Name.	Mag	Colour.	R.A. 1890.	Decl. 1890.
(1) G.C. 1425	—	—	h. m. s.	° ' "
(2) D.M. + 17° 1479 ...	6	Yellowish-red.	6 26 31	+ 10 14
(3) e Canis Minoris ...	5	Yellowish-white.	6 56 1	+ 17 53
(4) γ Gemmorum	2	Bluish-white.	7 19 6	+ 9 30
(5) 78 Schj.	6	Reddish-yellow.	6 31 24	+ 10 30
(6) R Leonis	Var.	Very red.	6 28 59	+ 38 31
			9 41 39	+ 11 56

Remarks.

(1) This nebula is described by Sir John Herschel as "pretty large, cometic, much brighter nucleus south following." The remarks relating to the nebula G.C. 1185 (see p. 257) apply equally in this case, the spectrum not having been recorded. Next in importance to observations of the general character of the spectrum will be observations of differences between the spectrum of the nucleus and that of the "tail." It seems hardly likely that the same spectrum will be given by the dense and sparse portions of the nebula.

(2) This star has a fine spectrum of the Group II. type. Dunér states that bands 2-8 inclusive are visible, and possibly also band 9, all the bands being very wide and dark. The point chiefly requiring attention in a spectrum of this character is the presence or absence of the compound fluting of carbon which extends from about wave-length 468 to 474, it having been suggested that band 9 is simply a contrast band due to the presence of this fluting. The mean wave-length given by Dunér for the edge of band 9 is 476.0, and if the suggestion referred to be of any value, this ought to be coincident with the less refrangible edge of the carbon group. This can only be satisfactorily settled by direct comparisons of the spectrum of the star with that of carbon, obtained in the usual way from a Bunsen or spirit-lamp flame.

(3) Vogel classes this with stars of the solar type. The usual differential observations are required.

(4) A star of Group IV. (Gothard). The usual observations are required (see p. 285).

(5) This is a star of Group VI., Dunér stating that the bands 2-9 are visible. Band 6 is a little weaker than the other carbon flutings. It seems probable that some of the brighter stars of the group will give metallic line absorptions, seeing that they are most probably formed by the cooling of stars like the sun, in which there are only traces of carbon absorption, whilst the line absorption is strongly marked. If the δ group be present, it will most likely produce an apparent displacement of the carbon fluting to a slightly less refrangible position, its absorption being added to that of carbon. This can readily be determined by comparison with the spirit-lamp flame. Other lines may also appear, but δ is mentioned as being amongst the more prominent solar lines.

(6) Mr. Espin found bright lines in the spectrum of this variable, when near its maximum in 1889. The star will again be at a maximum on January 30, and observers will therefore have an opportunity of making a more detailed examination of the spectrum. The general spectrum is of the Group II. type. Particular attention should be given to the bright carbon flutings, both at maximum and for some time after, as it seems probable that an increase of carbon radiation will accompany the appearance of the bright lines of hydrogen. The star ranges from about magnitude 6 at maximum to 9.5 at minimum, and the period is 313 days.

A. FOWLER.

THE TOTAL ECLIPSE OF JANUARY 1, 1889.—With a summary of the observations of this eclipse, Prof. Holden has come to the conclusion that coronal forms vary periodically, those of 1867, 1878, and 1889 being of the same form; that the outer corona, terminated in branching forms, suggests the presence of streams of meteorites near the sun, whilst the extension of the corona along and very near the plane of the ecliptic would show that such streams must have long been integral parts of the solar system. The photographs taken just before second and after third contact prove the corona to be, without doubt, a solar appendage. Spectroscopic observations indicate that the true atmosphere of the sun may be comparatively shallow, it being conclusively shown that the length of a coronal line is not always an indication of the depth of the gaseous coronal atmosphere of the sun at that point.—*Observatory*, January 1890.

THE ORBITS OF THE COMPANIONS OF BROOKS' COMET (1889 V., July 6.—The four companions which accompanied this comet

were notified as B, C, D, and E, respectively, by Prof. Barnard, of the Lick Observatory (*Astr. Nach.*, 2919), the principal portion being called A. Prof. Bredichin has computed, as far as possible, the orbits of the companions (*Astr. Nach.*, 2949). Taking the elements given by Mr. Chandler for the principal mass A, the following elements have been found for C and E; all are reduced to mean equinox 1889.0:—

Elements of A's Orbit.

