners of cubes obliquely placed and the theorem (*infra*) shows that the edges of such cubes will be commensurable with the unit of the system. Take $OA = OB = OC$, orthogonal to one another, and the co-ordinates of A, B, C referred to rectangular axes, rational numbers, it is shown that the length $OA = OB = OC$ is also a rational number. If $l_1\ m_1\ n_1$; $l_2\ m_2\ n_2$; $l_3\ m_3\ n_3$ are the co-ordinates of A, B, C respectively, then we have—

$$l_2 l_3 + m_2 m_3 + n_2 n_3 = 0,$$

and two other like equations. Also if

$$r = \frac{m_2 n_3 - m_3 n_2}{l_1} = \ldots = \ldots$$

then $(l_2^2 + m_2^2 + n_2^2)(l_3^2 + m_3^2 + n_3^2) = r^2(l_1^2 + m_1^2 + n_1^2)$, or $OB^2 . OC^2 = r^2\, OA^2$. Therefore if any two of the three lines OA, OB, OC are equal, the third is rational. A few numerical examples are given:—

$$r = 9, \begin{Bmatrix} -8 & 4 & 1 \\ 4 & 7 & 4 \\ 1 & 4 & -8 \end{Bmatrix} \qquad r = 21, \begin{Bmatrix} -19 & 8 & 4 \\ 8 & 11 & 16 \\ 4 & 16 & -13 \end{Bmatrix}$$

$$r = 11, \begin{Bmatrix} -9 & 6 & 2 \\ 6 & 7 & 6 \\ 2 & 6 & -9 \end{Bmatrix} \qquad r = 25, \begin{Bmatrix} 9 & 12 & -20 \\ 12 & 16 & 15 \\ -20 & 15 & 0 \end{Bmatrix}$$

Values were also given for $r = 19$, 23, other values proved refractory. If the above are read as determinants, the groups are all symmetrical, 9, 11, 19 being symmetrical about both diagonals. The value of the determinant is always $\pm r^3$ as it should be, being simply the volume of the cube of which r is an edge. Mr. Glaisher pointed out that the diagonal about which there is symmetry has the sum of its terms $= \pm r$. The reason for this and why there should be symmetry, is not so apparent.

Geological Society, December 3.—Henry Clifton Sorby, F.R.S., president, in the chair.—Syed Ali, Wynne Edwin Baxter, Arthur Robert Boyle, Rev. John Lowry Carrick, M.A., Prof. Edward Waller Claypole, Rev. T. Dowen, Rowland Gascoyne, George M. Henty, John Marshall, Josiah Martin, Charles Maxted, Edward Provis, Thomas William Rumble, Rev. John Reuben Taft, Octavius Albert Shrubsole, Samuel Richard Smyth, and William Neish Walter were elected Fellows of the Society.—The following communications were read:—The gneissic and granitoid rocks of Anglesey and the Malvern Hills, by C. Callaway, F.G.S., with an appendix on the microscopic structure of some of the rocks, by Prof. T. G. Bonney, F.R.S., Sec.G.S. The author described the results of his investigations into the stratigraphy and petrology of the above districts, which have led him to the following conclusions:—1. The granitoid (Dimetian) rocks of Anglesey pass down into an anticlinal of dark gneiss (above) and grey gneiss (below). 2. Associated with the granitoid series are bands of felsite, hälleflintas, and felspathic breccias. 3. The succession of gneissic and granitoid rocks in Anglesey resembles so closely the metamorphic series of Malvern as to justify the correlation of the two groups. 4. The pre-Cambrian rocks of Anglesey and the Malverns, from the highest known member down to the base of the gneiss, may be thus classified:—A. Pebidian (to be described hereafter); B. Malvernian; (*a*) Dimetian, with associated quartz-felsites and hälleflintas (Arvonian) passing down into (*b*) Lewisian.—Petrological notes on the neighbourhood of Loch Maree, by Prof. T. G. Bonney, F.R.S., Sec.G.S. The author described the microscopic structure of a typical series of the Hebridean gneiss, and gave reasons for considering the mass of rock on the right bank of Glen Laggan to be not an intrusive "syenite," as has usually been supposed, but a mass of the Hebridean gneiss faulted against the *newer* series. By examination of specimens, collected both in Glen Laggan and at other points along the northern escarpment of the *newer* series, the author showed that its rocks have been rightly called metamorphic; and then, by comparison of these with specimens collected in Glen Docherty, he concluded that the latter belonged to the *newer* series, and that no part of the Hebridean series reappeared here.—On some undescribed Comatulæ from the British secondary rocks, by P. Herbert Carpenter.

