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THE

INTELLECTUAL OBSERVER

REVIEW OF NATURAL HISTORY

MICROSCOPIC RESEARCH

AND

RECREATIVE SCIENCE

VOLUME XII.

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THE INTELLECTUAL OBSERVER.

AUGUST, 1867.

NOTES ON STAR-STREAMS.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

(*With a Coloured Plate.*)

To those who rightly appreciate its meaning, the Milky Way is the most magnificent of all astronomical phenomena. However opinions may vary as to the configuration of the star-streams composing this object, no doubt now exists among astronomers that the Milky Way is really a bed of suns, some doubtless, falling short of our own sun in brilliancy, but many probably surpassing it. Around these suns, we may fairly conceive, there revolve systems of dependent orbs, each supporting its myriads of living creatures. We have afforded to us a noble theme for contemplation, in the consideration of the endless diversities of structure, and of arrangement, which must prevail throughout this immensity of systems.

I propose to examine what is known of this marvellous object, and to present some considerations which appear to me to have an important bearing on the views we should form of its structure.

As the complete figure of the Milky Way is not easily gathered from most star-maps that I have met with, and is incorrectly delineated in many, I have drawn out, in Figs. 1 and 2, that zone of the heavens which contains the Milky Way. The advantage of selecting a zone, in this way, is that the whole object can be presented with very little distortion. If the strips represented in the figure were connected, and the long strip thus formed were bent into a circular belt, the complete figure of the galaxy (as exhibited on a celestial globe) would be satisfactorily represented. Owing to the irregularity of the object, it was not possible to include the whole (and also certain stars necessary to the treatment of the subject), without selecting a zone along which the galaxy is not absolutely central. I think, however, that the reader will find little difficulty on this account.

The figure here given to the Milky Way, is that I have adopted in my star-maps, my authorities being chiefly Johnstone's Atlas of Modern Astronomy, and Sir J. Herschel's description of the galaxy; but in the northern portion the figure given in the Society's maps has occasionally been followed. I will here epitomize Herschel's description, the most complete yet given. The reader will see that it corresponds closely with the configuration adopted in the illustrative figures.

The galaxy traverses the constellation Cassiopeia. Thence it throws off a branch towards α Persei, prolonged faintly towards the Pleiades. The main stream, here faint, passes on through Auriga, between the feet of Gemini and the bull's horns, over Orion's club, to the neck of Monoceros. Thence, growing gradually brighter, the stream passes over the head of Canis Major, in a uniform stream, until it enters the brow of Argo, where it subdivides. One stream continues to γ Argus, the other diffuses itself broadly, forming a fan-like expanse of interlacing branches which terminate abruptly in a line through λ and γ Argus. Here there is a gap, beyond which the Milky Way commences in a similar fan-shaped grouping, converging on the brilliant (and in other respects remarkable) star, η Argus. Thence, it enters the Cross by a narrow neck, and then directly expands into a broad, bright mass, extending almost to α Centauri. Within this mass is a singular cavity known as the Coal-sack. At α Centauri the Milky Way again subdivides, a branch running off at an angle of 20°, and losing itself in a narrow streamlet. The main stream increases in breadth, until "making an abrupt elbow," it subdivides into one continuous but irregular stream, and a complicated system of interlacing streams covering the region around the tail and following claw of Scorpio. A wide interval separates this part of the galaxy from the great branch on the northern side, which is seen in Fig. 2, terminating close on β Ophiuchi.

The main stream, after exhibiting several very remarkable condensations, passes through Aquila, Sagitta, and Vulpecula to Cygnus. In Cygnus there is a "confused and patchy" region, marked by a broad vacancy, not unlike the Coal-sack. From this region there is thrown off the offset to β Ophiuchi already mentioned; the main stream is continued to Cassiopeia.

There only remains to be noticed "a considerable offset or protuberant appendage," thrown from the head of Cepheus directly towards the pole.

A word as to the changes in the appearance and position of the Milky Way from month to month, at any given hour. Selecting ten o'clock in the evening, as the most convenient hour, we have the following variations of configuration:—At the winter solstice the Milky Way passes nearly through the zenith, crossing the horizon towards the south-east and north-west. Its brightest part is low down towards the last named quarter, where the constellation Cygnus lies close to the horizon. One month later, the Milky Way crosses the horizon towards the south-south-east, and north-north-west, and is bowed some 20° from the zenith towards the west-south-west. Cygnus is now half-set. Yet another month, and the Milky Way is found crossing the northern and southern points of the horizon, and bowed about 40° from the zenith towards the west—Cygnus more than half set. At the Vernal Equinox, the Milky Way crosses the horizon towards the south-south-west, and north-north-east, and is bowed upwards of 50° from the zenith towards the west-north-west. One month later (that is about the 20th of April), and we find the Milky Way crossing the horizon towards the west somewhat southerly, and towards the east somewhat northerly, and only raised about 20° above the northern horizon. It is now easy to follow the remaining changes without special comment. The eastern end travels southwards, the western northwards, along the horizon, the central part approaching the zenith, just as hitherto it has been seen to leave the zenith. The bright parts in Cygnus and Aquila are more and more favourably seen as they approach the zenith, being best seen in July and August (at 10 P.M.). About this time we see the southern portion of the Milky Way somewhat beyond Antares (the heart of Scorpio), whereas six months before the greatest range on the opposite side (including nearly the whole of the gap in Argo) had been visible. At the end of October the Milky Way (at 10 P.M.), is seen vertically overhead, and crossing the horizon towards the east and west quarters, the western half being the most conspicuous.

Galileo was the first to prove, though earlier astronomers had entertained the notion, that the Milky Way is composed of a vast number of stars, crowded closely together. But no attempt was made to offer a theory of its structure until in 1754, Thomas Wright, in his "Theory of the Universe," propounded views closely according with those entertained at the present time. This philosophic observer, having examined a portion of the galaxy with a reflecting telescope, only one foot in focal length, came to the conclusion that our sun is in the midst of a vast stratum of stars; that it is when we look along the direction in which this stratum extends, that we see the zone of light constituting the Milky Way; and that as the line of sight is inclined at a greater and greater angle to the mean plane of the stratum, the apparent density of the star-grouping gradually diminishes.

But it is to Sir W. Herschel, and the supplementary labours of Sir J. Herschel, that we owe the more definite views at present entertained respecting the Via Lactea. The elder Herschel, whose nobly speculative views of nature were accompanied by practical common sense, and a wonderful power of patient observation, applied to the heavens his now celebrated method of gauging. He assumed as a first principle, to be modified by the results of observation, that there is a tolerable uniformity in the distribution of stars through space. Directing his twenty-feet reflector successively towards different parts of the heavens, he counted the number of stars which were visible at any single view. The field of view of this reflector was 15′ in diameter, so that the portion of the sky included in any one view was less than one-fourth of that covered by the moon. He found the number of stars visible in different parts of the heavens, in a field of view of this size, to be very variable. Sometimes there were but two or three stars in the field; indeed, on one occasion he counted only three stars in four fields. In other parts of the heavens the whole field was crowded with stars. In the richer parts of the galaxy as many as 400 or 500 stars would be visible at once, and on one occasion he saw as many as 588. He calculated that in one quarter of an hour 116,000 stars traversed the field of his telescope, when the richest part of the galaxy was under observation. Now, on the assumption above-named, the number of stars visible when the telescope was pointed in any given direction was a criterion of the depth of the bed of stars in that direction. Thus, by combining a large number of observations, a conception—rough, indeed, but instructive—might be formed of the figure of that stratum of stars within which our sun is situated.

One section of the galactic nebula, as determined from Herschel's observations, is given in Figure 3. The projections extending to the left correspond to those portions of the

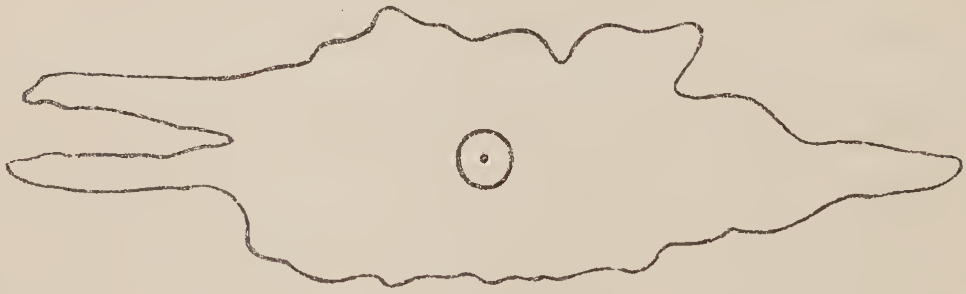


Fig. 3.

particular great circle considered, which cross the double part of the Milky Way; the opposite projection represents the portion crossed by the single stream; while the comparative flattening of the central part indicates the gradual diminution of star-density in directions removed from the galactic zone. It is, of course, to be understood that Herschel was far from supposing that such a figure correctly represented the figure of the section. He looked upon it as affording but a rough indication of the true figure. He had indeed noticed, so early as 1785, that there is a tendency in the Milky Way to cluster around definite regions of the heavens; and he saw that the fact of such clustering was sufficient to account for many irregularities of the figure, quite irrespectively of the absolute extent of the Milky Way in space. If we are looking from a height at the lights of a large town, we may fairly assume that a row of many lights very closely ranged, lies at a greater distance from us than another row containing lights more widely dispersed, *if* we have reason to suppose that throughout all the streets of the town the lights are separated by distances approximately equal. But if we have reason to suspect that there are some streets lighted more fully than others, the inference would be no longer valid. And, again, Herschel suspected that there are stars so large, as to bear a sort of sway among other stars by superior attractive influence. Here, then, was another element of difficulty, since it becomes clear (1) that the brilliancy of a star is no positive evidence of proximity; and (2) that there may be (besides the obvious clusterings already considered) laws of systematic distribution, which might largely modify the evidence afforded by star-gauging. For instance, returning to the illustration given above, if we have reason to suspect that there are many lights of superior brilliancy, in some parts of a town, and that further there are in some streets laws of arrangement among the lights, or that there are irregularities of surface-contour, which produce here and there a greater or less foreshortening than would result on a level ground, we should have to make allowance for these points in attempting to form an estimate of the distances at which the different parts of the town are removed from us.

Still, the results obtained by Sir W. Herschel have very properly been accepted as affording general evidence of high value.

Sir J. Herschel, during his residence at the Cape of Good Hope, carried out an extensive series of observations of the southern heavens. Applying his father's method of gauging, with a telescope of equal power, he obtained a result agreeing, in a most remarkable manner, with those obtained by Sir William Herschel. It appeared, however, that the southern hemisphere is somewhat richer in stars than the northern, a result which has been accepted as indicating that our system is probably somewhat nearer the southern than the northern part of the galactic nebula.

Combining the results obtained by the two Herschels, we should assign to the stratum of stars a figure somewhat resembling that of the solid cloven disc exhibited in Figs. 4 and 5. The latter figure, being a side view, gives the figure of the

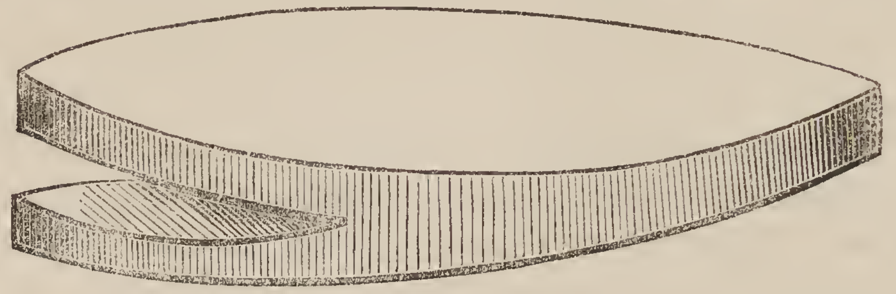


Fig. 4.

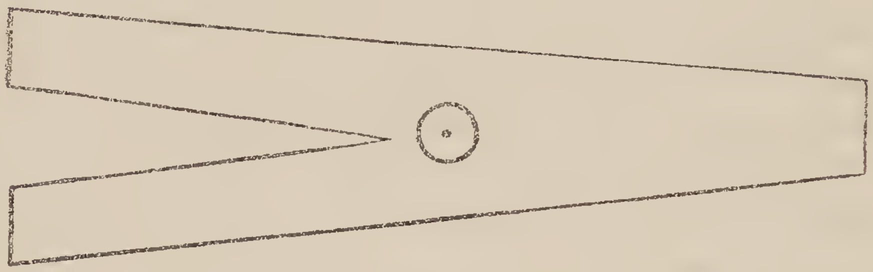


Fig. 5.

imaginary section which appears so often in works on astronomy. In Figs. 3 and 5 the small circle near the centre indicates the probable extent (on the theory in question) of the sphere within which stars down to the fourth magnitude may be supposed to be included.

The main difficulties in attempting to form an estimate of the real configuration of the galactic nebula are those which have been already mentioned. Have we evidence confirming or disproving (1) the tendency to clustering suggested by the elder Herschel, (2) the possible variability among star-magnitudes, and (3) of influences exerted by large stars in guiding or swaying others? It appears to me that there are indications of a very obvious and important character, which have been either altogether unnoticed, or much less noticed than they deserve. In considering these indications, I would refer the reader chiefly to Figs. 1 and 2; but some portions of the evidence cannot be thoroughly understood without reference to star-maps, in which (at a single view, if possible) the course of the Milky Way is exhibited in a manner which enables us at once to determine its relations to the constellations not included in these figures. I write with my black star-maps before me, my object being to consider the special evidence afforded by stars of the leading magnitudes. It may seem (and, indeed, on the assumption of any approach to uniformity in the true magnitudes, or distribution of stars, it must necessarily be) a very imperfect method to refer to star-maps including only the first five magnitudes, still more to consider the first four magnitudes which are alone represented in Fig. 1. It is obvious that if our sun is placed within such a stratum as is exhibited in Figs. 3, 4, and 5, no evidence whatever as to the structure of that stratum can be afforded by considering the comparatively few stars included within the small central circle. But it is this very fact on which I wish to dwell. If any connection *does* appear between the configuration of our galaxy, and the arrangement of stars which are assumed to be much nearer to us than the Milky Way, it will be obvious that we must somewhat modify the views illustrated by these figures.

Now, taking Figs. 1 and 2, I think one can trace a connection between the stars there depicted, and that stream of nebulous light which the view we are examining teaches us to consider as at an indefinite distance beyond those stars. In the northern portion, perhaps, the connection is not very remarkable. We see that a large number of the brighter stars lie on or near the Milky Way, but it would require the examination of a somewhat wider zone than that here presented to exhibit this arrangement as positive evidence of aggregation. However, I think no one who has attentively examined the glories of Orion, the richly-jewelled Taurus, the singular festoon of stars in Perseus, and the closely-set stars of Cassiopeia, but must have felt that the association of splendour along this streak of the heavens is not wholly accidental. The stars here seem to form a system, and a system which one can hardly conceive to be wholly unconnected with the neighbouring stream of the Milky Way. But in the southern portion the arrangement is yet more remarkable and significant. From Scorpio, over the feet of the Centaur, over the keel of Argo, to Canis Major, there is a clustering of brilliant stars, which it seems wholly impossible not to connect with the background of nebulous light. It is noteworthy, also, that this stream of stars merges into the stream commencing with the group of Orion already noticed. Nor is this all. It is impossible not to be struck by the marked absence of stars in that region of the sky which lies in the upper right-hand corner of Fig. 2. One has the impression that the stars have been attracted towards the region of the stream indicated, so as to leave this space comparatively bare.

Now, this last circumstance would appear less remarkable if the paucity of stars here noticed were common also in parts of the heavens far removed from the Milky Way. But this is not the case. Beyond this very region, which we find so bare of stars, we come upon a region in which stars are clustered in considerable density, a region including Crater, Corvus, and Virgo, with the conspicuous stars Algores, Alkes, and Spica. But, what is very remarkable, while we can trace a connection between the stream of bright stars in Fig. 2, and the stream of nebulous light in the background, it is obvious that the two streams are not absolutely coincident in direction. The stream lies (in the figure) above the Milky Way near Scorpio, crosses it in the neighbourhood of Crux, and passes below it along Canis Minor, Orion, and Taurus. Does the stream return to the Milky Way? It seems to me that there is clear evidence of a separation near Aldebaran, one branch curving through Auriga, Perseus, and Cassiopeia, the other proceeding (more nearly in the direction originally observed) through Aries (throwing out an outlier along the band of Pisces), over the square of Pegasus, and along the streams which the ancients compared to water from the urn of Aquarius (but which in our modern maps are divided between Aquarius and Grus). The stream-formation here is very marked, as is evident from the phenomenon having attracted the notice of astronomers so long ago. But modern travels have brought within our ken the continuation of the stream over Toucan, Hydrus, and Reticulum (the two latter names being doubtless suggested by the convolutions of the stream in this neighbourhood). Here the stream seems to end in a sort of double loop, and it is not a little remarkable that the Nubecula Major lies within one loop, the Nubecula Minor within the other. It is also noteworthy that from the foot of Orion there is another remarkable stream of stars, recognised by the ancients under the name of the River Eridanus, which proceeds in a sinuous course towards this same region of the Nubeculæ.

Having thus met with evidence—striking at least, if not decisive,—of a tendency to aggregation into streams, let us consider if, in other parts of the heavens, similar traces may not be observable. We traced a stream from Scorpio towards Orion, and so round in a spiral to the Nubeculæ. Let us now return to Scorpio, and trace the stream (if any appear) in the contrary direction. Now although over the northern hemisphere star-streams are not nearly so marked as over the southern, yet there appears a decided indication of stream-formation along Serpens and Corona over the group on the left hand of Bootes to the Great Bear. A branch of this stream, starting from Corona, traverses the body of Bootes, Berenice's Hair, the Sickle in Leo, the Beehive in Cancer, passing over Castor and Pollux in Gemini, towards Capella. A branch from the feet of Gemini passes over Canis Minor, along Hydra (so named doubtless from the obvious tendency to stream-formation along the length of this constellation), and so to the right claw of Scorpio. Four small stars of Hydrus are indicated in Fig. 2 between Scorpio and Centaurus near the upper edge of the figure.

One other remarkable congeries of stars is to be mentioned.

From the northern part of the Milky Way there will be noticed a projection towards the north pole from the head of Cepheus. This projection seems to merge itself in a complex convolution of stars forming the ancient constellation Draco, which doubtless included the ancient (but probably less ancient) constellation Ursa Minor. After following the convolutions of Draco, we reach the bright stars Alwaid and Etanin (β and γ) of this constellation, and thence the stream passes to Lyra, where it seems to divide into two, one passing through Hercules, the other along Aquila, and curving upwards (see Fig. 1) into the remarkable group Delphinus.

The streams here considered, include every conspicuous star in the heavens. But the question will at once suggest itself, whether we have not been following a merely fanciful scheme, whether all these apparent streams might not very well be supposed to result from mere accident. Now, from experiments I have made, I am inclined to believe that in any chance distribution of points over a surface, the chance against the occurrence of a single stream so marked as that which lies (in part) along the back of Grus, or (to take one within our figure) as the curved stream of bright stars along Scorpio, is very great indeed. I am certain that the occurrence of *many* such streams is altogether improbable. And wherever one observes a tendency to stream-formation in objects apparently distributed wholly by chance, one is led to suspect, and thence often to detect the operation of law. I will take an illustration, very homely perhaps, but which will serve admirably to explain my meaning. In soapy water, left in a basin after washing, there will often be noticed a tendency to the formation of spiral whorls on the surface. In other cases there may be no spirality, but still a tendency to stream-formation. Now, in this case, it is easy to see, that the curved bottom of the basin has assisted to generate streams in the water, either circulating in one direction, or opposing and modifying each other's effects, according to the accidental character of the disturbance given to the water in the process of washing.* Here, of course, there can be no doubt of the cause of the observed phenomena; and I believe that in every case in which even a single marked stream is seen in any congeries of spots or points, a little consideration will suggest a regulating cause to which the peculiarity may be referred.

It is hardly necessary to say that, if the stream-formation

* Sometimes, a singular regularity of curvature is noticed, and a spiral is formed closely resembling in configuration some of the great spiral nebulæ, as drawn by Lord Rosse, so that one is tempted to see in the centrifugal tendency of the disturbed water, and the centripetal effects caused by reflection from the basin's surface, causes which may in some sense illustrate the laws operating in wider domains of space.

I have indicated is considered to be really referable to a systematic distribution, the theory of a stratum of stars distributed with any approach to uniformity, either as respects magnitude or distance must be abandoned. It seems to me to be also quite clear that the immense extent of the galaxy as compared with the distances of the 'lucid' stars from us, could no longer be maintained. On this last point we have other evidence, which I will briefly consider.

First, there is the evidence afforded by clusterings in the Milky Way. I will select one which is well known to every telescopist, namely, the magnificent cluster on the sword-hand of Perseus. No doubt can be entertained that this cluster belongs to the galactic nebula, that is, that it is not an *external* cluster: the evidence from the configuration of the spot and from the position it occupies, is conclusive on this point. Now, within this spot, which shows no stars to the naked eye, a telescope of moderate power reveals a multitude of brilliant stars, the brightest of which are of about the seventh magnitude. Around these there still appears a milky unresolved light. If a telescope of higher power be applied, more stars are seen, and around these there still remains a nebulous light. Increase power until the whole field blazes with almost unbearable light, yet still there remains an unresolved background. "The illustrious Herschel" says Professor Nichol, "penetrated, on one occasion, into this spot, until he found himself among depths, whose light could not have reached him in much less than 4000 years; no marvel that he withdrew from the pursuit, conceiving that such abysses must be endless." It is precisely this view that I wish to controvert. And I think it is no difficult matter to show at least a probability against the supposition that the milky light in the spot is removed at a vast distance behind the stars of the seventh magnitude seen in the same field.

The supposition amounts, in fact, to the highly improbable view that we are looking here at a range of stars extending in a cylindrical stratum directly from the eye—a stratum whose section is so very minute in comparison with its breadth, that, whereas the whole field within which the spot is included is but small, the distance separating the nearest parts of the group from the farthest, is equivalent to the immense distance supposed to separate the sphere of seventh magnitude stars from the extreme limits of our galaxy. And the great improbability of this view is yet further increased, when it is observed that within this spot there is to be seen a very marked tendency to the formation of minor streams, around which the milky light seems to cling. It seems, therefore, wholly improbable that the cluster really has that indefinite longitudinal extension suggested by Professor Nichol; I think, therefore, that the milky light comes from orbs really smaller than the seventh magnitude stars in the same field, and clustering round these stars in reality as well as in appearance.

The observations applied to this spot may be extended to all clusters of globular form; and where a cluster is not globular in form, but exhibits, on examination, either (1) any tendency within its bounds to stream-formation, or (2) a uniform increase in density as we proceed from any part of the circumference towards the centre, it appears wholly inconceivable that the apparent cluster is—not really a cluster, but—a long range of stars extending to an enormous distance directly from the eye of the observer. When, in such a case, many stars of the higher magnitudes appear within the cluster, we seem compelled to admit the probability that they belong to it; and, in any case, we cannot assign to the farthest parts of the cluster a distance greatly exceeding (*proportionally*) that of the nearest parts.

Of a like character is the evidence afforded by narrow streams and necks within the galactic circle. If we consider the convolutions over Scorpio, it will seem highly improbable that in each of these we see, not a real convolution or stream, but the edge of a *roll* of stars. For instance, if a spiral roll of paper be viewed from any point taken at random, the chances are thousands to one against its appearing as a spiral *curve*, and, of course, the chance against several such rolls so appearing is indefinitely greater. The fact that we are assumed to be not very far from the supposed mean plane of the Milky Way would partly remove the difficulty here considered, if it were not that the thickness and extent of the stratum, as compared with the distances of the lucid stars must necessarily be supposed so very great, on the assumption of any approach to uniformity of distribution.

Evidence pointing the same way is afforded by circular apertures in the galaxy, or indeed by apertures of other forms, since a moment's inspection of Figs. 3 and 5 will show the improbability of any tunnelling (so to speak) through the star stratum, being so situate as to be discernible from S. Another peculiarity of these cavities is also noticeable; whereas on the borders of every one there are many lucid stars, or in some cases two or three very bright stars, *within* the cavity there is a marked paucity of stars. This phenomenon seems to indicate a much closer connection between the brighter stars, and the milky light beyond, than is supposed in the stratum theory. One can hardly conceive the phenomenon to be wholly accidental.

There are some other points on which I would fain dwell, but space will not permit me. I may, perhaps, on another occasion, return to the consideration of the subject. For the present, I will merely note that there are peculiarities in the distribution of double and multiple stars, in the position in which temporary stars have made their appearance, and in the distribution of nebulæ, which seem very worthy of notice.

One point, however, immediately connected with my subject, remains to be mentioned. I have traced streams of stars *more* conspicuous than those forming the Milky Way: we have also evidence of streams of light yet more delicate and evanescent than the light of our galaxy. In Sir John Herschel's great work on the southern skies, he notes the frequent recurrence of "an exceedingly delicate and uniform dotting, or *stippling* of the field of view by points of light too small to admit of any one being steadily or fully examined, and too numerous for counting, were it possible so to view them." In thirty-seven places he detected this remarkable and significant phenomenon; a phenomenon so faint, that he says, "The idea of illusion has continually arisen subsequently;" an idea well befitting the modesty of the philosophic observer, but which those who appreciate Sir John Herschel's skill as an observer will be very unwilling to accept. As Professor Nichol remarks, "It is enough to read from Herschel's note-book—'I feel satisfied the stippling is no illusion, as its dark mottling moves with the stars as I move the tube to and fro'—to feel convinced that the phenomenon is real." Now, a remarkable fact connected with those observations is, that when Sir J. Herschel marked down in a star-chart the places in which he had detected this nebulous appearance, he found that, "with the exception of *three*, which appeared outlying and disconnected, they formed several *distinct but continuous streams.*"

JAPAN, AND ITS CURRENCY.

BY JOSEPH NEWTON, H. M. MINT.

It is highly probable, if it be not morally certain, that, ere many years shall have passed away, the thick veil of mystery which has so long, and so effectually concealed from us an exact knowledge of the laws which govern, and the peculiar habits which distinguish the inhabitants of Japan, will be removed. Such a consummation we believe must result from the more enlightened, and, it may also be said, far more rational mode of conducting negotiations with the authorities of that strange empire of islands which now prevails. This country, indeed, is particularly fortunate at present in having as its chief representative at the Court of the Tycoon so able a diplomatist, and so dispassionate a man as Sir Rutherford Alcock. If it be true that—

> "A wise physician skilled our woes to heal,
> Is more than armies for the public weal,"

it is equally certain that a talented and honest statesman may contribute largely to the promotion of the social and commercial intercourse, and the happiness of nations. In time past it has been too much the custom for ambassadors and others, while "dressed in a little brief authority," to play very "fantastic tricks" indeed with those to whom they were accredited, and thus to create, or widen breaches instead of promoting peace and confidence. The fact, which is sustained by abundant evidence, has had the effect, in too many instances, of preventing instead of aiding the extension of commerce, and thereby arresting the progress of civilization and of Christianity itself.

The manner in which our intercommunication with the Japanese has been conducted during the last few years is happily not amenable to any such painful criticism. Confidence, it has been truly asserted, is a "plant of slow growth," but it appears to be one in process of rapid cultivation between England and Japan, and we all know the value of the production when fully matured. At this moment, there are in this country many intelligent young Japanese, some of them of noble birth, and destined for future legislators, under course of educating and training in Great Britain, whilst several of the vexatious restrictions which heretofore prevented the admission of Englishmen into Japan have disappeared. In short, a quiet and gradual, yet sure and steady revolution in these directions is going on, and its course is fraught with advantage to the peoples of both countries.

In the magnificent exhibition of fruits and flowers of the world's industrial gardens, now in full display at Paris, a considerable section is devoted to the exposition of articles from Japan. This forms, indeed, one of the most interesting portions of the wondrous show, and the ingenuity and originality manifested by the artists and workpeople who have prepared the articles are extraordinary. The fact of their transmitting so much valuable property to France, and taking so palpable an interest in the success of the gigantic undertaking, is in itself a strong proof that the Japanese are becoming fully alive to the advantages of international traffic; as it certainly proves that the councils of the Tycoon are not now under the influence of the old spirit of exclusiveness. Taking this, with other signs and portents of a similar character into account, there can be little danger in predicting that closer and far more familiar relations between the states of Europe generally and Japan will soon exist. Such a result cannot but be productive of good to all, and we hail its approach as a certain guarantee of increasing commercial prosperity, for this country especially.

If, however, there are externally to Japan, as it were, symptoms of an increasing intercourse such as has been indicated, there are corresponding symptoms within its own limits. To one of these latter it is proposed now to invite attention, namely, that of a proposed reformation of the metallic currency, which subject is under discussion by the Japanese Government. On matters of trade and currency which, as we so well know, have the most direct and vital bearing upon each other, the people of Japan have been instructed to some extent by the Dutch, with whom their trading transactions have hitherto been almost exclusively carried on. The information thus gained nevertheless was of a limited kind, and was probably sought for the purpose of meeting the internal wants of the country, and the consequence was the establishment of a system of coinage by no means cosmopolitan in its application, but, on the contrary, most narrow and artificial. The coinage of Japan was, however, it must be admitted, carefully devised, from one point of view, for its especial object, and its arrangement, though presenting startling anomalies to those unaccustomed to it, was not ill adapted to the daily necessities of the native population. The treaty which was completed in 1858, conjointly between Great Britain, America, and Japan, and which, to a very limited degree, opened up commerce between the three countries, first induced the Japanese to take into earnest consideration the nature and peculiarities of their own metallic currency, and its adaptability or otherwise to the purposes of foreign trade. This consideration was a fact forced upon them by pressure of the strongest influence which it is said can operate upon traders in general—that of self-interest. To make this point more clear and intelligible, let us describe the coinage of Japan, as it was arranged at the period just cited.

The principal coins circulating anterior to 1858, were the gold *kobang*, the gold *itzebu*, and the silver *itzebu*. The original kobang of gold was worth about 18*s*. $3\frac{3}{8}$*d*., or 18*s*. 5*d*. British. The gold itzebu was worth one-third of the gold kobang, and the silver itzebu equalled in value 1*s*. 4*d*. English money. At the time of the partial opening up of foreign trading transactions, the kobang circulated in Japan at *four* itzebus, although its European value was actually nearly *fourteen* itzebus! The immediate consequence of this latter circumstance on the sharp traders of America and England, was to induce them to buy up all the kobangs that came in their way at the Japanese valuation. By this proceeding, which no doubt enlightened the poor natives, and revealed to them the truly *commercial* character of their new customers, the latter gained large sums of money. The lesson thus practically taught and forcibly illustrated, was speedily learnt by the Japanese, who set about purchasing the remaining kobangs. The result necessarily was a total disappearance of the kobang from the channels of general circulation.

At present, therefore, gold and silver itzebus are the coins which mainly do duty as the circulating media of Japan. These are supplemented, however, by a silver coin known as the *itacune,* and which is equal in value to 12*s*. British. There are also in use among the humbler classes of the native population, subsidiary pieces of copper and of iron, and which are known individually as the *sen*, or cash.* Of these 376 are required to equal in value an English shilling. The obsolete kobangs were thin and oval-shaped discs of flattened gold, two inches in length, and $1\frac{1}{4}$ inches in width. Their weight averaged 200 English grains, and their almost universal degree of fineness was $\frac{161}{280}$. The ornamentation of the kobang was of the most primitive and simple nature. A kind of scroll like a floreated design at the top, and at the bottom of the obverse, was supposed to represent the coat of arms of the *Dairi.* Characters stamped in immediately beneath the upper coat of arms indicated the exact weight and value of the coin and the date of its production. Above the lower coat of arms was the name of the Master of the Mint at which it was

* The coarsest specimens of mintage extant, and not equal to the Chinese "cash," illustrated at page 121, vol. iii. of INTELLECTUAL OBSERVER.

minted, and who thus guaranteed and made himself responsible for its genuineness.* In the centre of the reverse was the official mark of the Director-general of the gold and silver coinages, and not unfrequently the names also of private individuals were imprinted on the same side to demonstrate that the coin had passed through their balances and not been "found wanting."

The gold itzebu, or, in the more vulgar tongue, the "itjib," weighs about 60 English troy grains, and its degree of fineness is $\frac{560}{1000}$. It is simply an oblong piece of gold plate metal, with rectangular ends admirably adapted for cutting holes in pockets. It is $\frac{3}{4}$ of an inch in width, and ornamented by a coat of arms, characters exemplifying its weight and value, and other official marks of the director of coins. The *itacune* is an oval-ended plate of silver, three inches in length, $1\frac{1}{2}$ inches in width, weighing 1160 English troy grains, and possessing a degree of fineness equal to $\frac{656}{1000}$. It is stamped with the Imperial arms, top and bottom, with declaration of current weight and value in the middle.

As has been stated, some of the consequences of the treaty were soon *felt* in a material sense. It was ascertained that one Mexican dollar was, approximately, equal in value to three itzebus. Foreign merchants were therefore entitled to demand three itzebus in exchange for a dollar, and as, by the provisions of the same treaty, permission was given for the free export of gold and silver, the gold coins could be obtained at the Mint price for the itzebus thus acquired, they were speedily bought up and exported. Is it surprising that the Japanese soon complained that they were being robbed under the actual conditions of the treaty which thus legalized fraud? Sir Rutherford Alcock, who was a witness of these evils, strenuously endeavoured to remove, or at least to mitigate them. He advised that the Government of the Tycoon should remodel its own currency laws, and his suggestions were partially adopted. Had they been wholly acted upon, greater good would have resulted. Timidity and prejudice prevented this and half measures, as usual, ended in disaster, or at any rate in failure.

Further counsel has been recently invoked from the English Government, and while we write, vigorous attempts are being made to effect a complete re-arrangement of the Japanese currency. It would be premature to adumbrate even the nature of the bases upon which the new system of currency will be placed, but it may be predicted with safety that decimilization will be one of them. At all events, it is undoubtedly true, that the experiences of the last few years have enlight-

* An arrangement existing in this country in the days of the Saxon Heptarchy.

ened the minds of the ministers of the Tycoon in respect of the highly important matters of trade, currency, and coinage, and it is therefore more than probable that on these, as on other questions, ideas once reckoned as inadmissible, will be warmly entertained, if not willingly realized.

The currency system of Japan, during the isolation of that country for many centuries from the rest of the world, was constructed on principles and framed with views so entirely different from those adopted by other countries within the circle of general commerce, that it may well be regarded, like other institutions of that strange nation, as a puzzle. The Government was able to control the coinage as it pleased, and there were only two channels by which it was attainable—the Dutch and the Chinese establishments at Nagasaki. *Now* all this is changed, or in process of transformation, and American coins are in partial circulation throughout Japan.

It will not astonish us very much to learn that a new Imperial Mint, fitted with the best machinery and most complete apparatus which England can furnish, is ordered, or that such an establishment is actually in course of construction at Nagasaki. In this respect, at least, Japan will presently be placed on an equal footing with America and the states of Europe. Who shall predict the future history of the mysterious nation in question, or guess even at the final extent of the moral, intellectual, and physical development of its people?

FUNGI OF THE PLAINS OF INDIA.

BY THE REV. M. J. BERKELEY, M.A., F.L.S.

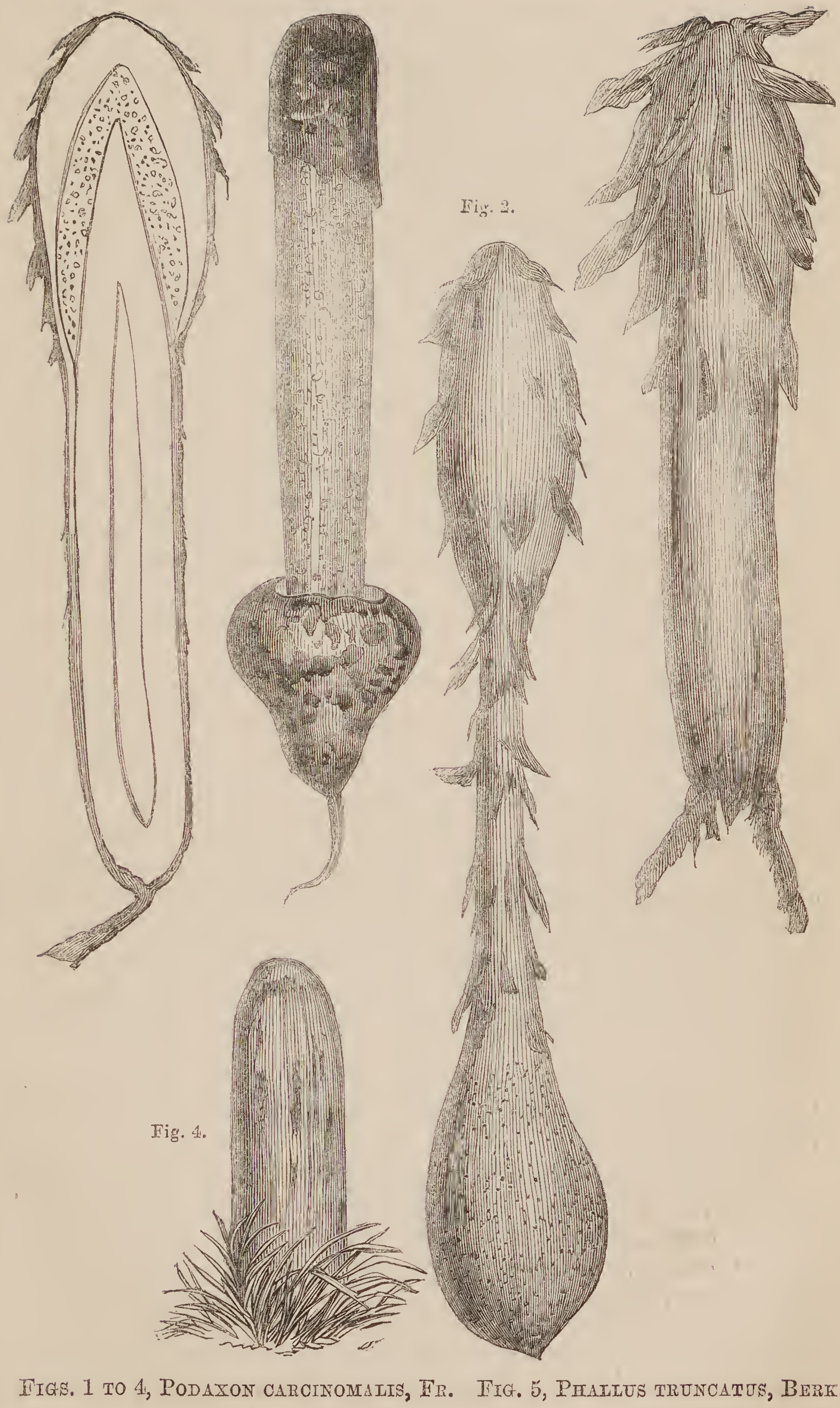
It is curious that so little comparatively has been done respecting the fungi of India. A large collection, indeed, was made in Sikkim and the neighbouring countries by Dr. Hooker, but with this exception, and a few from the Neilgherries, Paras Nath, the Northern Himalayas, and other scattered points, scarcely any have been recorded, and indeed, the mycology of few countries had been so little explored. It is, however, quite certain from what I have seen of collections made in Bombay by Dr. H. J. Carter and Capt. J. C. Hobson, and what I have received from my son, Capt. E. S. Berkeley, from the Madras Presidency, that there is a very rich harvest in store.

This of course applies chiefly to mountainous districts. It is not to be expected that the plains of India should be equally prolific, but there are some fine undescribed species to be met with occasionally; and I have already published in the *Introduction to Cryptogamic Botany*, some curious forms from the Deccan. It is, moreover, pretty certain that one or two of our hothouse fungi, as *Agaricus volvaceus* and *Agaricus Cepæstipes*, were originally imported from thence or some neighbouring country.

Many years ago, General Hardwicke had a number of drawings of fungi prepared for him at Dum-dum. Etchings of several of these were made on their transmission to Dr. J. E. Gray, but in the midst of numerous zoological engagements, the intention of publishing them was never carried out. They of course comprise a few cosmopolites, as *Polyporus lucidus* and *Schizophyllum commune*, and some widely distributed exotics, as *Irpex flavus* and *Dædalea sanguinea*; but they are especially interesting, as (together with two of the finest species of the Volvaria sub-genus of Agaricus, known in Europe, as *Agaricus volvaceus* and *A. bombycinus*) there are at least two new species of the same division, while amongst European forms such as *Agaricus campanulatus* and *A. papilionaceus*, we have others decidedly tropical or sub-tropical, to one or two of which I shall presently draw attention.

I have, however, been induced to look more especially to these fungi of the plains of India, in consequence of receiving some drawings of a few fine species from my son, who is now quartered at Masulipatam, most of which are undescribed, and of the one which has been noticed in several quarters from its singular habitat on the nests of white ants, and its peculiar

Fig. 1. Fig. 5. Fig. 3.



FIGS. 1 TO 4, PODAXON CARCINOMALIS, FR. FIG. 5, PHALLUS TRUNCATUS, BERK.

characters, *Podaxon carcinomalis,* no information has hitherto been received as to its condition when young, though adult specimens are not uncommon in collections. A very curious allied genus *Xylopodium,* occurs among General Hardwicke's collection, but without any details.

The species which I propose to describe are five in number, and they all worthy of record; the two latter being figured in the Dum-dum collection.