T = 1889 October 2.1112

 $\omega = 344^{\circ} 29' 20''$ $\Omega = 17^{\circ} 52' 19''$ $i = 6^{\circ} 5' 6''$ $\phi = 28^{\circ} 2' 11''$ log $a = 0.565011$

Period = 7.0390 years.

Elements of C's Orbit.

T = 1889 October 1.3369

 $\omega = 344^{\circ} 11' 47''$ $\Omega = 17^{\circ} 15' 24''$ $i = 6^{\circ} 5' 6''$ $\phi = 28^{\circ} 2' 13''$ log $a = 0.505059$

Period = 7.0402 years.

Elements of E's Orbit.

T = 1889 October 8.7356

 $\omega = 347^{\circ} 30' 18''$ $\Omega = 17^{\circ} 52' 24''$ $i = 6^{\circ} 5' 6''$ $\phi = 28^{\circ} 10' 15''$ log $a = 0.564834$

Period = 7.0348 years.

The orbit of the mass B is situated between the orbits of A and C, and the orbit of D between those of C and E. From the inclination and position of the node it is evident that the division of the comet was effected in the plane of A's orbit, and the elements of C and E indicate almost the same point for the separation of the comet into these masses. It may be, therefore, that the separation was due to the action of Jupiter.

GREENWICH OBSERVATORY.—The Astronomer-Royal has issued the Greenwich Observations for 1887. An additional feature is the ten-year catalogue of 4059 stars, deduced from observations extending from 1877 to 1886, and reduced to the epoch 1880. The work, therefore, appears more bulky than ever.

THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF METEORITES AS THROWING LIGHT UPON THEIR PAST HISTORY.

IN several articles which appeared in NATURE last year I used the term meteorite as a generic one, to include all meteoritic masses, whether they consist of the tiniest specks which give rise to the instantaneous appearance of a shooting-star in the highest reaches of our air, or of the largest masses which have so far been found after their descent to the earth's surface.

I must now confine it to those masses which have reached the earth's surface, whether large or small, and I have first to refer to the various suggestions which have been made as to their origin.

The members of the Academy of Sciences of Paris were the last to acknowledge their extra-terrestrial origin, and that long after the writings and reasonings of Chladni, to which reference has been made.

Laplace ascribed them to lunar volcanoes,¹ by others it was imagined that they came from our own volcanoes; there were those, also, who held that they came from the sun; while, again, others thought they were fragments of a broken planet.

The theory of the volcanic origin of meteorites, whether lunar or terrestrial, does not satisfactorily explain the orbital motions around the sun, for, if this were their real origin, the meteorites would travel round the earth. Neither does it explain the relations which exist between comets and meteorites, for no one supposes that comets are effects of volcanic action. Further, fragments thus ejected from the earth's surface would be consumed in the journey by the same process which is afterwards to render them visible to us as shooting-stars.

With regard to the theory of the solar origin of meteorites, it is difficult to understand how solid bodies can come from the sun after passing through an immense thickness of the intensely heated solar atmosphere. Then, again, particles shot out from the sun would not travel in an orbit, as the meteorites do, but would simply move outwards in a straight line, and then fall back.

That the meteorites are fragments of a broken planet is supported by a considerable number of facts, but the main difficulty

¹ "Les Météorites," Meunier, p. 112.

is to establish the connection between comets and meteorites, as even the supporters of the theory do not claim that the comets are parts of a broken planet. Then, again, it is only an assumption that such a planet ever existed, and it is difficult to understand how a broken planet should so far disobey the law of gravity as to divide itself into small scattered fragments.

The real parentage of those meteorites which fall on our earth is, therefore, probably cometic, for the association of comets, meteorites, and shooting-stars can no longer be denied, and it is an observed fact that comets do break up.

The discovery of Schiaparelli (1866), and his view that the head of a comet was the largest meteorite in a swarm, of course, put these origins of some meteorites, at all events, out of the question.

Reichenbach (1858) did not consider that the head of a comet was a large meteorite, but a swarm of small ones, and the large meteorites he considered to be built up in some way out of the smaller ones brought into our system by comets. If this view be subsequently confirmed, since we now know that, as suggested by Schiaparelli, comets are nebulous shreds, brought into our system by solar or planetary attraction, it follows that in the nebulae also we may be only dealing with excessively small masses.