Zoological Society, December 16.—Prof. Flower, F.R.S., president, in the chair.—Mr. H. Seebohm exhibited and made remarks on a collection of birds made by Captain the Hon. G. C. Napier, in the valley of the Atreck, near the south-east corner of the Caspian Sea.—Mr. R. G. Wardlaw Ramsay exhibited a specimen of *Pericrocotus flammeus* in an abnormal state of plumage, obtained on the Neilgherry Hills in Southern India.—Mr. Sclater exhibited a small collection of birds from the Island of Montserrat, West Indies, received from Mr. J. E. Sturge, of that island. This collection, though small, was of much interest, as nothing was previously known of the ornithology of Montserrat.—Mr. T. J. Parker read a paper on the intestinal spiral valve in the genus *Raia*. Mr. Parker showed that there were four types of valve exhibited in individuals of that genus, differing from one another in morphological characters, in the extent of absorption surface presented to the food, and in the resistance offered to the passage of food.—A communication was read from the Marquis de Folin on the mollusca of the *Challenger* Expedition of the genera *Parastrophia*, *Watsonia*, and *Cæcum*.—Prof. W. H. Flower, F.R.S., read a communication on the cæcum of the Red Wolf (*Canis jubatus*), in which it was shown that that animal differed from the majority of the *Canidæ* in possessing a very short and perfectly straight cæcum.—A communication was read from Mr. Edward Bartlett containing a list of the mammals and birds collected by Mr. Thomas Waters in

South-East Betsileo, Madagascar. The collection contained a new species of rodent belonging to the genus *Nesomys*, and two new species of birds of the genera *Cypselus* and *Zapornia*.—Dr. A. Günther, F.R.S., read the description of a new species of Dwarf Antelope, obtained by Dr. Kirk near Brava in the South Somali country. Dr. Günther proposed for this new species the name of *Neotragus kirki*.—A communication was read from Mr. Martin Jacoby containing the descriptions of new species of phytophagous coleoptera.—A communication was read from Prof. J. Reay Greene, F.Z.S., on a remarkable Medusa (*Charybdæa haplonema*), from Santa Catharina, Brazil.—Mr. Edward R. Alston read a description of a skull of a chamois with four horns, which had been exhibited at a previous meeting of the Society.—Mr. Henry Seebohm read a paper on certain obscure species of Siberian, Indian, and Chinese thrushes.