1. *Agaricus* (Lepiota) *malleus;* pileus nearly globose or mallet-shaped when young, then expanded and hemispherical, 3-9 inches across, white and silky spotted with dark brown scales of various breadth, especially towards the disc; fleshy; flesh white; stem 3-5 inches or more high, three quarters of an inch thick in the middle; attenuated upwards, bulbous below, stuffed with a delicate cottony substance, turning red when cut, externally brownish and nearly smooth; ring moderately broad, fixed near the top; gills pale yellowish, moderately broad, remote; attenuated behind. Just above the gills, the flesh of the pileus is very dark, though elsewhere white, the dark part being continuous with the outer coat of the stem; the tip of the stem is slightly sunk into the substance of the pileus.

Allied with some other exotic species to *A. clypeolarius,* but on a scale as large as that of *A. procerus,* like which, in all probability, it is esculent. We have, however, no information on the subject, nor do we know whether the Indian varieties of *Agaricus campestris,* like those of Italy, are unwholesome.

2. *Agaricus* (Lepiota) *alliciens,* bright yellow; pileus one and a half inch across, at first campanulate, then slightly expanded with a broad extremely-obtuse umbo, clothed with small pilose red-brown scales; margin striate when dry; stem three and a half inches high, two lines thick in the centre, slightly thickened below and attenuated above, flexuous, nearly smooth; gills thin, tinged with green; spores lemon-shaped.

On the roof of a house at Masulipatam. It differs obviously from *A. cepœstipes* in the brown persistent scales and lemon-shaped spores.

3. *Agaricus* (Hebeloma) *holophlebius;* pileus at first campanulate, then expanded and sub-hemispherical with a broad obtuse umbo, above two inches across, pale umber, darker in the centre, deeply rivulose with little sinuous narrow depressions, fleshy; flesh white; stem three inches high, two lines thick in the centre, bulbous below, slightly attenuated above, pallid, white within, stuffed; gills rounded in front, shortly adnate, pinkish at first, then pale brown; spores brown, elliptic-oblong.

This is one of the most interesting Agarics with which I am acquainted. The whole pileus is veined. *Agaricus phlebophorus*, which belongs to a different sub-genus, is the only one with which I can compare it.

4. *Podaxon carcinomalis*, Fries.; *Lycoperdon carcinomale*, Linn. fil. (Figs. 1 to 4). At first cylindrical, obtuse, white with a few brown elongated adpressed scales, gradually becoming clavate above, with the scales standing out, then with a distinct elliptic head; stem nearly smooth, penetrating deeply, and surrounded within the thick peridium with the hymenium, which is at first porous like the crumb of a loaf, and then, as in a puff-ball, filled with dusty spores. Varying considerably in size, sometimes six inches or more high.

It occurs at the Cape of Good Hope, where it was originally found by Thunberg, and has lately been gathered by Dr. Welwitsch on the western coast of Africa. It is probably common in India. It is said to have been used for dressing cancerous sores in Africa, whence it derives its specific name. Our woodcut represents it in three stages of growth, together with a section of the plant while the hymenium is still young.

5. *Phallus truncatus* (Fig. 5), n.s. Volva dark brown, pointed below, where it gives off a strongish rootlet, truncate above, not lobed, but with the margin entire; stem three inches high, half an inch thick in the centre, bright sienna brown inclining to orange, porous, attenuated at the base, capped above with the connate receptacle, above three quarters of an inch high, which is slightly reticulated, broadly truncate at the apex. Sometimes the cap carries up with it a portion of the white inner membrane of the volva.

Nearly allied to *Phallus aurantiacus*, Montagne, but differing in the remarkably truncate apex and brown volva. This, with the foregoing species, is figured in General Hardwicke's drawings.

A VISIT TO GLEN CLOVA—ITS GEOLOGY AND FERNS.

BY BERNARD HENRY WOODWARD.

Clova is a village situated in the extreme north-west of Forfarshire, the most picturesque part of that county, being in the midst of the Grampian mountains. It consists of a few small farm-houses and shepherds' cottages scattered along the glen from which it derives its name, and which is about ten miles in length and stretches from N. W. to S. E. The houses are clustered a little more thickly round the church, which stands about four miles from the head of the valley ; and near it, at the foot of Ben Reid, are the ruins of Clova Castle, formerly inhabited by the Ogilvy family, who have owned the parish since 1445. The present proprietor, the Earl of Airlie, one of their descendants, resides at Cortachie Castle, which we passed just before entering this glen on our road from Kirriemuir, the nearest railway station, though fifteen miles distant.

There is a good carriage-road the whole length of the glen, running by the side of the South Esk river, a fine trout stream rising in Loch Esk, a small lake at the head of Glen Bach-na-gairn, and flowing into the sea at Montrose. At the lower part of Clova Glen, the hills on each side are rounded, covered with fir-trees, and are about 1500 feet high, from which they gradually rise to upwards of 3000 feet above the sea level in the upper part, where they are quite bare of trees and very wild and precipitous. The valley widens considerably for the first four miles, and then draws in again. A considerable extent of the level ground at the bottom of the valley is ploughed, though the greater portion is left for pasturage, on which a good many Highland cattle are reared; which, together with the sheep that are turned loose to browse on the hills, afford a means of support to about 200 people, the present population of the parish. Some years ago, as is testified by the many ruined cottages in the glen, its inhabitants were three or four times as numerous, when they obtained a livelihood by the distillation of "mountain-dew"; but a more strict surveillance on the part of the excise officers stopped that lucrative pursuit. Last year the oat crop turned out very badly ; when we were there, in the latter part of August, many of the fields were quite green, and in some no ears were visible.

But we ought not to have said *level* ground, for it is only level in comparison, being covered with rounded hillocks, "moraines," formed of the debris deposited by the glacier which once filled this glen. Where its surface has been ploughed, the numerous boulders of granite, with which the glen and the valley of Strathmore to the south are strewn, have been used to build dykes to separate the fields. These boulders are chiefly of syenitic granite and gneiss, of which latter rock the hills at the top of the glen are composed, while those at the lower part are mica-slate.

We noticed on ascending the glen a strange murmur, quite distinct from the rushing and splashing of the South Esk in its numerous small falls and rapids, which seemed to pervade the whole air, continually growing louder as we advanced, and we also observed that the narrow, tortuous, silvery streaks running down the sides of the hills, became more frequent, and on a close approach found that these were small streamlets, which in their headlong course caused this murmuring sound with their miniature cascades, which made up by number what they wanted in strength. A succession of falls from the summits to the feet of the hills, caused them to appear white in the distance, though here and there they formed small still pools, which were fringed with mosses, and sheltered by rocks; on their sides were growing luxuriantly the delicate Oak fern, *Polypodium dryopteris*, together with the Beech fern, *P. phegopteris*, and the Brittle Bladder fern, *Cystopteris fragilis*.

Clova Glen separates at the north-west end into two narrower but wilder glens, that to the left being called Glen Dole, and the one to the right Bach-na-gairn. There is a bad carriage-road up the latter for four miles to a shooting-box, and beyond that a bridle-road leading over the hills and down Glen Muick to Balmoral. At the head of this glen is Loch Esk, where the South Esk river has its source, and forms a fine waterfall over sixty feet in height just below the loch. The scenery all along is very grand, surpassing the famed Spital of Glenshee.

Near the loch, which is on the borders of an extensive deer-forest covering sixty square miles of country, are a number of fine larch and spruce trees, planted some fourteen years ago, to afford shelter to the deer. Craig Ought, the hill at the commencement of this glen, which separates it from Glen Dole, is extremely precipitous on this side, and at its base is an immense quantity of rock, that has been thrown down in the course of years by the disintegrating action of frost. Many of the fractures being quite fresh, we had a good opportunity for inspecting the nature of the rock, which consisted principally of felstone, porphyry, and syenite; the latter varying very much in texture, some parts being extremely fine-grained, while others contained very large crystals of hornblende. In some the quartz was almost wholly absent, and in other parts it preponderated largely. The prevailing colour of the syenite is dark grey, and is heightened, in some places, by a considerable quantity of black mica. Higher up the glen, we found some granite containing pyrrhotine (magnetic iron pyrites), in which the felspar was flesh-coloured, as it is in the gneiss, which latter rock covers nearly the whole of Scotland to the north and west of this district.

In Glen Dole, which we explored on the Wednesday, there is not even a pathway, except those made by the sheep; and after we had passed a short distance beyond Dole farm-house, the last in Clova Glen, we did not see a single person during the whole day, until we had almost reached the same place on our return in the evening, when we saw a shepherd on the opposite hills!

Here the moraines are much more frequent and clearly defined than in Clova Glen. They are all covered, as are the hills, with heather, which was just coming into bloom. We followed the "White Water," as the branch of the South Esk flowing down this glen is called, for a couple of miles, and then turned with it up Glen Phee, where it forms a charming waterfall, or rather a succession of falls, which, at a short distance, look like one, and from the appearance of the spray give to the burn its name. The water, as is the case with all mountain streams which flow over peaty soil, is of a brownish colour. This is plainly seen in any of the numerous deep pools occurring here and there along its course, and affording good shelter for many a "lusty trout." Here we found the Brittle and the Toothed Bladder ferns, *Cystopteris fragilis* and *C. dentata*, growing luxuriantly, with the Oak and Beech ferns, *Polypodium dryopteris* and *P. phegopteris*; the two latter are very common throughout the Clova district at the bottoms of the valleys; also, in the moist crevices of the rocks, Wilson's film fern, *Hymenophyllum unilaterale*, and, higher up on the hills, splendid plants of the Holly fern, *Polystichum lonchitis*, with fronds two feet high. This was tolerably abundant; but we were unsuccessful in our search for *Woodsia ilvensis*, which has been found here by Dr. Balfour, as has also the *Woodsia hyperborea* in Glen Bach-na-gairn. The Hard fern, *Blechnum boreale*, grows to the summits of the hills, though it is rather stunted at the greater altitudes.

On Thursday we visited Loch Brandy, a mountain tarn, situated about half-a-mile to the east of the church, but at an elevation of 1300 feet above it, which made it a good hour's walk, for there is not even a foot-path up to it. On our ascent by the side of Corrie Burn, we noticed *Lastrea spinulosa*, *L. dilatata*, and *L. oreopteris*. The latter is very common throughout the district. *Polystichum lonchitis*, *P. angulare*, etc., the

Bilberry and the Mountain or Cloud-berry, *Rubus chamæmorus,* together with that pretty Alpine plant with silvery leaves, *Alchemilla alpina,* grow everywhere amongst the heather which covers the hills here; and we saw also a great many of those rare Alpine species for which Clova is such a noted locality.

Loch Brandy is about a mile and a half in circumference, and abounds in pike and trout. From the summit of the hills, which rise precipitately in a semicircle at the north of the Loch to about 700 feet above it, one obtains, on a fine day, a splendid view over the surrounding country to the south, along the Clova Glen, across the valley of Strathmore; while to the east, north, and west are to be seen nothing but mountains, and mountains beyond mountains, right away into the blue distance. A shepherd whom we met told us the names of a great many, but with such a Highland accent that we could catch only one here and there, amongst which were Loch-nagar, and Glas Miel, etc.

But we must not omit to point out the best means of access to Clova. We preferred travelling by sea from London to Edinburgh, to being shut up in a close railway carriage for twelve hours; and so took a steamer from Irongate Wharf, bound for Leith. We had a pleasant and quick passage down of only thirty-seven hours, on board the "Oscar," one of the swiftest of the Leith steamers, which are all noted for their speed, the weather being almost too calm; but on our return it was rather rough, which was a pleasant change. The "Oscar" is 240 feet long, by 30 feet broad, and of 900 tons burden. From the steamer one has a good view of a great portion of the eastern coast. We had to give the flat shore of Essex a wide berth, but approached land a little nearer when passing Suffolk and Norfolk, though almost the only objects to be seen on them were the Martello towers placed at intervals along the shore, and the two lighthouses on Orford Ness. At Cromer we first see cliffs. In crossing by the Wash we lose sight of land for some time. While passing the bold Yorkshire coast, we kept still closer to the shore, sighting Flamborough Head, at 7·15 on the Sunday morning, having left London at 10 the day before; next Filey Brig, Scarborough, with its ruined castle, Robin Hood's Bay, then Whitby, in the neighbourhood of which so many fossil ammonites are found, and of which the popular tradition runs:—

> "And how, of thousand snakes, each one
> Was changed into a coil of stone,
> When holy Hilda prayed."

The magnificent abbey, now in ruins, which forms a conspicuous object on the cliffs to the south of the town, was dedicated to that lady.

After this we did not see much of the land, owing to the curve of the coast-line, until we approached the Ferne and Staple Isles, and Lindisfarn, or Holy Island. The weather was so favourable that we sailed between the former and the shore. We passed within half-a-mile of St. Abb's Head just at sunset, and the sight of this fine headland alone, we felt, would have repaid us for coming by sea. The rock is a dark red colour, but, in the more sloping places, was covered with vegetation which, in the declining rays of the sun, appeared an unusually bright green; while here and there were patches of yellow lichen, and all the sheltered ledges were white with gulls, hundreds of which were flying about.

It was quite dark when we reached Tantallon Castle and the Bass Rock. We arrived at Leith at 11 o'clock the same night.

After staying a couple of days in Edinburgh and seeing a few of the "lions," including the charming Botanical Gardens, said to be the finest in Europe for their size, we took a steamer from Granton Pier to Stirling. The scenery on each side of the Forth is said to be very lovely, but as we were favoured with a Scotch mist and a little rain, we are not in a position to pass an opinion upon it. The numerous windings of the river between Alloa and Stirling, known as the "Links of Forth," are very remarkable.

We spent an hour or two looking over the Castle, which was for a long time a favourite residence of the Scottish kings, but is now used as a barrack; and a regiment of Highlanders were then stationed in it, who, in their kilts, added greatly to the picturesqueness of the scene.

It is situated on a hill, and which rises gradually from the east, but terminates abruptly in a precipice, below which is a large expanse of level country. The Wallace monument, a memorial tower now in construction on a lofty hill on the opposite side of the river, forms a conspicuous object in the landscape.

In the afternoon, we took the train on to Forfar, which we had determined to make our headquarters for a few days, for although it is in itself a very dull, uninviting town, there are several very interesting places within easy access. Our first excursion was to the famed coves and caves of Forfarshire, for which we took the train to Arbroath, where are the ruins of a fine Abbey founded by William the Lion, in 1178, who was afterwards buried in it; it was dedicated to St. Thomas à Becket. It was chiefly built in the early English or first pointed style of Gothic architecture. The church was 269 feet long, the nave and side aisles 65 feet broad, and about 67 feet high. Portions only of the nave and choir, the east and west ends, and of the south transept, now remain, but they exhibit some beautiful mouldings and details. The abbey gateway, upwards of sixty feet long, which was only unroofed at the commencement of the present century, is of rather a later date, and shows a dawning of the decorated or second pointed style. The chapter house, the most perfectly preserved portion of the building, is of two storeys, with a short spire at the south-west angle, and is now used as a museum for any relics found among the ruins.

About twelve miles S. by E. out to sea from Arbroath is the Bell Rock Lighthouse, built under the superintendence of Mr. Robert Stephenson, on a range of rocks that rise four feet above low water at spring tides; the outer casing is of Aberdeen granite, and its height 115 feet. It was commenced in 1807, and finished in 1811.

It derives its name from the circumstance of one of the abbots of Arbroath having had a bell fixed on it to warn mariners. This was wantonly cut down by a Dutch pirate, who was afterwards, it is said, wrecked upon it, in just retribution for his misdeed.

We walked along the cliffs to Auchmithie, a small fishing village about five miles to the north. The cliffs, here composed of old red sandstone, are extremely picturesque, being much indented and broken up by the action of the sea and weather, leaving here and there insulated rocks, and containing numerous caverns which penetrate in many places through projecting portions of the cliffs. Many of the caves are occupied by the sea at all times, others at high tide only, and some are altogether out of the reach of the water. One is called the Mason's Cave, from the appearance of the rocks at its entrance, which look at a short distance as though they had been built up artifically; another the Green Cave, from the luxuriant manner in which the Hart's Tongue fern, *Scolopendrium vulgare*, grows in it. We also found in this cavern a few stunted plants of the Sea-spleenwort, *Asplenium marinum*.

On Friday we confined ourselves to the immediate neighbourhood of Forfar, in order to see the ruins of Restennet Priory, situated about a mile to the east of the town. We passed on our way the source of the Lunan, a stream that originates at the head of Restennet marshes. It flows into the sea in Lunan Bay, a few miles south of Montrose, forming in its course Roscobie and Balgaries Lochs. Till the latter end of last century it also formed a loch where the Restennet marshes are now, and which was drained for the valuable marl it contained. The ruins of the priory of Restennet, or Rostinoth as it was originally spelt, are situated upon a small eminence in the marsh formerly an island in the loch.

The greater part of the walls of the church are almost entire, including the tower, which is surmounted by an octagonal spire. They have lately been repaired by the proprietor. The south-east and west walls of the cloisters are in a ruinous condition. The whole building appears to have been in the first pointed style of architecture, or that which prevailed in Scotland during the thirteenth century. It is believed to have been erected on the site of the old church of Rostinoth, founded by St. Boniface when he came into Scotland in the beginning of the seventh century. Growing in these marshes, near to Clocksbriggs station, we found the Marsh fern, *Lastrea thelypteris*.

We walked round Loch Feithie on our return to Forfar, a charming little lake entirely surrounded by woods, about half a mile to the south of Restennet; but it is much choked up by the soldier-weed. This loch contains no deposits of marl, "which," says Sir Charles Lyell, "is owing to there being no springs in it." It is only where a stream enters a lake, or where it is fed by springs, which may introduce a fresh supply of calcareous matter, that shells accumulate and help to form marl. For otherwise, the thin shells of one generation of mollusks in decomposing only afford sufficient nutriment to the succeeding races.

On Saturday we walked to the *vitrified forts*, situated a little to the west of the village of Aberlemno, on the north brow of the Finhaven hills, and five miles N. E. from Forfar. These hills form the southern boundary of the vale of Strathmore, above which they rise to the height of 600 feet, and so the fort occupies a most commanding situation. The origin of these vitrified forts, of which there are several in the country, though this one is the most extensive, goes so far back into antiquity, that not only the names, but even the races of their builders are unknown. The Finhaven fort is in shape a parallelogram, having its corners rounded off. It declines with the hill to the W., in length from E. to W., 476 feet, at the E. end its breadth is 83 feet, and at the W. 125 feet; the wall is from three to ten feet in height, but is supposed at one time to have been much higher. Great quantities of the stone have been carted away for mending the roads. In the west end of the fort there was a well, but this is now filled up. The fort is built of several kinds of stone, chiefly sandstone and gneiss, which have been fused together by the action of fire, a good substitute for cement. It must have required an immense amount of wood to vitrify such a large fort, but in those days that could easily have been obtained, for the whole of this district was once covered by forest, as is shown by the quantities of old wood that are found in the mossy and marshy grounds. In some of the hilly parts of Tartary and India, the nations still vitrify their forts instead of using cement.

We saw on our road several stone and "slate" quarries, in which we found several tails, spines, and teeth of fossil fish, but were not so fortunate as to obtain a specimen in anything like a perfect condition. The upper beds of the old red sandstone formation are very compact, and having good cleavage planes, are used as roofing-slates in the neighbourhood.

Near one of these quarries some soil had recently been removed, laying bare the surface of the rock, on which were well-defined glacial markings, and which, from their direction, had evidently been made by a glacier coming from Glens Prosen and Clova. In a field near Aberlemno are two of those curious sculptured stones, of which a good many exist in this part of Scotland, and concerning which volumes of theories have been written, conclusively proving that nothing whatever is known about them, neither by whom or for what purpose they were erected. They had figures of horses and men, and an ornament like a pair of spectacles, amongst other symbols, carved on them.

On the commencement of the following week we went by rail to Kirriemuir, a small town, six miles W. by N. from Forfar, and then drove to the Den of Airlie, twelve miles further. The Den is a most beautiful ravine, formed by the Airlie river, which flows down it. In some parts the sides are quite perpendicular, and over 400 feet in height, while in others they slope more gradually. The valley is well wooded, and in the shade and moisture many species of ferns abound, the most noteworthy of which is the Green Spleenwort, *Asplenium viride*.

We walked up the valley from Airlie Castle to the Reeky Linn, a magnificent waterfall, sixty feet in height. It is said to be one of the finest in Scotland. We returned to Kirriemuir by way of Lentrathan Loch and through Kingoldrum.

Kirriemuir is within an easy walk of Clova; and if any of our readers are in search of a place whereat to spend the holidays, we strongly recommend to their notice the latter; and to a lover of botany it is extremely attractive, for in few localities of equal size in the British isles have so many rare plants been noticed. And last, but not least, there is a very comfortable hotel, where the charges are very moderate, for at present this district has not been overrun by tourists.

ORIGIN OF THE CHEDDAR CLIFFS.

BY D. MACKINTOSH, F.G.S.

The Mendip range of hills, in Somersetshire, presents a striking instance of a truncated anticlinal fold or axis. According to Professor Ramsay, a mass of strata nearly a mile in thickness has been cut off from the summit by denudation, exposing the old red sandstone in the middle, with the carboniferous, or mountain limestone, dipping away on both sides. The outcrop of the limestone, under the old red, has been shaped into steep escarpments, with cliffs at intervals. A very remarkable line of upland cliffs runs from the Shuteshelve pass (between Sidcot and Axbridge) to Longbottom pass, and some distance beyond. It is here and there indented by cliff-bound ravines which, were they to become partially submerged, would differ very little in shape from inlets of the sea. Nearly on a level with the summit of this line of cliffs, there is an approximately horizontal table-land, which few geologists would hesitate to regard as a "plane of marine denudation." Beyond Longbottom pass, in a south-easterly direction, this table-land becomes irregular, and its south-west escarpment, facing the Cheddar plain, is indented with combes which are more or less cliffy, especially at their inner termination. A formation of Permian conglomerate, which in most places may be found fringing the base of the Mendip Hills, runs into these combes, proving that they must have been mainly excavated before or during the Permian period. The trumpet-shaped mouth of the Cheddar ravine might be classed among these combes, were it not that it must have been formed at a subsequent period, for its floor, as well as sides, consists of carboniferous limestone. This ravine, at first sight, suggests the idea (not confirmed by farther inspection) of the limestone ridge through which it passes, having been "rent in twain" from the top to the bottom.

The Cheddar ravine, though long celebrated, deserves something more in the way of description than the very brief notices that have hitherto appeared. In the preface to a legendary article in a late number of the *Gentleman's Magazine*, it is justly regarded as "one of the most gorgeous specimens of rocky scenery to be found in Europe. . . . The eye grows accustomed to Switzerland, but Cheddar is a continual surprise."* The object of the present paper is to give some

* In the *Penny Cyclopædia* it is alluded to as follows:—". . . the defile of Cheddar cliffs, with its long line of stupendous mural precipices, certainly among the most magnificent objects of this kind in Britain. . . ."

idea of its structure and extent from personal observations, and to consider the most probable way in which it has been formed.

Immediately to the north-east of the village of Cheddar, which stands on ground only a little elevated above high-water mark, there is a combe-shaped valley. Its sides gradually contract, and become more rocky and precipitous, until it forms a narrow winding gorge, with walls of limestone. About a quarter of a mile from the village the gorge becomes very narrow, and the cliffs, especially on the right hand side, very steep and even overhanging. For some distance beyond, the road runs along what may be called the Strait of Cheddar, after passing which the ravine gradually opens, and its sides become more sloping, until it loses its rugged grandeur of outline. In the most contracted part of the Strait the observer is so completely hemmed in by bare rocks as to require little to make him fancy himself in a mountain solitude remote from the habitations of mankind. When all is still in the neighbouring plain, the wind here often blows violently, and is deflected from cliff to cliff with a sound which, to the mind of a contemplative geologist, might suggest the idea of audible spectres of stormy billows which once may have followed the same course, as they rebounded from side to side of a narrow inlet of the sea. During the writer's first visit to this spot, numbers of rooks were soaring from precipice to precipice, and often appeared like black dots against a narrow strip of sky; while the resemblance to white ants presented by sheep browsing on ledges near the top of the cliffs furnished a much more impressive idea of their height than any process of measurement.

Some of the old women, who importunately press their services on the tourist as guides, will tell him that the Wind Cliff is 480 feet high. This cliff (to which no drawing can do justice) is certainly a most remarkable specimen of a literally mural precipice of considerable breadth, and at least 300 feet in height. It is *quite* perpendicular from top to bottom, excepting where it overhangs. It is a much finer and larger face of rock than the cliff at the entrance to Goredale in Craven, Yorkshire, and nearly twice the height of the rocky part of the High Tor, near Matlock, in Derbyshire. As regards continuous perpendicularity, I believe it is not equalled by any limestone cliff in the kingdom. Next to the Wind Cliff, the so-called Cathedral Rocks are the most impressive. They consist of several buttresses projecting forward from the main line of cliffs. Their sides are perpendicular, and their fronts overhanging. The height of the summit of one of these rocks above the level of the road at the bottom of the ravine has lately been ascertained to be about 420 feet. The way in which it was measured is deserving of notice. A worthy scientific gentleman of the neighbourhood ventured to crawl on to the summit from the grass-covered down behind, until he found himself on the brink of three precipices—those on the right and left perpendicular, the one in front overhanging. He dropped a line from the most extreme part of the brink, which went down without touching rock until the plummit struck a slightly-projecting terrace near the bottom of the ravine, and then fell on the road. There is probably no other part of England where a conformation of cliff-architecture would admit of a similar feat being accomplished. But our wonder at the cool intrepidity of the performer will not be so great when we consider that he was a member of the Society of Friends.

It has already been hinted that the Cheddar ravine is very tortuous. It consists of an alternating series of recesses and projections, or small bays and headlands. In some places there is a certain degree of correspondence between the hollows on one side and the protuberances on the other, which might at first lead one to fancy that the ravine is solely or mainly the result of a violent severance of the rocks; but a little observation will be sufficient to show that the two sides were never in contact. On the right, looking from Cheddar, the cliffs are very precipitous; on the left, they generally slope down into the ravine at a small angle.

The cliffs mainly consist of large faces of moss-covered rock, but the clefts and narrow terraces furnish a habitat for various plants, which add beauty to the sublimity of the scenery. Ivy and yew grow out of the fissures, and in various places may be found liverwort, polypody, meadow-rue, crimson mountain-pink, etc. The "screes"* at the bases of the cliffs have in many places acquired a covering of grass, and do not now appear to be in course of accumulation. The positions they occupy in some places would seem to indicate that they must have been thrown up against a wall of rock, or into a recess, rather than hurled down from above. The effects of the action of frost and rain, however, may be seen in favourable situations. The frost detaches angular fragments from incoherent parts of the cliffs, and from the under sides of rocky projections. The rain carries previously-detached fragments and chips down the "rakes," or vertical passages which indent the face of the cliffs. Vegetable mould and red loam are likewise washed down by rain from the top of the cliffs, and subjacent fissures. Nearly the whole surface of the Mendip Hills is covered with red loam, which fills up the fissures, and, to a certain extent, the caverns. Its derivation, and period or

* A convenient name used in the Lake district for the accumulated wrecks of cliffs and declivities.

periods of deposition are involved in mystery; but it seems to be generally admitted that it must have been a kind of sea-ooze left by retiring waters during one or more submergences of the land. In later times, it has been re-arranged by sub-aerial and subterranean fresh-water streams.

The Cheddar caves are regarded by the natives as the greatest source of attraction. One, in particular, has become very celebrated for its stalactites. But as it is probably surpassed in this respect by caves in Derbyshire and elsewhere, the main attraction of the Cheddar ravine must ever lie in the almost unparalleled grandeur of its cliff scenery. In this ravine there are many caves, little known and seldom visited, which present phenomena more interesting to the geologist than stalactitic concretions, however much the latter may resemble any earthly or unearthly objects the guide or the visitor may fancy. On the left side, walking from Cheddar, before reaching the Strait, there is a cave with a very conspicuous entrance at some height above the road. It has apparently been scooped out, or at least enlarged, by an inwardly-directed agent, such as sea waves, and not by an out-flowing fresh-water stream. On the right side, at various altitudes, there are many caves. In nearly all of them the roof is more or less rounded, and the sides here and there smoothly hollowed out into pot-shaped cavities. In short, the interior of these caves display obvious signs of the action of water, charged with a sufficient amount of solid matter to enable it to round and smooth limestone rock; and the position in which the rounded and smoothed surfaces often occur, would seem to point to the action of powerful waves as the only adequate explanation. It is true that fresh-water percolates through crevices in limestone districts, and the Cheddar brook has its visible source in several streams which flow out of subterranean cavities near the south-west end of the ravine; but it is not very difficult for one who is familiar with the peculiar forms resulting from the inward and upward gyratory action of the waves of the sea to distinguish these forms from marks left by fresh-water streams. The latter tend to wear their channels downwards, and can never produce smooth vaulted roofs, hanging or inverted pot-holes, arched entrances, and other characteristics of sea-worn caverns.

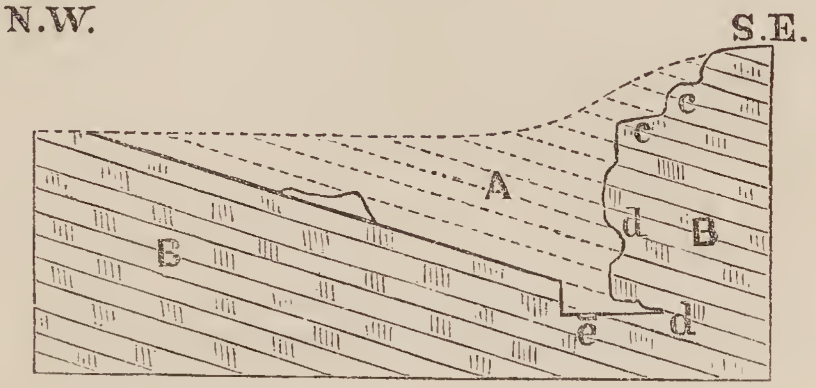
Mr. W. Boyd Dawkins (to whom the scientific world is so much indebted for the exploration of Wookey Hole Cavern, a few miles from Cheddar*), believes that the Cheddar ravine is an immense unroofed cave, the abstraction of the rocks once filling the now vacant space having been effected by atmo-

* See first paper on Wookey Hole, in the "Quarterly Journal of the Geological Society."

spheric agency. It is true that rain-water, especially when assisted by *humus* derived from the vegetable soil above, is capable of enlarging crevices. But the erosion resulting from its chemical action is limited to spaces where stalactitic and stalagmitic deposition is not going on. This deposition evidently rather tends to preserve caverns than facilitate their destruction. The detachment of chips from rocks by frost in favourable situations is a process likewise limited to spaces where the chips have not accumulated to too great an extent. All atmospheric agencies which can only remove matter a short distance must tend to choke up or glut their sphere of action. Without the assistance of a powerful transporting agent they can never, in such situations as the Cheddar ravine and its caves, make permanent progress in the great work of denudation. But supposing atmospheric action during millions and millions of years to be capable of producing a vacuity as large as the Cheddar ravine, its *form* would still remain to be explained. Sufficient time allowed, a colony of ants might be considered capable of rearing a mountain mass equal to the Alps, but an examination of the form of the Alps would at once forbid the idea of insects having been the architects. Atmospheric agents, whether operating above or under ground, are now producing nothing similar in form to the main features presented by the Cheddar ravine. That the cliffs have been modified in exposed situations by frost is evident, but the modification has been in the direction of *destroying* and not developing the characteristic forms of the cliffs. The same remark applies more or less to the action of fresh-water in caves.

The common notion that the Cheddar ravine is a crack or rent may, in a very limited sense, be correct. It is possible, if not probable, that at first there may have been a narrow winding fracture similar to that behind the High Tor at Matlock. It is, however, certain that no fracture ever occurred sufficient to disturb the angle at which the strata dip in a south-easterly direction, which on both sides of the ravine exactly corresponds. A very little observation will be sufficient to convince any one that the ravine has been mainly, if not entirely produced by the *abstraction* of an immense mass of limestone rock. The following diagram will show the stratigraphical structure of the locality, the dotted lines representing the strata which have been removed.

From the foregoing observations I think it must appear obvious that the *clean removal* of a stupendous quantity of rock must form the burden of any satisfactory explanation of the origin of the Cheddar Cliffs. It is true that in some places the rocks are now crumbling, but there is no agent (with the exception of man) to carry the detritus away. In most places the rocks have preserved their original smoothness and regularity of outline. Here and there concave undercuts run hori-



Section of Cheddar Ravine.—A, rocks removed; BB, remaining rocks; cc, terraces; dd, undercuts; e, road.

zontally along the the faces of cliffs, while at the base of others there are cavernous recesses with water-worn roofs. But the most instructive forms of rock surface are the planes caused by jointing and bedding. They show that the mode in which the adjacent blocks or masses were carried away was not a process of granular dissolution, nor even fragmentary dilapidation, but a bodily displacement. The cause must have been equivalent to the translation of large blocks of limestone. To borrow an illustration from the well-known cheese of the neighbouring plain of Cheddar, if a farmer were to find one morning that a part of a cheese was missing, and that the surface left was smooth and regular, he would conclude that some person had cut a slice with a knife, not that a mouse had been nibbling at the cheese during the night; or, suppose the farmer were to find that a whole cheese had been removed from his storeroom, he would at once conclude that a power capable of carrying it away in a lump had been concerned in the theft. A puny agency, which carries on its work grain by grain, or bit by bit, cannot leave a smooth, plain, and regular surface of any extent; but a violent and powerful agency, while it is not incapable of leaving a rough surface (circumstances being favourable), mainly tends to produce breadth and uniformity of contour.

The most philosophical way of trying to explain natural phenomena is to seek for similar phenomena now in course of being produced; and many modern sea-coasts exhibit fac-similes of the Cheddar cliffs. The forms of these cliffs are precisely those which would result from waves driven by storms into a narrow inlet of the sea. At a greater elevation, near the summit of the Mendip hills, smoothed (sometimes polished), rounded, hollowed, perforated, and grooved surfaces of rocks may here and there be traced. The way in which they have been shaped may be seen on the neighbouring sea-coast at the present day. At a little lower level than the Cheddar ravine there are generally-acknowledged indications (such as sea-shells*) of the sea having once covered the plain between the Mendip range and Polden Hill. During the great glacial submergence the sea may have washed through the Cheddar ravine, and completed, if not entirely effected, its denudation.

DOUBTS AND FACTS CONCERNING LINNÉ.

The progress of investigation into the evidence of recent changes in the lunar crater Linné has cast considerable doubt upon the opinions so positively expressed by Schmidt, and accepted by most astronomers. In order to place the question as fairly as possible before our readers, we now publish a short paper by Mr. Birt, F.R.A.S., and some extracts from an important communication just made by Mr. Huggins to the Astronomical Society, and published in the "Monthly Notices;" and also a letter from the astronomer Wolf, recently read before the French Academy.

THE NEW CRATER ON LINNÉ.

BY W. R. BIRT, F.R.A.S.

The question of change on the moon's surface, supposed to have been manifested in the case of the crater Linné, with which our readers are acquainted, remains *undecided.* Respighi, on the Continent, as well as several eminent astronomers in our own country, having come to the conclusion that no change whatever has taken place in the condition of Linné, and that if any appearances have been presented indicating change, such appearances are to be explained either by defective observations, by unfavourable conditions of our own atmosphere, by variations in the angles under which we see lunar objects, or by different incidences of the solar light falling upon them. There can be no doubt that each of these circumstances materially affects the *appearances* of lunar objects, and it is the more important in the instance which is now exciting considerable attention, to *know* more fully the *facts* rather than to rest on the conclusions that may have been drawn from a partial examination of facts presented, it may be, by a single series of observations.

* At Burtle, in the marshes of the river Brue, there are sand-banks full of marine shells, which are believed to indicate a comparatively recent and partial submergence of the land.

The results that have as yet been arrived at, and which are supported both by English and Continental observations, are as follows :—

First. The existence of a *shallow* crater, usually presenting the appearance of a whitish cloud, which, by the way, is of variable size; the crater itself has been very rarely seen. Respighi saw it on the 10th of May, 1867, during a perfectly tranquil state of the air. Knott caught a sight of the ring on January 12th, 1867, and, on the same evening, in moments of quiet air and good definition, Buckingham noticed the shallow depression. Webb saw the ring on April 11th, 1867.

Second. In this shallow crater or depression, a little west of the centre, a small crater with a well-marked interior shadow has been seen more or less distinctly, both in England and on the Continent, since November, 1866; in some cases as a perfect crater, in others portions only have been detected. The evidence tending to establish the existence of this small crater is certainly beyond dispute.

Third. Herr Schmidt, of Athens, carefully observed Linné from October 16th, 1866, and during November, 1866, without having detected either the large *shallow* crater or the small one within it. The rim of the small crater appears to have first arrested his attention on December 13th, 1866, as a delicate white hill; Buckingham seems to have first seen the shadow as a black spot on the following evening, December 14th.

In all former records of Linné nothing is said of *two* craters, *one within the other*. Linné is simply described as a crater.

In the older records the diameter of Linné is given by one authority (Schmidt) as 1·5 German miles, and by another (Beer and Mädler) as 1·4 German miles.

Since December 14th, 1866, the diameter of the white cloudy mass has been measured *nine* times. Schmidt has given *two* estimates of its extent, October 18th, 1866, at 2 German miles, and December 27th at 2000 toises only.

Three estimations of the size of the small crater have been given; the first, 1867, February 11th, by Secchi, at most $\frac{1}{3}$ of a second. The second, some time in April or May, 1867, by Respighi, viz., 4 seconds. The third, by Wolf, 1867, June 12, at 1 second. These estimations differ very considerably the one from the other.

In cases of measurement the values were obtained in seconds of arc. The estimations were in German miles, or toises.

As the value in miles, or English feet, of a second of arc at the moon's apparent centre increases as the object is removed from the moon's centre in the proportion of the secant of the angular distance from the centre, it is easy to find the value in seconds of arc of the estimations on the one hand, and in English feet of the measures on the other. From the data given, the following table has been constructed :—

ESTIMATIONS AND MEASURES OF THE EXTENT OF LINNÉ.

Authority.	Epoch.	Eng. feet.		Objects.	Remarks.
Schmidt		36,449	5″·17	Crater	
B. and M....	1831	33,482	4·83	Crater	
Schmidt	1866, Oct. 18	48,688	6·90	Whitish cloud	
Birt	1866, Dec. 15	81,920	11·61	Whitish cloud	Measured
,,	1866, ,, 18	49,886	7·07	Whitish cloud	Measured
,,	1866, ,, 19	51,650	7·32	Whitish cloud	Measured
,,	1866, ,, 21	47,627	6·75	Whitish cloud	Measured
Schmidt	1866, ,, 27	12,790	1·81	Whitish cloud	
Birt	1867, Jan. 14	56,100	7·95	Whitish cloud	Measured
Buckingham	1867, Mar. 14	42,336	6·00	Whitish cloud	Measured
Wolf	1867, June 12	31,752	4·50	Whitish cloud	
Birt	1867, July 8	37,623	5·33	Whitish cloud	Measured
,,	1867, ,, 9	49,420	7·00	Whitish cloud	Measured
,,	1867, ,, 10	37,845	5·36	Whitish cloud	Measured
Schmidt	1866, Dec. 13	1918·4	0·27	Delicate hill	
,,	1866, ,, 26	1695	0·24	Fine black point	
,,	1867, Jan. 25	1279	0·18	Fine black point	
,,	1867, ,, 25.	1918·4	0·27	Fine white peak	
Secchi	1867, Feb. 11	2352	0·33	Small crater	
Respighi	1867, Apr., May	28,224	4·00	Small crater	
Wolf	1867, June 12	7056	1·00	Small crater	

This table furnishes three sets of numbers: first, the diameter of the crater in 1831, and about that epoch; second, the estimations and measures of the whitish cloud, in which there are considerable variations; and third, the estimations of the small crater. Under this head the most serious difference is that between Secchi and Respighi.

It would be highly improper to question for a moment the estimation of Respighi. The difference, however, between his estimation and that of Secchi, of nearly 26,000 English feet, calls for some remark. Respighi's observations were made with great care, and it is probable that he might have seen an opening which he estimated at that diameter, especially as the small crater was seen with greater distinctness in April. The diameter of this opening may, from some cause or other, not have been permanent in its extent. I am quite satisfied, that with the Royal Society's refractor of 4¼ in. aperture (Respighi's was 4½ French inches aperture) I could have seen and measured a crater of 4″·0 in diameter; in fact, I have many smaller on the British Association outline map, which I have not only seen, but discovered with the 4¼ inch aperture, power

230. I have records of observations made on April 11 and May 11, 1867, in which I expressly state that *I could not detect any object on the surface of Linné.* With Mr. Barnes' silvered glass reflector (*With*) I very carefully examined Linné, on the 10th of June, 1867; but although both Mr. Barnes and Mr. Browning saw a white nucleus, I was unable to detect it, and saw nothing of a crater of the magnitude of 4″·0, which I think I must have seen, had it been there.

With regard to the variations in the extent of the whitish cloud, I have observed phenomena of the same kind on the Mare Crisium, and about seventy sets of measures of Dionysius, yield the same result, though not to so great an extent as in the case of Linné.

OBSERVATIONS ON LINNÉ.

BY WM. HUGGINS, ESQ., F.R.S.