If meteorites, in the restricted sense of the term above referred to, do not exist sporadically in external space, they must be manufactured in our system, and two tests should be open to us: (1) no meteorites should reach us from outer space; and (2) they should bear traces of the process by which they have been built up from cometary materials.

If we can establish this, then we imagine a gradual progression in the size of meteoritic masses from regions where they are so small that luminous collisions are all but impossible, to those regions nearest to a cooling sun, like our own, where there has been the richest supply of cometary material, furnished at successive perihelion passages for the longest time.

With regard to (1), we have the facts that it is only very rarely meteorites fall in displays of shooting-stars, and that when the earth has passed near a comet no increase in the average number of meteorites has been noticed.

The most important piece of evidence on this point, however, has been recently furnished by Prof. Newton, who, from a complete discussion of the data extant from all known falls, has come to the conclusion that all the meteorites now in our collections have come from a single ring of bodies circulating round the sun.

We next come to (2). The most important point to consider here, in the first place, is the very special structure of meteorites.

Thumb Markings.

Regarding the origin of the remarkable pittings of the surfaces of aërolites and aërosiderites, an opinion was lately expressed and advocated by Daubrée,¹ that in their flight through the air they undergo erosion and excavation by joint effects of combustion and fusion, assisted mainly by air vortices attacking most violently certain portions of their surface. An important paper on this subject by Prof. Maskelyne was published immediately afterwards in the *Philosophical Magazine* (of August 1876). It is true that pittings identical in appearance with those of meteorites are found on the surfaces of certain large grains of powder blown unconsumed from the mouths of the large modern rifled ordnance (excellent specimens of this kind received from Prof. Abel and Major Noble having been shown by Prof. Maskelyne to M. Daubrée in the summer of 1875); but two important grounds for exception, in regard to this explanation, are pointed out by Prof. Maskelyne, which must not be overlooked. The closest examination of the molten glaze with which, like other parts of these surfaces, the pittings or depressions of meteorites are coated over, shows no indications of vortice action of the air, although stream-lines of the glaze from front to rear are of frequent and conspicuous occurrence. The process of atmospheric combination, or combustion, is also rare, if not entirely absent, during the period of most intense operation of the heat, as is shown by particles of metallic iron which are occasionally found embedded in the glaze, and even by cases where the highly oxidizable mineral oldhamite (calcium sulphide), occurring in spherules in the Bustee meteorite, is glazed over equally with the augite without offering any signs of combustion or of the production of cavities where they are exposed.

¹ *Comptes rendus*, April 24, 1876. See "Report on Observations of Luminous Meteors for the year 1875-76," p. 167.

Chondritic Structure.

We have spherules of iron, like small shot of different sizes, in the stones.

These spherules, or chondroi, as they are sometimes called, vary very considerably in size; some reach the size of a cherry, while others are so small that they can only be seen by the aid of a microscope.

Chondroi in Soko-Banya meteorite (magnified 10 diameters)

Chondroi in Mocs meteorite (magnified 10 diameters)

By examining sections of chondritic stony meteorites we find that they consist sometimes almost entirely of spherules. The Parnellee aërolite affords us a very good instance of this, the most varied groups of spherules being seen collected together in one section. These spherules are sometimes encased in small shells of nickeliferous iron, or sometimes in addition with a kind of pyrites, a sulphide of iron termed troilite (FeS), peculiar to meteorites.

Some chondroi have round depressions which point to plasticity during contact, as if the spherules which form the splintered fragments had acquired their form during the act of rubbing. Others, again, have projections of a rounded form, or an almost pointed end.¹

Our terrestrial rocks contain no structure identical with that chondritic structure so peculiar to meteorites, and the characters of the spherules are found to be quite different from those in either perlite or obsidian.

Tschermak² directs attention to the peculiarities observed in several chondritic meteorites. The first is the occurrence of a crust over the surface of the bronzite spherules, possessing fibrous structure. This crust is thin, and is distinguished from the inclosed material by its paler colour; it has the same fibrous

¹ Flight, "History of Meteorites," p. 207.

² Quoted from "Report of Observations of Luminous Meteors during the Year 1877-78," p. 107.

structure, doubly refractive power, and, in fact, is optically orientated like the inclosed silicate. It appears to be produced by some agent acting from without, perhaps heat in conjunction with a reducing gas. The agent has not caused friction, but a slight modification of the texture of the surface.

Indications afforded by Crystalline Structure.