Physical Society, December 1.—Prof. W. G. Adams in the chair.—New Members—Mr. J. H. Poynting, Mr. R. T. Glazewood, Dr. R. C. Shettle, Prof. Rowland, Mr. John Gray, D.Sc., Mr. H. R. Brook, Mr. E. B. Sargent, Mr. E. Paterson.—On the graduation of the sonometer, by M. J. H. Poynting, Trinity College. The author had endeavoured to reduce the present arbitrary readings of the sonometer of Prof. Hughes to absolute measure by adapting the formula given in Maxwell's "Electricity," vol. ii. chap. xiv., to the induction of two circular coils on the same axis, separated by a distance greater than the radii of the coil, on a third coil intermediate. By applying the formula thus obtained to the results of Prof. Hughes for different metals, he finds that either the specific resistances of metals as given in the tables are not the same as the resistances of the metals employed by Prof. Hughes, or that the induction effect of the balance or sonometer is not proportional to the conductivity of the metal.—Prof. Ayrton reminded the Society that at a former meeting he had shown mathematically that the effect was not proportional to the conductivity, but to an exponential function of the conductivity. Mr. Chandler Roberts, F.R.S., stated that Prof. Hughes did not profess that the metals used by him to obtain his results were pure. Prof. Adams mentioned that Prof. Hughes had shown that the effect was dependent on other conditions than the mere purity of the metal.—Dr. J. A. Fleming, St. John's College, Cambridge, exhibited and described a new form of Wheatstone balance, designed principally for comparing the B.A. units of resistance deposited in the Cavendish Laboratory. The divided resistance is a circular platinum-iridium wire and an arm fitted with a contact at its extremity revolves round after the manner of circular resistance coils, thus altering the ratios of the divided resistances. The contact is a knife-edge of platinum, and it is made and broken by hand like a key. A series of ingenious copper mercury cups are fitted to the balance so as to permit of two coils being compared at any temperature with great exactness by the method suggested by Prof. Foster and adopted by Prof. Crystal, of Cambridge. This consists in exchanging the positions of the units on the balance and observing the difference in the results. By Dr. Fleming's arrangement this exchange can be effected without removing the coils from the heating apparatus in which they are placed or otherwise altering their conditions. The mercury contact cups and the heating cans were also improved by Dr. Fleming for the purpose of facilitating accuracy of results.—Prof. Perry described a dispersion photometer devised by himself and Prof. Ayrton for the purpose of comparing intense lights such as the electric with a standard candle without taking up much room, in order to put the stronger light at a distance from the screen proper, to give an illumination equal to that of the candle. To reduce the distance of the stronger light from the screen, the authors had inserted a lens in the track of the beam, so as to disperse the beam to a degree which could be determined by an easy formula. Thus by artificially diluting the powerful beam they could compare it with the feebler beam from the standard light in a shorter space. For an electric light of 6,400 candles only eight feet need be required by the new plan instead of eighty feet by the unassisted method. Dr. John Hopkinson, F.R.S., stated that he had actually used the same method for some months past in his electric light experiments. He recommended a plano-convex lens as the best to use, and suggested that the focal length should be calculated. He thought that the error due to absorption could easily be obviated.—Prof. Ayrton then described a method by which Prof. Perry and he had determined the value of g, or the coefficient of gravity at the Imperial Engineering College, Tokio, Japan, by means of pendulums. Their result is 980·06, and calculation from the position of the places makes it 979·8.—An improved form of spherometer, designed by Mr. W. Goolden and made by Mr. Adam Hilgar, was exhibited to the meeting. The frame is of aluminium, combining lightness and rigidity; the legs and screws of hard steel. The screw carries a drum divided into 1,000 parts, and the instrument gives a reading to the $\frac{1}{100000}$th of an inch by the usual method of touch. Increased sensitiveness is got by employing a galvanometer to indicate the contact of the middle pointer with the surface. By this means it is made correct to the $\frac{1}{200000}$th of an inch.

Anthropological Institute, December 9.—Edward B. Tylor, F.R.S., president, in the chair.—The President read some communications from the Rev. L. Fison and Mr. J. Forrest, on Australian marriage customs, which will materially assist in clearing away the difficulties which surround this interesting subject. Mr. Morgan in his "Ancient Society," says that amongst the aborigines of Australia there exists a state of communal marriage not found elsewhere, viz., that any man in a given tribe or class A is the husband of every woman in another class B. This view, however, Mr. Fison states, is not quite accurate, and he explains that men belonging to a class A can marry women belonging to another class B and no others; and that if a man from class A visit a station occupied by class B, he is provided during his stay there with a temporary wife. The offspring belongs not to either the father's or the mother's class, but to a third class C which is in its turn provided with wives exclusively from a fourth class D.—In the absence of the author the Director read a paper on savage and civilised warfare, by Mr. J. A. Farrer. It is interesting to note the existence of certain laws of war among the lower races, because it is generally assumed that they are only the product of an advanced civilisation, and the glory of a so-called civilised warfare. Even amongst the Khonds, it is necessary, previous to an attack, to allow the enemy to complete the same fetichistic ceremony as the offensive tribe itself performs.—The Caffres consider it shameful to attack their enemy without a declaration of war, and when war has broken out they refrain from seeking to starve him out; they spare the lives of women and children, and restore them after the war. The Canarians held it to be base and mean to injure the women and children of the enemy. War between civilised nations might well become a moral impossibility irrespective of any international treaty of disarmament. All that is wanted is a certain amount of human opinion and human will; of opinion, that quarrels may and should be settled peaceably, of will, that they shall be settled in no other way. Not more will is required than sufficed to put down the slave trade; nor is any stronger opinion needed than was enough for the extinction of duelling and torture.—Mr. Worthington G. Smith exhibited a collection of sixty specimens of Palæolithic implements chiefly from the valley of the Axe, many of them unusually large and heavy and in an excellent state of preservation.—Four water-colour portraits of Tasmanians were exhibited taken about forty years ago, and showing clearly all the physiognomical peculiarities of that interesting race.