In "Monthly Notices" Mr. Huggins publishes a view of Linné, as seen by him on May 11, at 8h. 45m. It represents Linné as an oval white spot, and to the west of its centre shows a white ring surrounding a black spot. Mr. Huggins remarks, "At the time when the diagram was made, the shallow, saucer-like form of Linné was not seen; but I have detected it on other occasions. June 8, at 7h., when a great part of the light reflected from our atmosphere was removed by means of a Nicol's prism, I observed a shadow within the eastern margin of this shallow crater. When the diagram was taken, on May 11, the "interior of the small crater was in shadow, with the exception of a small part of it towards the east. The margin of the small crater was much brighter on the western side, and at this part appears to be more elevated above the surface of Linné. Under a very oblique illumination this high eastern wall appears as a small bright eminence, and casts a somewhat pointed shadow."

On the 9th July, at 9, Mr. Huggins measured Linné, and found the

Length of the bright spot	7″·85
Breadth	6″·14
Diameter of small crater	1″·71

The power employed was 500.

On the 14th Feb., 1866, Mr. Huggins examined the spectrum of the light from Linné, but could detect no lines not belonging to solar light.

Mr. Huggins quotes Schröter's description of Linné, and remarks that in Plate IX. of his "Selenotopographische Fragmente," "the place occupied by Linné is marked by a round white spot, and not by the figure of a crater." Schröter's words are, "*Als ein weisses sehr kleines rundes Fleckchen erscheinende, etwas ungewisse einsenkung in sich hat;*" which may be translated, "Appearing as a white, very small round spot, with a somewhat uncertain depression in it." Mr. Huggins observes that such a description coincides very well with existing aspects, and he does not think the absence of any notice by Schröter of a small interior crater is of much weight in indicating its subsequent formation. He adds, that "Lohrmann's description and that of Mädler do not appear to be in accordance with Schröter's observations, or with the present condition of the object."

WOLF ON LINNÉ.

(*From* "*Comptes Rendus,*" *June* 17, 1867).

Since the 10th May I have noticed that the crater Linné continues to exist, but with a much smaller diameter than that of the crater indicated in the maps of Lohrmann or Beer and Mädler. In the centre of the white spot a circular black hole may be seen, bordered on the west by a portion of ground which seems prominent above the remainder of the spot. This slight extra elevation has already been described by Schmidt. Atmospheric circumstances did not allow me to obtain an irreproachable image of the moon before the 10th June. On that day, at 8 o'clock, Linné had already been in full light nearly 48 hours, and the central hole could be seen with perfect sharpness. It is a deep crater—deeper than most of the little craters surrounding it, if one may judge from the comparative intensity of the shadows; but its diameter is not equal to that of craters A and B of Beer and Mädler. The white spot which spreads radiatingly (*s'étend en ragourant*) round it, had, on the 12th June, a diameter of 4″·5, that of Bessel being 7″·7. The crater itself subtending a little less than one second. The perfect purity of the atmosphere, and the optical power of the telescope (0m. 40) which I employed, allowed a number of small craters to be seen very distinctly round Linné, or rather a number of small round holes without elevated margins, and which are not shown in Beer and Mädler's map. Six of these little craters form a very remarkable double range to the north and north-east of Linné. They are smaller than the craters in a line situate to the north-west of Linné, and noticed by Schmidt. I employed magnifications of 235, 380, and 620 times.

The brightness of Linné has not changed since Beer and Mädler's observations, for it is always equal to that of the white spot situated near Littrow, on the western margin of the Sea of Serenity, to which B. and M. assigned the luminosity 6.

If, then, we compare, the actual appearance of Linné with the *text* of Lohrmann and his successors, it is possible, *à la rigeur*, to believe that it has undergone a certain change. Linné has always been a deep crater, with elevated margins; its lustre has not changed—its total diameter has remained about the same. A comparison of *maps*, on the contrary, indicates a real alteration, for these figure a large crater occupying all the space now filled by the white spot. Schmidt thinks that we cannot refuse to attribute great weight to the identity of the indications of these two maps. The authors of the second, having the first at their disposal, it is probable that if they had not found the great crater drawn by Lohrmann, they would have noticed so extraordinary a fact. It is not, however, without interest to compare their indications with that of earlier maps. The picture drawn and presented by Lahire, which is in the library of St. Geneviève, represents Bessel, Sulpicius Gallus, and other little craters, equal to Linné in the map of Mädler; but he does not indicate Linné. He has only many white spots in this part of the sea. Cassini's map appears merely a copy of Lahire with less detail. According to Schmidt's note, Schröter seems not to have seen Linné,* at least not as one of the principal craters in the Sea of Serenity, although he noticed others that were smaller.

If we consult the photographs of the moon, we see, in the large copy of Warren De la Rue (1858), Bessel and Sulpicius Gallus exhibiting an indication of an interior shadow, while Linné figures as a white spot. The same is seen, though clearer, in the enlarged copy of the magnificent photograph obtained by Mr. Rutherford on the 4th March, 1865.

The disappearance of the great crater of Linné, then, dates as far back as 1858, if not as far back as Lahire. Apart from the indications supplied by the maps of Lohrmann and Beer and Mädler, to which we may oppose the counter indications of Lahire and Schröter, we only possess a single positive document testifying that Linné has undergone any change, and that is the affirmation of Schmidt that his crater and drawings of 1841 represent the object differently to what is now seen.

REMARKS OF ELIE DE BEAUMONT.

M. de Beaumont observed, when the paper was read to the French Academy, that if observers placed in the moon viewed Vesuvius or Etna before and after an eruption, they

* See Mr. Huggins's quotation from Schröter.

could only notice very slight changes. A great eruption even of Vesuvius would produce no other effect than to diminish slightly the depth of the semicircular trench of the Atrir del Cavallo, and to change its colour. Seen from the moon, such an alteration would appear problematical, and would give rise to discussions amongst observers. The observations made by P. Secchi on the 10th and 11th of February last ("Comptes Rendus," 25th February), tend materially to the belief that some change of this sort must have been produced in the configuration of the crater Linné, since the date of Lohrmann's and Beer and Mädler's maps. Moreover, it is to be desired that observations relating to the absolute permanence, or to very slight alterations on the moon's surface, should be multiplied, for a single change, however slight, would suffice to show that a geological life exists in the interior of the moon, as well as in the interior of the earth.

CURIOSITIES OF SOUND.*

Professor Tyndall's lectures on sound are, in their way, as admirable as the lectures on heat, which formed the foundation of his well-known work, "Heat as a Mode of Motion," though in dealing with the aerial vibrations which act upon our auditory nerves he has chiefly had to expound the discoveries of others, while in discussing the phenomena of heat it was his happy task to record many brilliant discoveries of his own. We are very glad that he has used plain English on his title-page; a book on "Sound" promises to be intelligible and interesting, while a treatise on acoustics would look alarming and dry. All through the work before us we meet with indications of the learned professor's remarkable aptitude for presenting his subject in a simple and elegant form, and it is gratifying to be assured that the present book will do far more than has been accomplished by any preceding publication to popularize a branch of science that has suffered much neglect, from the erroneous impression that it was too abstruse for ordinary minds.

A world without sound would seem a dismal solitude to those who are familiar with human voices, the notes of birds, the cries of animals, the hum of insects, and the multitudinous noises of active life. What we call the silence of night and of waste places, and which, for a brief period, yields the

* "Sound:" a Course of Eight Lectures, delivered at the Royal Institution of Great Britain, by John Tyndall, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution, and in the Royal School of Mines. Longmans.

sensation of calmness and repose, is not as soundless as we imagine; but even that would be oppressive if endured for long; and could we visit a planet without an atmosphere such as our moon is supposed to be, how appalling would be the dreariness of its great mountain shadows, throwing their huge black pall over the scene, as the sun deserted vast regions of crags and plains, in which not the faintest whisper of any voice was heard.

We have in several previous papers explained the nature of *waves*, and their propagation. Sound is the result of *vibrations*, or wave-movements, transmitted by the air to the delicate apparatus of our ears, and then reaching our brains, where they become transformed into *sensations*, of which the mind takes note. In wave-motion the particles of matter first affected vibrate or oscillate through small spaces, but they communicate their own motion to other particles; and so the *wave-form* spreads and spreads, until it becomes too feeble to be discerned. A stone thrown in a pond illustrates these actions. Circle after circle of ripples are formed, wider and wider, but shallower and shallower, until they are stopped by the banks; or, if the pond be big enough, until, in acquiring great *width*, they have lost so much *depth*, that they can no longer be seen. Further illustration of wave-propagation, as a series of spherical shells, will be found in the paper referred to; and though the subject may appear a little difficult at first sight, it will prove very simple when approached step by step.*

If we have an instrument capable of communicating strong vibrations to the air, such as a bell, and place it under the receiver of an air-pump, and strike it while in that position, we shall have a full sound while the receiver contains its ordinary quantity of air; but keep the bell ringing, and at the same time pump the air out, the bell sounds will grow weaker and weaker, until at last, if we make the vacuum sufficiently complete, they will no longer be heard at all. The intensity of a sound in a given medium depends on the force with which its particles are moved, or on the velocity of their motion. "Fix your attention," says Professor Tyndall, "upon a particle of air as a sound-wave passes over it; it is urged from its position of rest towards a neighbouring particle, first with an accelerated motion, and then with a retarded one. The force which first urges it is opposed by the elastic force of the air, which finally stops the particle, and causes it to recoil. At a certain point of its excursion, the velocity of the particle is at its maximum. *The intensity of the sound is proportioned to the square of this maximum velocity.*"

The intensity of a sound is, as we have seen from the air-

* See "Radiant Forces," Intellectual Observer, March, 1867.

pump and bell experiment, also dependent upon the density of the air in which it is generated, growing feebler as that density is reduced. Professor Tyndall says, "Supposing the summit of Mont Blanc to be equally distant from the top of the Aiguille Verte and the Bridge of Chamouni, and supposing two observers stationed, the one upon the bridge, and the other upon the Aiguille, the sound of a cannon fired on Mont Blanc would reach both observers with the same intensity, though in the one case the sound would pursue its way through the rare air above, while in the other it would descend through the rare air below." If the cannon were fired in the dense air of the bridge, its sound would reach the top of the mountain; while if fired in the thin air of the mountain-top, it might be too weak to be heard below.

Sound grows weaker by spreading. When strong vibrations act upon a small number of air particles, they throw them into violent commotion; but when the same amount of force operates on a much larger quantity of air, the movement of each particle is less rapid, and the sound declines. By speaking through pipes we check the lateral propagation of the sound-wave, and hence the voice can be heard at great distances; and it is easy, by means of apparatus now common in large places of business, to hold conversations with persons in any part of extensive premises. It is a curious instance of the force foolishly allowed to conventional habits, that this mode of communication is not applied in ordinary domestic life. It would be more rational for the parlour to adopt this quick mode of conveying its orders to the kitchen, than to ring bells to summon domestics to hear what is wanted, and then go and fetch it—a proceeding involving a waste of labour and a loss of time. Barbaric ideas of grandeur always include waste; but as civilization advances, it will be seen that the most dignified thing is to act in the most rational way, and to accomplish desirable objects with the greatest economy of any sort of force.

Sound may be readily deadened by the interposition of non-elastic bodies. It would be difficult to talk through a feather bed, though easy to be heard through the wainscot panelling of a room.

Sound is capable of being reflected like light. Echoes are the result of natural or artificial arrangements, which send the waves back again, as many times as the echo repeats, and by interposing a balloon filled with carbonic acid in the way of sound-waves, they may be bent out of their diverging course, and concentrated just as a spherical lens concentrates beams of light. A parabolic reflector will send the rays of a lamp in a long narrow divergent cone for many miles across the sea, and if a speaker or singer were placed in such an apparatus, his voice might be heard at great distances by persons situated within the boundaries of the cone.

The velocity of sound propagated through air at the freezing temperature is 1089 feet per second, and at 26.6° Cent., or 78.8° F., 1140 feet.* If the *elasticity* remains the same, augmentation of the density of air or gas diminishes the velocity of sounds. Hydrogen gas, which is as elastic as air, and much lighter, is consequently more favourable to the rapid transmission of sonorous effects.

At the freezing temperature, hydrogen transmits sound at the rate of 4164 feet per second, or nearly four times as fast as air, while carbonic acid does so at the much lower rate of 858 feet per second. Water conducts sound with more than four times the velocity of air; pine wood, *along its fibres*, ten times as fast; and iron, seventeen times as fast.

The elasticity of air is increased by raising its temperature, and as air opposes a certain resistance to the passage of a sound-wave, its temperature is actually raised a little by its stoppage of a quantity of motion, and its conversion into heat. From this cause air conducts sound a little quicker than was originally calculated by Newton, who did not take into account this curious cause of its change of temperature.

The ear is pleased with the regular recurrence of impulses, and with the succession of sounds, or their combination, according to certain principles of proportion. Noises as distinguished from musical sounds are wanting in regularity, and discords lack the desired proportions. All sounds consist in a series of pulsations, and if they are to form musical notes, they must be quick enough to give the sense of continuity to the ear, and not too quick to be audible—a matter explained in a former paper, which we published, entitled, "Sounds we Cannot Hear."† Sounds may be too deep for a particular human ear, or for any human ear, and they may be too shrill. It is only a small part of the entire music of nature that we can hear, but our range is fortunately considerable, being from 16 to 38,000 vibrations in a second. The lowest notes are, however, imperfect, and do not sound well alone, and the highest are above those used in orchestral compositions, the practical range being comprised between 40 and 4000 vibrations in a second.

* The relation of the velocity of sound to the elasticity and density of the air, or other medium, is thus expressed:—"The velocity is *directly* proportional to the square root of the elasticity of the air, and *inversely* proportional to the square root of the density of the air."

† Vol. viii. p. 413.

The transmission of musical sounds through solids received some beautiful illustrations in Professor Tyndall's lectures. The following passage shows one of the magical effects which he produced :—

"In a room underneath this," said the lecturer, "and separated from it by two floors, is a piano. Through the two floors passes a tin tube two and a half inches in diameter, and along the axis of this tube passes a rod of deal, the end of which emerges from the floor in front of the lecture table. The rod is clasped by india-rubber bands, which entirely close the tin tube. The lower rod rests upon the soundboard of the piano, its upper end being exposed before you. An artist is at this moment engaged at the instrument, but you hear no sound. I place this violin upon the end of the rod; the violin becomes instantly musical, not however, with the vibrations of its own strings, but with those of the piano. I remove the violin, the sound ceases. I put in its place a guitar, and the music revives."

A harp was rendered musical in the same way, and as Professor Tyndall says, an uneducated person might well believe that witchcraft was concerned in the production of such music.

The vibrations of columns of air of various lengths give rise to the notes of organs and wind instruments, while pianos, violins, etc., are an illustration of the operation of vibrating strings, the sound of which would be feeble if it were not reinforced by the elastic wood introduced into the structure of such instruments.

Long strings vibrate more slowly than short ones, and thick ones than thin. If a whole string vibrates with a given velocity, half of it will vibrate twice as quickly, a third three times, and so on.

Strings, or air columns may vibrate as *wholes*, or may divide themselves into a number of equal parts, each one of which vibrates as if it were a whole; but when strings vibrate as *wholes*, they vibrate more or less in subdivisions at the same time, and hence arise *harmonic notes*, higher than the fundamental, or whole string, note. Different sorts of instruments tuned to produce the same fundamental notes, will add to them different harmonics, and thus be characterized by distinct qualities of tone, *timbres*, as the French call them.

The vibration of a string being compounded of whole length vibrations, and of the harmonic, or part length vibrations, just explained, there will be certain places at which the two sets interfere and produce *nodes*, or points of comparative (but not complete) rest; and Dr. Thomas Young discovered that when a string is plucked at any point, and caused to vibrate, "all the higher tones which require that point to form a node, vanish from the clang."

To illustrate these facts, Professor Tyndall used an apparatus which our readers can easily imitate. He had before him a single chord instrument, with a scale divided into a hundred equal parts. By plucking the string at any division, and touching it (damping it) at any division, he was able to produce a number of easily-repeated effects. Plucking the string at 50, he said, "and now I affirm that the first over-tone, which corresponds to a division of the string into two vibratory parts, is absent from the clang. If it were present the damping of the point 50 would not interfere with it, for this point would be its node. I now damp the point 50; the fundamental tone is quenched, and no octave of that tone is heard. Along with its octave, its whole progeny of over-tones, with rates of vibration four times, six times, eight times—all even numbers of times—the rate of the fundamental tone disappears from the clang. . . . I now pluck some other point, say 25, and damp 50 as before. The fundamental tone is gone, but its octave, clear and full, rings in your ears." In fact, by damping the string at 50 he made a node there, and it vibrated as two half-length strings, yielding the octave above the whole length.

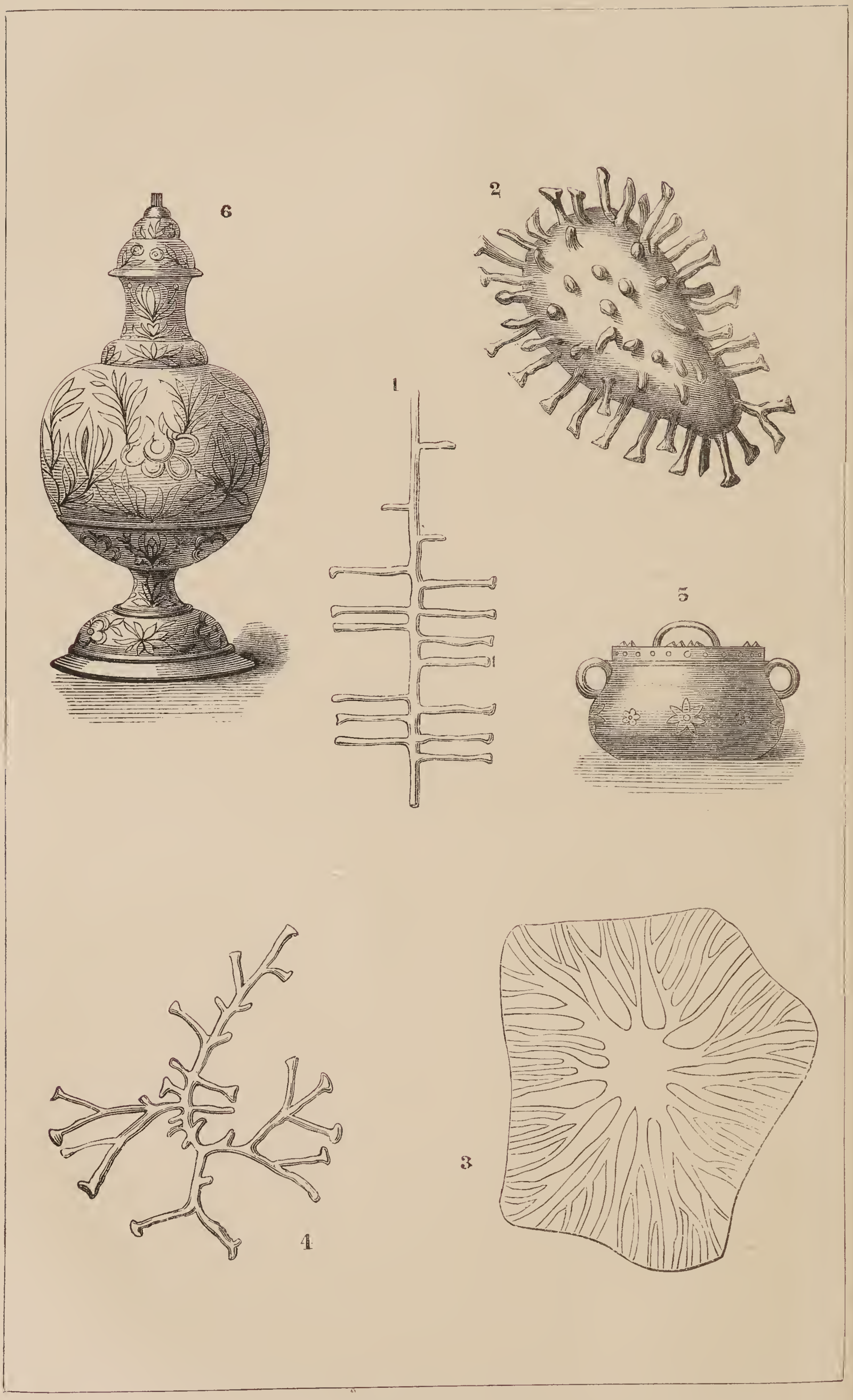
The nodal points spoken of may be made visible by several contrivances: thus, when a string is employed, little riders of paper will keep their places where such points occur, and will be thrown off in other positions. By employing a square plate of glass fixed to a stand by its centre, and sprinkling fine sand over the surface, very beautiful figures, known from their discoverer as Chladni's figures, may be made, the sand being first agitated, and then resting in nodal lines. The plate is vibrated by a fiddle-bow, and damped by touching it at certain points with a moistened finger. Very beautiful and intricate patterns may be obtained in this way.

Musical effects depend very much upon *resonance,* or the reinforcement of a feeble sound, by enabling it to associate other and sympathetic vibrations with its own. Thus, a tuning-fork produces a feeble note alone, but when it is able to set another body or mass of air in vibration the sound becomes loud. An experiment referred to by Professor Tyndall is easily made. A tuning-fork is sounded over a tall narrow jar, and water gradually poured in until the air column in the jar is reduced to the length which gives the greatest resonance, when the sound is much louder. Pouring in more water diminishes it, by making the air column too short; the maximum effect being produced when the air column is one-fourth of the length of the sound-wave produced by the fork. An open tube gives a maximum of resonance when twice the length of a closed one. The strengthening by resonance of feeble sounds not previously heard or noticed, is the cause of the "sea music," which children are so fond of when cowry shells are held to their ears. Caves and rocks resound to the noise of waterfalls, and deep wells to the fall of objects on the water which they contain.

Amongst the most beautiful and curious of the strange ways of sound, we must allude to singing and to sensitive flames. If a glass or metal tube, two or three feet long, is held at a proper height—easily found by trial—over a small jet of gas, a musical note is heard; and if the experiment is made on a large scale, the sound is violent. The musical note arises from a series of impulses communicated by the flame, which is a rapidly twinkling one, to the air. Hydrogen gas answers for these experiments better than coal gas.

The sensitive naked flames are the most extraordinary and apparently magical things. A broad fish-tail flame exhibits the phenomena to a considerable extent. Such a flame will jump and put forth tongues in sympathetic response to a particular set of vibrations. Professor Tyndall showed that, by producing a slight flutter with a blowpipe in a candle-flame, it was made sensitive, and jumped when a whistle was sounded. By adding to the pressure, and obtaining flaring flames from common fish-tail and bat's-wing burners, they became sensitive to whistles, and put forth curious tongues; and striking a distant anvil with a hammer gave similar results. By using a single orifice burner and suitable pressure, flames eighteen inches long were obtained, smoking copiously, and remarkably sensitive to sound vibrations of the right quality. By sounding a whistle, Professor Tyndall caused the flames to change instantly, and become short, forked, and brilliant. Another flame exhibited by the professor to his wonderstruck audience was twenty-four inches long, and by the slightest tap on a distant anvil it was reduced to seven inches. Dropping sixpence from the hand twenty yards off was sufficient to knock the flame down; the creaking of boots, the rustle of a lady's dress, the patter of rain, and the tick of a watch—all influenced it in a striking way. When lines of poetry were recited, the flame nodded to some sounds, took no notice of others, and when the tones of the voice were most in sympathy with it, "its obeisance was profound."

Here we must leave Professor Tyndall and his most interesting book, intending, however, to take another opportunity of recurring to more of the "Curiosities of Sound," to whose wonders, we hope, the present pages may prove an introduction for those who love science in its recreative aspects and lighter moods.



POTTERY TREE OF PARA.

THE POTTERY TREE OF PARA.

BY JOHN R. JACKSON.

(*With a Plate.*)

Amongst vegetable economic products the barks of various plants hold a prominent place, whether for medicinal, manufacturing, or other purposes. The structure and formation of all barks are more or less similar, though the contents of the cells vary much in different plants, thus we have soft or fibrous, hard or woody, and even stony barks, and the bark of the pottery tree of Para is a notable example of this latter. To outward appearance the formation of the bark in many plants would appear to bear no relation one with another, as, for instance, the cork of commerce compared with its near ally, the bark of the common oak, and again with the fibrous barks of many of our British trees. Naturally, the bark of a tree is, at first, composed of uniform cellular tissue, similar to the tissue of the central portion of the stem. The formation of the layers in the fully-developed bark is on the reverse system to that of the woody layers of the stem, the inner portion being the most vascular, and the outer portion the most cellular. Between the wood and the first formation of bark lies the cambium layer, a single series of nucleated cells, which originally are connected with both wood and bark, and perform certain functions in the formation of the woody fibres of the inner bark, and likewise in adding to the cells of the medullary rays of the wood. The innermost part of the bark next the wood, or rather next the cambium layer, is called the liber, or endophlæum; next to the liber, which is the fibrous part, the cellular part is placed, called the mesophlæum, or middle bark, and next that the epiphlæum, or outer bark. These three divisions are usually included under the general term of cortical layers. It is from the liber, or inner bark, which is composed of fibres more or less long and tenacious, that our most valuable commercial fibres are obtained.

In some plants the fibrous system prevails through the inner bark, but we shall have occasion to speak more fully upon these particular kinds at another time. What we have to deal with at present is a noted example of the harder, more woody, or more silicious barks, which example is to be found in the Para pottery tree. This is a large tree of very straight and slender growth, attaining a height of 100 feet before giving off any branches; the diameter of the base is seldom more than one foot, and rarely exceeds fifteen inches. The wood itself is very hard, and, as will be presently seen, contains a great deal of flinty matter. The tree—which is called in Spanish El Caouto, or El Caouta; in French, Bois de Fer; in Brazil, Caraipe; and in English, pottery tree—is now known to botanists as the *Moquilea utilis, H.f.* Aublet was the first to bring the tree into notice, and it was at one time placed in the natural order *Ternstrœmiaceæ,* under the name of *Caraipa angustifolia.* Further information and research, however, has caused it to be placed where it now is. Sound and durable as the wood is, it is on the bark that the natives set the greatest value. The Indians employed in the manufacture of pottery from its bark always keep a stock of it in their huts for the purpose of drying or seasoning it, as it burns more freely, and the ashes are collected with greater ease than when it is fresh. For the manufacture of the pottery the ashes of the bark are powdered and mixed with clay, the purest clay that can be obtained from the beds of the rivers is preferred on account of its taking up a larger quantity of the bark ash, and producing a stronger kind of ware. The most valued bark, or that which contains the largest quantity of silex, is produced by trees which grow in a rich but dry soil. Those growing in low or sandy forests being much inferior in the quality of this deposit. In the best kinds the silex can readily be seen with the naked eye, but to test the quality of the various kinds of bark, the natives burn it and then try its strength between the fingers; if it breaks easily it is considered of little value, but if, on the contrary, it requires a pestle and mortar to break it, its quality is pronounced good. Though the proportions of ash and clay are varied at the will of the maker, and according to the quality of the bark, a superior kind of pottery is produced by mixing equal portions of fine clay and powdered ashes of the bark. All sorts of vessels of large or small size, for domestic or household use, are made of this kind of ware, as well as vases or ornamental articles, some of which are painted and glazed as in Fig. 6, which is a representation of a specimen in the Kew Museum. The figures upon this vase are not burnt in, but are merely superficial, the colour being laid on with a brush and secured by a coat of glaze. Fig. 5 is a representation of an unglazed pot, with lid, the figures of which are in relief. Articles made of this ware are very durable, and will bear almost any amount of heat; they are consequently much used by the natives for boiling eggs, heating milk, and, in short, for general culinary purposes.

Having shown the great value of this bark to the natives for a purpose which, to say the least, is novel in the application of barks, we will endeavour to arrive at the cause of such an adaptation by a brief exposition of its component parts.

The bark seldom grows more than half an inch thick, and is covered with a skin or epidermis frequently covered with lichens. A superficial examination shows nothing out of the common; the fresh bark, however, cuts somewhat similar to a soft sandstone, but, when dry, it is very brittle and flint-like, and sometimes difficult to break. By biting a piece of the bark the presence of silex can be well ascertained, as it grates between the teeth like fine sand. If we examine a section under the microscope, we find all the cells of the different tissues or layers are more or less silicated, the silex forming in the cells while the bark is very young. In the inner bark the silex or flint is deposited in a very regular manner, as will be seen by Fig. 1. The flint, however, from the ash of a porous cell of the bark assumes a very different appearance, as shown in Fig. 2. Fig. 3 shows a porous cell macerated, and Fig. 4 is a flint skeleton from a similar cell. The bark of young trees and branches contain a much larger quantity of water than that of old trees; the proportion of water, however, are more equal in the old and young woods. From an analysis made of both the old and young barks, the old was found to give 30.8 per cent. of ash, and the young bark 23.30. Of the different layers of the old bark, the outer gave 17.15 per cent., the middle 37.65, and the inner 31. A larger percentage of ash was yielded by the bark of an old branch, which was found to give 77. In comparison to the bark the wood is relatively poor in silex, the duramen, or old wood of an old trunk, giving only 2.5 per cent., and the alburnum, or young wood, 2 per cent. only.

The wood, bark, ash, and various specimens of the manufactured pottery, may be seen in the Kew Museum.

MARE VAPORUM AND THE LUNAR CLEFTS—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

With the object of comprehending in a continuous description the whole extent of the Lunar *Apennines,* our guides have carried us considerably beyond the 1st Meridian, and into the 2nd Quadrant of the Moon. They now bring us back towards the W. to complete the Quadrant with which they commenced, and introduce us to the *Mare Vaporum* (F in our map). This is a level surface, of a lighter tone than the other *Maria,* and possessing no very definite boundary, but lying in a general sense between the S.W. slope of the *Apennines* and the crater *Agrippa* (26). There would be little to make the region worthy of especial notice were it not that its S. part contains a full development of one of the most curious of the lunar features, the system of clefts (or *Rills*). Fortunately for the telescopic observer, this district, while it lies in so central a position as to be very little affected by foreshortening, contains two of the largest and most obvious of these mysterious formations, "in which," say B. and M., "an attentive observation can recognize something more than their mere existence." Before we proceed, however, to describe them, it may be premised that there is a difficulty, not merely in comprehending their nature, but even in providing for them a suitable name. This arises from the fact that we are so little familiar with anything analogous to them on the surface of our own globe. It is true that features do exist, which, viewed at a corresponding distance, might have a somewhat similar aspect. We might refer to the transverse fractures of the Balkan range, and of some of the chains of Greece, the *Barrancas* of Mexico, or the marvellous *cañons* of the Colorado River (described in Int. Obs. iv. 309), which may, perhaps, exhibit as great a similarity to the clefts of our satellite as the terrestrial does to the lunar crater; and more could not in fairness be expected. But still, the fissures of our globe are too exceptional to constitute a system such as obtains on the moon, and consequently to have received any generally accepted name. Astronomers, therefore, are somewhat at a loss how to designate the lunar *crack,* if such it may be termed. Schr., the first discoverer of these objects, in 1788, called them "canals," or "rills": the former term is obviously unsuitable to a dry surface, and has gone out of use; the latter has held its ground among the German observers, and very deservedly so, as far as their language is concerned, in which it signifies a small furrow, or groove. Its adoption, however, by ourselves, though sanctioned by some great names, does not seem free from objection, on account of the existence of a similar, but by no means equivalent English word, the derivation of which, from the Latin, *rivulus*, and its meaning as given by Johnson, "a small brook, a little streamlet," refer unequivocally to the presence of water. It is, however, frequently easier to find a fault than to mend it; and in the present instance (*furrow* having been rejected, on high authority, as not sufficiently comprehensive), if the employment of the term *cleft* is suggested, it need only be looked upon as a provisional arrangement, till something more appropriate has been brought forward in its stead. It would indeed be a gain to selenography, if the whole subject of lunar terminology were to undergo a careful revision at the hands of those whose geological as well as astronomical acquirements would enable them to frame such a nomenclature as would command universal acceptance.

But, to proceed from the name, to the objects which it designates. The lunar clefts are characterized by B. and M. as very narrow and long depressions either in a straight or moderately curved direction; occasionally serpentine or hooked in form: with very steep,* parallel sides, and usually without any external rampart: in Full Moon they appear as delicate white lines; near the terminator usually as black ones, as we perceive only the shaded interior. They sometimes pass through or close by small craters, or come to an end in them; at others they lie isolated in level surfaces, without any marked termination; in fact, one of their frequent characteristics is this want of apparent object, as we might speak with reference to the handywork of intelligent beings. They are frequently hemmed in by mountains, but do not appear to run straight over them; occasionally they are found to unite like veins, and even to intersect one another. Their individual breadth varies but little; if there is any enlargement, it is somewhere in the middle, never at the end [rather an inattentive assertion, by the way]. They occur in every kind of surface, excepting on lofty summits, or in the centre of the great plains; being of course less distinguishable towards the limb. A few of them are only from 9 to 14 miles in length; the generality 45 to 70; some, again, reach a maximum of 115 to 140 m.: their breadth is in places not inconsiderable, a mile or upwards; but they may be traced down to ¼ of that size.† Connecting links with other formations may often be perceived: the enlargements occasionally noticed take the form of longish craters, or if these are frequent, the whole cleft appears almost like a chain

* Schmidt considers them not extremely steep.

† Schmidt gives their depth from 100 yards to ¼ mile.

of minute craters, with a lateral communication throughout: on the other hand, there are regions where contiguous mountains form, with their straight and parallel sides, gorges much resembling these clefts, and where long straight valleys are distinguished from them chiefly by their greater proportional breadth and inferior steepness; and several valleys of this kind are to be met with in the immediate neighbourhood of true clefts, and parallel to them. From these and other indications, such as their want of connection with any definite object, their occasional repetition in parallel lines within a small distance, and more especially their magnitude (as Schr. had already perceived), the idea of an artificial origin must be aid aside.

On this subject B. and M. have some remarks, which, though referring to speculations which have never found great favour among ourselves, are still worthy of consideration. They observe that, but from inattention to the scale of the objects we are studying, and from the unreasonable expectations entertained at the end of the last century of a marvellous increase of magnifying power (some persons, in Germany we may presume, seem to have been anticipating the use of powers of 15,000!), the idea of these clefts being lines of road, or anything else of an artificial nature, would never have been seriously entertained.* In all such analogies, they judiciously remark, one very important point has been ignored—the relative proportion of gravity on the different bodies of the system. When this, as on the Moon, is $6\frac{2}{3}$ times inferior to that on the Earth, fresh relations are introduced between power, weight, and motion; and while we have no positive information as to artificial products on the Moon, it may be maintained with great probability that they would be totally unlike our own, and that, even if our optical means were capable of reaching them, they would not appear in any recognized or familiar form. Remarks of this kind are valuable if they check the vagaries of irrational fancy. We should take care, however, not to push them too far; it would be possible, though much less probable, to err in an opposite direction, and to impede the progress of discovery by an overweening estimate of our own previous conclusions.

The hypothesis of their being actually existing or dried-up water-courses may be disposed of with little trouble. All modern observers are agreed as to the absence of water, at least in any noticeable quantity, from the Moon as it now is; but could we conceive, with Gruithuisen, that it had formerly

* Gruithuisen referred them partly to dried river-beds, or natural clefts, partly to artificial clearings through forest lands, used in either case as lines of communication.

found a place there, the traces of its smaller receptacles would be of a very different character. The river-systems of a dried-up Earth, as contemplated from the Moon, would have a wholly dissimilar aspect, with their confluent branches, and their regular increase from end to end. The lunar cleft, on the contrary, often begins and ends on a high level, without ever reaching lower ground: or runs from mountain to mountain through a plain: it does not grow broader towards one end: it very seldom receives branches: it is very frequently straight: its proportional depth is too great, especially with the slight force of lunar gravity, to have been excavated by currents of water: it is often only ten or twelve times longer than it is broad: it frequently reappears on the further side of mountains which have interrupted it: or it keeps a regular curvature in passing through obstacles lying in every direction: occasionally it goes through craters of considerable size. All this—as well as the absence of any noticeable atmosphere—is inconsistent with the hypothesis of water-currents of any assignable date. The supposition of life in the Moon thus seems negatived. But why, ask our authorities, should we assume, as alone possible, the existence of that one form of life with which we are acquainted on our planet? Even with us the most extraordinary differences in climates and modes of life are found, co-existent with the same ultimate elements, with an uniform force of gravity, and an unvaried general density: why, then, should not entirely new arrangements as to life and motion have place under totally different conditions of existence in other worlds? To these very sensible questions, the spirit of which had been in many points anticipated by Schr., may be added some reflections of the latter to the effect that our speculations ought to be confined to what is deducible in the strictest sense from observation, and that there is no necessity that we should denominate the Moon "an entirely dry mass of chalk, and that therewith at the same time every substitute for water, so beneficial to us, should be denied to those who, as well as ourselves, are indebted to the Universal Father of nature for the enjoyment of an active life. With the largest telescopes we still see the great works of God always in a remote background, and can only keep ourselves to sure observations and their *immediate* consequences." He goes on to suggest (but in a very modest and rational manner) the possibility of some transparent fluid on the Moon, bearing an analogous proportion to her atmosphere, in point of density, to that existing between our water and air, and that it may perform a similar function in point of utility with regard to the needs of such organized life as may exist there. Till of late it might have been said that the analysis of aerolites, in the composition of which no new chemical element has ever been detected, and from which we should infer a similarity of matter throughout the solar system, strongly contravenes such speculations. But the recent discoveries of Huggins, rendering it highly probable that the atmospheres of Jupiter and Saturn contain elements or combinations foreign to our knowledge, again restore the balance, and enable us to call the worthy old Hanoverian into court again. He always deserves at least a hearing.

Some other peculiarities of these clefts, pointed out by B. and M., in their "Beiträge," may be mentioned, as the result of their discovery, within six or seven years, of upwards of seventy, in addition to less than twenty previously known. Absolute straightness and singleness characterize the majority, and the average bearing falls between 8h. and 11h. of a clock-dial, divided into 24h. There is an optical cause why they should be frequently found in the line of the meridian, but scarcely ever in a 6h. (or E. and W.) direction, namely, the full development in the former, the absence in the latter case, of that internal shadow by which they are most readily distinguished. But no such reason will explain why more than fifty of them should be directed between 8h. and 11h., and only some thirty between 1h. and 4h. It is remarkable, however, that the prevailing direction of all lunar objects is so much the same that in some regions scarcely any other tendency is perceptible; that in the majority it predominates; and is absent from none; so that ridges alike and clefts seem to indicate a similar origin.

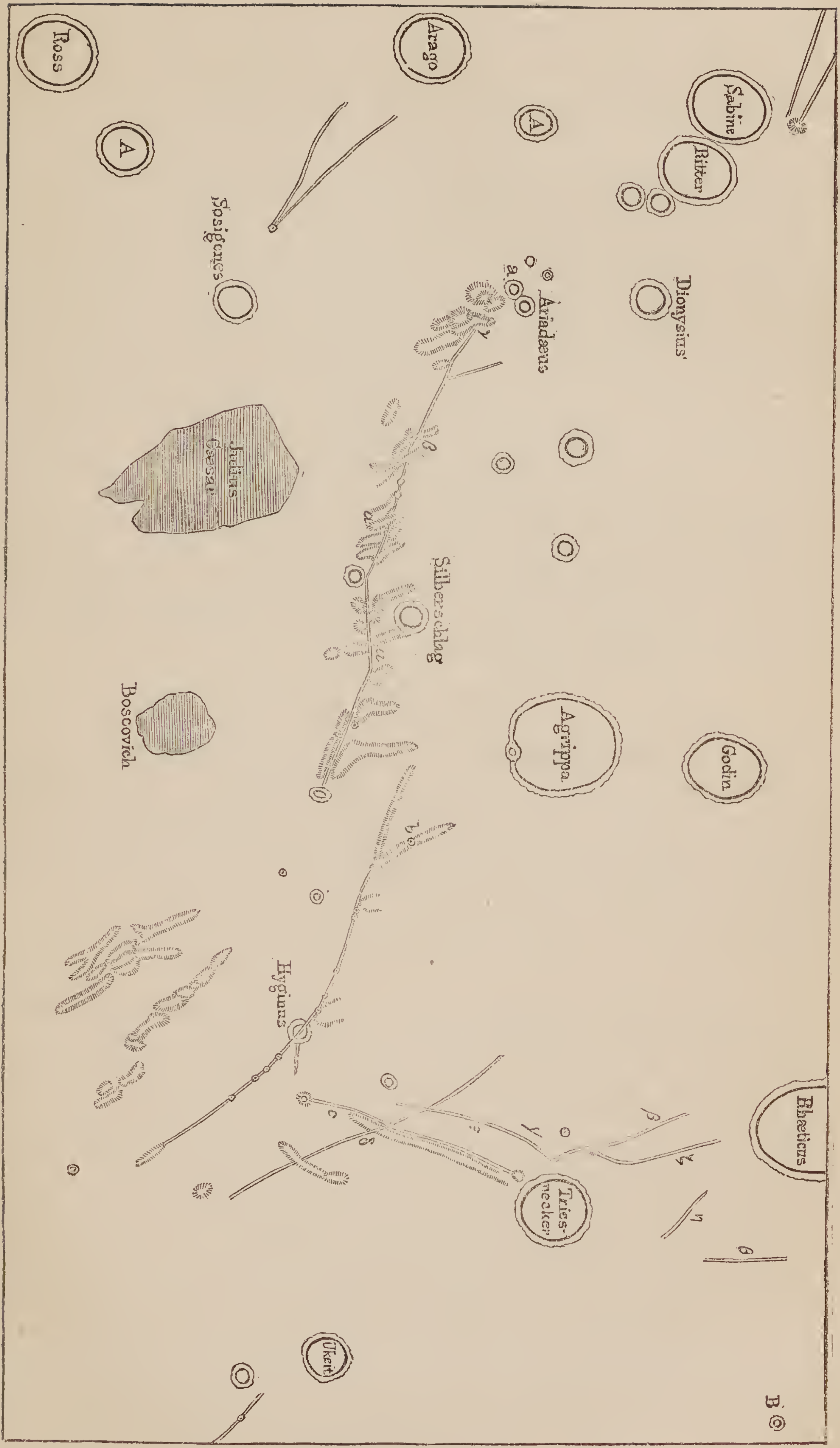
As to that origin, B. and M. consider it to have been due to a modification of the same eruptive force, the "reaction of the interior," as Humboldt would call it, which has so extensively modified the lunar surface. This would naturally press outwards along the line of least resistance, or, on the supposition of homogeneity of material, perpendicular to the surface; and during its earlier and intenser action would produce regularly circular cavities, or, if it encountered more coherent material, roundish mountains; as the activity decreased, and circumstances were changed by the great alteration of level, as well as of cohesive power, the direction of the force would be varied; it would take a horizontal course; and while in general it elevated the surface into those long ridges, or banks, of which instances are so abundant, it would occasionally burst it open, so as to form burrows or clefts. This speculation, which had been propounded by Schr. at a much earlier period, does not seem to commend itself by its plausibility. There is a difficulty in conceiving the continuous progress, perhaps for hundreds of miles, of an elastic force burrowing "straight on end" like a mole under the ground, and, nine times out of ten, finding less resistance in its front than in any other direction; while, if such a ridge were subsequently to "cave," or drop in, it would leave no noticeable hollow. It seems more consistent with appearances to refer these clefts to the cracking and splitting, which would result from a contraction affecting the superficial more rapidly than the subjacent material. Such an explanation would not be without serious difficulties, from the very plastic condition of the surface which would be required, and the inconsistency of such a state with the sharpness and cleanness of earlier outbursts; still it may claim attention; but we are as yet too little advanced in the collection and comparison of facts to be able to form any very conclusive generalization. One thing is evident; that if we follow the example of Schmidt in including the Great Valley of the Alps in the catalogue, it is there that we shall find the most satisfactory test of our hypotheses, and that nothing can be admitted which fails to account for the production of that colossal gorge.