The mixed minerals of meteorites have been subjected to microscopic examination by Sorby¹ and Rose,² and both have found that the crystals differ in some essential particulars from those of volcanic rocks.

Sorby long since showed that when crystals are formed by deposition from water or from a mass of melted rock, they often catch up portions of this water or melted stone which can be seen as cavities containing fluid or glass. Crystalline minerals formed by purely aqueous or by purely igneous processes can thus be distinguished. One of the most common of the minerals in meteorites is olivine, and when met with in volcanic lavas this mineral usually contains only a few and small glass-cavities in comparison with those seen in such minerals as augite. The crystals in meteorites are generally only small, and thus the difficulty of the question is considerably increased. However, by careful examination with high magnifying power, Sorby found well-marked glass-cavities, with perfectly fixed bubbles, the inclosed glass being sometimes of brown colour and having deposited crystals. On the contrary he was never able to detect any trace of fluid-cavities, with moving bubbles, and therefore he holds it very probable, if not absolutely certain, that the crystalline minerals in meteorites were chiefly formed by an igneous process, like that which has produced lava, and analogous volcanic rocks.

Passing from the structure of the individual crystals to that of the aggregate, Sorby points out that in some cases we have a structure in every respect analogous to that of erupted lavas, though even then there are very curious differences in detail.

The results of the observations of the kinds of crystallization noted in meteorites by many eminent authorities go to show that it took place hastily. Thus Brezina, after making a complete study of the Vienna collection, comes to the conclusion that the structural features of meteorites are the result of a hasty crystallization.

Again, it is the opinion of several high authorities that the crystallization did not necessarily take place under conditions of high temperature.

M. Daubrée's opinion is thus expressed :—³

"It is extremely remarkable that, in spite of their great tendency to a perfectly distinct crystallization, the silicate combinations which make up the meteorites are there only in the condition of very small crystals, all jumbled together as if they had not passed through fusion. If we may look about us for something analogous, we should say that, instead of calling to mind the long needles of ice which liquid water forms as it freezes, the fine-grained texture of meteorites resembles rather that of hoar frost, and that of snow, which is due, as is known, to the immediate passage of the atmospheric vapour of water into the solid state."

This possibility of the absence of high temperature is thus further insisted upon by Prof. Newton :—⁴

"The meteorites resemble the lavas and slags of the earth. These are formed in the absence of water, and with a limited supply of oxygen, and heat is present in the process. But is heat necessary? Some crystallizations do take place in the cold; some are direct changes from gaseous to solid forms. We cannot in the laboratory reproduce all the conditions of crystallization in the cold of space. We cannot easily determine whether the mere absence of oxygen will not account fully for the slag-like character of the meteoric minerals. Wherever crystallization can take place at all, if there is present silicon and magnesium and iron and nickel, with a limited supply of oxygen, their silicates ought to be expected in abundance, and the iron and nickel in their metallic forms. Except for the heat, the process should be analogous to that of the reduction of iron in the Bessemer cupola, when the limited supply of oxygen combines with the carbon, and leaves the iron free."

Should this view be subsequently confirmed, all early ideas touching the formation of meteorites will require to be modified. Thus, in 1855, Prof. Lawrence Smith stated :—"They have all been subject to a more or less prolonged igneous action corre-

sponding to that of terrestrial volcanoes." Haidinger, in 1861, not only declared for high temperature, but for high pressure.

Obviously, these views, which were based more upon the analogies of some of the meteorites with volcanic basic rocks than upon the actual character of the crystallization, suggested the formation of large masses; and the ideas that comets were solid bodies and that meteorites were fragments of comets or planets were both based upon these views,¹ and the higher the temperature required and the slower the crystallization, the larger in imagination did these possible birthplaces of the meteorites become.

If neither much time nor heat be required to produce the crystallization observed, then, with Prof. Newton, we can suppose "a mass containing silicon, magnesium, iron, nickel, a limited supply of oxygen, and small quantities of other elements, all in their primordial or nebulous state (whatever that may be), segregated somewhere in the cold of space. As the materials consolidate and crystallize, the oxygen is appropriated by the silicon and magnesium, and the iron and nickel are deposited in metallic form. Possibly the heat developed may, before it is radiated into space, modify and transform the substance. The final result is a rocky mass (or possibly several adjacent masses) which sooner or later is, no doubt, cooled down throughout to the temperature of space."