Royal Microscopical Society, December 10.—Dr. Beale, F.R.S., president, in the chair.—Ten new Fellows were elected, and ten proposed for election at the next meeting.—The following papers were read:—Mr. Dallinger on a series of experiments made to determine the thermal death-point of known monad germs when the heat is endured in a fluid.—Mr. Gulliver on the classificatory significance of rhaphides in *Hydrangia*.—Prof. M. Duncan on a part of the life-cycle of *Clathrocystis æruginosa*.—Mr. Washington Teesdale on a simple revolving object-holder.—Amongst the objects exhibited were annelid jaws by Mr. G. J. Hind, sections of plants by Mr. G. J. Ward, a revolving table microscope for thirty objects, a Schmidt's microscope with spiral focal adjustment, and various hose-pieces and stage plates, by Mr. Crisp.

Meteorological Society, December 17.—Mr. C. Greaves, president, in the chair.—T. Buckland and J. Wigner were balloted for and duly elected Fellows.—The following papers were read:—On a sand-storm at Aden, July 16, 1878, by Lieut. Herbert H. Russell, 8th Regiment.—On a new form of hygrometer, by G. Dines, F.M.S. This is a modification of the hygrometer which was first described at the British Association meeting in 1872. The outside dimensions of the instrument, inclusive of the wood casing, are about 10 inches in length, 3 inches in breadth, and 2 inches in depth. The upper part consists of a vessel of thin metal, 6 inches long, 2½ inches broad, and 1¼ inch deep. Beneath this, and detached from it,

but connected by a pipe, is a small chamber 2¾ inches long and 1¼ inch deep from back to front, standing about ½ inch more forward than the vessel above, and with a piece of thin, black glass in front. Inside this chamber, parallel to the front, is a division which separates it into two parts. This division does not extend quite to the top of the chamber, and is slightly turned over towards the front, so as to allow water to pass over it, and to induce the latter to flow more directly to the centre of the front of the chamber. The upper vessel is connected with the bottom and back part of this chamber by a small pipe with a tap to it, which is turned from the outside. The front of the chamber has a pipe attached to the bottom, passing upward in an inclined direction, and terminating at the outside in a small lip or spout. A thermometer, with the bulb inside and over the front of the chamber, passes through an india-rubber collar at the top of it, and is protected by a groove sunk in the face of the wooden case. The action of the instrument is as follows:—Water, of a lower temperature than the dew-point, is placed in the upper vessel, and, on the tap being turned, flows into the back of the small chamber, and thence, passing over the top of the middle division, flows downwards, cooling in its passage the thermometer and black glass, and eventually escapes by the small spout on the right side of the instrument. As soon as dew appears on the glass, the flow of the water is stopped by means of the tap, and the temperature is read off by the thermometer. When ether is used it is poured into the small spout, passes down the inclined pipe, and remains in the front part of the chamber. A piece of metal tube, ground so as to fit tightly the inclined pipe, and with an aspirator attached, is then inserted, and the dew-point is ascertained in the same way as by Regnault's hygrometer.—The diurnal range of atmospheric pressure, by R. Strachan, F.M.S. The author has compiled a table of constants from thirty places in various parts of the globe, which support Sir John Herschel's remark that "the diurnal oscillation of the barometer is a phenomenon which invariably makes its appearance in every part of the world where the alternation of day and night exists, and that within the Arctic Circle the diurnal dies out, or rather merges in, the annual oscillation."—Note on a curious fracture of a solar radiation thermometer, by G. M. Whipple, B.Sc., F.R.A.S.—Mr. R. H. Scott, F.R.S., exhibited and described a new form of sunshine recorder, which is to be used during the coming year at a considerable number of stations distributed over England.