At any rate, B. and M. consider it certain that with, perhaps, a few exceptions, these clefts belong to the latest epoch of the lunar formations. Assuming the identity of their origin with that of the long low ridges, we may remark that it does not appear how this idea can be made to harmonize with the aspect of these latter, which in so many cases look like channels of communication contemporaneous with the formation of the more important mountains and craters; but there seem to be instances in which the posterior date of the clefts is capable of proof; and one such will shortly be laid before us. Considering it as well established that their general epoch is comparatively a modern one, these observers do not wholly deny the possibility of such processes being still in operation; and they admit that their opinion to the contrary, however strong, rests only upon the experience of seven or eight years.

The inquiry—a very curious one—has also been treated as an open question by a modern authority of great weight, Dr. J. F. J. Schmidt. This eminent astronomer has informed us, in his interesting memoir on the "Rills" of the Moon, that he has been occupied for twenty-five years in the study of lunar topography, during which he has made upwards of 1000 drawings and 3000 height-measures, without coming to any other conclusion than that no change of surface has recently taken place on any considerable scale; but that, as to the progressive multiplication of these minute clefts, he has by no means abandoned the idea of its possibility. He has succeeded in adding a great number to those already known; but this may be readily accounted for, partly by his having made them more his especial study than B. and M. could do while occupied in a general selenography, and partly by the superior aperture of his telescope, and, still more, the charming purity of the Athenian sky, far transcending that of Berlin or even Rome. The value of his evidence may be understood from his principal instance, which relates to the region N.W. of *Aristarchus* (43). Here, 1862, May 10, with a power of 200 on his 8-in. dialyte (an instrument of inferior quality, from the decomposition of the glass), he detected no less than fifteen unknown clefts, some of considerable length and breadth, and not more difficult than many shown by Lohrmann and Mädler. He saw also, in the same neighbourhood, a group of new craters of no remarkable minuteness. Schr. had drawn this district six times; L. and M. must have done so eight or ten times, and under opposite illuminations. Schmidt himself had made twenty-one sketches and numberless observations, without perceiving these objects. On three evenings in 1836, M. drew the very spot, probably with the great $9\frac{6}{10}$-in. achromatic at Berlin; and while he inserted some smaller craters, omitted larger ones, as well as the clefts. In May, 1853, Schmidt had missed them all with the same instrument. All circumstances considered, if this is not wholly conclusive, we may look upon it as advancing a considerable way towards a conclusion. Schmidt's figure of this region gives high promise of the hitherto unpublished general Map of six (Paris) feet in diameter, which he is preparing solely from his own observations, and which we sincerely trust he may be permitted to complete. His catalogue of clefts gives 11 discovered by Schr., 75 by L., 55 by M., 6 by Kinau, and 278 by himself up to Feb. 1865—425 in all; a number which his diligence has probably since considerably increased.*

Having spent so much time in the general description of these curious objects, we must proceed to the complete and very instructive specimens referred to in the opening of our remarks; of which, and of the principal features of the neighbourhood, a diagram accompanies the present paper. It is copied from the Map of B. and M., omitting, however, a great accumulation of detail, and retaining only such features as serve our immediate purpose. The top coincides with the Lunar Equator. *Agrippa* and *Godin* will be easily identified

* One of those ascribed to Schr., the grand cleft in the *Alps*, was really discovered by Bianchini. Gruithuisen detected many, but has in general given very defective identification. Two of his, at least, are I think omitted in this list; and two if not three more might have been added which I noticed on the floor of *Atlas* with Mr. Bird's 12-in. silvered glass reflector, 1865, Sept. 7. I have also seen a bent cleft in the interior of *Furnerius* with a $5\frac{1}{2}$-in. object glass.



LUNAR CLEFTS.

as 26 and 27 in our little Map; the remarkable crater *Manilius* (24) lies only a little below the area represented; for telescopic search these features, previously recognized from their position relative to the *M. Serenitatis* and the *Apennines*, will always be sure guides. The cleft passing through *Hyginus* is the first described by B. and M. It is conspicuous enough to be seen in a good telescope with a power of 40, and under almost any illumination. Its commencement, from the N.E., is at a long, low hill, and here it appears almost as a flat valley, nearly 1½ mile wide, but after a length of 9 miles it becomes narrowed to a breadth of 1300—1500 yards, with such steepness and depth that, in one instance, B. and M. distinctly perceived the delicate black line of shadow on one side running parallel with the brightly-illuminated opposite bank. In this part of its course, which is through level ground, it encounters four little craters, the second of which is 3200 yards, or nearly 2 miles across; the others 2000 to 2500 yards. After running about 50 miles it reaches the larger crater, *Hyginus*. But what happens to it there, and in its further progress, must be reserved to a future opportunity.

OCCULTATIONS.

Aug. 2nd, 22h. 34m. to 23h. 16m., or in common reckoning, 3rd, 10h. 34m. to 11h. 16m. A.M. the planet Mars. This obviously requires a large aperture and equatoreal mounting. —15th, e^1 Aquarii, 6 mag. 11h. 54m. to 12h. 52m.—16th, λ Aquarii, 4 mag. 7h. 50m. to 8h. 51m.

PHYSICAL GEOGRAPHY AS A POPULAR STUDY.*

Amongst the newly-cultivated branches of science, Physical Geography is one of the most generally interesting, because its broad facts and reasonings are easily appreciated, and no expensive apparatus is necessary for its pursuit. It ought to form a prominent subject in any national system of education; and when it is absent, school-teaching in what is called "geography," usually consists of little more than lists of latitudes and longitudes, courses of rivers, and positions of cities, separated from all associations that could give them the character of true knowledge. The simplest facts and problems of physical geography are eagerly apprehended by young children, when properly explained, while the complex considerations of terrestrial structure, and its influence upon temperature, climate, and civilization, tax the highest intellect, and furnish material for the profoundest thought.

During the last twenty years many excellent works on physical geography have been produced by various writers; but no one has appreciated more clearly than Professor Ansted the range of subjects that ought to be included, or the way in which they ought to be presented, so as to make the philosophy of the science intelligible as well as its facts. The advantage of a comprehensive scheme is very great, though it is necessarily associated with an unavoidable degree of incompleteness, when, as in the book before us, a variety of important matters are compressed within the limits of a few hundred pages.

Professor Ansted begins by considering "the Earth as a Planet," after which follows a chapter on "Physical Forces," succeeded by one on "the Succession of Rocks." These chapters are introductory, and it is in the second part that what is commonly understood as "Physical Geography" really commences. The distribution of land occupies three chapters; water, including ice phenomena, four chapters; four more are devoted to air, including winds and climate; igneous phenomena are treated in two chapters; and the work concludes with expositions of the broad features of terrestrial life. Any one of these subjects might be easily expanded into a treatise the size of the whole book; but there is an obvious advantage in presenting them in an epitomized form, and in the order which the Professor has adopted.

* "Physical Geography." By Professor D. T. Ansted, M.A., F.R.S., F.R.G.S., F.G.S., Honorary Fellow of King's College, London, and late Fellow of Jesus College, Cambridge, etc., etc. Wm. Allen & Co.

The size of the earth, its average density, the velocities of its diurnal rotation, and of its annual course, the size and weight of its satellite—these and similar facts belonging to astronomy, supply considerations which lie at the root of physical geography. We are continually, and, on the whole, equally affected by one class of astronomical facts, such as the recurrence of night and day, summer and winter, lunar action on the tides, and many others; while another class of astronomical facts relate to changes very slowly effected, and only producing important results after the lapse of long periods of time. We, or the people of any given generation, are of course most immediately influenced by the quickly-recurring changes; but, looking to the laws of succession and continuity, manifested throughout the operations of nature, it will be seen that our physical structure, our methods of life, and even our habits of thought, are, to a certain and large extent, the results of previous conditions of our planet, dating back even to its origin in the remote abysses of the past.

A very important consideration, well adduced by Professor Ansted, arises out of the astronomical fact that the eccentricity of the earth's orbit is the subject of secular changes. "When the eccentricity is greatest, the greatest distance of the sun from the earth may amount to 102,256,873 miles, and its nearest distance will then only be 87,503,039 miles, showing the very considerable difference of 14,753,834 miles, or more than one-seventh of the larger semi-diameter. This is a very important fact; for, as the amount of heat received from the sun varies as the square of the distance, it follows that the quantity of heat received in the former position, compared with that in the latter, will be as 19 to 26."

It will take twenty-four thousand years for the minimum of eccentricity to be reached, so that the change does not immediately concern the present inhabitants of the globe; but in past periods it may have materially affected the creatures then living upon it, and likewise produced modifications of form and climate, the influence of which has descended to our own times.

At present the earth comes nearest to the sun in winter; but "if, when the eccentricity is greatest, the case is reversed, the land of the northern hemisphere would be warmed only to the very minimum extent in winter, and heated to a maximum in summer, the difference would then equal one-fifth of the whole. There would then be far more extreme climates on the earth than there are now." In his "Outlines of Astronomy," Sir John Herschel, commenting on speculations of this nature, observes that about four thousand years before the Christian era, the place of the perihelion must have coincided with the vernal equinox (or have been situated in long. 0°), and in long. 90° about A.D. 1250. In A.D. 11700, he adds that "the extreme summer and winter of the southern hemisphere will be transferred to the northern." Such changes must have taken place thousands of times in geological eras, and may have partially accounted for those changes of climate which geology and palæontology show to have occurred.

Terrestrial climate is still more strongly affected by the disposition of masses of land and water, the height and direction of mountain-chains, the character of the soil, its being covered with trees or left bare, etc. Of the whole surface of the earth "only a fourth part, or about fifty-two millions of square miles, rises above the uniform level of the water and form land," and it is remarkable that a great part of this land "is grouped round one hemisphere, so that not more than one twenty-seventh part has land opposed to it on the opposite hemisphere. Thus, if a person stationed vertically over Falmouth in England could see half the globe, he would see more than forty-nine out of the fifty-one millions of square miles of land, or about an equal surface of land and water. If, however, he were perched equally high above New Zealand, he would see ninety-six and a half millions of square miles of water, and less than two millions of square miles of land."

Any important change in the relative proportions and dispositions of land and water would materially modify the earth's climate. Supposing the quantity of each within a moderate number of miles from the surface to remain the same, but the shallow seas to be considerably deepened and at the same time narrowed, and the bulk of continuous continents very much augmented, there would be a diminution of evaporation, and an addition to excessive or continental climate. On the other hand, rendering deep seas shallower, and diminishing the area of land by a corresponding change in its level would produce opposite effects, and the violence of the alteration would depend partly on the average extent to which levels were modified, still more on the position of the high lands.

The laws which determine the relative disposition of land and water are very little known; and hence there is room for two opposite suppositions, according to one of which the present arrangement depends on permanent causes of very ancient date; and, according to the other, great changes may have taken place within comparatively moderate periods, and equally important alterations may still be going on, though their rate may be very slow. Professor Ansted refers to a speculation of Mr. James Yates, that the centre of gravity of the earth would not be coincident with the centre of magnitude without the protuberance of water on one side, and that the inequality of land in the two hemispheres is permanent. We have not read the paper in which Mr. Yates put forward this ingenious speculation, but we doubt there being sufficient evidence to raise it above the level of a conjecture, and when we look to the action of aqueous, igneous, and aerial causes of modification, we are not disposed to attach very great importance to a difference of average specific gravity, if it exist, in the land of the two hemispheres, through a great metalliferous deposit in one, and a more cavernous texture in the other.

The great continental mass ranges from north-east to south-east, thus crossing the earth's diurnal motion from west to east, but what was the direction of former continents we do not know; it may at some periods have been widely different from what it is now.

Passing for the moment from the consideration of the disposition of land and water masses as affecting climate, and through that acting upon civilization, another important influence of such arrangements must be noticed, and that is the facility they afford, or the difficulties they oppose to, intercommunication and commerce. Hitherto lands much indented by seas and navigable rivers have had an enormous advantage in this respect over massive continents; and the advance of Europe, as compared with Asia, has, in no small degree, been occasioned by the extent and sinuosities of its coast lines. In Europe there is a mile of coast for every hundred and eighty-seven square miles of surface; in Asia the proportion is one mile of coast to five hundred and twenty-eight square miles of surface; in Africa one to seven hundred and thirty-eight; in North America one to two hundred and sixty-six; in South America one to three hundred and thirty. But we now live in an epoch in which human invention modifies the value of these conditions, great continents are being traversed by railways, even before roads are constructed, and ultimately this may more than compensate for their deficiency in coast.

The physical characteristics of the different continents are peculiarly interesting:—"Europe is, on the whole, a hilly and mountainous country. Asia contains the loftiest mountain groups of the globe, and also vast plateaux. Africa has its lofty mountains and elevated plains. Deserts very little above the sea level accompany the plateaux; but are small in comparison. America, notwithstanding the important and lofty chains of the Andes and Rocky Mountains, is mostly characterized by its plains. The high lands are a fringe of plateaux, and the gigantic valleys, of which those of the Mississippi, the Amazons, and La Plata are examples, are low plains. Mountains, except in the great chain of the Andes, in Central America and on the west coast of the Andes, are subordinate, the important cultivation and vegetation of the continent being dependent on the broad, rich, level tracts that reach for thousands of miles in successive terraces, almost unbroken by hills, through a large part of both divisions of America."

Europe is the most complicated of continents. America and Australia are both simple, the one with its great mountain system in an almost continuous line, and its chief drainage in one direction; and the other with its prosaic destitution of great features, either mountain, lake, or river.

Variety of conditions and influences being essential to the progress of civilization, it is interesting to observe the tendency of different regions of the globe to assist or to hinder human advancement. Monotonous climates and monotonous countries tend to induce a stationary and conservative condition of the human mind, and had it not been for the warlike irruptions made from time to time by more impetuous mountain races, the inhabitants of great plains would have sunk into a state of vegetative repetition of the same forms of life, and of the same habits. The existence of variety to stimulate, and of difficulty to render industry indispensable, both of which arise, to a great extent, out of conditions of physical geography, exert the most powerful influence on the education of the human race; and if we understand the structure and position of different countries, we can easily see where civilization can be an early, and where it must be a late condition of the inhabitants.

A school of *un*philosophers has lately been trying to grow up amongst us, who caricature the doctrine of race, and who think themselves wiser than other persons, because they are unable to perceive that the mobility of certain races and the stationary character of others are intimately connected with the conditions under which they have existed. Such shallow reasoners feel no scruples in laying down the law that certain races must be extirpated, and that certain others must be enslaved, and they raise a sort of hyena laugh against those who believe that, by applying principles of justice, benevolence, and industry, all the great branches of the human family may be at last raised to a participation of the blessings of liberty and civilization. The unchangeable habits of savages are paralleled by the unchangeable habits of the pauper and criminal class in European countries, and yet there is no distinction of race between the tramp and the tradesman, the hereditary pickpocket and the thriving artizan. If a large portion of Africa is pointed out as the abode of races who do not improve, we ask, why should they? When have they been subjected to the operation of causes similar to those which have led Europeans in their progressive career? And if we look a little farther, we shall see that the physical geography of Africa has opposed difficulties to the advance of civilization which we do not yet know how to overcome. In like manner immense tracts of country on the borders of the Amazon cannot, from considerations of physical geography, become the home of a numerous and cultivated population, until gigantic means can be employed to cut away its rampant vegetation, and drain its enormous swamps. In dealing with Africa, the difficulties are physical and moral, and the beneficent influence of the European mind upon the African mind can only be exerted successfully by a combination of powerful countries like England, America, and France, to compel the cessation of the slave trade, and establish honest, commercial settlements at the most convenient points.

Professor Ansted has an interesting chapter on the efforts of human agency in modifying the earth's surface, and there is every reason to believe that, within a few generations, the conditions of prodigious tracts of country will be greatly improved. India is undergoing an enormous change, through the restoration and extension of works of irrigation, and the impulse given to cultivation by the augmentation of means of transport. The slave states of America are passing from barbarism to civilization, and in a generation or two, millions of educated men will replace millions brought up in a condition little above that of domestic animals, swamps will be drained, waste land reclaimed, barren land cultivated, and thus many thousands of square miles will experience a considerable modification of climate as well as of aspect. When sandy wastes are sufficiently near centres of civilization to be worth the cost of modifying, we find them gradually converted into pasture and forest. First, certain plants are grown which give stability to the shifting mass, and other plants succeed them, and, in time, trees with their power of attracting moisture and protecting the soil from evaporation, rear their heads. Even in certain extensive deserts, it is believed that water for their fertilization might be obtained by artesian wells, and the constant demands of commerce for new markets and new routes of transit, tend to bring into importance tracts of country that have for ages been stationary, because the world's industry and invention had left them alone.

Apparently trifling circumstances may lead to considerable changes, as when the accidental introduction of a new plant or a new insect interferes with pre-existing arrangements and modifies the vegetation of a country or a district, thereby leading to changes in its supply of moisture, amount of evaporation, etc., etc.

It is, however, when civilization is most active, that man's power over the earth becomes most apparent, and enters into rivalry with natural forces in producing modification. For immense periods it is probable that, *on the whole*, the amount of natural force at work to effect alterations of the earth's surface has been tolerably uniform in amount; but we who live in regions lying a little way out of the existing lines of maximum disturbance from action of fire, ice, or water, are apt to underrate the work that is going on from day to day. Wonderful is the amount of that work when fairly surveyed, and the time may arrive when fresh changes in the direction of disturbing forces may occur, and our own quiet regions may again be torn by earthquakes, fire-deluged by the volcano, or modified by glacial ice.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1867.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		Ra…
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	rea… 9 A…
	inches.	°	°		inch.	°	°	°	0—10		inc…
April 1	30·410	46·7	36·6	·70	·333	56·2	30·4	25·8	0, 1, 9	WSW, W, W by S.	0·
„ 2	30·136	52·5	48·1	·86	·406	61·8	46·2	15·6	10, 9, 4	W by N, W by S, W.	
„ 3	30·201	51·9	37·9	·61	·398	61·7	43·0	18·7	2, 1, 5	NW, WNW, W by N.	
„ 4	29·829	49·2	41·4	·76	·363	—	47·1	—	10, 9, 8	W, W by N, NW by W.	
„ 5	30·027	49·4	41·0	·75	·365	57·7	42·5	15·2	9, 10, 10	W by S, W by S, W.	
„ 6	30·009	51·0	46·1	·85	·386	60·8	44·5	16·3	10, 9, 9	W by N, W, W by N.	
„ 7	...	...	...	...	...	56·8	46·8	10·0	...	... ...	
„ 8	29·397	47·6	44·0	·88	·343	56·4	43·4	13·0	10, 10, 10	W, W by S, W.	
„ 9	29·717	47·4	34·3	·63	·341	56·0	43·3	12·7	6, 7, 7	WNW, W by S, WSW.	
„ 10	29·801	45·4	39·7	·82	·318	54·1	33·0	21·1	8, 10, 10	SW by W, SSW, SW.	
„ 11	29·720	42·9	33·8	·73	·292	54·3	44·3	10·0	10, 7, 9	W by S, NW by W, N.	
„ 12	30·170	47·5	33·0	·60	·342	56·2	34·5	21·7	2, 7, 5	NW, SW by W, SW by W.	
„ 13	29·934	45·0	45·2	1·00	·314	54·5	41·9	12·6	10, 10, 10	SW by W, SW.	
„ 14	...	...	...	...	...	54·1	47·3	6·8	...	... ...	
„ 15	29·564	47·6	38·2	·72	·344	56·0	45·6	10·4	7, 6, 3	W by N, WNW, W by N.	
„ 16	29·662	49·8	46·5	·89	·371	55·7	44·0	11·7	10, 10, 10	S, WSW, W by S.	
„ 17	29·869	49·7	46·3	·89	·369	61·2	45·3	15·9	10, 7, 9	ENE, WNW, NW.	
„ 18	29·836	51·8	48·5	·89	·397	62·3	44·5	17·8	5, 10, 9	S by W, S by E, S by E.	
„ 19	...	...	...	...	...	61·8	51·7	10·1	...	... ...	
„ 20	29·200	50·1	47·5	·91	·374	57·5	53·1	4·4	10, 10, 10	SW, SW, S by W.	
„ 21	...	...	...	...	...	51·2	40·3	10·9	...	... ...	
„ 22	29·810	46·1	40·4	·82	·326	55·1	42·3	12·8	7, 10, 10	W, SW, S.	
„ 23	29·759	53·9	48·5	·83	·426	62·3	48·3	14·0	10, 9, 5	WSW, SW by S, S.	
„ 24	29·635	51·0	45·3	·82	·386	59·9	47·9	12·0	5, 8, 8	SW by S, SW, SW by S.	
„ 25	29·801	43·0	41·4	·94	·293	50·6	46·3	4·3	10, 10, 10	N, NE, NNE.	
„ 26	29·761	44·1	41·8	·92	·305	52·3	41·4	10·9	10, 10, 10	E by S, E, SE.	
„ 27	29·494	49·6	44·8	·85	·368	58·2	45·1	13·1	9, 7, 3	S, S by E, SW by S.	
„ 28	...	...	...	...	...	54·1	33·7	20·4	...	... ...	
„ 29	29·861	49·8	37·5	·65	·371	60·1	38·5	21·6	1, 1, 3	NNE, —, NE by E.	
„ 30	29·699	50·2	46·2	·87	·376	60·0	38·8	21·2	10, 7, 4	S by W, W, W.	
Daily Means.	29·812	48·5	42·2	·81	·356	...	...	14·2	...	... ...	1

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—April, 1867.

	Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
	Hour.																															
	12	4	10	18	8	16	10	9	15	27	17	26	5	14	22	26	9	15	3	14	19	26	12	13	10	6	12	11	4	7	3	13·0
A. M.	1	4	11	15	12	14	5	9	14	26	13	23	4	13	22	30	11	15	1	14	16	24	10	12	11	6	12	9	1	7	3	12·2
	2	4	10	12	15	10	6	8	12	29	13	25	4	13	24	25	11	14	1	10	15	23	11	10	7	6	11	4	3	5	4	11·5
	3	2	9	11	19	5	8	13	15	25	9	28	3	16	25	24	11	15	3	8	15	25	10	9	11	8	11	4	2	7	4	11·8
	4	4	8	13	15	4	9	13	15	22	4	29	4	14	27	24	8	15	1	12	17	27	10	11	16	5	10	7	3	7	6	12·0
	5	3	10	10	14	1	12	7	19	22	7	30	5	17	24	25	10	10	1	11	20	26	10	11	15	5	8	7	1	6	11	11·9
	6	3	10	4	14	1	11	11	16	25	6	30	5	16	32	25	8	8	3	12	21	28	14	14	14	5	8	5	2	6	11	12·3
	7	7	10	9	17	3	16	9	21	28	9	33	4	17	30	28	11	7	5	15	21	29	16	11	18	6	11	8	4	6	9	13·9
	8	7	12	14	13	5	13	11	21	31	11	27	4	15	30	24	12	7	6	15	24	30	18	14	21	6	12	11	7	6	10	14·6
	9	6	9	16	21	13	21	13	22	31	11	29	6	17	33	23	10	6	11	20	24	31	17	17	23	3	11	12	10	6	13	16.2
	10	13	13	14	15	13	16	14	22	27	16	29	7	17	39	27	12	4	14	21	21	27	17	17	20	14	13	13	12	7	13	16·9
	11	14	18	16	18	15	17	17	19	28	17	33	7	18	36	26	11	3	13	22	22	29	15	15	25	14	13	17	12	6	10	17.5
	12	14	19	13	24	15	17	13	24	31	20	32	9	18	38	24	10	6	18	29	27	30	15	15	27	13	15	17	14	9	15	19.0
P. M.	1	16	18	12	21	17	18	18	27	26	22	31	10	21	36	25	14	5	13	21	21	25	15	16	26	14	13	14	13	6	18	18.4
	2	16	15	15	24	16	18	22	31	26	23	24	10	20	32	25	17	11	11	24	15	27	15	18	29	12	12	19	15	5	16	18·8
	3	17	10	14	24	18	12	24	34	25	24	26	9	18	30	26	18	12	10	23	19	30	15	17	26	13	11	21	15	5	18	18·8
	4	15	14	12	26	19	14	24	33	25	20	22	13	15	25	27	17	11	7	27	19	29	13	23	23	13	10	20	16	3	14	18.3
	5	12	16	7	21	19	12	16	27	26	26	23	16	15	30	24	14	4	6	26	21	20	8	24	22	13	10	18	15	3	14	16.9
	6	10	15	10	15	19	14	19	32	24	27	9	14	15	27	29	15	3	6	21	20	20	9	19	20	10	14	14	7	5	11	15.8
	7	10	13	10	14	17	13	24	33	25	28	5	11	15	29	18	14	2	5	20	17	17	10	14	20	14	15	12	8	7	10	15.0
	8	13	16	9	11	12	10	22	30	19	30	1	10	19	29	12	15	1	5	18	24	16	10	12	16	12	15	10	7	6	10	14.0
	9	8	13	9	13	14	10	21	31	17	27	4	11	20	26	10	15	1	5	18	29	13	10	8	12	11	15	7	6	6	11	13·4
	10	12	17	12	13	14	9	22	33	18	23	1	10	23	30	10	14	2	9	18	30	12	10	13	7	13	14	5	7	6	8	13·8
	11	11	11	12	14	11	8	16	29	17	23	5	11	20	29	10	12	3	12	20	25	14	10	11	8	10	12	6	5	2	5	12·7
	12																															
Total Daily Movement.		225	307	287	401	291	299	375	575	600	426	525	192	406	705	547	299	180	169	439	502	578	300	344	427	232	288	271	189	139	247	14·9

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain read 9·[illegible] A.[illegible]
	inches.	°	°		inch.	°	°	°	0—10		inch[illegible]
May 1	29·944	50·3	37·6	·64	·377	59·3	43·2	16·1	10, 8, 4	W by S, NW, W.	0·06
„ 2	30·056	50·5	43·5	·79	·380	60·0	37·1	22·9	1, 8, 10	—, E by N, WSW.	·00
„ 3	30·110	57·1	45·6	·68	·474	67·0	44·6	22·4	7, 2, 2	SW, SSW, SSE.	·00
„ 4	30·065	58·3	41·9	·57	·494	66·7	43·4	23·3	2, 1, 3	SSE, SE, ESE.	·00
„ 5	...	...	...	...	...	72·2	45·6	26·6	...	... ...	·00
„ 6	29·910	70·2	56·4	·63	·731	79·5	46·7	32·8	2, 4, 7	—, SE, SSE.	·00
„ 7	29·964	68·3	56·7	·68	·687	77·4	56·7	20·7	5, 7, 9	W, NW, N.	·00
„ 8	29·841	66·2	51·0	·60	·642	77·3	51·3	26·0	0, 3, 7	E by N, S, S by W.	·00
„ 9	29·909	62·3	51·9	·70	·564	70·1	51·1	19·0	5, 4, 10	SW by S, SE by S, SSW.	·00
„ 10	29·709	66·0	54·8	·69	·638	75·9	51·8	24·1	7, 5, 9	S by W, S by E, SE by S.	·00
„ 11	29·534	59·1	49·8	·73	·507	67·0	53·8	13·2	8, 7, 3	SW, SW by S, W by S.	·29
„ 12	...	...	...	...	...	57·5	46·9	10·6	...	... ...	·01
„ 13	29·610	42·6	39·4	·89	·289	49·6	44·1	5·5	10, 10, 10	ENE, E by S, E by N.	·02
„ 14	29·789	41·1	31·9	·72	·274	50·0	43·7	6·3	10, 10, 10	E by N, ENE, E by N.	·00
„ 15	29·873	40·9	31·2	·71	·273	48·5	41·6	6·9	10, 8, 10	NE, NE, NE by E.	·00
„ 16	30·040	41·3	35·6	·82	·276	49·4	41·4	8·0	10, 10, 10	ENE, NE by N, NE.	·00
„ 17	30·106	48·5	39·3	·73	·354	55·1	38·1	17·0	3, 10, 8	S, SW, S by W.	·00
„ 18	29·992	52·5	40·1	·65	·406	61·8	33·0	28·8	5, 3, 3	—, E, E by N.	·000
„ 19	...	...	...	...	...	63·2	45·4	17·8	...	... ...	·000
„ 20	29·591	51·9	51·5	·98	·398	62·3	49·5	12·8	10, 10, 10	NNW, N, —.	·00
„ 21	29·686	42·5	38·9	·88	·288	50·1	49·1	1·0	10, 10, 10	NE, NE, NE by E.	·300
„ 22	29·972	38·7	30·5	·74	·252	47·0	36·0	11·0	7, 8, 8	ENE, NE, NW.	·06
„ 23	30·059	42·1	30·7	·67	.284	48·9	32·4	16·5	7, 7, 8	N, NE by N, NE by N.	·065
„ 24	30·146	41·1	29·8	·67	·274	49·5	31·6	17·9	9, 10, 10	N, NE, E.	·00
„ 25	29·988	44·3	34·2	·70	·307	52·5	31·2	21·3	9, 10, 10	ENE, E, E by S.	·000
„ 26	...	...	...	...	...	66·8	44·9	21·9	...	... ...	·376
„ 27	29·591	54·5	47·8	·80	·434	64·1	49·6	14·5	4, 8, 5	S by E, S by W, SW.	·029
„ 28	29·794	58·1	49·7	·75	·491	69·0	47·9	21·1	10, 6, 7	S by W, SSW, SSE.	·015
„ 29	29·893	60·4	54·8	·83	·530	71·1	52·3	18·8	3, 4, 9	SSE, E, E.	·000
„ 30	29·998	58·4	55·6	·91	·496	69·2	51·9	17·3	4, 10, 10	—, —, SW.	·015
„ 31	30·096	60·0	51·6	·75	·523	71·1	47·5	23·6	10, 2, 5	W by S, SW, SW.	·019
Daily Means.	29·899	52·9	43·8	·74	·431	...	...	17·6	...	... ...	1·285

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.
† Rain and snow.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—MAY, 1867.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
	12	6	1	1	1	9	4	10	14	3	6	4	2	10	12	17	17	3	1	9	1	1	10	10	3	2	14	6	11	9	2	6	6·6
A. M.	1	8	2	3	3	6	1	9	6	7	3	4	2	8	15	15	15	4	1	7	1	3	10	9	2	3	14	4	10	5	1	5	6·0
	2	9	1	3	3	4	4	7	7	5	5	.2	3	7	15	17	16	1	2	8	2	4	10	8	5	3	15	3	6	2	6	6	6·1
	3	8	2	3	2	3	1	5	10	3	4	4	3	6	15	14	17	1	1	10	4	2	11	5	3	2	14	3	9	4	7	4	5·8
	4	10	8	1	3	7	4	2	13	4	4	4	1	9	16	16	14	1	1	7	3	3	9	9	3	5	11	5	9	5	4	7	6·4
	5	10	4	1	2	9	2	2	11	4	4	10	4	10	15	16	15	2	2	9	1	4	10	10	4	6	11	10	11	3	5	7	6·9
	6	14	3	3	1	11	5	1	11	5	5	5	5	12	14	22	15	3	2	11	2	8	14	12	7	7	8	14	12	3	10	8	8·2
	7	12	4	3	7	4	4	5	11	9	5	9	10	14	15	21	15	3	6	12	4	6	18	16	9	3	8	15	18	5	9	7	9·3
	8	14	1	5	11	11	7	9	13	10	5	11	14	14	20	23	20	4	6	12	5	13	18	22	10	5	9	19	22	2	7	5	11·2
	9	16	4	7	9	12	8	6	12	10	5	16	17	13	20	21	16	5	9	14	7	15	15	25	10	6	6	19	25	4	6	8	11·8
	10	15	4	7	13	16	9	5	15	10	9	21	13	12	26	22	20	5	8	19	5	24	12	29	11	13	10	20	21	7	8	5	13·4
	11	12	3	9	17	14	6	6	12	7	4	21	14	11	20	20	16	5	9	16	8	20	15	26	11	16	8	15	25	10	9	6	12·6
	12	15	4	8	17	16	8	8	14	6	5	21	16	12	27	20	17	4	9	15	11	18	13	27	10	16	13	18	26	9	10	10	13·6
P. M.	1	12	3	9	16	17	9	7	14	7	14	24	19	10	25	20	11	4	9	16	4	19	11	22	7	17	16	18	29	9	7	11	13·4
	2	11	10	9	14	15	11	7	18	5	16	18	17	9	24	19	9	8	11	12	7	18	10	26	6	19	17	23	30	14	11	10	14·0
	3	9	4	9	15	17	10	8	16	5	19	18	14	8	24	20	12	10	11	10	3	22	11	23	6	23	17	22	24	17	11	9	13·8
	4	12	8	10	15	12	16	11	12	3	16	20	15	8	23	19	9	7	15	9	4	18	15	24	5	22	16	21	20	15	8	11	13·5
	5	9	6	11	15	13	13	11	15	3	13	19	11	10	21	18	7	7	15	6	4	17	14	20	9	21	14	22	19	18	7	10	12·8
	6	7	5	6	12	9	7	9	12	1	12	14	10	14	23	17	9	7	13	6	5	17	14	19	6	23	8	21	16	12	6	10	11·3
	7	8	5	8	14	5	8	14	12	2	6	10	14	17	19	18	12	5	10	4	3	15	15	15	6	21	7	19	14	7	8	9	10·6
	8	7	6	3	13	3	4	12	8	6	8	7	13	14	17	15	3	8	9	2	4	10	9	7	4	18	6	16	10	4	6	6	8·3
	9	5	6	3	10	5	7	15	7	5	5	5	11	15	14	16	6	5	8	3	2	9	10	6	3	20	4	15	9	5	6	5	7·9
	10	3	6	4	9	7	11	17	5	3	3	4	10	13	15	16	2	6	8	3	2	11	12	4	4	19	8	13	9	4	5	6	7·7
	11	2	2	2	8	3	12	14	2	2	4	1	10	12	15	17	3	4	9	2	1	5	8	3	2	16	6	10	9	1	5	1	6·2
	12																																
Total Daily Movement.		234	102	128	230	228	171	200	270	125	180	272	248	268	450	439	296	112	175	222	93	282	294	377	146	306	260	351	394	174	164	172	9·9

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867. Day of Month.	Reduced to mean of day. Barometer corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
June 1	30·093	65·2	50·7	·61	·621	74·9	46·2	28·7	1, 7, 4	S by W, SW, SW by W.	0·000
,, 2	...	...	...	...	...	78·1	50·3	27·8	...	... ...	·000
,, 3	29·736	52·5	51·1	·95	·406	61·0	55·5	5·5	10, 10, 10	NNW. NW by N, W.	·727
,, 4	29·947	54·5	46·9	·77	·435	64·5	46·7	17·8	7, 7, 6	W by N, WNW, WNW.	·030
,, 5	29·820	52·4	53·5	1·00	·405	60·9	45·9	15·0	10, 10, 10	S by W, SW, SW by S.	·095
,, 6	29·706	55·1	47·9	·78	·444	64·9	53·0	11·9	10, 3, 8	SW by S, SSW, SW by S.	·160
,, 7	29·720	54·0	49·2	·85	·428	64·6	51·4	13·2	8, 7, 6	W by S, SW by W, W.	·000
,, 8	30·077	54·3	45·0	·73	·432	63·3	46·7	16·6	6, 9, 7	SW, SW, SW.	·110
,, 9	...	...	...	...	...	68·7	51·2	17·5	...	... ...	·000
,, 10	30·265	65·5	50·8	·61	·627	75·9	50·1	25·8	0, 0, 0	WNW, WNW, —.	·000
,, 11	30·236	69·7	57·0	·68	·719	78·6	50·8	27·8	1, 1, 2	S, ESE, SE by S.	·000
,, 12	30·044	68·0	59·2	·75	·681	77·7	55·5	22·2	2, 4, 7	SW, W by N, NNW.	·000
,, 13	30·014	55·0	50·7	·86	·442	62·7	53·3	9·4	8, 9, 10	W, SSW, WNW.	·060
,, 14	29·840	50·2	45·0	·83	·376	61·9	51·7	10·2	9, 9, 9	NW, W by N, W by N.	·000
,, 15	29·995	49·1	42·6	·80	·362	57·9	44·5	13·4	6, 10, 10	NNW, NW, NNE.	·114
,, 16	...	...	...	...	...	58·5	47·6	10·9	...	... ...	·065
,, 17	30·130	51·1	47·5	·88	·387	61·3	47·7	13·6	9, 10, 10	NW by W, NW, N by E.	·000
,, 18	30·066	60·3	55·3	.84	·528	70·5	46·3	24·2	8, 6, 1	W by N, NW, N.	·000
,, 19	29·986	56·7	55·6	·96	·468	66.5	58·6	7·9	10, 10, 10	E by S, E, E by S.	·000
,, 20	30·023	53·1	52·7	·98	·415	61·7	52·4	9·3	10, 10, 10	NNE, NE by N, NE.	·000
,, 21	30·112	52·3	49·4	·91	·404	62·8	49·8	13·0	10, 10, 10	N by E, NE, N.	·000
,, 22	30·121	55.2	45·8	·73	·445	66·9	45·5	21·4	2, 3, 3	NNE, NE, NNW.	·000
,, 23	...	...	...	...	...	69·4	46·6	22·8	...	... ...	·000
,, 24	29·995	55·5	50·9	·86	·450	66·3	51·5	14·8	10, 10, 9	NW, N, NNE.	·000
,, 25	30·234	60·0	51·8	·76	·523	70·0	48·9	21·1	2, 3, 1	N, NE, NNW.	·000
,, 26	30·512	58·9	49·8	·74	·504	69·3	47·5	21·8	3, 1, 1	NE, NE, NE.	·000
,, 27	30·533	66·8	47·7	·53	·655	77·3	45·0	32·3	0, 1, 3	NE, N by E, NNE.	·000
,, 28	30·537	54·3	49·5	·85	·432	64·7	51·7	13·0	10, 5, 3	NNE, NE, NE by N.	·000
,, 29	30·344	62·1	50·2	·67	·561	74·3	41·0	33·3	1, 3, 3	SW by W, S by W, NW.	·000
,, 30	...	...	...	...	...	77·9	48·1	29·8	...		·000
Daily Means.	30·043	57·3	50·2	·80	·486	...	...	18·7	...	... ...	1·361

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—JUNE, 1867.