We shall see subsequently that there are many known causes in operation which will provide us with just such a mixed mass of vapours as Prof. Newton requires, and it is at once obvious that, not only is the generic separation into iron and stones thus accounted for, but the special form of crystallization observed in stones and the special chondritic structure observed both in irons and stones would all arise from the same cause.

Evidences of Heating and Action of Violent Forces at Different Times.

The peculiarities in the mineralogical structure of the meteorites are probably in part due to the successive heatings and coolings to which they were subjected with each approach of the comet to the sun, and partly, perhaps, to the heat of combination of oxygen and silicon. They were most probably formed in a limited supply of oxygen, so that the elements possessing greatest affinity for that element were the first to form compounds, leaving iron and nickel in the metallic or uncombined state.

Some meteoric stones from examination seem to have been heated to a high temperature right through their mass. Such cases as Orvinio, Chantonay, Juvenas, and Weston show signs that fragments are cemented together with a material of the same substance as themselves. Again we have indications of chemical changes, the chondroi in some stones being found to be surrounded by spherical and concentric aggregations of minute particles of nickel, due, as is supposed, to the reducing action of hydrogen at a high temperature.

Some meteorites are merely breccias, consisting of fragments, the *débris* of pre-existing meteorites, or of the original mass tremendously shattered, and subsequently cemented together.

In this connection Sorby writes :—

"It would therefore appear that, after the material of the meteorites was melted, a considerable portion was broken up into small fragments, subsequently collected together, and more or less consolidated by mechanical and chemical actions, amongst which must be classed a segregation of iron, either in the metallic state or in combination with other substances. Apparently this breaking up occurred in some cases when the melted matter had become crystalline, but in others the forms of the particles lead me to conclude that it was broken up into detached globules whilst still melted (Mező-Madaras, Parnellee). This seems to have been the origin of some of the round grains met with in meteorites; for they occasionally still contain a considerable amount of glass, and the crystals which have been formed in it are arranged in groups, radiating from one or more points on the external surface, in such a manner as to indicate that they were developed after the fragments had acquired their present spheroidal shape (Aussun, &c.). In this they differ most characteristically from the general type of concretionary globules found in terrestrial rocks, in which they radiate from the centre; the only case that I know at all analogous being that of certain Oolitic grains in the Kelloway rock at Scarborough, which have undergone a secondary crystallization."²

Mr. Sorby remarks :—"A most careful study of their microscopical structure leads me to conclude that their con-

¹ Proc. R.S., January 1864.

² Berlin Acad. Trans.

³ Quoted by Newton, NATURE, vol. xxxiv. p. 535. ⁴ NATURE, loc. cit.

¹ See Newton, NATURE, vol. xxxiv. p. 534.

² "Microscopical Structure of Meteorites," Proc. R.S., June 16, 1864.

stituents were originally at such a high temperature that they were in a state of vapour, like that in which many now occur in the atmosphere of the sun, as proved by the black lines in the solar spectrum." We may, in fact, look upon them as being to planets what the minute drops of water in the clouds are to an ocean. He has shown that possibly, after the condensation of the vapour, they collected into larger masses, which have been subsequently changed by metamorphic action, broken up by mutual impact, and again collected and solidified, the meteoric irons possibly being those portions of the metallic constituents which were separated from the rest by fusion when the metamorphosis was carried to the extreme point.

In this manner the subsequent heating, or any number of subsequent heatings, are explained.

Iron Meteorites not fused in falling.¹

A question of no slight interest in regard to the changes which meteoric irons undergo during their passage through the atmosphere is whether their surface becomes fused. From his study of the Charlotte meteorite, Dr. Smith is inclined to answer it in the negative. The fact of the delicate reticulated surface having been preserved is a proof that the heat, instead of having been raised to a high temperature, has quickly been conducted away into the mass of metal. Had fusion of the superficial layer taken place, the meteorite would have been coated with molten oxide.

Veins.

Now and again we come across meteorites which have veins, like terrestrial rock-veins, running right through them. Prof. Maskelyne's description of them is as follows:—²

"Just as in a mine one may meet with a fissure that, once dividing the 'country,' but subsequently filled by rocky matter, cuts across the course of a mineral vein which itself was originally formed in a similar way; and just as such a cross fissure, thus intersecting with the original metalliferous vein, often gives us evidence of a heave, *i.e.* that one side of the new fissure has slid upwards or downwards along the other, so an exactly similar thing is met with in meteorites, and is admirably seen in the microscopic sections of them."