Society of Telegraph Engineers.—At the annual general meeting of the Society on the 10th inst., the following gentlemen were elected office-bearers for the year 1880:—President—W. H. Preece. Vice-president—Prof. Foster, F.R.S., Carl Siemens, Willoughby Smith, Major Webber, R.E. Council—Prof. Adams, F.R.S., W. A. Andrews, W. T. Ansell, Sir Charles Bright, H. G. Ericksen, Col. Glover, R.E., Charles Hockin, Prof. Hughes, Louis Loeffler, C. E. Spagnoletti, Augustus Stroh, C. F. Varley, F.R.S., Members, and Alexander J. S. Adams, Capt. Macgregor Green, R.E., and J. T. Hill, Associates. Hon. Treasurer—Edward Graves. Hon. Sec.—Lieut.-Col. Frank Bolton. Secretary—F. H. Webb.—The Annual Report of the Council stated that fifty-nine new Members and Associates had been elected during the year. Among the losses by death the Society had to deplore those of Sir William Fothergill Cooke, Prof. Clerk Maxwell, and Mr. R. S. Brough. Special mention was made of the International Telegraph Conference, held in London in the summer, many of the most distinguished delegates being foreign members of the Society. Many valuable and interesting papers have been read during the session. The printing of the "Ronalds Catalogue," containing upwards of 12,000 entries, is being rapidly proceeded with, nearly 400 pages have been set up in type, of which 360 have been finally corrected and struck off. The valuable library bequeathed to the Society by Sir Francis Ronalds, including some hundreds of rare pamphlets, and constituting the most important collection of works on electricity and magnetism in the world, is being bound, and will shortly be available for the use of the members of the Society, and all students of electrical science. It was stated that steps were being taken for the incorporation of the Society, and that arrangements were in contemplation for the further development of its proceedings in respect to the purely scientific branch of electricity. The Society would be duly represented in the deliberations, being held to give effect to the proposal for the erection of a central hall to accommodate all the societies established for the encouragement of the applied sciences, towards which scheme Dr. Siemens had offered the munificent contribution of 10,000*l*. The financial position of the Society is very satisfactory.—A paper was read by Mr. E. Marsh Webb on the operations connected with the laying of the new Algiers-Marseilles cable, which led to an interesting discussion.

MANCHESTER

Literary and Philosophical Society, November 10.—Charles Bailey, F.L.S., president, in the chair.—Additional note on hydra, by Marcus M. Hartog, F.L.S.—On some undescribed hairs in Copepoda, by the same.—On an undescribed Acinetan, by the same.

November 18.—J. P. Joule, F.R.S., president, in the chair.—Recording sunshine, by David Winstanley, F.R.A.S.—On some notices in classical authors of the action of sunlight on purple dye, by James Bottomley, F.C.S.—On the origin of the word chemistry, by Carl Schorlemmer, F.R.S.

December 2.—R. Angus Smith, F.R.S., in the chair.—On a peculiar feature in the water of the well in Carisbrooke Castle, Isle of Wight, by Harry Grimshaw, F.C.S.—Note on the identity of the spectra obtained from the different allotropic forms of carbon, by Arthur Schuster, F.R.S., and H. E. Roscoe, F.R.S.

BOSTON, U.S.A.

American Academy of Arts and Sciences, November 12.—The following papers were presented:—On the relative replacability of the bromine in the three brombenzyl bromides, by Prof. C. Loring Jackson.—On a new form of astronomical level, by Prof. W. A. Rogers. This consists of a mercury surface to which any surface can be brought parallel by means of electrical contacts.—On orthobrombenzyl compounds, by C. Loring Jackson and J. L. White.—On measurements of the satellites of Mars, by Prof. E. C. Pickering. Prof. Pickering described the measurements of the position angles of the satellites of Mars, now in progress at the Harvard College Observatory. Instead of spider lines, two glass threads of such a diameter that they are visible without illumination are used. The settings are made accurately and rapidly by placing the lines so that they shall cut off equal segments of the planet and that the satellites shall be midway between them. The light of the planet is reduced by a shade glass, so that it can be seen at the same time as the satellite. The improvement of the method more than compensates for the increased distance of Mars, so that the observations are much more accordant than those taken in 1877. When the outer satellite is well seen, the probable error of the separate settings, compared with their mean, is less than half a degree. 180 settings of Deimos and 33 of Phobos have already been obtained.—Prof. Hagen read a paper on the destruction of insect pests by dilute yeast.—Prof. Trowbridge read by title a paper on dynamical ideas in the calculus.

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