Day. / Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
12																															
A.M. 1	3	4	1	8	7	16	14	11	11	5	1	3	2	3	5	6	6	2	3	11	8	6	2	4	8	5	7	2	2	5	5·7
2	2	1	5	6	6	15	12	13	8	5	0	3	3	3	6	4	3	1	3	10	9	6	1	8	9	5	6	4	5	4	5·5
3	2	1	4	6	7	13	14	10	9	6	2	5	3	3	8	5	3	3	3	9	8	6	1	6	5	5	9	1	2	1	5·3
4	2	1	5	5	5	13	9	9	8	4	2	4	4	2	8	3	3	3	4	11	9	7	1	5	7	10	7	5	3	3	5·4
5	2	1	9	7	10	12	15	5	8	4	1	2	3	5	8	3	5	4	1	10	5	5	1	7	7	10	12	6	2	6	5·9
6	3	0	9	8	12	12	14	4	10	6	0	2	4	4	10	4	5	5	4	10	9	5	1	8	7	10	8	8	3	1	6·2
7	2	3	12	9	18	11	14	6	11	7	2	3	4	3	13	7	4	5	1	10	7	6	0	10	7	15	13	13	0	3	7·3
8	10	2	4	10	21	17	16	6	12	7	7	5	4	5	16	8	7	5	3	9	9	8	4	10	11	15	11	15	3	2	8·7
9	14	2	5	9	22	17	16	6	10	8	5	8	6	8	14	10	7	6	3	10	9	9	6	13	14	15	7	17	2	3	9·4
10	15	4	4	11	17	18	13	9	12	10	8	8	8	7	16	7	6	8	6	9	9	6	5	12	8	17	9	18	2	2	9·5
11	14	14	5	5	20	19	14	10	11	13	11	10	11	13	16	13	11	6	7	9	11	8	12	13	18	19	19	6	6	3	11·6
12	15	10	5	5	23	23	14	11	11	10	9	12	10	9	17	12	6	6	9	10	8	6	11	12	15	20	18	6	6	3	11·1
P.M. 1	14	10	8	7	21	23	18	12	11	10	10	9	12	12	14	11	6	7	12	11	9	8	14	11	18	20	17	4	6	3	11·6
2	14	7	11	14	24	26	12	10	7	10	8	11	10	12	11	10	9	8	10	11	10	5	10	13	18	18	14	7	6	4	11·3
3	13	13	16	12	25	26	14	15	8	10	12	11	11	15	12	8	6	9	6	12	8	4	13	12	19	19	19	6	6	7	12·2
4	12	13	17	13	25	26	11	17	9	9	12	13	8	15	10	12	5	13	9	10	10	5	12	14	18	19	15	6	3	10	12·4
5	14	13	15	14	24	25	10	19	9	6	13	10	8	14	10	9	9	14	10	10	10	7	10	15	20	19	17	8	5	12	12·6
6	12	12	11	14	23	24	10	18	7	6	12	9	7	5	6	5	5	11	10	8	8	3	11	15	17	19	13	10	3	15	11·0
7	12	9	10	11	20	18	13	15	8	4	9	9	6	8	5	5	5	11	7	9	9	4	10	13	17	15	6	8	2	11	9·6
8	8	6	9	9	20	18	14	15	4	4	5	8	8	5	6	8	7	6	8	9	7	3	5	13	13	13	4	6	6	7	8·5
9	6	6	7	6	18	15	10	12	4	3	4	7	5	7	4	1	5	2	7	7	7	5	5	11	10	10	4	9	4	4	6·8
10	4	4	6	6	21	10	10	15	4	6	4	3	5	6	2	4	4	5	7	7	6	5	2	12	12	10	3	7	1	4	6·5
11	5	2	6	11	18	15	10	14	4	2	5	4	5	6	5	4	2	4	11	9	7	5	3	12	10	5	5	7	7	1	6·7
12	3	4	6	5	17	11	9	11	6	0	2	3	3	6	5	2	2	3	10	8	6	3	2	12	8	2	4	6	7	7	5·8
Total Daily Movement.	201	142	190	211	424	423	306	273	202	155	144	162	150	176	227	161	131	147	154	229	198	135	142	261	296	315	247	185	92	121	8·6

PROGRESS OF INVENTION.

Economic Production of Formic Ether, on the Large Scale.—The peculiar odour of the peach, possessed by this compound, has recently given to it an importance that renders any simplification or diminution of expense during its manufacture a matter of interest. It may be very conveniently made by placing a mixture containing twenty-nine parts, by weight, peroxide of manganese, and nine parts starch in an alembic, and sprinkling it with a mixture formed with twenty-eight parts sulphuric acid, five parts water, and fifteen parts alcohol, and, after agitation, closing the alembic. Distillation takes place generally without the application of heat; the products being, first, alcohol, then nearly pure formic ether, and, finally, formic acid. Before sprinkling with the alcoholic mixture, the latter should be cooled, or the action may be far too energetic.

Improvement in the Manufacture of Steel.—In the old mode of forming steel all the carbon is removed from the cast iron, malleable iron being formed; and steel is made from this malleable iron by the addition of the proper amount of carbon. By the Bessemer process only enough carbon is removed from the cast iron to change it to steel; and the carbon is removed by the introduction of an abundance of atmospheric air into the cast iron in a state of fusion. The oxygen of the air burns the carbon. It might be supposed that any substance capable of affording oxygen, introduced into the fused cast iron, would answer instead of atmospheric air; and therefore the use of substances, such as nitrate of soda, etc., capable of furnishing large quantities of oxygen, was very soon attempted. But it was found that the very property possessed by these compounds of affording oxygen, caused them to rapidly destroy the converter—a vessel in which the change from cast iron to steel was effected. Not only was the carbon of cast iron, but the metal of which the converter was formed, burned. This was, of course, fatal to the employment of these salts as a source of oxygen. The difficulty was, however, not insuperable, and it has since been overcome. The converter is lined with a refractory material, and the nitrate is placed in pockets formed in this material. The cast iron is brought in contact with the nitrate, by means of a rapid rotation imparted to the converter: and the centrifugal force thus generated throws the fused cast iron into violent collision, and therefore complete contact with, the salt.

New Breech-loading Gun.—A safe and very simple breech-loading gun has been recently invented in France. The gases generated by the explosion are prevented from escaping at the breech by the application of the principle used by Bramah to render the pistons of hydraulic presses water-tight, however great the pressure. Attached to the screw that forms the breech of the gun, is a thimble of soft copper which protrudes into the barrel, and when the gun is fired its sides are expanded by the gases in all directions, so that no gas or vapour can escape between it and the barrel. There is no trigger, and therefore it is impossible that the gun can go off by accident. The needle which ignites the explosive compound in front of the powder, passes into the screw which forms the breech, being kept back in its normal position by a spiral spring: it abuts against a thin elastic plate that closes the aperture in the screw, and does not project beyond the general surface. When the gun is to be discharged, the thumb of the right hand is pressed on the elastic plate. This forces in the needle, and ignites the detonating compound.

Improvements in Galvanic Batteries.—If the nitric acid in the Bunsen battery is replaced by an aqueous solution of picric acid, the evolution of disagreeable and unwholesome gases will be prevented, while the efficiency of the battery will not be injuriously impaired. The dilute sulphuric acid may be replaced by a solution of sea salt. The addition of picric acid also to a battery containing but one fluid greatly improves its action. The resistance to the current caused by the porous vessel of a Daniels battery is removed by a slight modification of its details. Within the outer vessel, which may be made of glass or porcelain, is placed a cylinder of copper much smaller than the outer vessel, but having attached to its lower end a disc of copper that just fits on the bottom of the outer vessel. Between the latter and the copper cylinder is the diaphragm, a cylinder of glass or ordinary porcelain, having on the outside, at the distance of one-third of its height from its lower extremity, small projections for supporting a cylinder of zinc. This battery is charged by placing siliceous sand in the interior of the diaphragm, and on this sand crystals of sulphate of copper; then pouring a solution containing about five per cent. sulphuric acid gradually into the outer vessel, until it reaches the crystals of sulphate. The electricity passes directly from the zinc to the copper disc, without being retarded by passing through a porous vessel. If the exterior vessel is glass, any deposit of copper on the zinc can be perceived at once and prevented. The greater the number of times per day the battery is to be used, the more permeable ought to be the sand, that the sulphate may be supplied with sufficient rapidity. The stratum of dissolved sulphate must never be allowed to rise high enough to come in contact with the zinc; if it is becoming too high, sand is to be added, or some of the liquid within the diaphragm is to be removed with a syphon—which will cause the sulphate to be driven back, on account of the greater height of the liquid in the external vessel.

Improvements in Plating and Gilding.—The danger to the workman from contact with mercury is entirely prevented in gilding and plating, by dipping the article to be gilt or plated in the solution of a *basic* salt of mercury while in connection with the positive pole of a galvanic battery, and, when it is covered with mercury, immersing it in a strong solution of the gold or silver salt; then plunging it a second time in the mercurial solution, and afterwards evaporating the mercury in a furnace. Or the article which is to be gilt may be dipped into sodium amalgam, the surface of which has been covered with a little water, the portions which are not to be gilt having been protected with varnish; after which an amalgam of gold is to be applied, and the mercury is to be evaporated by heat. Amalgam containing only the one two-hundredth part sodium will be sufficiently active to amalgamate tarnished metals, or iron and platinum, which, in ordinary circumstances, have no tendency to become wetted with mercury.

Improvement in Horological Machines.—It is scarcely too much to assert that the rate of a well-constructed clock or watch would be invariable, but for alterations of temperature. With an increase of temperature the pendulum is lengthened, and consequently its vibration is rendered slower; with a decrease, the contrary takes place. Analogous effects are produced by changes of temperature on watches and chronometers: and as, during summer and winter, night and day, the temperature of the air is perpetually changing, it may well be supposed that without the adoption of some means for counteracting the effects of changes of temperature, the rate of clocks, watches, and chronometers would be subject to perpetual alteration; and such is the case with ordinary horological instruments. But ingenious means have been devised for compensating the changes produced by temperature. These means, however, are subject to two considerable drawbacks: they are more or less complicated and therefore expensive, and they are rarely as perfect in their action as might reasonably be desired. A new mode of compensation for clocks, watches, and chronometers has been invented by M. Menon, which is extremely simple, and therefore inexpensive; and very effective, because calculated exactly to counterbalance the effect of changes of temperature, by bringing into opposite actions two precisely equal forces. In the compensations hitherto in use, the expansions and contractions of different substances are made to counteract each other; and thus, from the difficulty of making them exactly equal in their operations, a serious source of error is introduced. With the gridiron pendulum, for example, the rods which raise the bob of the pendulum may not expand to the same degree as the rods of a different metal which lower it: and the raising and lowering may thus not be equal—that is, the length of the pendulum may vary. With the mercurial pendulum, the centre of gravity of the mercury may not be altered in position so as exactly to counterbalance the alteration in the length of the pendulum rod produced by change of temperature. In M. Menon's contrivance, the two portions of the compensation are exactly the same in every respect, and therefore when their expansions or contractions are made to neutralize each other, the effect must be zero—that is, the length of the pendulum must remain unchanged. In the construction of a compensation pendulum on this principle, two rods of the same metal, and of the same dimensions, are used; the pendulum is attached to one, and the other is coiled up—merely for convenience, the alterations produced by change of temperature being exactly the same whether the rod is in the form of a right or curved line. The rod, in the form of a spiral, is used to suspend the bob of the pendulum, or the pendulum itself. For this purpose, one end of it is fixed to the bob, which is easily moveable on the rod, and the other is connected with the rod: or one end is fixed to a support, and the upper end of the pendulum is attached to the other—the arrangement being such that when the spiral rod expands or contracts, it raises or depresses the bob on the pendulum rod, or raises or depresses the pendulum itself through the fork: the effect being a practical shortening or lengthening of the pendulum exactly to the extent that the change of temperature has lengthened or shortened the pendulum rod; the acting length of the latter, therefore, never alters. In applying this principle to the watch or chronometer, the spiral spring and the compensator are made of the very same material and dimensions: and it is so arranged that, when change of temperature alters the length of the spiral spring, the same change alters that of the compensator which acts on the "regulator;" and thus the length of the acting part of the spiral spring is kept without change.

Improvement in the Safety Valve.—Without an effective and reliable safety-valve, the use of a steam-boiler must be constantly attended with the most imminent danger. Whatever care may be bestowed by the manufacturer on the construction of the safety-valve, it may be rendered nugatory by the ignorance or temerity of the person in charge of the engine: since he may overload the valve, and thus create a pressure within the boiler which it was not constructed to endure, and which it may not be capable of bearing. The evil may indeed be prevented by the use of two safety-valves, one of which is beyond the power of the engine man. But ingenuity has devised a still more simple remedy; one that not only prevents the production of steam at too high a pressure, but which actually causes every attempt to produce it to be accompanied by a reduction of pressure, and thus removes all temptation to tamper with the valve. The new form of safety-valve differs little from the ordinary kind, and is extremely simple. In the ordinary kind the fulcrum of the lever is absolutely immovable: in the new kind, it is fixed; in ordinary circumstances, being kept down by a spiral spring. But attempting to overload the valve brings the lever down on a stud, which is at the side of the valve most remote from the fulcrum, and which comes into action as a new fulcrum by supporting the lever, changing the latter from the third to the first order. The former fulcrum yields to the additional weight, the spiral spring being compressed, and is raised up, the safety-valve being at the same time opened, or allowed to open; and thus the steam is permitted to escape, though at a pressure too small to raise the valve when weighted as it should be. In its normal state the fulcrum of the lever is at one end, the weight at the other, and the power—that is the tendency of the safety-valve to rise—between the fulcrum and weight. When the valve is overloaded, the weight—that is the resistance of the spiral spring—is at one end, the power—that is the weight with which the lever is loaded—is at the other, and the fulcrum—that is the stud on which the lever has been brought down by the overloading—is between the power and weight: the effect of the latter being aided by the tendency of the steam to raise the valve.

A New Glass for Optical Purposes.—The density imparted by thallium, as illustrated in thallic alcohol, suggested the application of that metal to the production of a very dense, and therefore highly refractive glass; and experiments made on the subject have been extremely successful. Difficulties of a serious character were encountered at first, the glass produced being fibrous, and not very transparent; but these have been overcome by the assistance of M. Feil, a glass manufacturer of great experience, and a thallic glass in every respect suited to optical purposes has been obtained. When carbonate of thallium is employed in its manufacture, its tinge is yellowish; but if this is considered an objection, the substitution of sulphate for the carbonate affords a perfectly colourless result. Thallic glass is the most dense, and the most highly refractive and dispersive known.

Magnetism and Diamagnetism of Gases and Vapours.—A simple and effective experiment by which the magnetism and diamagnetism of gases and vapours may be rendered visible to a large audience has long been sought for, and has at length been discovered. It consists in blowing a bubble at the end of the stem of a clay tobacco-pipe, the gas used for inflation being oxygen, and the fluid a solution of soap mixed with glycerine, which affords a bubble that lasts a considerable time. The bubble is placed above the poles of an electro-magnet, and at very small distance from them. When a current is sent through the coil of the electro-magnet the bubble is attracted, and if the circuit is completed and broken several times in succession, a very striking oscillation of the bubble will be produced. If magnesium is burned over the pole of an electro-magnet to which a conical form has been given, when the circuit is complete, the smoke will be divided laterally, and assume the form of the letter U.

LITERARY NOTICES.

The Constellation-Seasons: An Easy Guide to a Knowledge of the Stars. Exhibiting, in Twelve Planispheres, the Appearance of the Heavens at any Hour of the Night, all the Year round. By Richard A. Proctor, B.A., F.R.A.S. (Longmans.)—Mr. Proctor has produced one of the most useful series of maps we have seen for the purpose he had in view, namely, enabling students to learn the position of the chief stars and constellations at various periods of the year, or to recognize them at any time. "Each map," he tells us, "contains the whole of the visible heavens at the hour and date mentioned beneath it; the centre of the map is the point over the observer's head at the time named; the outline of the map is the observer's horizon; each star is placed in its proper direction as respects the compass-points (marked in round the map); and each star is placed at its true proportionate distance from the centre." For the teaching of young people, and for adults who wish to know the position of particular stars at certain dates, these maps will be found very handy. Mr. Proctor has devoted great labour to their production, and he deserves the sincere thanks of all who wish to see the elementary facts of stellar astronomy simplified. They will be of important value to amateur telescopists.

A Handy Book to the Collection and Preparation of Fresh Water and Marine Algæ, Diatoms, Desmids, Fungi, Lichens, and Mosses, and other of the Lower Cryptogamia, with Instructions for the Formation of an Herbarium. By Johann Nave. Translated and Edited by the Rev. W. W. Spicer, M.A., F.R.M.S. (Hardwicke.)—This is really what it calls itself, a "Handy Book," with twenty-six plates, and elaborate directions for collecting and preserving the objects to which it alludes. It will be found of much use to beginners. The information is conveyed in a very clear and simple manner.

A Treatise on Punctuation, and on other Matters relating to Correct Writing and Printing. By an Old Printer. (Pitman.) —Good punctuation is an immense aid to the intelligibility of a book, and many works of merit are quite puzzling to read for the first time, because their punctuation has not been made upon a good system. The little book before us is well conceived and judiciously executed. We recommend it to all who desire to learn a simple but necessary art.

NOTES AND MEMORANDA.

Neptune's Grotto.—Under this title some ingenious person has brought out a pretty chemical toy, which we saw in operation at Messrs. Horne and Thornthwaite's. A white solid is put into a clear solution, and thereupon beautiful arborescent and other forms are seen to grow in the course of a few minutes. If the experiment is performed on a small scale in a little zoophyte trough, under the microscope, and viewed by *reflected* light, with a $1\frac{1}{2}$-inch objective, the effect is singularly beautiful. A chemist will easily recognize the materials employed. They give rise to a double decomposition, and the precipitation in crystalline form of an insoluble salt of lead.

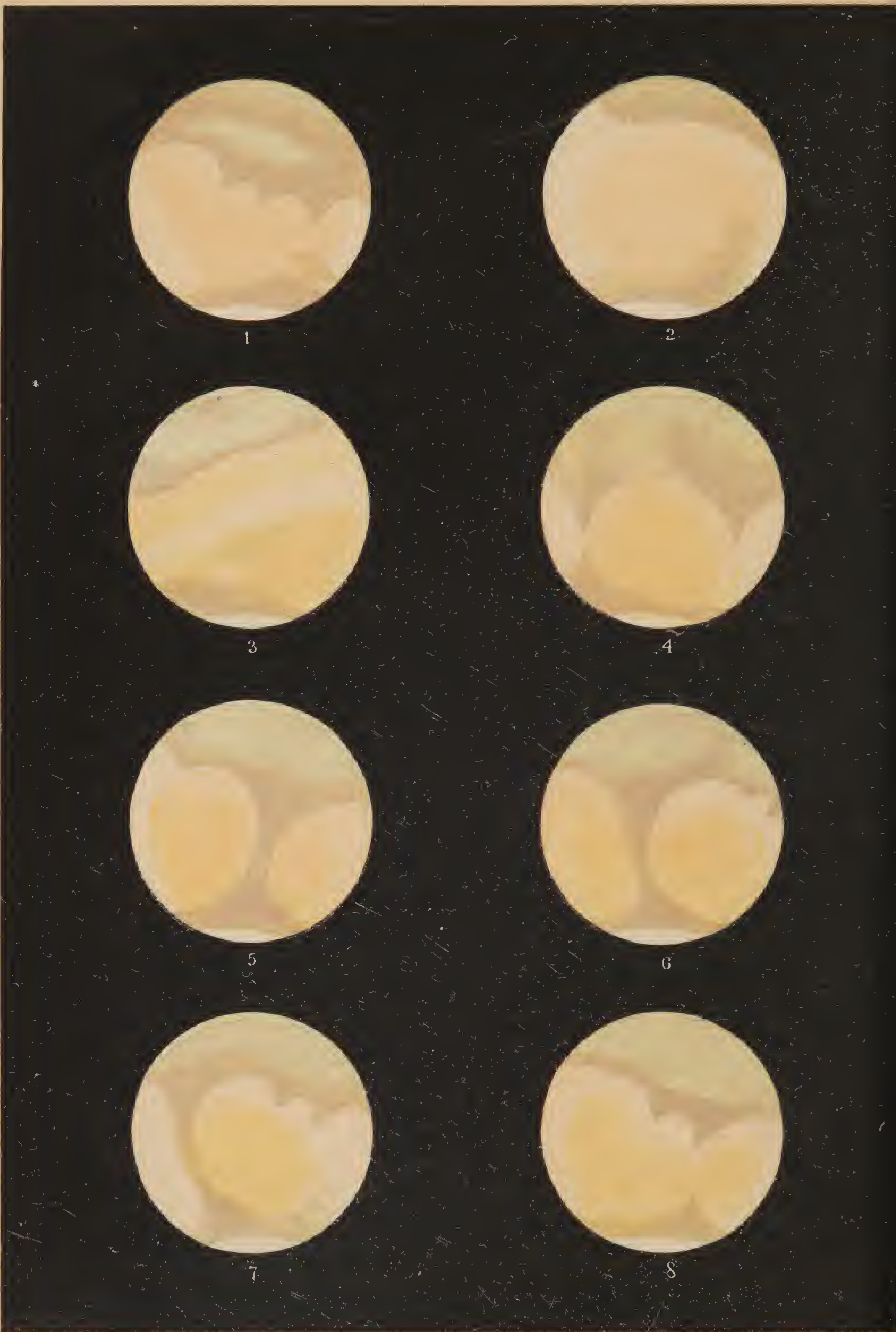
Volcanic Action in the Azores.—M. St. Claire Deville read to the French Academy a letter, dated Angra, June 7, 1867, published in the journal "A Persuaso," at St. Michel, in the Azores, stating that, from May 26, they had experienced strong earthquakes, and that in the night of June 1-2, a volcanic vent was formed nine miles north-west of Serreta, which continued active, and occupied a zone of more than $2\frac{1}{2}$ miles in a westerly direction. The writer states, "It was in the sea, lat. 38° 52′, and long. west of Greenwich 27° 52′, in a line from Tercera to Gracioza. It constantly emits great stones and enormous masses of lava, the accumulation of which may produce a new islet, likely to be dangerous. Jets of vapour and boiling water appear in different positions, and for a considerable distance a strong odour of sulphur is noticeable. From time to time noises are heard like repeated discharges of artillery. The Intendant of the Marine, various civil and military engineers, and others, have gone off to survey these phenomena, but the danger has kept them at a considerable distance.

Medicines through the Nose.—M. Raimbert recounts to the French Academy various experiments in administering medicines in the form of a snuff, to act by absorption through the membrane of the nose. Sugar powdered with hydrochlorate of morphia, and taken in this way, he found useful in violent headache. He mixed five centigrammes of the morphia with two grammes of powdered sugar, and in some cases strengthened the dose. He thinks digitalis, nux vomica or strychnine, iodide of potassium, calomel, etc., may be administered with advantage in this way.

THE LEPORIDES.—Some time ago there was a good deal of talk about the leporides, or crosses between hares and rabbits, that were alleged to be raised in considerable quantities by an enterprising Frenchman. Dr. Pigeaux, writing in the "Bulletin de la Societé Imperial Zoologique d'Acclimation," observes, "To sum up, therefore, we would affirm that leporides exist, undoubtedly, under both forms, with predominance of the hare or of the rabbit; but as a species, or even as a variety, we cannot admit them, since, like all other crosses, they have only an accidental productiveness." He adds that their flesh has neither the whiteness of the rabbit nor the flavour of the hare.

COAL-FIELDS OF BRAZIL.—A paper read before the Geological Society shows the existence of large coal-fields in the province of St. Catherine's, Brazil. The coal is found to be of good quality, and its profitable working will depend on facilities for transport.

METEORIC APPEARANCES ON JUNE 11.—We have received the following from Mr. D. A. Freeman:—"It was stated in the 'Gazzata Ticinese' of June 20, that in several of the Swiss cantons, at Basle, at Zurich, at San Gall, at Geneva, there was observed on June 11, at 9 p.m., the sky being serene, a meteor of great splendour, which for an hour showed remarkable changes, and terminated by assuming the appearance of a small cloud."—[*From the " Opinione," published at Florence, June* 23.] We find in "Comptes Rendus," June 17, the following letter from M. Silbermann, referring to a remarkable meteor seen by him about the same time:—"Thursday, June 11, at 8.10 p.m., a shooting star, more brilliant than the finest of 13th November last, passed a little north of the zenith, moving with extreme slowness from the west to the north-east. I reckoned that it took two seconds and a half to traverse an arc of about 20 degrees. Before becoming extinct it manifested a remarkable recrudescence of splendour, shooting forth yellowish green sparks. Before the last instant it was exactly like a *fusée d'artifice*, burning with white fire. M. Louft at Palaiseau, and M. Auzou at St. Aubin d'Ecroville (Eure), inform me that they noticed the same facts." In "Comptes Rendus," June 24, M. Bonnafont states:—"On the 11th of this month, at 8 to 8.15 (about), I was sitting in my garden at Antony, near Paris, when towards the north a splendid meteor appeared. Its form appeared to resemble an enormous Congreve rocket (*fusée a là Congreve*), with a red incandescent point in front. Immediately afterwards this body exhibited a very brilliant yellow-white colour, like a hood, over two-thirds or less of its length, from which streamed an incandescent, hairy train, leaving considerable traces in the atmosphere. M. Barba, engineer of the Imperial Marine, studying the points I indicated to him, was able to lay down its exact trajectory. At the moment the bolide appeared to me, it was N. 3° E. of the meridian of Paris, and 22° 30 above the horizon. It then described a parabolic curve, with the convexity towards the zenith, and constantly approaching the horizon, disappeared in a few seconds behind my house, at 34° N.E. Its height above the horizon was then 16°."



MARS IN JANUARY AND FEBRUARY, 1867.
From drawings by John Browning, F.R.A.S.

Fig. 1. 9 p.m., Jan. 8.
Fig. 2. 9 p.m., Jan. 28.
Fig. 3. 10 30 p.m., Feb. 8.
Fig. 4. 6 45 p.m., Feb. 16.
Fig. 5. 6 45 p.m., Feb. 23.
Fig. 6. 8 45 p.m., Feb. 23.
Fig. 7. 10 30 p.m., Feb. 23.
Fig. 8. 1 a.m., Feb. 24.

THE INTELLECTUAL OBSERVER.

SEPTEMBER, 1867.

MARS DURING THE LATE OPPOSITION.

BY JOHN BROWNING, F.R.A.S.

(With a Coloured Plate.)

Though Mars is, with the exception of Mercury, the smallest of the chief planets in the solar system, exceeding but little in magnitude Titan, the sixth of Saturn's satellites, yet it has always excited great interest, from the fact of its being the only planetary body which in its physical conformation bears a close resemblance to that of our earth.

With a good telescope we see its surface mapped out into what are believed to be continents and seas, though these would seem to be distributed in the contrary order to that which they occupy on our globe—the great seas being situated near the poles of the planet, while a broad belt of land surrounds it at the equator. Near the poles, but not corresponding exactly with them, are seen ice and snow, which melt as the poles are respectively presented more directly towards the sun. Like our earth, Mars has a cloudy atmosphere, betokening the presence of both air and water.

The accompanying drawings of Mars, so beautifully rendered in colours, were made in Mr. Barnes's Observatory, at Upper Holloway, with his telescope, an equatoreal reflector of my own make, having a silvered-glass speculum, 8½ inches in diameter, which was parabolised for me by Mr. With. Achromatic eye-pieces of positive construction were alone employed. The power used was generally 300, but, occasionally, on nights when the air was unusually steady, I have used powers as high as 600, with great advantage.

Many persons who have seen the original drawings, have addressed such questions to me as these:—But, did you get such definition as you have represented? Could you really make out all those details? To answer these questions I must describe the method I adopted in making the drawings.

A number of circles were previously prepared, each being a white disk on a black ground. On looking at the planet through the telescope, it frequently happened that only the general character of the markings upon it were discernible. The most prominent of these markings were at once noted on one of the prepared circles, as quickly as possible, consistent with accurate estimation and determination of their position. It is important that this portion of the work should be promptly executed, because the *position* of the markings rapidly changes with the rotation of the planet.

Having obtained the outline of the principal markings in the manner above described, intervals of good definition were watched for, and upon their occurring, details of minuter markings, colours, and shadows were successively filled in, until in about an hour the drawing was completed.

It will be understood that a drawing made in the manner stated will show many features of interest that would escape notice in a cursory observation. It will, in fact, represent the most that can be made out by patient watching, with a telescope of the aperture employed on the particular night.

In the present drawings the planet is shown as it was seen in the telescope. As inverting eye-pieces were alone used, the lower white markings always represent the ice or snow on the north pole of the planet, while the smaller light patches on the upper part of some of the disks indicate the ice near the south pole. I have made nearly thirty sketches at the telescope, but I have carefully copied only thirteen. These were all made when the air was tolerably steady, and the definition so good that I could work well with powers above 200. Of this number eight of the most interesting have been selected for representation.

When several sketches were made on the same evening, they were taken at intervals of two hours, if the weather permitted. In only one instance have I failed to make out that the form of the markings was permanent, due allowance being made for the effect of perspective in foreshortening them as they approached the edge of the disk.

It is highly probable that in the view of the planet taken on February 16th, at 6·45, the two pointed markings on the extreme left, one above, and the other below the equator, would have been seen united if they could have been observed when they were on the centre of the disk. This drawing would then have agreed pretty closely with one of Mr. Dawes's views engraved in the "Astronomical Register" for September, 1865.

The colour of the body of Mars I have found vary from rose-madder to burnt ochre, the colour appearing ruddiest when there was most mist in our atmosphere. The comparative absence of the ruddy colour towards the edges of the disk of the planet, Mr. Norman Lockyer has ascribed to the presence of clouds in the planet's own atmosphere.

Mr. Huggins in his valuable paper on the "Spectrum and the Colour of Mars" ("Monthly Notices of the Astronomical Society," March 8, 1867), has referred the absence of colour at the edges of the planet to some peculiar effect of the surface of the planet itself. That the ochreish colour is due to some peculiarity in the surface is, I think, almost proved by Mr. De la Rue's exquisite drawings of Mars, as in these markings of that tint are seen with definite outlines. As I have said, when our atmosphere is free from mist the colour of the equatoreal part is pale, and has not nearly so strongly marked a ruddy tint. This is accounted for by supposing that mist stops the most refrangible rays of light, that is, those towards the blue end of the spectrum, whose waves have the greatest velocity; the red light thus being allowed to preponderate.

When observed under these conditions, the edges of the disk appear Naples yellow, the centre orange, tinged with burnt ochre, while the parts immediately under the dark markings, near the south pole, are whitish, with a tinge of salmon colour. The colour of the dark markings on Mars has been described as greenish or bluish grey; they always appear bluish grey to me, and with this colour I have depicted them. Occasionally the north polar ice has been seen strongly tinted with a bluish colour. I have examined the spectrum of the planet with a direct-vision spectroscope, fitted in the eye-piece of a telescope; the spectrum of the dark markings presented no distinctive peculiarity. This would scarcely prove the entire absence of a blue or greenish shade of colour in the markings, as I have found that if white light be reflected five or six times from surfaces of metallic silver, and then received on white paper, it will be strongly tinged with a chocolate colour. Yet if the light reflected from white paper thus illuminated be examined by means of a spectroscope, no appreciable difference can be seen between the spectrum of this light and that of white light.

In consequence of the effect of irradiation, I have not been able to make out satisfactorily the outline of the north polar ice. I have frequently seen faint white spots appear on the disk, and as these spots approached the edge of the disk, they increased in brilliancy, until, when nearly at its extreme edge, they almost rivalled the polar snows in whiteness; these white cloudy patches never had any definite outlines. They were generally nearly circular in form, and they always appeared in the region of the equator. One of these white cloudy spots I have shown in the sketch taken on February 8th, at 10.30. The spot is represented passing off the left hand edge of the disk.

Mr. De la Rue has shown the dark markings near the south pole as darkest towards the edge nearest to the centre of the planet, and just below the edge of the dark markings the ruddy colour of the body as much fainter than it is nearer to the centre of the body about the equator. I see these appearances distinctly.

In the drawing taken on January 28th, at 9h, a number of breaks will be seen in the edge of the dark marking near the south pole, and forming a series of light streaks directed towards the pole. Mr. Barnes also sketched this appearance, without seeing my sketch, and as, with the exception of a slight difference in the angle given to the light streaks, the two sketches agreed, I cannot have been mistaken in their appearance having been as I have drawn and described them.

On the 31st of March, at 7h, I obtained an exact repetition of the markings in precisely the same position shown in the drawing taken on February 23rd at 9h.; the two drawings coincide so perfectly that I can only distinguish between them by the dates affixed to them. In these two drawings the mark usually termed the hour-glass mark is represented as having just passed the centre of the disk of the planet. The movement, in the time I have stated, includes a period of 35 revolutions, and the time of a single revolution on its axis deduced from the observed recurrence, would be 24h. 38m. 8s. Beer and Mädler, who have observed the largest number of revolutions, give the period of rotation as 24h. 37m. 23s. My own determination is, however, less than Sir Wm. Herschel's.

Could a repetition of the markings in exactly the same position have been observed after a much greater number of revolutions had been completed, a period of revolution more closely accordant with B. and M.'s determination would probably have been obtained. The very unfavourable weather we have had to contend with for some months, has, I regret, rendered a repetition of the observations impossible.

I have said elsewhere that between my own drawings, Mr. De la Rue's, and Mr. Dawes's, there exists a great similarity, and to one of Secchi's drawings one of mine has a considerable resemblance, but I cannot trace a likeness between any of my views and those of Beer and Mädler. This observation leaves on the mind a suspicion that in the course of time some change may have taken place. With regard to the point that no flattening of the planet at the poles has been detected, even by that admirable observer, Mr. Dawes, I would remark that although if the sphere of the planet were oblate to the extent of one-sixteenth, or one-tenth of its diameter, as in the case of Jupiter and the globe of Saturn, the flattening might be easily discerned, yet, if the flattening should not exceed, in proportion, that of the earth, as would probably be the case from its having nearly the same axial velocity, we could not hope to perceive it, for, under such circumstances, the flattening of the disk of Mars would not exceed twelve miles, and this when the planet is nearest to us, would subtend an angle of only one-tenth of a second.

Professor Phillips's drawings of Mars, of which three are engraved in the "Proceedings of the Royal Society," No. 55, were taken when the north pole of Mars was invisible. Allowing for the difference produced by this cause, the drawings agree with mine in the general form of the markings, but the white margin which I only see in the bays, Professor Phillips shows completely fringing the whole of the markings.

Now half a second is the smallest amount of difference in diameter we could hope to detect, even by the aid of the most delicate micrometric apparatus. The double-image micrometer, devised by the Astronomer Royal, would be the best to employ for this measurement.*

No satellite attending on Mars has yet been discovered. Pursuing the analogy between the planet and our earth, if such a satellite existed of a size proportionate with our moon, as it would be one-quarter the diameter of the primary, we might expect it to be easily visible, but should a satellite exist, not exceeding in size proportionately the second satellite of Jupiter, it would only be visible in very powerful instruments, still it would not, I think, have escaped the notice of the persistent observers who have searched for it hitherto vainly.

The discovery of a satellite to Mars is looked for with interest, as the effect of the sun and the primary in producing perturbations of a satellite would enable the density and mass of the planet to be accurately calculated. At present these are only imperfectly known, but the density is considered to be almost exactly the same as that of the earth.

Unfortunately, observations of value can scarcely be made upon this difficult planet with telescopes of less than six inches aperture, and, unless the observer has extremely good sight, eight or ten inches will be found necessary. During the next opposition I hope to be able to continue my observations with an instrument having a silvered glass speculum twelve inches in diameter.

* In measuring, micrometically, the diameter of Mars, it is very difficult to avoid obtaining too large a result for the polar diameter, the effect of the irradiation causing the white spots near the poles to appear to project slightly from the disk of the planet. The best method, probably, of overcoming this difficulty is by using a single reflecting solar eye-piece.

THE FUNCTIONS OF THE BLOOD.

BY C. W. HEATON,

Professor of Chemistry to Charing Cross Hospital College.

Every one who has looked through a microscope at a drop of blood, knows that the red or purple colour is confined to certain minute discs, which resemble pieces of money in form, and which float in a clear yellow liquid. The discs are known to physiologists as the *blood-corpuscles,* and the liquid as *liquor-sanguinis.* Both these constituents of the blood have their own specific functions to fulfil in the operations of life, and both have been the subject of numberless researches. Very much still remains to be done; but it is not too much to assert that this most wonderful of liquids is slowly yielding up its secrets to the patient workers who have so long sought for them in vain, and that "the blood, which is the life" of the animal, is no longer the utter, hopeless mystery which it has for ages remained.

Careful microscopic measurements have been made of the size of the corpuscles in the blood of different animals, and it is now generally agreed that in the human subject their average length is 1-3200th of an inch, and their thickness 1-12400th of an inch. Hence it would be possible, if they were packed close together, for 8,126,464 to lie in the compass of one cubic millimetre—a space not larger than a good-sized pin's head. Now the corpuscles occupy, in the aggregate, about one half of the volume of the blood,* and we are, therefore, able to form a good guess at their probable number. Vierordt and Welker have, indeed, gone through the laborious process of counting them; and the former fixes their number at 5,069,000, and the latter at 4,600,000, in the cubic millimetre. It will be seen that these figures agree tolerably well with the rough calculation founded on the size of the corpuscles, and we are, therefore, forced to admit that the tiny red drop obtained from the finger by the prick of a needle, may contain four or five millions of these curious bodies. Such figures, however, give but vague ideas to the mind. A more distinct one is, perhaps, conveyed in the fact, that a room sixty feet long, thirty feet wide, and fifteen feet high, could not contain as many grains of corn as there are corpuscles in a single tea-spoonful of human blood, the number being, approximately, eighteen thousand millions!

* This is, of course, only a rough approximation. Their quantity varies extremely in different parts of the body, and even at different times of the day.

It is still doubtful whether the corpuscles consist of red liquid, enclosed by a membrane, or whether they are semi-solid, and of uniform structure throughout. Two of the latest investigators, Max Schultze and Ofsiannikof, assert directly opposite opinions upon this point. Whatever they be, however, it is at least certain that they possess a definite term of life. They are incessantly being formed in the chyle and lymph, and also probably in the liver and some other glands. And after the completion of their work, they disappear or are destroyed, this destruction being seen most remarkably in the liver, and in the blood which has traversed muscular tissue.*

The chief function of the blood-corpuscles in the body has long been known, or, at any rate, strongly suspected. They are the carriers of oxygen, the agents of oxidation, in the animal body. During its passage through the lungs, the blood, as every one knows, loses carbonic acid and takes up oxygen. Every 100 volumes of the blood which enters the lungs is capable, according to Claude Bernard, of absorbing twenty-one volumes of oxygen. This is about seven times as much as an equal quantity of water could dissolve, and Berzelius, long ago, showed that serum, which differs but slightly from liquor-sanguinis, was hardly superior to water in this respect. Consequently, it is evident that the great mass of the oxygen must be attracted by the blood-corpuscles. The corpuscles, as before mentioned, constitute about one-half of the bulk of the blood, and, therefore, allowing for the small quantity dissolved by the liquor-sanguinis, we find that they absorb thirty-nine per cent., or thirteen times as much oxygen as water could. That this oxygen is combined in, and not merely dissolved by, the corpuscles, is indicated by the fact observed by Bernard, that pyrogallic acid, a substance that combines eagerly with free oxygen, when it is injected into the veins, will pass out of the body of the animal without undergoing oxidation. It has, therefore, been generally assumed, although upon imperfect proof, that the colouring matter of the corpuscles was capable of combining with oxygen in the lungs, and afterwards of giving that oxygen out again—in small doses, as it were—to the substances to be oxidized. This notion has been recently raised to the dignity of a theory by some beautiful experiments which physiology owes to a physicist—Professor Stokes, of Cambridge. Stokes's researches appear hardly to have received from physiologists the attention they deserve, and I, therefore, venture to present a brief description of them here. Hoppe-Seyler had previously recorded the curious fact, that when a ray of white light passes through a weak solution of blood, and is afterwards decom-

* Bernard, "Liquides de l'Organisme," i. 460.

posed by a prism, two dark bands make their appearance in the green portion of the spectrum. Stokes repeated and verified the fact, and it soon became in his hands the starting-point of a new train of research.

He treated a solution of blood-corpuscles with an alkaline reducing agent, and observed that its colour almost instantly changed from scarlet to purple-red, the hue of veinous blood. On examining the spectrum, he now found that the two dark lines had disappeared, and that a single line, intermediate in position between them, had become visible. On shaking the tube with air, the scarlet colour and the two lines at once returned, but, after a few minutes, again disappeared; and this could be repeated many times. Hence it was evident that the scarlet arterial blood lost its oxygen to the reducing agent, and subsequently recovered it again, when shaken, from the air. The fact is so important that I prefer to give it in Stokes's own words. He says,—

"The colouring matter of blood, like indigo, is capable of existing in two states of oxidation, distinguishable by a difference of colour, and a fundamental difference in the action on the spectrum. It may be made to pass from the more to the less oxidized state, by the action of suitable reducing agents, and recovers its oxygen by absorption from the air."*

Hoppe-Seyler had shown that this colouring matter is different from the so-called *hæmatin,* which is obtainable by artificial means from the blood, and Dr. Sharpey therefore suggested that the true colouring matter should be named *cruorine.* The name is a good one, and does not, like "hæmato-globulin," which is adopted by Hoppe-Seyler, involve any hypothesis. In the oxidized—the scarlet state—it is distinguished as *scarlet cruorine,* and in the reduced state as *purple cruorine.* It is hardly necessary to point out how intelligible an explanation these facts afford of the oxygen-carrying power of the blood-corpuscles. In the lungs the purple cruorine of veinous blood takes up oxygen, and becomes scarlet cruorine; and in the whole of the general circulation, but more particularly in the capillaries, oxidation is effected by means of this oxygen, and the cruorine, to a great extent, passes back to the purple state. Hoppe-Seyler has since found that the blood of a rabbit which has been killed by drowning exhibits the spectrum of purple cruorine. In ordinary states, however, even veinous blood retains enough unreduced cruorine to give the two-line spectrum.

But Stokes has discovered another fact which is of extreme importance in regard to the question of animal oxidation. He

* "Proceedings of the Royal Society," vol. xiii. 357.

found that a solution of the blood-corpuscles from arterial blood—a solution, that is, consisting mainly of scarlet cruorine—when excluded from the air, slowly *reduced itself*, and showed, after a time, the purple colour and the one-line spectrum of purple cruorine. On opening the tube and shaking it with air the scarlet colour returned, and with it the two-line spectrum. Hence it is clear that scarlet cruorine is capable of oxidizing a portion either of its own substance or else of the serum, from which it is impossible wholly to free it in the experiment. Whichever it be, it certainly is a part of the blood itself which is oxidized by the cruorine; and this fact is, as we shall presently see, in perfect accord with the theory to which we are led by other considerations.