Faults and throws are both represented in meteorites. In that of Aumière there is a throw of several centimetres indicated, and faults intersect. These faults are accompanied by heat due to the friction of the surfaces, and in the case of gray stony meteorites the faults are black like the crust.³ (The black veins are physically connected with the crust, and are supposed to have the same origin, the melted material having filled up the fissures.)

On examining such meteorites as Château-Renard, Pultusk, and Alessandria, it is found that some of the spherules even are broken in half and the halves separated from each other by a vein of meteoric iron or troilite, and in some cases by a black fused substance, like the crust of a meteorite.

The Presence of Sulphides.

The presence of sulphides, which must have been formed when both water and free oxygen were absent, shows a distinctly non-terrestrial condition, as, indeed, does also the presence of small particles of iron. On this point Dr. Flight remarks: ⁴ "If the conditions necessary for the formation of pure calcium sulphide be borne in mind, the evidence imported into this inquiry by the Bustee aërolite seems further to point to the presence of a reducing agent during the formation of its constituent materials."

Sorby's General Conclusions.

We have before referred to Sorby's microscopical examination of meteorites. In 1865 he stated the general conclusions he had arrived at as follows. It will be seen how remarkable the agreement is between him and Reichenbach.

"As shown in my paper in the Proceedings of the Royal Society (xiii. 333), there is good proof of the material of meteorites having been to some extent fused, and in the state of minute detached particles. I had also met with facts which seemed to show that some portions had condensed from a state of vapour; and expected that it would be requisite to adopt a modified nebular hypothesis, but hesitated until I had obtained more satisfactory evidence. The character of the constituent

particles of meteorites and their general microscopical structure differ so much from what is seen in terrestrial volcanic rocks, that it appears to me extremely improbable that they were ever portions of the moon, or of a planet, which differed from a large meteorite in having been the seat of a more or less modified volcanic action. A most careful study of their microscopical structure leads me to conclude that their constituents were originally at such a high temperature that they were in a state of vapour, like that in which many now occur in the atmosphere of the sun, as proved by the black lines in the solar spectrum. On cooling, this vapour condensed into a sort of cometary cloud, formed of small crystals and minute drops of melted stony matter, which afterwards became more or less devitrified and crystalline. This cloud was in a state of great commotion, and the particles moving with great velocity were often broken by collision. After collecting together to form larger masses, heat, generated by mutual impact, or that existing in other parts of space through which they moved, gave rise to a variable amount of metamorphism. In some few cases, when the whole mass was fused, all evidence of a previous history has been obliterated; and on solidification a structure has been produced quite similar to that of terrestrial volcanic rocks. Such metamorphosed or fused masses were sometimes more or less completely broken up by violent collision, and the fragments again collected together and solidified. Whilst these changes were taking place, various metallic compounds of iron were so introduced as to indicate that they still existed in free space in the state of vapour, and condensed amongst the previously formed particles of the meteorites. At all events the relative amount of the metallic constituents appears to have increased with the lapse of time, and they often crystallized under conditions differing entirely from those which occurred when mixed metallic and stony materials were metamorphosed, or solidified from a state of igneous fusion in such small masses that the force of gravitation was too weak to separate the constituents, although they differ so much in specific gravity. (Report of British Association, 1864.) Possibly, however, some meteoric irons have been produced in this manner by the occurrence of such a separation. The hydro-carbons with which some few meteorites are impregnated may have condensed from a state of vapour at a relatively late period.

"I therefore conclude provisionally that meteorites are records of the existence in planetary space of physical conditions more or less similar to those now confined to the immediate neighbourhood of the sun, at a period indefinitely more remote than that of the occurrence of any of the facts revealed to us by the study of geology—at a period which might in fact be called *pre-terrestrial*."

Are Meteorites merely Modern Phenomena?

It has often been a subject of remark that in spite of the very considerable number of undoubted meteorites now in various collections, we scarcely have traces of any which suggest like falls in any of the geological periods preceding the present one.

The iron found by Prof. Nordenskiöld at Ovivac, Western Greenland, was at first thought to be meteoric iron of Miocene age, but after an analysis of the basalt or lava rocks of Assuk, Disco Island, a part of the same basaltic range in Greenland, only 100 miles from the spot where Prof. Nordenskiöld's discovery was made, it was held by most authorities to be no other than the metallic nickel-iron which is, though extremely rarely, a native product in some terrestrial rocks. Other explorers besides Prof. Nordenskiöld have brought back specimens of this iron, and Dr. Lawrence Smith has stated, not only that the nickel-iron of Ovivac is without doubt of terrestrial origin, but that the specimens brought back by the other explorers resembles the Ovivac and each other remarkably, while they differ from meteoric iron by the large proportion of combined carbon in their composition.