These curious optical experiments, apart from their physiological interest, have already yielded some practical results of considerable importance. Soon after the publication of Stokes's memoir, Mr. H. C. Sorby contrived an ingenious adaptation of the spectroscope to the microscope, and by its means succeeded not only in repeating all Stokes's experiments, but also in furnishing medical jurisprudence with a new and most valuable means of identifying blood-stains. The spectrum-microscope has since but somewhat improved in construction, and many readers of this journal have no doubt seen it, and the beautiful experiments which its inventor performs with it at some one of the recent scientific *soirées*. It is described in detail in a paper by Mr. Sorby, read before the Royal Society, April 11, 1867. A scrap of blood-stained fabric, 1-10th of an inch square, containing possibly not more than 1-1000th of a grain of colouring matter, may be experimented upon by its means, and the most certain evidence of the nature of the colour obtained. It has already been found useful in criminal trials.

Another interesting application of the spectroscopic examination of blood was made by Hoppe-Seyler. Claude Bernard discovered, some years ago, that the poisonous action of carbonic oxide gas was due to the circumstance that it had the power of displacing all the loosely-combined oxygen from the corpuscles, and of occupying its place in a somewhat more stable form of combination. All blood, veinous as well as arterial, after treatment with carbonic oxide, acquires a uniform red tint, which it retains with singular persistency, being, in fact, as Bernard expressed it, *mineralized* by the gas. Hoppe-Seyler submitted some of the blood so treated to optical examination, and found that it gave a spectrum very similar to, but not identical with, that of scarlet cruorine. But when excluded from the air, instead of reducing itself like scarlet cruorine does, it remained unchanged for an indefinite period of time. Hence the process indicated a delicate and certain test for use in cases of suspected poisoning by carbonic oxide. I myself, in ignorance of Hoppe-Seyler's experiments, made the same observations. I have by me now a sealed tube, which has for more than a year contained a solution of blood through which carbonic oxide had been passed. The spectrum has not altered in the slightest degree.*

To return from this digression, it is clear that we are now acquainted with the mode in which oxidation is effected in the body, as far as the earlier stages go. Oxygen is absorbed in the lungs, combines with the cruorine, and is afterwards given out again. But at this point we are compelled to pause to consider two more complex and exceedingly important questions. These are, firstly, What is oxidized? and, secondly, Where is the oxidation effected? Liebig, as everybody knows, divided the substances oxidized in the body into two great classes, corresponding with the chief constituents of food. These were the non-nitrogenous, or "respiratory" elements, and the nitrogenous, albuminous, or "plastic" elements. The former embraced fat, sugar, starch, etc., and all its members were supposed by him to be oxidized in the blood, and to evolve no force but heat as the result of their combustion. The latter consisted of the organized tissues, and in particular the muscular tissue, the oxidation of which chiefly resulted in the production of mechanical work. It is an obvious corollary from this hypothesis, that the oxidation of a solid tissue must be effected in the tissue itself, outside the walls of the capillaries, and we are therefore compelled to believe in two distinct modes of oxidation. Substances in the blood are in direct contact with the corpuscles, and may therefore be supposed to unite directly with the oxygen of the scarlet cruorine; whereas, for the direct oxidation of a tissue, it is necessary to assume that some of the oxygen leaves the corpuscles, traverses the walls of the blood-vessels, and arrives at the comparatively distant fibres in a state of solution, but in an uncombined condition. In its extreme form, Liebig's hypothesis has long been known to be untenable, for it cannot be doubted that nitrogenous substances, as well as non-nitrogenous ones, are oxidized in the blood, and contribute to the animal heat; and

* I believe reduced cruorine to be the most delicate, as it certainly is one of the simplest, qualitative tests for oxygen known. If a weak solution of blood is inverted in a test tube over mercury, it reduces itself in a day or two, and a small prism will then show the one-line spectrum. The minutest trace of oxygen will now restore the original spectrum; a single drop of distilled water will often contain enough. I obtained incidentally in the above experiments a confirmation of the previously known fact, that carbonic oxide is disengaged during the absorption of oxygen by potassic pyrogallate. Air from which the oxygen had been removed by this re-agent, when added to reduced cruorine, caused the latter to give a two-line spectrum, which lasted for weeks.

it has recently been demonstrated by the conjoined efforts of Traube, Heidenhain, and Donders, and still more distinctly by Fick and Wislicenus, Frankland and Parkes, that the oxidation of nitrogenous substances cannot account for nearly all the work done in the body. Traube, indeed, has started a rival hypothesis, which has been accepted by Fick and Wislicenus in their celebrated memoir;* namely, that the oxidation of muscle contributes nothing whatever to muscular power, but that the whole of the latter is derived from the oxidation of non-nitrogenous bodies, such as fats and the so-called hydrates of carbon. But as they agree with Liebig in placing the seat of this oxidation in the tissue, there is no great difference, as far as the blood is concerned, between the two views.

But are there, indeed, two distinct kinds of oxidation going on in the body, one inside and one outside the walls of the blood-vessels? Is it probable, or indeed possible, that sufficient oxygen can pass out through the thin walls of the capillaries to account for the enormous force exerted by the body in twenty-four hours? Mayer thought not, and argued against the notion in his immortal treatise, "Organic Motion in its connection with Change of Matter," published more than twenty years ago.† I believe he was right in this, as in so many other things, and I have elsewhere‡ drawn attention to his arguments, and endeavoured to add others to them. The question is one of immense theoretical and practical importance, and I will therefore enter into it in some detail.

To begin with, it is necessary to bear in mind another well-known and most important function of the blood. All the tissues of the body, the muscles among the number, are subject to a ceaseless process of disintegration and destruction. The elementary parts of which a tissue consists, have a definite term of life. They are born, grow, decay, and die, having previously developed new germinal matter from which their successors arise. There is no doubt about this, and it is equally certain that the nutrient matter, the *pabulum*, from which the new parts are formed and nourished, is derived from the blood, some portion of which must travel through the thin walls of the capillaries, and irrigate the tissue. Extreme uncertainty exists as to the mode in which this exudation takes place. At first sight it would appear to be simply a question of liquid diffusion; but, apart from the colloidal nature of the albuminous bodies of the blood, there are some striking points of difference between the composition of the blood and that of

* "On the Origin of Muscular Power," "Phil. Mag.," June, 1866 (Supplement).

† "Die Organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel." Heilbronn, 1845.

‡ "Phil. Mag.," May, 1867.

the muscular juice, in respect even of some of the most diffusible substances. Thus common salt, an extremely diffusible compound, is found in large quantity in the blood, but is almost entirely absent in muscular juice, and the blood is invariably and necessarily alkaline; whereas the liquid of the tissue is acid, and may even contain, as Liebig has remarked, enough acid to neutralize the blood. Probably the pressure under which the blood flows, influences in some manner the exudation, but it would be vain to pretend that it explains it.*

The excess of the nutrient fluid, together with the products of the disintegration of the tissues, returns to the blood, a portion perhaps direct to the capillaries, but the great bulk, in all probability, through the lymphatics, which seem to act as overflow-pipes to the tissues. Mayer therefore suggested that the quantity of lymph might be taken as a measure of the quantity of fluid exuded in a given time. Bidder and Schmidt estimate the lymph returned to the blood in twenty-four hours at 22 lbs., but it is safer to assume it to be at least 30 lbs. It would hardly do, however, to take even this quantity as a representation of the average exudation through the capillary walls in twenty-four hours, and I have thought it right to treble it, so as to have a decided over-statement of its probable quantity. We thus get 90 lbs. a day, or about 40 litres. Now if oxygen leaves the blood and passes into the tissues, it is evident that it must pass in solution in this 40 litres of exudate. How much oxygen could possibly be dissolved by this 40 litres? There is every reason to believe that the exudate does not differ materially from liquor-sanguinis in composition, and we have before seen that liquor-sanguinis is about equal to water in its power of dissolving oxygen. 40 litres of water would dissolve less than two grammes of oxygen; and this quantity of oxygen, whether it were employed in the oxidation of muscle, of fat, or of sugar, could not yield as much as 3000 metre-kilogrammes† of force. But it may be urged that, though unlikely, it is still possible that the exuding fluid may be able to carry with it a larger proportion of oxygen than this. Be it so. Let us make the absurd assumption that every hundred volumes of exudate contains more oxygen than the arterial corpuscles themselves do, when saturated with the gas. If each hundred volumes of exudate contained forty volumes of oxygen, 40 litres would still only contain about 23 grammes, and this, in uniting with oxidizable

* Some of these arguments were suggested to me by Dr. Marcet, F.R.S., who has studied the bearings of dialysis on pathology with great care and success.

† A metre-kilogramme is the force required to raise one kilogramme one metre. It is equal to about 7¼ foot-pounds, and is now almost universally employed as the measure of force.

materials, could only yield about 30,000 metre-kilogrammes of force.

Now the daily work of the heart alone is estimated by Donders at 86,000 metre-kilogrammes, and it is an extreme under-statement to assert that the total daily work of the body in health is 100,000 metre-kilogrammes. To do even this quantity of work, twice the quantity, or 200,000 metre-kilogrammes of force must, as Heidenhain has proved, be provided; so that even taking the highest possible calculation of the quantity of oxygen which could pass into the tissues, we see that it cannot account for one-sixth of the work done in them. It is more probable, indeed, that it cannot account for one-sixtieth. To supply the minimum force per diem exerted in the body, there must be a daily exudation of about

264 litres, or $\frac{1}{4}$-ton, if the exudate contains as much oxygen as arterial corpuscles; or,
3500 litres, or $3\frac{1}{2}$-tons, on the more probable supposition that it will not dissolve more than water will.

These figures appears to me to furnish a complete answer to the current theory of tissue-oxidation, and to force us inevitably to the conclusion so clearly pointed out by Mayer, namely, that the whole, or nearly the whole, of the animal oxidation, is effected in the blood itself, and consequently that there must exist some provision by which chemical force set free inside a capillary is converted into mechanical work in the tissues outside of it.

This view of the nature of animal oxidation tends to define more clearly our knowledge of the functions of the blood. Nutrition is one of its functions. It carries with it in its course the appropriate *pabulum* for the repair of all the tissues of the body. Bones, nerves, glands, and muscles, all alike reproduce their elementary parts at the expense of material derived from its fertilizing stream. And as these elementary parts attain their term of life they decompose and liquefy, passing again into the blood, for the most part through the same lymphatic vessels which take back the excess of the nutritive fluid. In the lymphatic vessels and glands much of the lymph is once more organized into blood, but the products of the disintegration of tissue are probably incapable of this renewal, and, in the absence of evidence must be supposed to return into the blood in an unorganized condition.

Equally important with the foregoing is the function of oxidation, to which the force as well as the heat of the body is due. Nitrogenous as well as non-nitrogenous bodies are oxidized in the blood, and though we do not yet know the precise conditions or the precise mode in which the oxidation is effected, we are justified in inferring that it is by the direct agency of the corpuscles. There is on this view no ground for the assumption that either force or heat is due exclusively to the oxidation of one or the other class of organic compounds. Both are oxidized, and one is as likely as the other to be the motive power. Even the muscle itself, inasmuch as it is finally oxidized in the blood, may give rise to muscular work, and we must therefore conclude that Traube's hypothesis is as much an over-statement on the one side as Liebig's was on the other.

The changes effected by the blood in the exercise of its functions are subject, to a most remarkable extent, to the control of the nerves; and little as we know of this the most obscure region of physiology, we cannot avoid the conclusion that they are directly concerned in the transformation of chemical force into mechanical effect. The muscular currents of electricity, which have been so carefully studied by Du Bois-Reymond, Helmholtz, Heidenhain, and many others, are, no doubt, closely connected with this conversion; but I will abstain from speculations which are apt to degenerate into bare guesses. Dim foreshadowings of great discoveries lie before us, and it is better, after clearly stating to ourselves the truths already established, or made probable, to wait with humility, watching till diligent and patient search shall have been rewarded with fresh unveilings. If we can clear a point or two in the intricate forest of knowledge which lies before us, we shall have done truer work than by any amount of speculation.

THE LUNAR CLEFTS—MARE VAPORUM—JUPITER'S SATELLITES—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

In our last paper we followed the Great Cleft as far as the crater *Hyginus:* we now proceed to give the results of the observations of B. and M. upon its future course; referring at the same time to the diagram in our last number. This crater, $3\frac{2}{3}$ miles in diam., and tolerably deep, with 6° or 7° of brightness, has its ring split by the cleft, which passes across the interior, with elevated edges, in such a manner that the continuity of its banks is nowhere interrupted. Of this they had an interesting proof upon one occasion in the waning moon, when the steady air admitted of a power of 300: the interior of the crater was wholly in shade, with the exception of two minute but very brilliant lines of light in the position of the cleft, while the wall on the N.E. and W., where the cleft encountered it, was interrupted by a very narrow but perfectly black shadow. From the E. side of *Hyginus* issues an extremely small cleft, 4 or 5 miles in length, which was detected by Lohrmann, and seen, once only, by B. and M. After leaving this spot, the cleft, in its westward course, touches on five extremely small craters, or possibly only "longish circular widenings," and is bordered on the S. by two broad flat hills; all these being objects of an exceedingly difficult character. Beyond the tenth crater the cleft becomes wider, flatter, and less regular, and ends as it began, at a long hill, at whose S.W. extremity a little crater (*Agrippa* b) is faintly perceptible. Its whole length is about 106 miles, its average breadth nearly 1 mile: the steeper are the more reflective parts; the light of the flatter ends losing itself in that of the surrounding surface. With the great achromatic at Dorpat, M. subsequently found that a great part of this cleft consisted of a chain of confluent roundish cavities. The plain S. of the cleft contains a few small craters of various sizes, two small dark spots and one larger, and one of a green hue, about 3° in brightness, and extending over about 3,600 square miles. On the N. the cleft is attended by a number of very low parallel chains of hills; one mass immediately N. of *Hyginus* shows a curious spiral arrangement; but generally they point S.W. or S.S.W., and this bearing is visible over a considerable area in this direction, overspread with minute banks and ridges, invisible excepting near the terminator, and usually only from 40 to 60 yards in height. Our authorities especially direct attention to the fact that in this region, where no deception can be occasioned by foreshortening, the general parallelism of all chains of hills and lines of valleys is peculiarly evident: this bearing—"geognostically" towards 10h. (of a dial divided into 24h.) is visible throughout the *Apennines*, the *Hæmus*, the *M. Vaporum* and its neighbourhood, *Ukert, Pallas, Bode* (28), *Julius Cæsar, Agrippa, Godin, Dionysius,* and in part the *M. Tranquillitatis* itself: in many parts it exceeds any other direction as 30: 1, and between Mt. *Hæmus* and the cleft of *Ariadæus,* it is almost the exclusive one. They point out also another peculiarity, the great variety of local shading, or "colour," in this region under varied illumination. In Full Moon the higher of the ridges N. of *Hyginus* come out with a reflective power of 4° or 5°, the interjacent valleys, with 3° or $3\frac{1}{2}$°, brighter than the levels of the *M. Vaporum,* and the darkest part of the neighbourhood does not lie here, but at the foot of some higher mountains E. of the cleft; and even these are less dark than the spot *Boscovich.* On the other hand, about the time of the quadratures, a large blackish somewhat undefined spot comes out just between the two higher chains of mountains near *Hyginus* γ (the two N. of that crater in our diagram) covering these ridges, whose summits are with difficulty visible in it, and contrasting singularly with the surrounding landscape. It is evident, on inspection, as B. and M. remark, that it cannot be shadow; nor can it be merely a feebler illumination, which could not in this way reduce to blackness the yellow, yellowish grey, and pale greenish hues of the lunar surface; so that we have here a colour variable with the phases, which appears to require some further explanation than merely varied reflection. The day and night are also the summer and winter of the moon; and consequently a change of colour whose period is that of a lunation may as well be the result of temperature as of light; and a careful examination of such regions seems especially suited to lead to some discoveries as to the physical economy of our neighbour-world. Had this been Schr's. conclusion, it would have been entirely in character with his general ideas, but proceeding from observers so little disposed to receive any evidence of change, it is worthy of pointed attention. Fortunately the district is one very well marked, easily found, and unaffected in appearance by libration.

The second great cleft, that of *Ariadæus,* lies W. of the preceding, and is described by B. and M. the reverse way—from W. to E. It was discovered by Schr., like the other, which it exceeds in length, breadth, and probably depth, though less easy to find on account of its more mountainous surroundings. It begins at a mountain *Ariadæus* γ (see the diagram), and after a course of about 18 miles, receives another cleft coming from the S., 16 miles long, very narrow, and of inferior depth—a difficult object detected by B. and M. 23m. further, it strikes on the mountain *Ariadæus* β, without, however, perceptibly dividing it, as it had done a small ridge a little previously. On the other side of β it recommences in the same direction, and passes through two minute craters, appearing here to be very deep. 14m. further on, it is interrupted by the mountain *Ariadæus* a, till its traces are next recovered in a narrow ravine among the hills, in a somewhat altered direction. Henceforward it splits every elevation, great and small, in its way, although a high ridge, Silberschlag a, so compresses it that the separation can only be perceived with difficulty. Further on, the heights on either side are flatter, and it terminates in a small crater S. of *Boscovich*, after a course, windings included, of 143 miles. Gruithuisen observed a very minute prolongation of it, between *Arago* A and *Ritter*, for a considerable distance towards the equator. This, though confirmed by Kunowsky, was not made out by B. and M., but has since been seen by Kinau and Schmidt. If it is really a continuation of the great cleft, it may possess considerable selenological interest, as showing how much more effect the same cause has produced on a comparatively mountainous surface than on a depressed plain. Two other very minute clefts (if not three) between *Sosigenes* and *Arago*, and two more S. of *Sabine* (which had been seen by Lohrmann) belong to the *M. Tranquillitatis*. Schmidt has detected several others along this shore.

S.E. of *Hyginus*, and on the edge of the *M. Vaporum*, lies the crater *Triesnecker*, encompassed by a narrow equable wall, 14 miles in diameter, and 5400 feet high on the E. On every side but the E. it is encompassed by long clefts, forming the most numerous group known to B. and M., some of which had been seen by G. β and γ, the most distinct, form an angular junction near the wall: the whole could very seldom be seen at the same time. δ is interrupted by a low ridge. Between β and γ is a very difficult little crater. Though the connection and branching out of these clefts appeared to B. and M. unique on the moon, yet the similarity to a terrestrial river-system is very slight: there is no winding, or widening in either direction, and the interruption by a hill must negative any such idea.

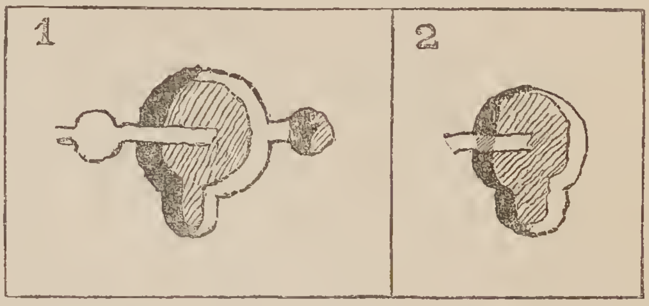
Having thus given an abstract of B. and M.'s description of this curious region, we may find it worth while to compare it with the results obtained by other observers. First of all, the original discoverer, Schr., has given a long description, and a figure of the two principal clefts, which alone he saw, and two additional diagrams of the W. one. The name *Hyginus* was applied by him to the whole dark hill-country N. of the small crater now so called: and his first cleft commences there as a flat valley: he did not notice any of the minuter craters in its course, but places upon it, as interrupting it, the *Hyginus* of B. and M., of which he remarks, in a subsequent observation with the 27 f. reflector, that it has certainly no ring: at the same time he found that the W. end of the cleft, which he had previously carried right up to the wall of *Agrippa*, is lost about one diameter of that crater N. of it. The second cleft he brings, not out of B. and M.'s small crater, which he does not notice, but from a point further E., the end of his *Hyginus*; and originally drew it as dividing a flat bright crater (his D), about half as large as *Agrippa*, which has on its S.W. side a smaller crater, q, and another flat, crater-like depression ν, between q and the cleft. Of these objects q is the *Silberschlag* of B. and M., but D and ν cannot be identified in their Map; the ridges, however, about their a, N.E. of *Silberschlag*, and those N. of that crater, in some states of illumination assume a ring-like aspect: a source of deception well known to lunar observers. Schr. also shows the crater which B. and M. place on the N. bank of the cleft; but in two separate designs he has made the cleft pass further S., about equidistant between this lesser crater and *Silberschlag*. From all this it will be seen how difficult it is to reconcile representations by different hands, or even to account for their discrepancy. Further W. Schr. places two mountains in the course of the cleft; the first of these, σ, seems to be the a of B. and M.; the second, μ, is their β. What struck him greatly was, that he saw, 1794, Mar. 8, with a 7 f. Newtonian, the ring of his D on both sides, and the mountains σ and μ, all split by the cleft: Sept. 1, with his 27 f. reflector he found the ring of D and the mountain μ undivided (agreeing in this last with B. and M.). 1796, Feb. 15, μ was divided, with a four-inch Dollond: Mar. 15, with his 13 f. reflector, D had its ring incomplete and open on the N.E., where the cleft enters it; but the other side of the ring (namely, the very narrow gorge at a, B. and M.) was undivided, as well as the mountains σ and μ: 1798, July 19, he and Olbers, with the 13 f., both saw μ undivided, and the latter noticed the slight bend in the cleft shown by B and M. a little W. of this spot. Schr. also found at the S. end of the chain of which μ is the central portion, a mountain which he had never seen before, though the highest of all, casting a long spire of shadow while the rest had none, and measuring 3200 f. From this he was induced to infer former atmospheric obscuration; and he could not resist a very cautious suggestion, that the singular alternately open and closed aspect of the mountains above the cleft might point to some artificial operation in utilizing a natural feature. The alteration is much more probably due in part to libration, exposing to the eye more or less, at different times, of a very narrow line of shade, and partly to the change of seasons on the moon, which, slight as it is, is sufficient, by varying a little the bearing of the sunrise, to cause the same edge of a cleft running E. and W. to be at one time illuminated, at another in shade.

We will now turn to Lohrmann, and hear what he has to say—premising that the date of his "Sections," though earlier, did not differ much from that of B. and M. And here again we find discrepancy enough to be unpleasant. His first cleft, to begin with, is much more sharply bent at *Hyginus* than in our diagram: and though he agrees with B. and M. as to the wider commencement, and the four craters in its course before reaching *Hyginus*, yet it is remarkable, that while he makes the first and fourth very minute, he enlarges the two intermediate ones to two-thirds of the size of *Hyginus*, saying also in his text that there are two larger and two smaller deep cavities, which under favourable circumstances he has several times distinctly seen. One of these little craters, he adds, lies on the edge of *Hyginus;* his drawing shows that it is additional to the other four. He remarks that *Hyginus* has no visible ring, and has drawn none round the two larger of the four craters. Another minute crater is drawn, but not described, just W. of *Hyginus*. He carries the end of the cleft as far as the site of B. and M.'s *Agrippa* b, stopping it against a chain of hills running up to the wall of the great crater.

The cleft of *Ariadæus* he begins (from E.) with a small crater, as B. and M., and has shown their two minute pits on either side of it, further W. He recognizes Schr.'s D as a flat crater, the ring of which is a mere bank on the N.: he shows traces of ν, and like Schr. places the smaller crater opposite *Silberschlag* at some little distance from the N. bank. After several failures he found the mountain measured by Schr. He carries the cleft through everything in its course, expanding it a little at its W. end. It is less luminous, he says, than that of *Hyginus*, but still visible in Full. Of the cleft-system near Triesnecker he perceived nothing. Chacornac perfectly recognizes Schr.'s D and ν, and makes the cleft divide α, but not β, W. of *Silberschlag*. Schmidt has added considerably to the number of clefts in this district; but as the descriptions in his catalogue are very brief, and without designs, they are little more than memoranda, which will become fully intelligible, we trust, hereafter, by comparison with his promised lunar map.

As the present is our best opportunity of studying these curious objects, I shall beg permission to add a few observations of my own; they are indeed of a very fragmentary character, but may perhaps be useful to those who are disposed to make out the whole detail of this interesting region, which, after all the attention given to it, is still but imperfectly known. My excellent $5\frac{1}{2}$ in. object-glass carried me, of course, considerably further than B. and M., and my $9\frac{1}{3}$ in. "With" speculum, would have made a much greater advance, but for the long continuance of unfavourable weather.

Beginning, as at first, at the widened extremity of the *Hyginus* cleft, where it lies like a long pool under a bank of some height on the left-hand, I find that in the middle of this part it sends out a narrow continuation towards the E., which having cut through a low dark mass of hills, is soon lost in the plain on the other side of them; beyond this, at a short distance, its direction is carried on by the N. edge of a mountain mass, but I could not trace any cleft there. Less than half-way from this "pool" to *Hyginus*, an insulated hill stands close above it on the right, after passing which it becomes convex towards the W., and evidently broader, contracting, however, suddenly, and turning more to the left a little way before reaching *Hyginus*. In this broader part, it would seem that the three first craters of B. and M. must be placed (including the two which L. has so exaggerated in size), and I might have detected them at this time in steadier air. *Hyginus* itself I have repeatedly seen without a wall, though possibly it might come out close to the terminator, where I have never observed it. Schm. doubts whether any actually ringless craters exist on the moon, but they are known on the earth, the "explosion-craters" of Humboldt; cavities surrounded by inconsiderable margins of ejected fragments only; such are the Maars of the Eifel, and several in Auvergne and Java. I have never seen the two bright lines crossing the floor, as described by B. and M. Once I detected one of them, corresponding with the S. edge of the cleft, very narrow, but obvious, and cut off by a narrow black space from the E. slope of the crater; but I have more frequently seen the whole cleft entering the crater as a broader line of light. On one occasion, an indistinct uncertain shading led me to suspect that its level was somewhat depressed as it passed through the crater's edge, and I have never been able to trace it beyond $\frac{2}{3}$ the breadth of the floor, nor to ascertain how this white stripe comes to an end, though once I thought there was a slight shadow there. The two accompanying sketches, taken (1) 1861, April 18; (2) 1867, Feb. 7, will give some idea, though a very rough one, of the object. They show also the cavity which encroaches on the N. edge of *Hyginus*, and which has been given, though too small, by L., but omitted by B. and M.; it is about $\frac{1}{3}$ the diameter of the larger crater. The projecting cusp on the right-hand was on the latter occasion very luminous. The two small craters E. and W. of *Hyginus* are larger than as shown in L. or B. and M.: when sketched, the one was all bright, the other partially in shade. The bending of the cleft does not take place in *Hyginus*, as shown by L.,



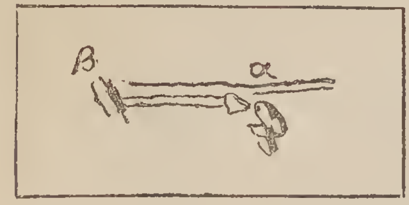
but in or near the latter crater. I have no note of any other crater W. of *Hyginus*, but I carry the cleft further than B. and M., turning it, like L., with a bend more S. towards the site of *Agrippa* b, and then again bending it W. and carrying it on as a very minute line across the N. slope of *Agrippa*, at a considerable distance from the ring. B. and M. may have seen part of this as the long bank shown (but a little too far N.) in our diagram.

The second great cleft I have seen bordered in all its length, though less distinctly in the portion E. of *Silberschlag*, by a narrow faint shadow parallel to it on the S., as though on that side at least it had an elevated margin.* I have drawn it as commencing on the N. side of *Ariadæus a*. Three times it has appeared to me interrupted by the narrow ridge W. of *β*, which it divides in B. and M. I have never seen *β* nor *a* divided by it; as to *a* on the other (E.) side of *Silberschlag*, I am less confident. I may have mistaken it for the ridge N. a little W. of *Silberschlag*, by which, like Schr., I have seen the cleft entirely intercepted. It has not appeared to me to pass close to the crater opposite *Silberschlag* as in B. and M., but at a little distance, as in Schr. and L., and the bend at this place is greatly exaggerated by B. and M. The semi-crater form of Schr.'s D I have plainly made out. A little E. of this spot it sends off a very distinct branch to the S.E., which apparently forms a communication with the W. end of the *Hyginus* cleft, somewhat N. of the point where the latter carries on a branch, already noticed, across the N. slope of *Agrippa*. I have no note of the small crater at the E. end of this cleft, but I have remarked a very faint narrow dark line continued on from near that spot still further E., towards the end of the *Hyginus* cleft.

These minutiæ may be of some interest as showing the multiplicity and intricacy of these cracks, and as aids to further study; but the most curious remains to be specified. 1861, April 17, I perceived that the part of the cleft between *a* and *β*

* With the great Northumberland Telescope, at Cambridge, aperture $11\frac{1}{2}$ in., Breen has seen both banks very plainly, alike in valley and mountain, and has noticed them stretching a short distance into the dark part of the disc.

is double, or rather that in this space are comprised the ends of two clefts not in the same line, but running parallel for a short distance, as is shown in the accompanying very rough sketch.



The S. portion, though narrow, was very evident. As I have found this subsequently confirmed, I would venture to propose an addition to the nomenclature here, and to call the E. portion "the cleft of *Silberschlag*," as the W. is that of *Ariadæus*. How so apparent a feature should have escaped all previous observers, and even Schmidt himself, it is not easy to understand; but it proves how much yet remains to be done for the topography of the Moon.

This becomes still more evident with great apertures and high powers, for which many peculiarities here are doubtless reserved. Such was especially my conviction in the use of Mr. Bird's noble 12 in. silvered mirror, 1865, Sept. 5. The illumination was then far too high, but some idea of the scene may be obtained from the fact that the bottom of the first cleft W. of *Hyginus* was distinctly seen as a grey streak bordered by two parallel bright lines. This was interesting in another respect. The steep banks, as less directly enlightened, should have had a darker appearance, on optical grounds, than the included level space; their opposite aspect must have been due to local colour. On one occasion I thought, in using my $9\frac{1}{3}$ in. mirror, that the *Silberschlag* cleft passed *over*, not *through*, a considerable mountain; but the observation was too hasty, and should be repeated.

As to the region of *Triesnecker*, I have noted several additions. The angular point of meeting, and the minute crater on the slope beneath it, are both set too near the ring by B. and M., and that angle is really the common junction of four clefts; one of which proceeds due S., I know not whether it may be ζ, ill-drawn in their map, or a line of communication with it; another runs as a continuation of β up to the N.W. edge of the great ring: the cleft γ, as Breen had previously found, is double, with overlapping ends, like those of the junction between *Ariadæus* and *Silberschlag*; and possibly this may be found to be a peculiarity of frequent occurrence. γ appears, too, to lead directly towards the small crater near its N. end: while c, or ϵ (both which letters are affixed in the map to the cleft pointing to the centre of *Triesnecker*—ϵ has been accidentally misplaced in our diagram), probably passes W. of the little crater E. of *Hyginus*.

We leave now this curious region with the sincere hope that some of our readers may be induced to make it an object of patient research: a very little experience will show that no hasty investigation can possibly master its difficulties: many of the clefts are extremely minute, and the shadows, by which alone they can be detected, are in proportion fugitive, so as to require watching, literally, almost from hour to hour, in order to trace their continuation and connection. It would be well, too, to check our results in the opposite illumination, though the large clefts, at least, are not so distinct in the waning moon.

A little way out of our diagram to the N. lies the fine crater *Manilius* (24) 25 miles in diameter: the broad and peak- and crater-besprinkled ring of which attains in general a luminosity of 8°, and so becomes always a conspicuous object; it may be perceived even in the lunar night, and was one of H's pseudo-volcanoes. The E. side attains 7700, the W. 7500f. (Schr. found 7500 E., 8000 to 9900 W., and the W. wall 2200f. above the plain).

Between *Manilius* and *Menelaus* (15), Schr. has represented a very dark spot of an oval form, to which he gave the name *Boscovich.* L., though he represents it, seems not to have thought it worthy of a name, and has transferred the appellation, without notice (a most unusual procedure with *him*), to another dark spot half-way between it and *Agrippa*, where it has been recognized by B. and M., and is shown in our diagram. From Mr. Birt's observations it seems that B. and M. have failed in delineating this region (the *old* site); Schr. and L. seem to be nearer the present state of the surface, but the dark tone given by Schr. seems either to be visible only under certain circumstances, or to have subsequently faded. In these districts the flat ring-form so common elsewhere, is supplanted by openings, or intermissions among the parallel ridges universally prevalent here, so that two of their sides only are bordered by a rampart. Of this kind is *Julius Cæsar*, a large steel-grey depression, of only 1° in reflective power at the N. end, becoming as bright as 3° southwards. In its peculiar aspect Chacornac traces the effect of a retreating tidal wave, which he thinks may have penetrated it from the neighbouring sea; and he considers this as one of the many evidences of similar action. Several dark valleys unite it with a similar, but much smaller and not quite so dark, formation at some distance N. On its W. side the true crater *Sosigenes*, 14m. broad, and, according to Schr., 3700f. deep, intervenes between it and the *M. Tranquillitatis*: at a little distance E. is the *Boscovich* of L., and B. and M., another very dark spot of the same kind.

JUPITER'S SATELLITES.

As the planet Jupiter is now conspicuous, though not so high as desirable, the following particulars of his system will be interesting. Sept. 6th. I. in transit, 7h. 56m. to 10h. 16m., its shadow 8h. 14m. to 10h. 34m. II. ditto, 8h. 26m. to 11h. 18m., its shadow 9h. 2m. to 11h. 54m.—13th. I. in transit, 9h. 40m. to 12h., its shadow 10h. 9m. to 12h. 28m. II. ditto, 10h. 43m. to 13h. 35m., its shadow 11h. 39m. to 14h. 32m. (These two will be beautiful spectacles.)—20th. I. in transit, 11h. 25m. to 13h. 45m., its shadow enters 12h. 4m. II. enters 13h. 2m.—22nd. I. leaves disc 8h. 11m., its shadow 8h. 52m.—29th. I. in transit, 7h. 38m. to 9h. 57m. its shadow 8h. 27m. to 10h. 47m.

OCCULTATIONS.

Sept. 7th. B.A.C. 6292, 6 mag. 9h. 49m. to 10h. 22m.—8th. ρ^2 Sagittarii, 5½ mag., 9h. 47m. to 10h. 51m.

THE FOOD OF THE SALMON.

BY W. HOUGHTON, M.A., F.L.S.

Difference of opinion has long prevailed with regard to what constitutes the food of the salmon. As I have lately been examining a large number of the stomachs of this fish, it may interest the readers of this magazine to hear the conclusion at which I have arrived. But let us first of all see what authors have said on this question. The earliest mention of the food of the salmon with which I am acquainted, occurs in Gesner's work "De Aquatilibus," p. 828. Quoting Hector Boëthius, he says, "On what food the salmon lives, or whether it lives on any at all, is as yet a doubtful question, since, when disembowelled, the stomach shows nothing but a certain thick fluid." Gesner then adds, "I myself also, whenever I have examined a dissected specimen, have never found anything in the stomach and intestines except a yellowish mucus and particles of white grit.* Our fishermen affirm that they never find anything in the stomachs of the large fish, but only in those of the smaller ones; for the larger ones which are known by the name of salmon, live on nothing but water, preferring that which is thick and muddy as being more nutritious. But I have heard from an old and experienced fisherman that the fish, until it is a true salmon, feeds on aquatic lice, but that after spawning it will eat any fish that happens to come in its way; the fisherman said he had frequently found fish in their insides." Shaw

* "Album lapillum." I suspect he means by these words the masses of calcareous crystals so frequently found in the intestines of salmon.

says, "All fishermen agree that they never find any food in the stomach of this fish. Perhaps during the spawning time they may entirely neglect their food, as the Phocæ, called sea-lions and sea-bears, are known to do for months together during the breeding season, and it may be that like those animals, the salmon returns to sea lank and lean, and comes from it in good condition. It is evident that at times their food is both fish and worms, for the angler uses both with good success, as well as a large gaudy fly, which the fish probably mistakes for a gay libellula, or dragon fly" ("Gen. Zool." v. Part I., p. 42). The preposterous idea that any fish can subsist without ever taking food was maintained by Daniel, who stoutly argued that the salmon lived on nothing but water! Dr. Knox states that from the time the salmon enters the fresh water it ceases to feed, properly speaking, although it may occasionally rise to a fly, or be tempted to attack a worm or a minnow, in accordance seemingly with its original habits as a smolt. But after first descending to the ocean and tasting its marine food, it never again resorts to its infantile food as a constant mode of nourishment. This great fact, he continues, well understood by fishermen and anglers, has been placed by Mr. Young, of Invershaw, beyond all doubt. Nothing is ever found in the stomach and intestines of the fresh sea salmon but a little reddish substance, which Dr. Knox, after a careful microscopic examination, concluded to be the ova of some species of Echinodermata. Of the salmon, therefore, while in the sea, he maintains this to be the sole and constant food.

M. Valenciennes describes the salmon as voracious, and states that its food consists of fishes (*Ammodytes Tobianus*), but Dr. Knox asserts that there exists not a single fact in the history of British salmon to support this opinion. He refers to various fanciful theories suggested by fishermen and others in regard to the marine food of the salmon, and concludes by stating that in spring, as the spawn fish are descending with the smolts, they may occasionally be tempted with an artificial fly or lob-worm, but as to their feeding regularly in rivers, Mr. Young's experiments have negatived the assumption beyond all doubt.

Dr. Knox is here partly right and partly wrong; he is right in saying that the fresh-water salmon seldom or ever feeds, but unquestionably wrong in maintaining so positively that other fish never constitute the salmon's food in the sea. The same writer thought that the excellent quality of the salmon as an article of food is to be traced to the rich eggs of the Echinodermata, which he considered to be its principal food.

Mr. Yarrell writes as follows—"That the salmon is a voracious feeder may be safely inferred from the degree of perfection in the arrangement of the teeth, and from its known habits, as well as from the well-known habits of the species most closely allied to it; yet of the many observers who have examined the stomach of the salmon to ascertain the exact nature of that food which must constitute their principal support, few have been able to satisfy themselves."* Faber says that "the common salmon feeds on small fishes, and various small marine animals." Dr. Fleming, as quoted by Yarrell, remarks that their favourite food in the sea is the sand eel, and Yarrell says he has himself taken the remains of sand-launce from the stomach. That herrings enter largely into the list of the food of the salmon while in the sea, I can state from personal observation. The salmon in whose stomachs I frequently found one, two, three, or even four herrings together, were from the coast of Norway. Some of the herrings were nine or ten inches long. I never found any other fish in their stomachs, nor, indeed, any other kind of food. This, however, will do no more than prove that salmon feed greedily enough on herrings, and not that other fish do not form part of their diet. There is an abundance of herrings off the coast of Norway, and probably they were more readily captured by the salmon than other fish, during the months of May, June, and July, at which time I made my examinations.

With respect to the river or fresh-water salmon, I never detected the smallest trace of food of any sort either in the stomach or intestines; and Mr. Bowring, a most respectable fishmonger at Wellington, obligingly examined for me a great number of stomachs. We neither of us ever found any food in them, nothing but a thick white or yellow mucus with the gritty particles already noticed, and some intestinal worms, amongst which tape-worms were the most common. But it is asserted by many that the idea of a salmon abstaining from food the whole time the fish is an occupant of fresh water, is a physiological heresy; that so active a fish *must eat* in order to maintain itself and supply muscular force; and that the very fact that salmon are taken with minnow, worm, or fly, is a convincing proof that they *do feed* in fresh water; that the vacuous condition of the stomach is readily accounted for by the well-known habit this fish has, in common with many others, of emptying its stomach when hooked or netted, by an instinctive act of fear, or to facilitate its escape by lightening its load. That the salmon does occasionally throw up the contents of its stomach is probable enough, and has indeed been witnessed. "I was

* See "British Fishes," ii. p. 52.

on the sea in a boat," writes Mr. Campbell, "rowing, one bright, calm day, along some rocks near the mouth of a salmon river, when I espied one of the poaching nets used by the Highlanders. . . . . We went towards the net, and in so doing started a salmon, which dashed into it. I saw the salmon strike and entangle itself, and in a moment begin to vomit a number of herring-fry. I could see them quite distinctly, for we were exactly over the fish. I pulled up the net as fast as I could, and in a second the salmon was in the boat. So quick was I, that there were upwards of a dozen of the fry still in his mouth, although he had been ejecting a shower of them as I drew him to the surface. Of course there was nothing in his stomach; but the idea of saying that salmon do not eat is ridiculous. I have myself caught scores with a worm, and thousands are so taken every year, which sufficiently proves that they eat; but when they find themselves fast on a hook or in a net, they disgorge, like the Solan goose, or as the salmon did that I have just described, and thus nothing is found in their stomachs when they are opened."*

Another way of accounting for the absence of food in the salmon's stomach is by its extraordinary digestive properties. "The rapid growth of the fish seems to imply that its digestion must be rapid, and may perhaps account for there never being food in its stomach when found."†

Let us examine these various arguments.

1. *The salmon vomits up his food when hooked or netted, consequently he has nothing in his stomach.* Granted that he does sometimes, does it follow that he always does so? Or if he always did so, can he vomit up the indigestible portions from the intestines? For it must be remembered that the whole intestinal tract in river-salmon, as a rule, never shows evidence of food. But since herrings and other fish are frequently found in the stomachs of sea-salmon, it is evident that the vomiting theory must fall to the ground. If they invariably eject the food from their stomachs in fresh water, why do they not invariably do so in salt?

2. *The rapid digestion will account for the absence of food in the stomach.* But if river-salmon feed, as asserted, there must be times at which the fish is caught immediately after having swallowed some food; for though the digestion may be rapid, it cannot be instantaneous. Besides, the digestion theory will not account for the absence of all indications of food in the intestine.

3. *The fact that salmon are frequently taken with a worm, minnow, or fly, is a proof that the fish do feed whilst in the*

* "Life in Normandy," pp. 36 and 37. Ed. 1865.

† "Harvest of the Sea," p. 192.

fresh water. I do not pretend to say that a fresh-water salmon never by any chance takes a particle of food, but that its doing so is so rare as merely to prove by its exception the generality of the rule. It must also be remembered that some fish will occasionally take a tempting bait more for sport than for food. A pike, when absolutely gorged with food, will not unfrequently seize a bait in his mouth, and yet refuse to swallow it, as trollers who use a gorge-bait well know. What does an artificial salmon-fly resemble in nature? Certainly no kind of winged insect, not even a gaudy *libellula* or *agrion* either in form or motion, for no libellula ever swims in the water, least of all after the fashion in which the artificial fly is made to locomote by the angler. Some have thought, among whom is Sir Humphrey Davy, "that the rising of salmon and sea-trout at these bright flies, as soon as they come from the sea into rivers might depend upon a sort of imperfect memory of their early smolt habits." But it is more probable the salmon takes the glittering fly—which is allowed to sink a little in the water—for a fish, for fish forms his principal food when an inhabitant of the sea. But be this as it may, the undoubted fact that the stomachs and intestines of fresh-water salmon are almost invariably found empty is a convincing proof, for reasons adduced above, that this fish abstains from food during its sojourn in fresh water.

4. With respect to the physiological paradox as to how an animal can live without taking food, it must be borne in mind in the first place, that, notwithstanding the voracity of the carnivorous fishes, and their extraordinary digestive capabilities, they are able to exist for long periods of time without food. Gold and silver fish may be kept for months without perceptible food, and certainly as we descend the scale of creation we shall find instances of long-continued abstinence more frequently. Snails in conchological cabinets have been known to live for years without a particle of food or drink. Frogs and toads will unquestionably exist for years immured in wood and stone in positions which entirely forbid the introduction of any kind of food.

But there must be a limit to this power of existing without food. A salmon, if he was never to eat, would undoubtedly die. But how, it will be asked, can muscular force be maintained for so many months without food? There can be no other explanation than this, that the salmon lives on his own abundant fat, stores of which are laid up throughout the whole body of the fish, but especially in the abdominal regions. This supply of fat was deposited during the time the salmon was an inhabitant of the sea, and when, as I have said above, he is a voracious feeder. Now we know, notwithstanding the assertion of old Izaak Walton* to the contrary, that the longer a salmon continues in fresh water the more does his flesh deteriorate. Mr. Alexander Russel, a good authority on salmon, is quite right when he says that "salmon taken in or near the sea are the best for food." Let any one compare the difference in the quality of the flesh between a sea-salmon and one that has long been a sojourner in fresh water. He will notice in the sea-salmon the abdomen to be soft and tremulous with abundance of fat, that of the river-fish firm and comparatively destitute of fat. And this continued abstinence from food is, no doubt, in some measure the reason of the fish's gradual deterioration till the exhausting process of spawning renders the salmon now altogether unfit for food. The salmon's abode, therefore, in fresh water should be regarded as a quasi-hybernation, during which life is maintained upon stores already laid up in the organism. That muscular force may be maintained, and in fact that it is chiefly kept up by the combustion, not of the nitrogenous elements, but of the carbonaceous, has been rendered tolerably certain, and the circumstance that a salmon may move about for a long time in fresh water without supplies of food beyond his own abundant fat, is not actually much more than a further instance of what takes place in hybernating animals, as the bear, which goes fat into winter quarters and comes out very thin. The same may be said with regard to experiments that have been made, showing that the Swiss mountains may be ascended solely upon the strength afforded by butter and other non-nitrogenous food.

According to the researches of Dr. John Davy, "the gastric juice, and probably the other. fluids concerned in the function of digestion in fishes, are not secreted till the secreting organs are stimulated by the presence of food—a conclusion in harmony with a pretty general physiological law, and in accordance with what has been best ascertained respecting the gastric juice in other animals." Dr. Davy infers the following corollary from the above, "that the migratory species of salmon, such as the salmon and sea-trout, which attain their growth, and become in high condition in the sea, there abundantly feeding and accumulating adipose matter, though not always abstaining in fresh water, which they enter chiefly for the purpose of breeding, are at least capable of long abstinence there without materially suffering."† He suggests the probability of this being owing to none of their secretions or

* Walton's words are:—"It is observed that the further they get from the sea, they be both fatter and better."

† "Physiological Researches," p. 168.

excretions, with the exception of the milt of the male and the roe of the female being of an exhausting kind.

The conclusion, then, at which I think we may safely arrive with regard to the food of the salmon is—that it feeds freely in the sea, and chiefly on other kinds of fish, such as sand-launces, herrings, and other *clupeidæ*, though other animals, such as shrimps, and various crustacea occasionally form part of its diet; that during its sojourn in the sea the salmon lays up a store of adipose matter; that it very seldom feeds during its abode in the fresh-water rivers, but lives on the supplies of its own internal fat; that though for some time the flesh does not perceptibly deteriorate, it is rendered poorer in quality towards the end of its sojourn in the fresh water, both from the exhaustion of its own supplies of fat and from the effects of spawning; that it rapidly improves when it has reached the salt water, when it again lays up a fresh supply of adipose matter, which will support it during its sojourn in the rivers.

A SYNOPSIS OF THE RECENT BRITISH OSTRACODA.

BY GEORGE STEWARDSON BRADY, M.R.C.S., C.M.Z.S.,

Secretary to the Tyneside Naturalist's Field Club.

(*With Two Plate.*)

Of the various orders included in the great tribe Entomostraca, there is, perhaps, not one more generally interesting than that of which we propose to treat in the present paper. When we consider the great abundance and wide dispersion of the Ostracoda through the fresh waters and seas of our own period, and the countless myriads in which the shells of ante-diluvian species have come down to us, embedded in strata of varied character and age—for example, Silurian, Liassic, Carboniferous, Permian, Tertiary, and Post-tertiary—it will be evident that the geologist and palæontologist must, to a very large extent, share their interest in this group with the student of recent zoology and physiology. It will be seen also that any light which may be thrown upon the structure and habits of living forms must likewise be of great importance to the student of extinct species, as tending to exhibit more clearly their natural affinities, and to establish sounder principles of classification than can be attained by the study merely of the external covering of the animal, which only is left to us in the case of fossil examples. The prodigious numbers in which the fossilized carapaces of these creatures sometimes occur, is almost incomprehensible, some strata of certain rock formations seeming to be almost entirely composed of them. Amongst the recent species I know of no case analogous to this, except that of the dwellers in salt marshes and estuary mud; and I have no doubt that, were the mud-banks of our tidal rivers, and the swamps adjacent, suddenly petrified, we should, in many cases, find that the resulting stratified rock would exhibit as wonderful a concourse of once-living crustacean shells, as those which have just been spoken of. Mr. W. K. Parker has indeed conjectured, from a study of their fossil Rhizopoda, that the post-tertiary clays of the district round Peterborough constitute a littoral, brackish water-deposit; and it is remarkable that the Foraminifera there found, agree, to a very large extent, with those which I have myself taken in the salt marshes of our north-eastern coast. In strata much older than the post-tertiary, one would not, of course, expect to find species exactly identical with those now living. In washings of these clays, however, with which Mr. Parker has kindly supplied me, I have not been able to detect any shells of Ostracoda; it is, indeed, noticeable, that fossiliferous strata which are rich in Foraminifera are mostly poor in Ostracoda, and *vice versa*. Such, on consideration, one would naturally expect to be often the case. In all the salt marshes which I have had the opportunity of examining, living Ostracoda have been very abundant. If the net be passed carefully along the surface of the soft mud, so as to take up a thin layer, and the mass thus obtained be then washed through the net sufficiently to clear it of the fine ooze which will be found to constitute the greater part of its bulk, the residue will mostly consist of Ostracoda, living and dead, grains of sand, fragments of decaying vegetable matter, and very probably a good many living Foraminifera. This will mostly be the result wherever the water is brackish, and deposits a good deal of slimy mud, but in fresh water, or at the mouths of rivers, where the stream is clear and rapid, and does not produce much fine deposit, the Ostracoda, and other Microzoa, will be found much less plentifully. My belief is, therefore, that those strata which exhibit such very abundant and closely-packed remains of the smaller Cypridæ and Cytheridæ have most likely been formed in shallow, brackish lagoons, or at the mouths and deltas of rivers. The species of Ostracoda which I have found in these situations are, *Cytheridea torosa* (Jones), *Cythere pellucida* Baird, and *Loxoconcha elliptica* Brady; while in water, a little further from the saline influence, but still slightly partaking of it, it is not uncommon to meet with *Cypris salina* Brady, and *Cypridopsis aculeata* (Lilljeborg), as well as Entomostraca belonging to other orders. Some crustacea of larger type are also commonly met with in brackish waters,* *e.g.*, *Corophium longicorne*, *Palæmon varians*, *Mysis vulgaris*, the common shrimp, etc.; but these, not having a hard, durable, calcareous investment, are not found in the fossil state. The Foraminifera which I have usually found in company with the Ostracoda above mentioned are, *Polystomella striatopunctata*, *Quinqueloculina agglutinans*, *Trochammina inflata*, *Rotalia Beccarii*, and *Nonionina depressula*; the relative abundance of these forms varying with the locality.† The marshes of the Northumberland and Durham coasts are the only ones which have yet been carefully examined, and it is quite probable that other districts might yield different species.

By far the greater number of Ostracoda at present known have been described from fossil specimens, and the generic and specific characters have, of course, been taken almost exclusively from the external characters of the shell, the chief of these being, its general form and contour, mode of hingement, arrangement of lucid (or muscle) spots and style of surface ornament. The general structure of the animals themselves has indeed been known sufficiently to form good grounds of separation between some well-defined families, such as Cypridæ, Cytheridæ, and Cypridinidæ, but the more minute anatomy indicative of generic and specific differences has, until recently, been very little understood or investigated. The family Cytheridæ, for instance, has been considered by most authors as consisting of some three or four genera (or sub-genera of Cythere), separated from each other by shell-characters merely, and the family Cypridæ of two genera. But when we consider that, of the one hundred and thirty-seven species of Ostracoda now known as living in the waters of Great Britain, all except ten belong to these two families, and that amongst fossil species the disproportion is even greater, it is evident that, amongst so vast a number of species, many important differences of internal structure must exist, and that these stood in need only of careful investigation in order to form good grounds of generic subdivision. Accordingly, we find that much has of late years been done in this direction, more especially by Zenker and Fischer in Germany and Russia, and by Lilljeborg and G. O. Sars in Scandinavia. The researches

* See my paper on "Salt Marshes and their Inhabitants," in Intellectual Observer, Vol. v. p. 26.

† Any readers of the Intellectual Observer living in the neighbourhood of salt marshes or muddy estuaries would materially contribute to the knowledge of a very important and interesting branch of natural history by collecting the Microzoa in the manner above described. The best material for collecting-nets is "crinoline;" the things captured may be preserved, either by drying, or by immersion in dilute spirit. I should myself be very glad of the opportunity of examining any such collections, and would with pleasure name the specimens obtained.

of the last-named author, embodied in his recent work on the marine Ostracoda of Norway,* are of particular interest to English naturalists, seeing that the marine faunas of the two countries exhibit a very close affinity. He has succeeded, after a most careful and painstaking investigation of the Norwegian species, in accurately ascertaining the minute structure of animals belonging to all the described fossil genera (excepting only, as he says, *Cytheridea,* which, however, I regard as belonging to the same genus as the forms he describes under the name *Cyprideis*), and has also established a large number of new species and genera. After a similar survey of the British marine and fresh-water species (in which I have received most valuable assistance from many collectors and naturalists whom I need not here stop to name), I have myself added many species to the list, and have found it needful also to propose some few new genera. A brief analysis of these I propose now to lay before the reader; but before doing so, it will be desirable to describe succinctly the general type of structure of the Ostracoda.

Each member of the class Crustacea is considered, typically, to be divisible into twenty-one annular segments, or somites, seven of which belong to the head (*cephalon*), seven to the thorax (*pereion*), and seven to the abdomen (*pleon*). But it is only in very few cases, and these amongst the more highly organized members of the class, that these segments, or their rudiments, are discernible. In most cases some of the segments are fused together, so that their real nature is to be recognized only by the presence of certain limbs or appendages which indicate their existence. Thus, under the hard, calcareous carapace, or shield, which protects the head and back of the lobster, we find gathered all the cephalic and thoracic members of the animal, and so we learn that the great dorsal buckler consists, in fact, of all the cephalic and thoracic segments of the body, cemented into one strong protecting plate. This principle, infinitely modified, runs through the whole class; but we also find that, in addition to the coalescence of various segments, other segments are often entirely absent, their presence not even indicated by the existence of any limbs or appendages. So that it is only by the careful study and comparison of the whole group that the real nature and homologies of any particular organ can be made out. The appendages of the twenty-one segments of the typical Crustacea may be tabulated as follows:—1, Eyes; 2, 3, First and second antennæ; 4, Mandibles; 5, 6, Two pairs of jaws; 7, 8, 9, Foot-jaws; 10—14, Ambulatory legs; 15—20, False or abdominal feet; 21, Tail-piece or post-abdomen. In the

* "Oversigt af Norges Marine Ostracoder" af G. O. Sars, 1865.

Ostracoda the segments of the body are almost entirely obsolete, the body itself being soft, and entirely covered by two usually hard and calcareous, but sometimes thin and horny, valves.

The family Cypridæ, which includes almost all the fresh-water, and a few of the marine Ostracoda, may be taken as the basis of our description. The various organs will be better understood by reference to the plates, where they are figured in detail.

The first limb, or *upper antenna* (Fig. 1, *b*), here consists of a tapering seven-jointed curved appendage, which bears at its apex a dense bundle of long plumose setæ. The second, or *lower antenna* (Fig. 1, *c*), is usually stouter, four-jointed, strongly bent or "geniculate," clawed at the extremity, and adapted for walking, though in many cases it is also provided with a lash of setæ, which adapts it likewise for swimming. The *mandible* (Fig. 1, *d*) consists of an elongated triangular body, the base of which is directed downwards, and is divided into numerous teeth. From one side springs a four-jointed palp (Fig. 1, *f*), whose basal joint bears one of the branchial organs (Fig. 1, *e*). Of the two pairs of jaws, the *first* (*g*) is the larger, and is divided into four segments; to it is attached a large branchial plate (*h*), the principal breathing organ of the animal. The *second* pair (*i*) is small, and has a non-articulate palp, which, in the male, is often modified into a prehensile organ. In some genera this pair of jaws bears also a small branchial plate. There are *two pairs of feet*, the first (*j*) clawed at the extremity, and adapted for walking; the last (*k*) slender, flexuous, and always tucked up within the shell. The *post-abdomen* (*m*) consists of two flattened elongated rami, which are very movable, strongly clawed at the extremity, and lie side by side, mostly within the shell. There are sometimes two eyes (*a*), but these are mostly confluent. The *ovaries* (*o*) lie round the body of the animal, directly beneath the shell. The *copulative organs* of the male are of very curious and complex structure, and have mostly attached to them a *mucous gland* (Fig. 4), consisting of a double central cylinder, and several whorls of radiating filaments. The shell is thin and fragile, and mostly somewhat reniform or ovate in shape, devoid of sculpture, except sometimes a fine impressed punctation; occasionally densely hispid or even spinous.

We shall now briefly point out the characters in which the other families chiefly differ from the Cypridæ.

Cytheridæ.—This family includes by far the greater number of the marine Ostracoda, and some few species are inhabitants of fresh water. Both pairs of antennæ (Fig. 2, *b*, *c*) are entirely destitute of the filamentous brushes which give swimming power to many of the members of the preceding family; but the upper antennæ (*b*) are beset with strong marginal spines or setæ; and the lower (*c*) are provided with a single long tubular flagellum, which communicates with a poison-gland (*v*), situated in the anterior portion of the body of the animal. There is only one pair of jaws (*g*), similar to the first pair of the Cypridæ. Three pairs of feet (*r*, *s*, *t*), all of which protrude from the shell, are very similar in form, though increasing in length from the first to the last, and are adapted for walking. The post-abdomen is composed of two very small and inconspicuous lobes (*m*). The ovaries are not produced between the two valves. The male copulative organs are exceedingly large, and of complex structure, and are not provided with a "mucous gland." The shell is mostly more or less quadrangular in outline, but sometimes ovate or subtriangular; very variable both in structure and in external ornamentation.

Cypridinidæ.—The antennæ are here exceedingly large and muscular, the upper pair (Fig. 10, *b*) often bearing very long and slender terminal setæ, as well as a densely-tufted auditory seta. The lower (*c*) is especially powerful, composed of an excessively large and muscular basal joint, to which is attached a nine-jointed branch, bearing numerous plumose setæ, which constitute it a powerful swimming apparatus. The mandible proper is rudimentary, but its palp (*f*) is developed into a large prehensile limb. Three pairs of maxillæ, of very variable structure (*g*, *h*, *i*). One pair of feet, of very peculiar structure (*k*), forming a long, flexuous, annulated, vermiform process, bearing several toothed spines at its extremity and evidently homologous with the second pair of feet of the Cypridæ. The post-abdomen is composed of two large closely-appressed plates (*m*), which are powerfully clawed along the posterior margin. Eyes two (*a*), pedunculated. Shell subovate or subspherical, having a distinct beak, with a large underlying notch in front, through which the antennæ are protruded whilst swimming.

Some of the members of this family have very slight swimming power, and live chiefly amongst mud; others are very agile swimmers, and are often taken in the towing-net—more especially at night—near the surface of the sea. They seem, indeed, to contribute very materially to the production of the wonderful phosphorescence of the tropical seas.

Conchoeciadæ.—Closely allied to the preceding family. The upper antennæ are, however, in the female, very small; the lower antennæ almost exactly as in Cypridina. Mandibles distinct, narrow, and toothed; palp large and pediform, terminating in long claws. Two pairs of jaws. Two pairs of feet, the anterior long, five-jointed, and dissimilar in the male and female; posterior very small and rudimentary. Post-abdomen consisting of two short, clawed laminæ. Shell excessively thin and flexible, almost membranaceous; in general shape approaching that of the Cypridinidæ.

Polycopidæ.—Both pairs of antennæ natatory: the upper simple; the lower two-branched. Mandibular palp small, not pediform. Two pairs of feet: the anterior natatory; the posterior branchial. Abdomen terminating in two short unguiferous laminæ. Eyes and heart wanting. Intestine forming a simple sac. Shell thin, calcareous, not notched.

Cytherellidæ.—Antennæ very large; the upper multi-articulate and geniculate; the lower broad, two-branched, much like the feet of the Copepoda. Mandibles very small, bearing a large setose palp. Three pairs of legs, which are scarcely pediform: the anterior two branchial; the posterior rudimentary. Abdomen terminating in two very small and narrow spiniferous laminæ. Ova and young borne under the shell of the female. Valves very unequal in size, not notched; structure very dense, hinge formed by a simple groove.

It is impossible, in the necessarily restricted limits of a magazine article, to give a detailed account of the specific characters of all the British Ostracoda. I propose, however, to indicate briefly the more important characters of the different genera (a thing which has not yet been done with reference to anatomical characters in this country), giving under each genus a list of the British species belonging to it, and appending such remarks concerning them as may appear likely to be of general interest, or helpful to those seeking for special information respecting this interesting group of Microzoa.

Family—Cypridæ.

Genus Cypris, Müller.—Upper and lower antennæ both provided with a tuft of plumose filaments, the lower pediform. Both pairs of jaws bearing branchial appendages. Second pair of jaws in the male prehensile; in the female consisting of a short lobe, a palp which terminates in three setæ, and a small branchial plate with six radiating respiratory setæ. Post-abdominal rami long and slender, having two terminal curved claws and a small seta. Males provided with a "mucous gland," composed of a double cylinder beset with radiating filaments. Shell mostly subreniform or ovate, and of no great thickness. Inhabits fresh water.

British Species.—*C. fusca*, Straus; *incongruens*, Ramdohr;

virens (Jurine), *obliqua*, Brady;* *elliptica*, Baird; *punctillata*, Norman; *bispinosa*, Lucas; *gibbosa*, Baird; *tessellata*, Fischer; *clavata*, Baird; *salina*, Brady; *gibba*, Ramdohr; *trigonella*, Brady; *reptans* (Baird); *serrata* (Norman), *compressa*, Baird; *striolata*, Brady; *ovum* (Jurine), *lævis*, Müller; *cinerea*, Brady; *Joanna*, Baird.

Most of the species of the genus Cypris, being enabled to swim freely by means of the setose appendages of the antennæ, are active in their habits, and very abundant in ponds and small pieces of water, especially where there is much decomposing vegetable matter. They do not appear to be so numerous in large clear lakes, and from elevated mountain tarns they are frequently altogether absent. Some species, however, have their lower antennæ very sparingly armed with setæ, and those so short and few as to give little or no swimming power. Species possessing such characters (*C. reptans* and *serrata*) have been placed by authors in the genus Candona; but it seems best to restrict that genus, as will be presently mentioned. There is considerable diversity in the colour and external appearance of the Cyprides: some being perfectly smooth; others simply punctate or striated; others densely hairy; while one species (*tessellata*) is most beautifully reticulated with a pattern which has much the appearance, in fine examples, of silver filagree work. The prevailing colours are uniform shades of brown and green; but some species, as *salina* and *serrata*, are variegated with dark markings upon a light ground. Four of the species mentioned above (*elliptica*, *gibbosa*, *clavata*, *Joanna*) have not been found, or at any rate have not been recognized, since their publication by Dr. Baird; and one, the finest of all (*bispinosa*), is claimed as British only on account of its occurrence in the island of Guernsey. It was originally found in Algiers. Perhaps the most abnormal species is *C. gibba*—an animal which, though its antennæ seem well adapted for swimming, apparently never uses them for that purpose, but contents itself with an inactive life upon clayey bottoms, with which its colour closely assimilates. Its shell is much more dense than is usual in this genus, and may perhaps need more power to sustain it in the water than the antennæ are able to afford.

Cypridopsis, nov. gen.—Like Cypris, except that the post-abdominal rami (Fig. 3) are quite rudimentary, consisting of two slender, setiform processes, springing from a common base. Lives in fresh water.

C. vidua (Müller), *aculeata* (Lilljeborg), *villosa* (Jurine).—

* The species to which my own name is attached, are quoted chiefly from a "Monograph of the Recent British Ostracoda," read before the Linnæan Society, and which will be published in the Transactions of that body.

All small species. The first-named is of common occurrence; colour whitish, marked with two broad and conspicuous transverse bands of black. The other two are somewhat rare; colour green. *C. aculeata* affects chiefly water that is slightly brackish, and in such situations is sometimes accompanied by *Cypris salina*. From the green colour of the animal, and the contents of the digestive canal, it would appear that it feeds upon the vegetation among which it is found, and not upon animal matter, as seems to be the case with most crustacea.

Paracypris, G. O. Sars.—Upper antennæ seven-jointed, shortly setose; lower antennæ bearing, on the last joint but one, a pear-shaped, pedicillated hyaline vesicle. Second pair of jaws having a branchial appendage. Second pair of feet like the first in form and size, pediform, five-jointed. Post-abdominal rami large, clawed. Shell much higher in front than behind. Habitat, marine.

P. polita, G. O. Sars.—A very handsome species living in water of considerable depth, and apparently of rare occurrence in our seas, though ranging from the Channel Islands to Shetland and Norway. The remarkable vesicle attached to the lower antennæ is visible also in Pontocypris; its use is entirely unknown.

Notodromas, Lilljeborg.—Antennæ like those of Cypris, upper seven, lower six-jointed. Second pair of jaws without a branchial appendage, pediform in the male. Post-abdominal rami long and rather slender. Mucous gland and copulative organs of the male very complex in structure. Shell of very different shape in the male and female. Inhabiting fresh water.

N. monachus (Müller).—A tolerably common species, often occurring in great abundance and at once recognizable by its peculiarly quadrate form, flattened ventral surface and deep black colour.

Candona, Baird.—Like Cypris, except that the lower antennæ possess no tuft of setæ and that the second pair of jaws is destitute of a branchial appendage. Inhabits fresh water.

C. albicans, Brady; *lactea*, Baird; *compressa* (Koch); *candida* (Müller); *detecta* (Müller).—These animals are unable to swim, and are altogether sluggish in their movements, mostly living on the muddy bottoms of ponds and stagnant water. They are all whitish in colour, the shell surface polished, finely punctated, or (as in *C. compressa*) delicately reticulated.

Pontocypris, G. O. Sars.—Lower antenna bearing a vesicle, as in Paracypris. Mandible and first pair of jaws having a branchial appendage; second pair of jaws without branchia, palp large and subpediform, three-jointed, the last joint in the female armed with two long claws. Last pair of feet four-jointed, flexuous, terminating in several long setæ, the margin of one of which (Fig. 5) is beautifully pectinated. Post-abdominal rami (Fig. 6) well developed. Shell thin, higher in front than behind, covered, more or less, with fine appressed hairs. Marine.

P. mytiloides (Norman); *acupunctata*, Brady; *trigonella*, G. O. Sars; *angusta*, Brady.—These animals, of which the first-named is by far the most common, seem to delight in a muddy bottom; their movements are far from active, and they have not much capacity for swimming. *P. mytiloides* often occurs pretty plentifully in the mud of sheltered, quiet bays, and I have found it very abundantly amongst the ooze from oyster-barrels.

Bairdia, M'Coy.—The anatomical structure of this genus is as yet very imperfectly known, but is most probably nearly similar to that of the following genus. It differs, however, in having the post-abdominal rami very large and well developed. The valves are very unequal in size, the left being much the larger and overlapping the right both on the dorsal and ventral surfaces; outline subrhomboidal.

B. inflata (Norman); *acanthigera*, Brady; *obtusata*, G. O. Sars; *complanata*, Brady.—The first-named species is very closely allied to *B. subdeltoidea*, a form first described from fossil specimens, but having a very wide range at the present day, extending over the Atlantic and Indian Oceans and into the Mediterranean. In the British seas its place is taken by *B. inflata*, which has not yet been observed in any other region. I possess specimens of *B. subdeltoidea* dredged off Guernsey, but these have every appearance of being fossilized.

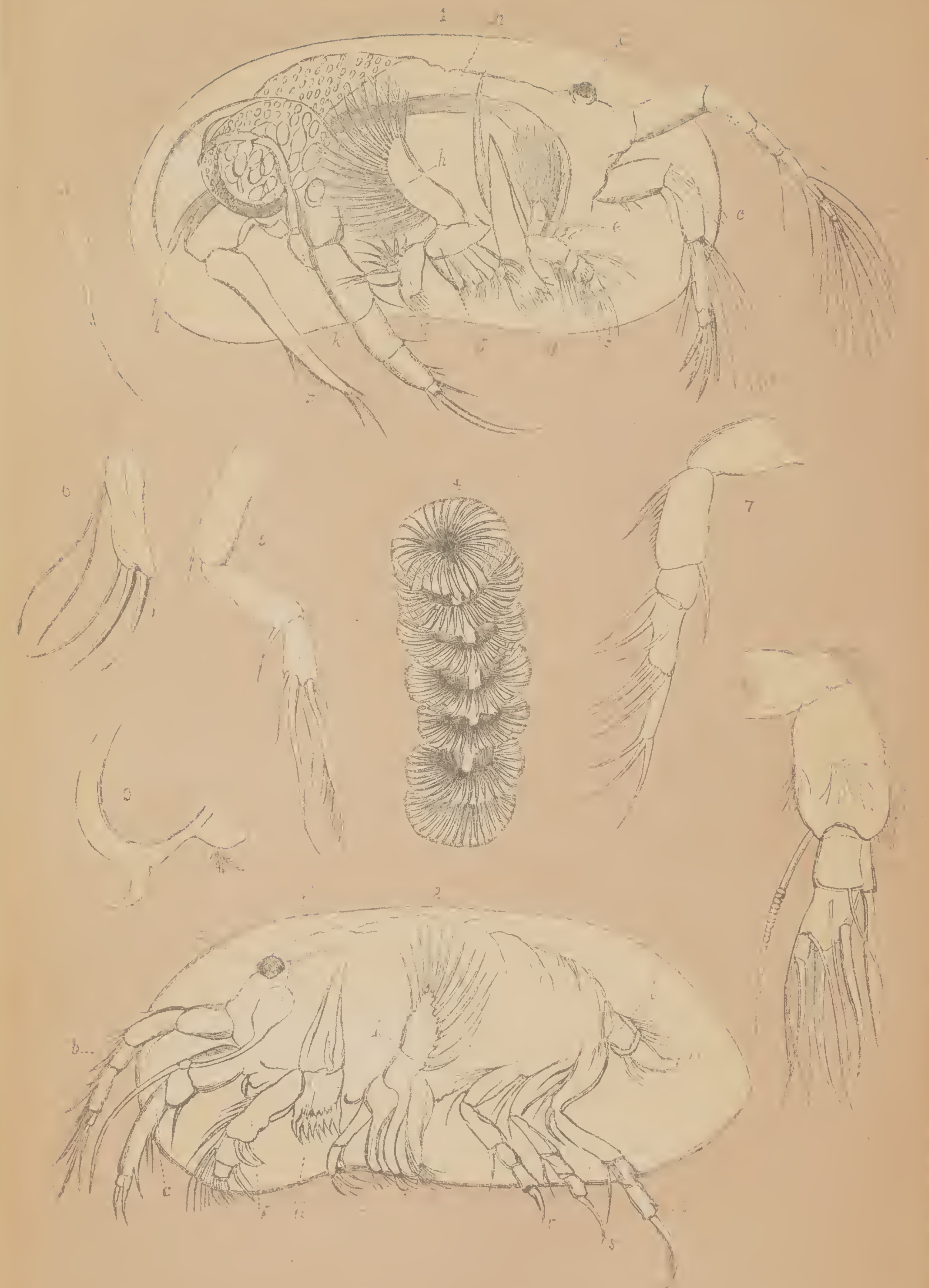
Macrocypris, nov. gen.—Antennæ short and robust, the upper seven-jointed and shortly setiferous, the lower five-jointed and armed with long apical claws. First pair of jaws having an unusually small, subovate, branchial plate; second pair destitute of any branchial appendage; palp, in the female, large and subpediform, in the male, very robust and clawed. First and second pairs of feet very different in structure, the first pediform and strongly clawed, the second entirely covered by the shell. Post-abdominal rami rudimentary. The male possessing a long and narrow mucous gland. Shell elongated, attenuated at the extremities, smooth and polished; right valve larger than the left and overlapping on the dorsal margin.

M. Minna (Baird).—This fine species is very rare in Britain, having been found only off the coast of Shetland, but in the Norwegian seas it appears to be more common. It is referred by Sars to the genus Bairdia, that author not having seen any living specimens belonging to the typical form of Bairdia. I have myself found, however, that the animal (and also the shell) of *B. inflata*, which certainly belongs to M'Coy's genus, differs in some important respects from *M. Minna*; it therefore becomes necessary to propose another generic name for this species.

Family—Cytheridæ.

Cythere, Müller.—Upper antennæ robust, five or six-jointed, armed on the anterior margin with three long curved spines, mostly one on the third and two on the fourth joint; lower four-jointed; mandibular palp three or four-jointed, bearing in place of branchial plate, a tuft of from two to five setæ. Eyes, one or two. Valves unequal, mostly thick and strong; surface variously ornamented with simple papillæ, tubercles, fine impressed punctations, or even with prominent ridges and spines or deep fossæ. Outline, as seen from the side, mostly sub-reniform or quadrangular. Hinge joint formed by interlocking teeth, two on the right and one or two on the left valve, with sometimes an intervening bar and furrow. Marine.

C. lutea, Müller; *viridis*, Müller; *pellucida*, Baird; *badia*, Norman; *tenera*, Brady; *oblonga*, Brady; *rubida*, Brady; *albomaculata*, Baird; *convexa*, Baird; *cuneiformis*, Brady; *limicola* (Norman); *globulifera*, Brady; *tuberculata* (G. O. Sars); *concinna*, Jones; *angulata* (G. O. Sars); *dubia*, Brady; *Finmarchica* (G. O. Sars); *villosa* (G. O. Sars); *Jeffreysii*, Brady; *laticarina*, Brady; *marginata*, Norman; *quadridentata*, Baird; *emaciata*, Brady; *mirabilis*, M.S.; *mucronata* (G. O. Sars); *Dunelmensis* (Norman); *Whiteii* (Baird); *antiquata* (Baird); *Jonesii* (Baird); *acerosa*, Brady; *semipunctata*, Brady. —The thirty-one species here included under the genus Cythere are distributed by G. O. Sars and other authors between the two genera Cythere and Cythereis. Considered with reference to mere shell-characters no tenable line of separation can be found, but Sars supposed that he had discovered, in some minute but constant differences of animal structure, peculiarities which sufficed to place the generic distinction on a satisfactory basis. These characters were chiefly that in the restricted genus Cythere the flagellum of the lower antenna was equally long in both male and female; the mandibular palp three-jointed, and armed with simple curved setæ; while in Cythereis the flagellum of the female was very much shorter than in the male, the mandibular palp four-jointed and bearing three stout curved and pectinated setæ. These distinctions, though perhaps of no great importance, might have been allowed to form sufficient ground for the division of a large and somewhat incoherent genus,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Anatomy of Cypridæ, &c.

but it happens that some species which are common enough in the British seas, though unknown to Sars when his memoir was written, are exactly intermediate in character, presenting different combinations of those peculiarities which were relied on to separate Cythere from Cythereis. It is therefore necessary either to constitute two or three new genera for the reception of these aberrant forms, or to give a more extended signification to the original genus, so as to include all under the one term Cythere. The latter is the course which I have adopted. The intermediate species here referred to are *C. albomaculata, convexa,* and *rubida. C. convexa* exhibits a remarkable approach to the genus Bairdia in general outline, the two valves being very unequal and decidedly beaked behind. In all essential points, however, it is a true Cythere. This genus includes a very large proportion of the fossil species; its preponderance appears, indeed, to have been greater during the earlier periods of the earth's history than now, though possibly this may partly arise from the great thickness and durability of the shells of many species, and especially of many of the fossil forms which have thus been preserved, while other more fragile species may have been destroyed.

The Cytheres have no power of swimming, and are met with abundantly both amongst the fuci of the littoral zone and amongst the mud and sand of the deep-sea bed. A muslin or crinoline net used amongst the rock-pools of any part of our coast cannot fail in the summer months to capture numbers of them. In these situations *C. albomaculata, lutea, viridis,* and *villosa* are perhaps the commonest; while beyond the littoral zone we most frequently meet with *pellucida, tuberculata, lutea,* etc. The forms here named *acerosa* and *semipunctata* seem to be very rare. Their anatomy is not at all known, but their external peculiarities lead to the belief that they may constitute the types of new genera.

Limnocythere, nov. gen.—Animal like Cythere, except that the upper antennæ (Fig. 7) are armed with short setæ instead of spines. They are five-jointed, slender, the antepenultimate joint excessively short, terminal joint much elongated. Shell rather thin, irregularly tuberculate or spinous. Inhabits fresh water.

L. inopinata (Baird); *monstrifica* (Norman).—I have not yet been able completely to examine the structure of these animals, but the conformation of the upper antennæ seems at once to separate them from the foregoing genus. They are very minute, and from their mode of life on clayey bottoms or amongst mud, are not easy of detection. Though hitherto noticed in but few localities, they are probably more common than that circumstance might lead one to suppose.

Cytheridea, Bosquet.—Upper antennæ (Fig. 8), robust, five-jointed and strongly spinous, the last joint narrow and elongated; lower antennæ four-jointed, flagellum long and slender. Right foot of the first and second pairs in the male different from the rest, that of the first pair very strong and prehensile, of the second very feeble, the apical portion rudimentary and not clawed. Shell subtriangular, highest in front, thick; surface smooth, closely pitted, or concentrically rugose. Hinge-joint formed by two crenulated elevations of the right valve, which are received into corresponding depressions of the left. Habitat, mostly marine.

C. elongata, Brady; *papillosa*, Bosquet; *Zetlandica*, Brady; (?) *subflavescens*, Brady; *punctillata*, Brady; *torosa*, (Jones); *lacustris* (G. O. Sars); *dentata*, G. O. Sars.

The genus Cyprideis, Jones, is here united with Cytheridea. Of the species enumerated, all are marine excepting *C. lacustris* and *torosa*, the former of which occurs in fresh water, but seems to be excessively rare; the latter mostly in brackish, though it has in one or two instances been found in fresh water. In the brackish pools of our salt marshes, and amongst estuarine mud, it often occurs in prodigious numbers. The powerfully chelate right foot of the first pair in the male is a remarkable character of this genus, and is interesting as showing a similarity of plan between this and other tribes of Entomostraca where the right and left limbs of the male exhibit analogous differences of structure. Somewhat similar differences occur likewise in other genera of Ostracoda, but they are especially well marked in Cytheridea. It may be noted that the male of *C. lacustris* has not yet been observed either in Norway or in this country, so that its place in this genus is merely provisional. Its only known British habitats are the North Shaws Loch, Selkirkshire, and the Glasgow and Paisley Canal, where it was found by Mr. D. Robertson.

Cytheropsis, G. O. Sars.—Antennæ much as in Cythere, except that the lower are much more robust. Incisive portion of the first maxilla weak, internal segment rudimentary. Second pair of maxillæ very large and much dilated at the apex, flabelliform, and beset with numerous setæ. Feet alike in male and female. Shell high and compressed in front, depressed and tumid behind; thin, pellucid, and marked with round white papillæ. Marine.

C. declivis (Norman), *Argus*, G. O. Sars.

Ilyobates, G. O. Sars.—Upper antennæ very stout, five-jointed, the first two joints much thickened. Feet very short, the first two pairs three, the last four-jointed. Right foot of the last pair in the male prehensile, and only three-jointed, terminal claw very large and strong. Eyes wanting. Shell thin and pellucid, subovate, truncate behind. Marine.

I. prœtexta, G. O. Sars.—This curious species is at once distinguished by its elongated ovate form and truncate posterior extremity, which is also centrally emarginate. It occurs very sparingly in our seas, having been found only on the Dogger Bank and on the west coast of Scotland. The absence of eyes is accounted for by its habit of burrowing in soft mud.

Loxoconcha, G. O. Sars.—Upper antennæ very slender, six-jointed, the last joint very long, linear, and bearing only long, simple setæ. Lowest seta of the branchial plate of first jaw deflexed. Feet long and slender, alike in male and female. Abdomen terminated by a hairy conical process; post-abdominal lobes bearing two long subequal setæ. Shell subrhomboidal or peach-stone shaped, surface mostly marked with regular concentric pittings and small papillæ, sometimes with deep polygonal excavations; posterior dorsal angle obliquely truncate. Hinge formed by four small teeth, two on each valve.

L. impressa (Baird); *granulata*, Sars; *elliptica*, Brady; *tamarindus* (Jones), *guttata* (Norman).

Identical with the genus Normania, described by me in the "Transactions of the Zoological Society of London," Vol. v.: the name Loxoconcha is however of prior date. The species are all marine, except *L. elliptica*, which inhabits brackish water.*

Xestoleberis, G. O. Sars.—Upper antennæ six-jointed, the last four joints gradually decreasing in length and bearing very short, simple setæ. Feet short, post-abdominal lobes bearing two setæ. Ova and immature young borne within the shell of the female. Shell smooth and polished, ornamented with small round papillæ, depressed in front, in the female very tumid behind. Hinge formed by a dentated crest of the left, which is received into a corresponding excavation of the right valve.

X. aurantia (Baird); *depressa*, G. O. Sars.—Zenker and Sars both agree in the statement that the animals of this genus are viviparous; a point which I have myself had no opportunity of investigating.

X. depressa is a common inhabitant of deep water, while *X. aurantia* is found almost exclusively between tide marks. The former is pearly white, exhibiting most beautiful iridescent tints, and sometimes deeply tinged with red at the anterior extremity. The latter is yellowish brown in colour, and has no iridescence.

* The remaining genera are entirely marine.

Cytherura, G. O. Sars.—Upper antennæ shortly setose, six-jointed; lower, five-jointed, terminal claws very short. Feet small, the terminal claws short and curved. Male copulative organs very complex, provided with several irregular processes and a very long spirally convoluted tube. Valves unequal and dissimilar in form, the right overlapping on the dorsal margin; produced into a more or less prominent beak behind; surface smooth or variously sculptured, mostly marked with a central areola of darker colour than the rest of the shell.

C. nigrescens (Baird), *angulata*, Brady; *striata*, G. O. Sars; *lineata*, Brady; *cuneata*, Brady; *Sarsii*, Brady; *similis*, G. O. Sars; *undata*, G. O. Sars; *producta*, Brady; *affinis*, G. O. Sars; *gibba* (Müller); *Robertsoni*, Brady; *cornuta*, Brady; *acuticostata*, G. O. Sars; *clathrata*, G. O. Sars; *cellulosa* (Norman).

The members of this genus are the most minute, speaking generally, of all the Cytheridæ, and the specific differences are not always very clear; more extended observation will, doubtless, reveal many more species. Those now known inhabit chiefly deep water; but *C. nigrescens*, and occasionally some others, are to be found in tidal pools. Several species are found fossil in the glacial clays. The most striking peculiarity of the genus is the production of the shell into a prominent beak or rostrum behind: the surface of the shell is often irregularly waved or ribbed.