Again, in NATURE, vol. xxxv. p. 36, we have a description of another meteorite supposed to be a fossil one, found in a block of Tertiary coal. It was said to belong to the group of meteoric irons, and was taken from a block of coal about to be used in a manufactory of Lower Austria. On its examination by various specialists, different origins were assigned to it. Some believed it to be meteoric, others an artificial production, and others again thought it was a meteorite modified by the hand of man. After a careful examination Dr. Gurlt came to the conclusion that there was no ground for believing in the intervention of human agency. The mass was almost a cube, two opposite faces being rounded, and the four others being made smaller by these roundings. A deep incision ran all through the cube. The

¹ Quoted from the "Report on Observations of Luminous Meteors during the year 1874-75," p. 247.

² NATURE, vol. xii. p. 505.

³ Flight, *loc. cit.*, p. 111.

⁴ *Loc. cit.*, p. 119.

faces and the incision bore such characteristic traces of meteoric iron as to show that the mass was not the work of man. A layer of oxide formed a thin covering of the iron; it was 67 mm. high, 67 mm. broad, and 47 mm. at its thickest part; it was found to be about as hard as steel, and besides carbon it contained a small percentage of nickel. It resembled the meteoric masses of St. Catherine in Brazil, and Braunau in Bohemia, found in 1847.

The evidence, however, is so strong that what we really obtain now at the earth's surface forms but a very small portion of the meteorites which enter the upper air, that it would not be probable that in former ages of the earth's history, when the atmosphere was denser than it is now, anything whatever would be left by the time the surface was reached.

J. NORMAN LOCKYER.

SCIENTIFIC SERIALS.

American Journal of Science, January.—Measurement of the Peruvian arc, by E. D. Preston. In this paper, which was read before the American Association for the Advancement of Science at Toronto, August 1889, the author reviews the whole question of the relative lengths of the earth's axes, dealing in detail with Bouguer's expedition to Peru in 1735, and arguing that the amplitude of his Peruvian arc may be in error by many seconds. Hence he contends that the geodetic science of to-day demands the remeasurement of this arc.—Neutralization of induction, by John Trowbridge and Samuel Sheldon. A system of neutralization for inductive disturbances is here described, which might be adopted where it is impossible to employ entire metallic circuits in which the earth plays no part.—Divergent evolution and the Darwinian theory, by Rev. John T. Gulick. The author discusses Darwin's apparently contradictory views on the causes of natural selection on the one hand, and on the other on the causes of diversity of natural selection. He concludes that, though Darwin has not recognized segregation as a necessary condition of divergence of species, he has indicated one process (geographical or local separation under different environments) by which segregation is produced in nature, adding, however, that this is not the only cause of segregation and consequent divergence.—The Devonian system of North and South Devonshire, by H. S. Williams. During a recent visit to England the author studied this system both on the spot and in the geological collections in London and elsewhere. He dwells especially, (1) on the close resemblance of the English Devonian species to those of the New York Devonian, though mostly passing under different names, and (2) on the character of the North and South Devonian rocks, which in appearance, composition, and order are as different as two distinct systems well can be.—The zinciferous clays of South-West Missouri, and a theory as to the growth of the calamine of that section, by W. H. Seamon. Full analyses are given of the so-called "tallow" and "joint" clays occurring associated and sometimes intermixed in every calamine digging in South-West Missouri. These analyses show a large percentage, often from 50 to 56, of zinc oxide, and it is inferred that at one time all the massive calamine probably existed in "tallow clays" precipitated from solutions.—On the spectrum of ζ Ursæ Majoris, by Edward C. Pickering.—Origin of normal faults, by T. Mellard Reade. Some critical remarks are offered on Prof. Le Conte's recent explanation of the origin of normal faults, which is not new, and presents many insuperable difficulties.—Papers were submitted by J. Dawson Hawkins, on a specimen of minium from Leadville; by William P. Blake, on some minerals from Arizona; by F. A. Genth, on a new occurrence of corundum in Patrick County, Virginia; by Alfred C. Lane, on the estimation of the optical angle of observations in parallel light; by L. G. Eakins, on a new stone meteorite from Texas; by Edward S. Dana, on the barium sulphate from Perkin's Mill, Templeton, Province of Quebec; and by O. C. Marsh, on some new Dinosaurian reptiles recently discovered in Wyoming, Colorado, and Dakota.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 9.—"A Milk Dentition in *Orycteropus*." By Oldfield Thomas, Natural History Museum. Communicated by Dr. A. Günther, F.R.S.

Of the few Mammalia in which no trace of a milk dentition

has been found, *Orycteropus*, the Aard-Vark, has always occupied a prominent place, owing partly to the peculiar structure of its prominent teeth, and partly to its very doubtful systematic position.

An opportunity has now fallen in my way of proving that it has after all two sets of teeth, those of the first, or milk set, being rudimentary, and probably quite functionless, but nevertheless so far developed as to be all completely calcified, and to be for the most part readily distinguishable by form and position from those of the second or permanent set.

Among the collections in the Natural History Museum there are two very young females of *Orycteropus afer* in spirit, presented by Sir Richard Owen, and it is in these that the milk teeth now to be described occur. The larger of the two measures 18 inches in total length, and the smaller 14 inches.

Each of these specimens has a complete, although rudimentary, set of milk teeth, extending the whole length of the maxillary bones above, and along a rather shorter portion of the mandible below. None, however, are observable in the premaxillæ, or in the corresponding anterior part of the mandibles. The teeth are all quite minute, and it is doubtful whether they would ever have cut the gum.

In the upper jaw there appear to be normally no less than seven milk teeth. Of these the most posterior is by far the largest, has a rudimentary crown, and two distinct roots, anterior and posterior. The others are simple and styliform.

In the lower jaw there are four milk teeth only, of which, again, the most posterior is more or less molariform.

As to the structure of the milk teeth, a horizontal section of the last upper one, ground down in the dry state, presents numerous large openings which are obviously the sockets into which pulp-papillæ have extended, so that the milk teeth show a commencement of the remarkable histological structure characteristic of the permanent teeth.

But important as a knowledge of the presence of a milk dentition in *Orycteropus* is, it does not at present render any easier the difficult questions as to the phylogeny and systematic position of that animal. Although called an Edentate, it has always been recognized as possessing many characters exceedingly different from those of the typical American members of the order.¹ It has in fact been placed with them rather on account of the inconvenience of forming a special order for its reception than because of its real relationship to them. Now, as they are either altogether toothless or else homodont and monophyodont (apart from the remarkable exception of *Tatusia*), it seems more than ever incorrect to unite with them the solitary member of the *Tubulidentata*, toothed, heterodont, and diphyodont, and differing from them in addition by its placentation, the anatomy of its reproductive organs, the minute structure of its teeth, and the general characters of its skeleton.

But if *Orycteropus* is not genetically a near relation of the Edentates, we are wholly in the dark as to what other Mammals it is allied to, and I think it would be premature to hazard a guess on the subject. Whether even it has any special connection with *Manis* is a point about which there is the greatest doubt, and, unfortunately, we are as yet absolutely without any palæontological knowledge of the extinct allies of either. *Macrotherium* even, usually supposed from the structure of its phalangeal bones to be related to *Manis*, has lately proved (see Osborn, *American Naturalist*, vol. xxii. p. 728, 1882) to have the teeth and vertebrae of a Perissodactyle Ungulate, and one could not dare to suggest that the ancestors of *Manis* or *Orycteropus* were to be sought in that direction. Lastly, as the numerous fossil American Edentates do not show the slightest tendency to an approximation towards the Old World forms, we are furnished with an additional reason for insisting on the radical distinctness of the latter, whose phylogeny must therefore remain for the present one of the many unsolved zoological problems.

Physical Society, January 17.—Prof. W. G. Adams, Vice-President, in the chair.—Owing to the unavoidable absence of Mr. F. B. Hawes, his paper on a carbon deposit in a Blake telephone transmitter was postponed.—Dr. S. P. Thompson made a communication on electric splashes, and illustrated his subject by beautiful experiments on the production of Lichtenberg's figures. The author has recently investigated these phenomena as modified by varying the conditions under which

¹ On this subject see especially Flower, "On the Mutual Affinities of the Animals composing the Order Edentata," *Zool. Soc. Proc.*, 1882, p. 358 *et seqq*.