Cytheropteron, G. O. Sars.—Upper antennæ five-jointed, shortly setose, penultimate joint elongated. Feet long and slender, abdomen ending in a long, narrow process. Male copulative organs armed behind with three spiniform processes, one of which is trifurcate. Eyes wanting. Valves unequal, the right overlapping above, produced towards the ventral margin into a broad lateral ala, and forming behind an obtuse beak. Surface marked with shallow round or angular depressions, or with transverse ribs and furrows.

C. subcircinatum, G. O. Sars; *latissimum* (Norman); *nodosum*, Brady; *punctatum*, Brady; (?) *multiforum* (Norman).

A genus well characterized by the strongly projecting lateral alæ, and great tumidity, in which, however, some species of the following genus very closely resemble it:—

Bythocythere, G. O. Sars.—Upper antennæ seven-jointed, second joint very thick, and having a single seta on each margin; the other joints much narrower, forming a slender setose lash. Mandibles constricted above the distal extremity, and bearing a well-developed branchial plate. Branchial plate of second maxilla large, numerously ciliated, the four lower cilia deflexed. Feet elongated; basal joint of the first pair bearing a small lobe, from which spring two large and two small setæ. Abdomen ending in a very long acuminate process; post-abdominal lobes narrow, bearing three hairs. Valves unequal, smooth, or sparingly sculptured.

B. simplex (Norman); *turgida*, G. O. Sars.—It would not be supposed, from the external appearance of these two species, that they ought to be referred to one and the same genus; their anatomical characters, however, seem to agree closely. The former is a much elongated species, acutely pointed at the posterior extremity; the latter very tumid, subtruncate behind, and much resembling, in general contour, the preceding genus: it is pretty generally distributed, while *B. simplex* appears to be confined to Scotland and the northern part of England. *B. simplex* approaches a form described by Professor T. Rupert Jones from fossil specimens under the name *Bairdia Harrisiana*.

PSEUDOCYTHERE, G. O. Sars.—Upper antennæ seven-jointed, bearing long setæ; second joint thick and armed with a single seta in front; last joint long and narrow, terminated by very long setæ: lower antennæ very slender. Mandibles small and weak. Three lowermost setæ of branchial plate of first maxilla deflexed. Feet very long and slender. Abdomen ending in a long slender process. No eye. Shell thin and pellucid, rounded in front, produced at the postero-dorsal angle.

P. caudata, G. O. Sars.—This genus contains only one species, which is a very remarkable one, and apparently uncommon. The shell is subquadrangular in outline, and so much compressed as to appear almost squamous at the posterior ventral extremity, where it is once or twice minutely toothed. Colour brown, owing to the transparency of the shell, through which the animal itself is seen. Its range is extensive; the few British specimens yet taken are from Connemara, Northumberland, Shetland, and the Channel Islands.

CYTHERIDEIS, Jones.—Carapace as seen from the side, much attenuated in front, highest behind. Hinge margins nearly simple: right valve overlapping the left in the middle of the ventral surface. Animal unknown.

C. subulata, Brady.

The name Cytherideis was proposed by Professor T. Rupert Jones, for a group of species which agreed in presenting a peculiar hinge structure, the margin of one valve projecting in a sort of angular crest, the other being cut away, so as to receive it. The genus was not in any case very definite in its characters, and its members must now be looked upon as distributed amongst several other genera; but the species above-named (*C. subulata*) cannot at present, from want of knowledge of its anatomy, be certainly classed under any other head; the overlapping right valve precludes the notion of its belonging to *Paradoxostoma*, with which, in other respects, it shows considerable agreement. I therefore retain for it the name Cytherideis. This species is described by Dr. Baird as *Cythere flavida*, Müller; but the two are most probably quite distinct: the latter species appears to be a yellow variety of *Paradoxostoma variabile*.

SCLEROCHILUS, G. O. Sars.—Antennæ robust, the lower larger than the upper; flagellum long and very slender; poison glands large and many-lobed; mouth produced, conical; labrum strongly toothed; mandible small; terminal lobes of the first pair of jaws partially wanting; branchial plate narrow, almost lanceolate; feet short and robust, the first pair having a strong spine at the apex of the basal joint; post-abdominal lobes very large; valves elongated, hard, especially at the edges; surface smooth and shining.

S. contortus (Norman).—This species shows, in the structure of the mouth and mandibles, a state intermediate between the typical Cytheridæ and Paradoxostoma.

PARADOXOSTOMA (Fischer).—Upper antennæ exceedingly slender, six-jointed and shortly setose; lower shorter and more robust, five-jointed, flagellum very large and stout; poison glands large, lobulated; mouth suctorial; labrum and labium forming together a large and stout subconical process, projecting downwards, and terminating in a disk, in the middle of which the orifice of the mouth is situated. Mandibles very slender, protractile, styliform; palp very slender, and without a branchial appendage. Terminal lobes of the first maxillæ very narrow, two lower setæ of the branchial plate deflexed. Feet short and robust, last joint elongated, terminal claws short and curved; basal joint of the first pair bearing a single strong spine; one eye; shell thin and fragile, having no definite structure; valves subequal, mostly higher in front than behind; ventral margins emarginate in front, so that when the valves are closed there is left an elongated orifice, through which the suctorial apparatus can be protruded.

P. variabile (Baird); *abbreviatum*, G. O. Sars; *Normani*, Brady; *pulchellum*, G. O. Sars; *obliquum*, G. O. Sars; *Hibernicum*, Brady; *Sarniense*, Brady; *ensiforme*, Brady; *flexuosum*, Brady; *arcuatum*, Brady.

The remarkable suctorial mouth of these animals at once separates them from all other genera, and even without examination of the internal parts, the shell itself gives evidence as to its affinities by the longitudinal aperture between the two valves on the anterior portion of the ventral surface; this opening, through which the mandibles and mouth can be protruded, is usually very distinct. Sars considers it most likely that these creatures derive their nutriment from the juices of the fuci, etc., amongst which they are usually found, for though the structure of the suctorial apparatus is very much akin to that of the parasitic Entomostraca, none of the Ostracoda have ever been found as parasites. It is, indeed, impossible to regard the members of this genus as parasitic, but neither do I think it likely that the poison gland and urticating setæ, which are with them very largely developed, can be meant to assist the creatures to prey upon *vegetable* food. It seems more likely that they serve an office similar to the urticating filaments of the Actiniæ in paralyzing the more minute animal organisms on which their owners probably subsist.

The genus is an especially littoral one, almost all its members being met with in tidal pools, though some of them range also into and beyond the Laminarian zone. The shell is usually very thin, pellucid, and variously marked with shades of olive, deep purple, or black.

Family—Cypridinidæ, Baird.

Philomedes, Lilljeborg.— Upper antennæ six-jointed, scarcely attenuated at the apex, antepenultimate joint bearing a stout seta, which is set with numerous long auditory cilia; last joint short, and bearing two setæ, which are much longer than the antenna itself. Secondary branch of lower antenna, three-jointed, geniculated, last joint turned upwards. First pair of jaws slender, palp bearing simply a small trisetose lobe; second pair having neither a mandibuliform appendage, nor clawed spines. Animal swimming with long jerks.

P. interpuncta (Baird).—This is the most abundant of the British Cypridinidæ, being sometimes taken in considerable numbers by the towing-net, and occasionally in tidal pools. It ranges, in our islands, from Guernsey to Shetland. The shell is thinner than in others of the family, and often finely reticulated on the surface. Identical with *P. longicornis*, Lilljeborg.

Cylindroleberis, nov. gen.—Upper antennæ of the *male* (Fig. 11) bearing at the apex two excessively long, annulated setæ, four shorter setæ and a short curved claw; penultimate joint bearing at its apex a stout, densely ciliated auditory seta; upper antenna of the *female* (Fig 12) terminated by a stout curved claw, and six or seven subequal plumose setæ, which do not exceed in length that of the last four joints; penultimate joint bearing a stout seta or process, from the extremity of which spring six similar setæ. Second joint of the natatory branch of the lower antenna in the *male* elongated; in the *female* scarcely longer than the succeeding joints; secondary branch in the *male* (Fig. 13) robust, subchelate, terminal joint slender, curved upwards; in the female simple, triarticulate, last joint setiform. Antepenultimate joint of the mandibular foot shorter than the following joint, bearing three long subequal curved setæ, two of which are plumose; last joint very short, armed with a curved claw and several setæ. First maxilla, consisting of a broad subquadrate or crescentic lamina, densely clothed on its distal side with long bristles; second pair swollen at the base, suddenly narrowed toward the apex, interruptedly setose; third narrow, uniformly setose. Oviferous foot terminating in two equal dentate lips (Fig. 14), and bearing about six pairs of spinous setæ. Shell elongated, fusiform, or subcylindrical, smooth; beak rounded, and not at all produced; notch narrow. Animal swimming freely.

C. Mariæ (Baird), *teres* (Norman).—Mr. Robertson takes these species in the Frith of Clyde (though never very abundantly) by means of the tow-net, during the night. It would seem, indeed, that these animals do not come to the surface except after sunset. This observation suggests that possibly in fresh-water lakes something might be done by naturalists during the "wee sma' hours ayont the twal."

Bradycinetus, G. O. Sars.—Terminal setæ of the upper antenna short and subequal. Secondary branch of the lower antenna in the *female* (Fig. 15) small and biarticulate, the last joint obtuse, and bearing at the apex a flexuous seta; in the *male* larger, three-jointed, the last joint long and membranaceous, terminating in two short setæ. Mandibular feet (Fig. 16) armed with a bifurcate process, in front of which are three toothed spines. Second pair of jaws having a strong mandibuliform appendage, composed of two robust tooth-like processes. Eyes small, and of pale colour. Animal mostly crawling slowly amongst mud. Shell much thicker and stronger than in the preceding genera, produced in front into a large beak, with a deep subjacent notch.

B. Brenda (Baird), *MacAndrei* (Baird).

Family—Conchoeciadæ.

Conchoecia, G. O. Sars.—This is the only genus of the family, and is sufficiently described previously (pp. 115, 116).

One specimen only has been seen in Britain, and is probably referable to *C. obtusata*, G. O. Sars. It was found by the Rev. A. M. Norman, in sand dredged off Shetland.

Family—Polycopidæ.

Polycope, G. O. Sars.—The principal characters of this genus are those of the family to which it belongs, and of which it is the only member.

P. orbicularis, Sars.; *dentata*, Brady.—The first-named species is probably not very uncommon, but owing to its small size—$\frac{1}{85}$th of an inch—is very likely to be often overlooked. It has occurred in Connemara, Shetland, and the West of Scotland. The shell is almost spherical, and often beautifully punctate and marked out into polygonal areolæ. Of the second species only one example has yet been found; this occurred to Mr. Norman in the same gathering as that which yielded the Conchoecia. According to the investigations of G. O. Sars, these animals are wonderfully active in the water, having no less than ten limbs adapted for swimming.

Family—Cytherellidæ.

Cytherella, Bosquet.—The anatomical structure has been noticed in the description of the family. The shell is very thick and dense in structure, the lateral outline mostly elliptical, and the hinge formed by a simple grooving of the edge of one valve into which the margin of the opposite valve is received. The "lucid" spots* are arranged in a curved pinnate series.

C. Scotica, Brady; *lævis*, Brady.—Both species are very rare, and hitherto have been found only amongst the Hebrides. The former is closely allied to a Norwegian species described by Sars—*C. abyssorum*. Several fossil species have been described by various authors; the great thickness and durability of the shell may perhaps account for this.

Explanation of Plate I.

Fig. 1.—Illustrating the anatomy of the female of the genus *Cypris*: *a*, eye; *b*, upper antenna; *c*, lower antenna; *d*, mandible proper; *e*, its branchial appendage; *f*, its palp; *g*, first maxilla; *h*, its branchial plate; *i*, second maxilla, with branchial appendage; *j*, first foot; *k*, second foot; *l*, abdomen; *m*, post-abdominal ramus; *n*, alimentary canal; *o*, ovary.

Fig. 2 illustrates the anatomy of the genus *Cythere*: the letters used refer to the same organs as in *Cypris*, except those

* These, though existing in all Ostracoda, have not, for the sake of brevity, been previously noticed, though they sometimes afford good generic characters. They are, in fact, thin, depressed portions of the shell which afford attachment to the muscular bands by which the animal is attached, and by which it is enabled to close the valves firmly.

following: *r, s, t,* first, second, and third feet; *v,* poison gland, communicating with the urticating seta (flagellum) of the lower antenna.

Fig. 3.—Rudimentary post-abdominal ramus of *Cypridopsis.*

Fig. 4.—" Glandula mucosa" of male *Candona candida.*

Fig. 5.—Second foot of *Pontocypris mytiloides.*

Fig. 6.—Post-abdominal ramus of *P. trigonella.*

Fig. 7.—Upper antenna of *Limnocythere inopinata.*

Fig. 8.—Upper antenna of *Cytheridea papillosa.*

Fig. 9.—Abdomen and post-abdominal setæ of *Cytheridea torosa.*

Explanation of Plate II.

Fig. 10.—Illustrating the anatomy of Bradycinetus (adapted from Lilljeborg): the letters are used with the same references as above, except the following: *r,* secondary branch of lower antenna; *s,* mandibular appendages of branchial plate of second maxilla.

Fig. 11.—Upper antenna of male *Cylindroleberis Mariæ.*

Fig. 12.—Upper antenna of female *Cylindroleberis Mariæ.*

Fig. 13.—Secondary branch of lower antenna of male *Cylindroleberis Mariæ.*

Fig. 14.—Termination of oviferous foot of *Cylindroleberis Mariæ.*

Fig. 15.—Secondary branch of lower antenna of female *Bradycinetus MacAndrei.*

Fig. 16.—Mandibular foot of *Bradycinetus Brenda.*

Fig. 17.—Termination of oviferous foot of *Philomedes interpuncta.*

Fig. 18.—Post-abdomen of *Philomedes interpuncta,* seen from below.

AN APRIL CLIMB IN THE HIMALAYAS.

BY GEORGE E. BULGER,

Captain, 10th Regiment.

The morning of April 6th, 1867, looked rather more promising than usual.* The sun peeped out at intervals from the light cumuloid clouds that screened the eastern heavens; and even the white peaks of the snowy range were faintly visible when we started from our residence on the west side of Jella Pahar, with the intention of walking to the summit of the great mountain called Sinchul, distant, perhaps, some six or eight miles from Darjeeling, and 8600 feet above the level of the sea. This noble hill—one of the loftiest in British Sikkim—is a grand and striking object from any point of view; and its numerous spurs and ramifications furnish nearly all the greater summits in the neighbourhood, upon which are built the stations of Jella Pahar and Darjeeling, and the settlements of Leebong, Tukvar, Dooteriah, Senadah, and Hope Town.

Having crossed the ridge of Jella Pahar, we found ourselves in the main road, leading, with a gentle slope, from a dip in the mountain called the "saddle" to the Sinchul barracks, which are situated fully six hundred feet higher up. But before we had gone very far, great piles of mist began to rise from the khuds and valleys below, ever and anon shutting out the view of all objects beyond a hundred yards, and threatening, ere long, to shroud the entire prospect, for the remainder of the day, in a dense mantle of heavy cloud.

The road winds slowly upwards, passing through the mutilated remains of glorious forests, that once overspread this mountain-side from base to summit, but which now, alas, in the vicinity of the highway and the military station, are very nearly obliterated from the soil that fed and nourished them, for, perhaps, thousands of years before the axe or the clearing-fire brought destruction amidst some of the fairest scenes on earth. But, even here, all the trees are not yet gone, and aged giants of towering height and huge proportions, gnarled, moss-covered, green with orchids, and festooned with climbers, still stand, among the unsightly stumps of their departed brethren, perfect marvels of magnitude, grandeur, and solemn majesty.

The walk to Sinchul is, to me, a somewhat melancholy one,

* The weather at Darjeeling and its vicinity has, this year, been almost continually cloudy since the end of March, as, possibly, before that time also.

owing to the wholesale destruction that has smitten these splendid woods, and to the continual sound of the fatal axe, which alone seems to break the stillness of the solitude, announcing, but too plainly, the inevitable doom that hangs over the face of nature in this region.

Amongst the multitude of trees which make up the forests of the Lower Himalayas, the magnolias and rhododendrons are most striking; and, in the season of bloom, their splendour exceeds, perhaps, anything else of the kind in the world: not that the trees are individually handsomer or finer than many other objects of the vegetable kingdom, but their great size, immense numbers, and profuse inflorescence, and last, not least, the localities where they grow—on the summits and slopes of the hills—which are eminently adapted to show them to the best advantage, come upon the observer in such grand combination as utterly to set aside the lesser, but, perhaps more brilliant glory of more contracted views.

Magnolia excelsa, a lofty and stately tree, displays an almost incredible number of white, fragrant flowers, which render even a solitary specimen conspicuous amidst the greenery of the woods fully a mile away; *Rhododendron argenteum* crowns the summit of the hills, and its glistening and silvery blossoms, in the aggregate, present to the beholder, at a distance, much the same effect as that of a recent fall of snow; and *Magnolia Campbelli*, a contorted and ungainly giant, at present without leaves, and with few and unsymmetrical branches, offers such a glorious show of rose-purple flowers that it must, in truth, be acknowledged as the pride of these mountain woods. It does not grow on the lower hills, but is abundant near the summit, and on the upper slopes.

Wild-flowers are, as yet, far from plentiful, a hardy few, only, having opened their blossoms to greet the returning spring; but, conspicuous from its brilliant azure and extreme beauty, the little *Gentiana coronata* cannot fail to attract attention, and elicit warm admiration. A purple foxglove and a pale violet (*Viola repens*) are also abundant; and, on the higher altitudes, the familiar forms of many other European genera, speak home to the heart of the traveller, who welcomes the little, humble-looking plants of his boyish recollections with thrice the warmth accorded to the more gorgeous children of the eastern sun.

Animal life is scarce in these dark, moss-grown, mysterious forests, reeking with moisture, and abounding in the most wondrous forms of the vegetable world; and even the occasional note of some lonely bird breaks on the ear as wild, and strange, and out of place, amidst the vastness of the solitude, where, it would almost seem, man stood apart from earth, and in the near presence of his Maker.* During the first part of the ascent, I only observed, in addition to a few tits and warblers, which I could not identify, the white-throated fantail (*Leucocerca fuscoventris*) and the verditer flycatcher (*Eumyias melanops*); while, higher up, the little chestnut-headed wren (*Tesia castaneo-coronata*) seemed to be the sole occupant of the woods.

The promise of the morning was not fulfilled; and, ere we had half completed the distance between our starting-point and our destination, we were enclosed in a fog so thick that we could hardly trace the path before us. Blindly following the track amidst this comparative gloom, and clambering over trees and slippery banks of moist and greasy earth, we at last completed the ascent of what we supposed was the highest point of Sinchul, and, sitting down, waited patiently for the atmosphere to clear. It did so, partially, for about ten minutes, and disclosed, not the grand panorama we had anticipated, for the clouds still lay in heavy masses all round the neighbouring hills, but the disappointing fact, that, instead of being, as we imagined, upon the apex of the mountains, we had only attained to one of the lesser summits, which had been cleared of trees for surveying purposes. It was too late in the day, and there was too little hope of a view, to induce us to complete the ascent to the highest peak, so, bidding adieu to the place until some brighter season, in the midst of the thick fog, which had again overspread the country, we descended from our lofty position, and trudged back towards Darjeeling, passing on our way a black and gloomy-looking little patch of water, which seemed more like a rain-puddle than the mountain-tarn I supposed it to be.

From the summit of Sinchul, in clear weather, is to be obtained a wide and marvellous view of the Nepal, Sikkim, and Bhotan Himalayas, presenting to the beholder a great and almost graduated crowd of mountains, extending from the lesser hills in the valley of the Great Runjeet river to those matchless tiers of snowy peaks which cluster round the stupendous mass of Kinchin-junga, and afford a prospect which, for grandeur and sublimity, has no parallel on earth.

* My subsequent experience of these forests has shown that the scarcity of birds, on the occasion referred to, was owing chiefly to the earliness of the season; for, by the middle of May, the woods were full of feathered creatures, and fairly ringing with the clear, metallic whistle of the black-headed sibia (*Sibia capistrata*).

ELECTRICAL COUNTRIES, AND THEIR ACTION ON THE WEATHER.

BY M. J. FOURNET.

(*From "Comptes Rendus,"* 1st *July*, 1867.)

It cannot be otherwise than interesting, in a scientific point of view, to ascertain whether or not there exist certain countries more electric than others; for, besides the strangeness of such a fact, it is not impossible that meteorological reactions may be produced, even at great distances, from unequal distribution of electricity.

The persevering studies of De Saussure, combined with those of other physicists, have made us accurately acquainted with what occurs in our regions in ordinary weather; and, in addition to this, many travellers have recorded certain highly curious effects which usually manifest themselves in remote countries; and, lastly, my own endeavour to add to our information on the storm action of the south-west, have led me to the idea that it may bring us electricity, excited on the other side of the Atlantic. It remains, therefore, to ascertain whether there are in existence any facts which may confirm such ideas.

On consulting the important work on Mexican Hydrology by M. H. de Saussure, grandson of the great explorer of the Alps, we see that, at the end of winter, dryness becomes excessive in the elevated plateaux of that country, where evaporation is immense. No vapours then disturb the purity of the sky, and the exhibition of electric sparks at the approach of various objects takes place at times with remarkable intensity.

This tension is even sustained in the rainy season, for in 1856, when M. H. de Saussure and M. Peyron ascended the Nevada de Toluca, in spite of the reiterated warnings of the inhabitants, they soon found themselves enveloped in a frost-fog—a menacing symptom of the storm which was coming on. Soon came a violent wind, with hoar-frost, then lightning and thunder, pealing incessantly and with a frightful noise, obliged them to descend lest they should be struck with the discharges. At a lower elevation the storm appeared to calm itself for a moment, and the travellers were enveloped in a grey fog, accompanied with hoar-frost; and they noticed the hair of their Indian guides in agitation, as if about to rise up. Soon there came a dull, indefinable sound, at first weak, though in all directions, and then growing stronger and stronger, very distinct, and even alarming. It was an universal crepitation, as if all the little stones on the mountain were jostled together. After a lapse of five or six minutes, thunder came on again, and rain, which lasted to the borders of the forest region, when the storm became more endurable, partly from the greater distance of the focus of electrical disturbance; and also from partial discharges which were promoted by the vegetation.

Previous to this, M. Craveri, a Mexican physician, had been present at a similar spectacle, on the 19th of May, 1845, when it was suddenly induced by a cloud coming from the north-west. The guides and himself experienced electrical sensations at all their extremities—their fingers, noses, and ears, followed by a dull sound, though no thunder was heard. The long hair of the Indians became stiff and erect, giving their heads an appearance of enormous size, and thus aggravating their superstitious terrors. The noise at length grew more intense. It appeared to extend throughout the mountain, and was like the rattling of flints, alternately attracted and repulsed by electricity; but was probably due to the tapping sound of innumerable sparks starting from the rocky soil. In this case no hoar-frost came on.

The same observer experienced another storm on the 15th of September, 1855, near the summit of Popocatepetl, which differed from the preceding one only that, taking place on the snow-fields, there was no crepitation of stones.

These Mexican storms, which remind me of less striking results observed in the Alps, have been noticed in May, August, and September—that is to say, in the most stormy period for Europe; and the coincidence ought not to be neglected. It will also be remarked that the storm of the 19th of May, 1845, was brought on by a west wind.

Phenomena of another kind have been observed at Chihuahua, in the Mexican Confederation, but more north. New York has supplied Professor Loomis with an assemblage of facts not less curious, in connection with the presence of an excessive quantity of electricity in the atmosphere. In the winter, hair frequently becomes electrical, especially when a fine comb is used. The greater the efforts made to smooth the hair, the rougher it becomes. It moves towards the fingers that approach it, and the only way to remedy this inconvenience is to make it damp.

At the same seasons woollen clothes, especially trowsers, attract particles of down or floating dust. These particles collect chiefly towards the feet, and brushing makes them stick tighter; a damp sponge is the only mode of removing them. During the night, thick carpets in hot rooms crackle and shine when walked over. By passing over them two or three times rapidly, sparks of some centimetres in length are obtained, and give noticeable pricks. A metallic object, such as a door-handle, shoots a spark at the hand which approaches it; and sometimes these discharges frighten the children. Occasionally a gas jet may be lit with a finger after walking on the insulating carpet.

These phenomena are so common in New York that they excite no surprise; but they attracted the attention of Volney at the close of the last century. This celebrated traveller observed that the quantity of electricity present in the air constitutes an especial difference between America and Europe. "The storms, also," he said, "furnish frightful proofs of this, by the violence of the thunder, and the prodigious intensity of the lightning." At Philadelphia, the sky seemed on fire from their rapid succession; and their zigzags and darts were of a magnitude of which he had no idea.

The extreme dryness of all the plateaux of the Andes occasion similar effects; and, according to M. Philippi, in the desert of Atacama, men's hair is often made to stand on end, and luminous manifestations spring from the ground.

According to Dr. Livingstone, in spring, which is the season of greatest dryness, the deserts of South Africa are often traversed by a hot north wind, so electrical, that the feathers of the ostrich become excited to active movements; and the slightest friction of clothing gives rise to luminous jets. And, as Volney noticed in America, the heat of the tropical season is not essential to this abundance of electricity, as it is never so striking as when a cool wind blows from the north-west; and the observations of Gmelin, Pallas, Muller, and Georgi, show that it is not less excessive in the glacial atmosphere of Siberia.

In India, electric disturbances in the atmosphere occasion remarkable difficulties in working telegraphic lines. The apparatus seems delirious, and works backwards and forwards. Storms of dreadful violence tear up the posts, and threaten to melt the wires; so that, as a narrator observes, we need not be surprised that Indian telegrams are often as puzzling as the cuneiform inscriptions on Babylonian bricks.

It would be easy to multiply further evidence of the same kind; but this may suffice to show that in the east, the south, and the west, electrical actions influence meteorology, and we may be permitted to believe that their influence may be brought to us by the winds.

RAINBOW PHOSPHORESCENCE.

UNDER this title we propose to describe a series of curious preparations made in France with great perfection, and capable, after exposure to sunshine, electric light, or magnesium light, of emitting in a dark chamber, very beautiful luminous effects, red, blue, yellow, and green. The substances sold for this purpose are enclosed in long flat bottles, and placed side by side in a box, the lid of which is removed when the experiments are made. The origin of all such preparations may be found in the "Bologna phosphorus," well known to all chemical students. It appears that in 1602 Vincenzo Casciorlo, an artisan of Bologna, engaged in alchemical pursuits, accidentally made a phosphorescent sulphide of barium by calcining sulphate of baryta in contact with charcoal, and this material, which attracted the greatest interest amongst philosophers, was subsequently named the "Bologna stone," or "Bologna phosphorus." In 1675 Baudouin described a similar preparation made by calcining nitrate of lime, and named it "hermetic phosphorus." To prepare Bologna phosphorus, sulphate of baryta is reduced to powder, moistened with water or white of egg, and made into cakes, which are placed in layers of *braise* (charcoal ashes), and calcined in a furnace.

In his recent work on light, M. Becquerel* states that Margraf, who published an account of his experiments in 1862, by pulverizing and calcining these substances two or three times in succession (as recommended by Pothier), obtained a mixture of phosphorescent tints, and thus to some extent anticipated the more recent preparations we shall proceed to describe. At the end of the sixteenth century, Homberg introduced his phosphorus made from chloride of calcium; and in 1730, Dufay published a memoir, showing that many minerals, shells, and calcareous concretions exhibited similar properties after calcination; and Beccaria soon afterwards demonstrated that insolation, or exposure to sun-light, imparted the property of phosphorescence to a considerable number of dried organic substances, and other materials. In the course of his experiments Beccaria devised a phosphoroscope, or rotating apparatus, for exposing a substance to the light, and then exhibiting it to an observer situated in the dark. By these means, which have been improved in later times, a very slight degree of phosphorescence may be rendered visible. Zanotti, secretary of the Bologna Academy, about the same time observed that

* "La Lunière ses Causes et ses Effets," par M. Edmund Becquerel, de l'Academie des Sciences, de l'Institut de France, Professeur au Conservatoire des Arts et Métiers, etc. Paris: Firmin Didot. 1867.

the Bologna phosphorus emitted one shade of colour without reference to the part of the solar spectrum to which it was exposed.

In 1764, Canton introduced the so-called phosphorus bearing his name, and as his method was easy to follow, it was very generally adopted. He calcined oyster-shells in a crucible, powdered the resulting substance, mixed it with one-fourth its weight of sulphur, and kept it a red heat for one hour. The result of this process is a sulphide of calcium, which, after exposure to light, shines in the dark with a green or yellow lustre, according to the details of its preparation. "Canton," observes M. Becquerel, "showed that the light of a candle, of the moon, or of electric sparks, rendered this substance active. He also showed that heating it in the dark did not render it luminous unless it had been previously exposed to the light, and that if heated immediately after such exposure, its action was more energetic than when it was heated a few days afterwards. Thus, heat occasions a rapid emission of light that would have been very slowly given forth at ordinary temperatures. Canton also showed that if at the end of several months this substance, previously insolated, was heated with boiling water, it gave no result; but when the heat was carried to a temperature of about 500° (C.), it became luminous, and then fell back to its inactive state until revived by a fresh insolation."

In 1780 Wilson published his experiments on the prismatic colours exhibited by phosphorus. He noticed that different portions of calcined oyster-shells exhibited different phosphorescent tints, red, yellow, green, or blue, and he separated them accordingly. Wilson also confirmed the statements of Dufay and Zanotti, that each portion of his calcined shells emitted their peculiar light, whatever might be the colour of the exciting rays; thus his red luminous fragments, he said, emitted a red light in the dark, whether placed in the violet, the blue, or the red of the spectrum, and the luminous portions exhibited a green phosphorescence after the action of violet, blue, or red rays. M. Becquerel remarks that these experiments were partly vitiated by the employment of an imperfect spectrum. His own researches show that the blue and violet rays act more energetically than the red, and that with Canton's phosphorus the red not only give no illumination, but exert a destructive power. A similar observation had been previously made by Goethe and Seebeck, and M. Becquerel cites the following passage from the work of the former on colours:—"The Bologna phosphorus becomes luminous under the influence of blue and violet glass, and never under yellow or orange glass; and it may be remarked that this phosphorus rendered luminous by blue or violet colours becomes extinguished sooner in yellow or orange rays than if placed nearly in a dark chamber. If these experiments are repeated with a prismatic spectrum the same results are always obtained."

The Newtonian theory that light consisted in an emission of minute particles shot forth with great velocity, led the older philosophers to conceive that these phosphorescent bodies had bottled up the light, something like the cucumber of Laputa, and gave it back again, as the celebrated sage of that island desired to make the cucumbers do. Such notions, however, and the somewhat similar one, that they absorb light, as sponges absorb water, are quite inconsistent with some important facts, and with the undulatory theory of light, which may now be considered as well established. M. Becquerel observes that such comparisons are incorrect, inasmuch as the light emitted usually differs from that which excites the phosphorescent body. Phosphorescence is generally an emission of light-waves of less velocity than those of the rays which excited it.

The most luminous of these phosphori are the sulphides of alkaline earths, calcium, barium, and strontium. The first gives Canton's phosphorus emitting a yellow or a green light; the second, the Bologna phosphorus, for the most part orange. M. Becquerel remarks that "these substances, when well prepared, will shine in darkness for many hours after their exposure to solar action, decreasing, however, rapidly in lustre in the first moments, and then growing weaker more slowly. Their light is emitted in vacuum as well as in gases, and their action is not accompanied by any chemical effect; it is the result of a temporary physical modification. Amongst the metallic sulphides, those of strontium and barium exhibit the greatest vivacity of luminous emission, and those of calcium yield the greatest variety of colours."

A sulphide of zinc, formed in a particular way, is as phosphorescent as the sulphides of the alkaline earths. Other metallic sulphurets do not exhibit the property, not even those of the alkaline metals, and the other compounds of barium, strontium, and calcium, excepting their selenides, do not manifest energetic action of this nature. Following the sulphides just mentioned, come minerals, such as certain diamonds, especially those of a yellow tint, and most specimens of fluoride of calcium. The variety of calcic fluoride called chlorophane becomes very luminous by insolation, emitting a slightly bluish green tint of light. The reason why particular diamonds, or chlorophanes, are phosphorescent, while others do not exhibit that property, is at present unknown. M. Becquerel says, "the diamond and fluoride of calcium do not exhibit a vivacious lustre, but they remain luminous for a long time. Thus, I have seen a fragment of green fluor spar and two white diamonds emit light for one hour after insolation."

In preparing these phosphori, it is noticed that the peculiarity of their luminous action depends on the primitive condition of the sulphates employed. "Thus the natural crystallized sulphate of baryta affords the orange yellow Bologna phosphorus; the natural sulphate of strontium from Sicily in rod-shaped (bacillary) crystals, yields a bluish green phosphorus, and if by the action of carbon different sulphates are reduced to the condition of sulphides, their luminous action will vary."

In preparing a phosphorescent sulphide with lime, or carbonate of lime, it is most convenient to add 85 parts of sulphur to 100 of the lime, or 48 to 100 of its carbonate. The materials are intimately mixed and placed in an earthen crucible in a charcoal furnace. M. Becquerel says it is necessary to pay attention to the temperature as well as to its duration. "Operating with fibrous arragonite, and heating the crucible to 500° (C.) for a time sufficient to allow the reaction between the lime and the sulphur to take place, and the excess of the latter to be eliminated, a feebly-luminous mass affording a bluish tint is obtained. If this mass is raised to a temperature of 800° or 900° (C.) and kept for five-and-twenty or thirty minutes at a point not exceeding the fusion of gold or silver, it yields a brilliant green light. The chemical composition is the same in both cases; but it is remarkable that if the process is conducted with carbonate of lime instead of with lime, the refrangibility of the light emitted does not vary with the temperature."

Too high, or too prolonged a temperature destroys the phosphorescence, and charcoal furnaces answer better than coke.

Among the lime preparations, those made with pure Iceland spar give, after insolation, an orange yellow light, calc spar affords a less vivid tint, Carara marble a very weak yellow light, oyster-shells yellow, chalk a scarcely visible yellow. Arragonite of Vertaison in bacillary crystals, a green of medium intensity, fibrous arragonite a dominant violet tint, with some parts green, and lime obtained from fibrous arragonite a very vivid green.

If nitric acid is employed to dissolve the lime of these minerals, and it is then precipitated by carbonate of ammonia, the tints of the phosphorescence will vary according to the sources of the lime.

Phosphori composed of strontium sulphides usually require less heat in their preparation than the lime series, and an excess of heat destroys their luminosity. The barium phosphori on the contrary are prepared with greater and more sustained heat. Chlorides of calcium and strontium tend to give blue and violet tints, those of barium yield green tints, while carbonates obtained from nitrates and acetates of baryta afford yellow orange phosphori, and analogous combinations of calcium and strontium give very luminous green ones.

A luminous orange phosphorus from barium is made by intimately mixing powdered crystalline sulphates with 12 to 15 per cent. of lamp black, moistened with a little alcohol. When the mass is dry it is calcined in a crucible for 45 to 60 minutes, at a temperature not exceeding cherry red, or the melting point of silver. The resulting mass is powdered and calcined a second time.

We have mentioned that, as a rule, these phosphori give the same tints whatever may be the colour of the light they are exposed to in order to excite them, but M. Becquerel cites three exceptional cases.

1. Sulphide of barium obtained by reducing the sulphate with lamp black, gives an orange yellow phosphorescence when illuminated by the action of the rays in the spectrum situated towards the end and beyond the violet (from lines H to P), while the effect of the rays from the blue to the violet (F to H) is to induce a redder phosphorescence.

2. The sulphide of calcium obtained from oyster-shells, which gives a red light when excited by rays from the blue (F) to the ultra-violet as far as O, has a green tint imparted to it when excited by the rays beyond O and P, which are non-luminous to human eyes.

3. A phosphorus obtained by the action of sulphide of potassium on oyster-shells, is excited to an indigo-violet luminosity by exposure to rays of that tint, while rays beyond the violet excite it to emit a blue colour.

It is interesting to observe from M. Becquerel's explanations and from a beautifully-coloured plate attached to his work, that while the most luminous parts of the spectrum, the yellow, actually exert a destructive effect on the light of these phosphori, they are all capable of excitation by non-luminous rays beyond its violet extremity.

We are afraid that experimenters will only succeed in making the more easy of their phosphorescent compounds, unless they possess a good deal of patience and considerable knowledge of chemical manipulation. When well prepared the varieties of colour are very distinct, and the luminous effects brilliant and pleasing. They not only afford an agreeable recreation, but they suggest curious speculations on the molecular condition of the several compounds. Light appears to excite a peculiar vibration of their particles without affecting their chemical condition; and it is most remarkable that notwithstanding the chemical decompositions and recompositions that occur during the preparation of certain sorts, their final properties depend upon the original condition in which their alkaline earths were found.

THE ERUPTIONS AT SANTORIN.*

We have on several occasions laid before our readers various facts concerning the interesting volcanic eruptions at Santorin, and we have now before us a valuable paper on the subject, accompanied by large and beautifully-executed maps and diagrams.

The German philosophers to whom we are indebted for this work commence by pointing out certain resemblances between the Kaimeni, or "burnt," Islands of the Santorin group, and the volcanic region immediately surrounding and comprehending Vesuvius. The island of Thera, or Santorin, is approximately semicircular in form, and opposite to its western or concave side are two other islands, Therasia and Aspronisi—the latter being very small—which follow the general curvature of the main island, and with it enclose a sea-basin more than five miles in diameter, in the midst of which the Kaimenis rise. Von Buch, in accordance with his well-known theory, considered the whole formation to be "a crater of elevation," formed by the upheaval of the sea-bed; but examination in this, as in most other cases, dissipates his conjectures, and shows these Santorin volcanoes to have modified the surface by the outpouring of molten matter. MM. Fritsch, Reiss, and Stübel say, "Let us imagine Mount Vesuvius and Somma to be lowered, so that the sea might enter into and partly inundate the Atrio del Cavallo, we should then obtain a distribution of sea and land analogous to that seen at Thera and the Kaimeni Islands, a smaller part of the cone of Vesuvius rising from the sea in the midst of encircling Somma." Somma is, as most of our readers will know, the name given to the *ancient* cone, the remains of which partially surround the newer cone known as Vesuvius, and formed in 79 during the tremendous eruption in which the elder Pliny lost his life. After indicating the analogies between Vesuvius and Santorin, our authors point out the differences, and observe that "while on Mount Vesuvius the volcanic action has always been confined to the existing

* "Santorin: the Kaimeni Islands." From Observations by K. V. Fritsch, W. Reiss, and A. Stübel. Translated from the German.—Trübner and Co.

crater, at least so far that they have never raised by its side any other mound approaching in height and extent to the great cone, we find, in the Gulf of Santorin, each separate revival of volcanic action, characterized by its separate and special formation, which we can trace as such even under water down to a common base. These formations owe their origin to a slow emission of large masses of lava quietly overflowing at their point of issue, filling up the irregularities of the bed of the sea, and rising by degrees as islands above the water-level. The eruptions of Mount Vesuvius, on the contrary, are mostly distinguished by a totally different character, inasmuch as the melted rock, flowing from a higher or lower point of eruption down the slope of the mountain cone, spreads in long but narrow streams."

An interesting peculiarity of the volcanic action at Santorin is the fight which the volcanic fires have had with the cold water of the sea. "The quantity of steam sent forth at intervals of but a few minutes was so considerable, that it often rose to a column of more than 2000 metres in height."* This magnificent display lasted for months, and acting upon the tough, viscid lava, assisted to produce the crater forms.

On the 16th of May, 1866, without previous symptoms of disturbance, two small islands appeared in the Kaimeni group. "No signs of anything occurring at the bottom of the sea had preceded this event, except that new soundings showed a depth less than that which had been previously observed in the channel." The new islands, which looked like large heaps of black rock, increased from day to day, moving at the same time horizontally from north-west to south-east, as shown by accurate geometrical measurements. In April, the progress of the field of lava of Aphroessa† was principally in a northerly direction, menacing thus to block up entirely the small harbour of St. George. In the beginning of May it became every day more apparent that the mass of lava had changed the direction of its onward movement, taking its course now to the south-west, in the direction of Palea Kaimeni." By the 30th of May the new islands had increased to four, and they represented the emergent portions of the lava currents, which had filled a deep sea-trough between Nea and Palea Kaimeni.

The displacement of the May islands is highly curious. Our authors describe them as made up of wildly accumulated and brittle blocks, and they regard their onward movement as indicating "not only a greater extension of the igneous mass at the bottom of the sea, but also a displacement and destruc-

* Rather more than 2187 yards, or exceeding a mile and a quarter.

† The name of a part of one of the islands.

tion of the yielding material in a much higher degree than that occasioned by the breakers." In actions of this kind they find an explanation of the increase and decrease and total disappearance of such islands.

The paper from which we have extracted the preceding information is illustrated by four large plates; the first is a reduction of the Admiralty chart of the Santorin group, with soundings of the adjacent waters; the second is a map, showing the successive enlargement of Nea Kaimeni; the third (called Plate II.) is a remarkably beautiful and interesting photograph of a model of the island and adjacent sea-bed, made by Herr Stübel; the fourth (called Plate III.) contains two fine photographs, one depicting a bird's-eye view of the island, previous to the eruption of 1866, and the other exhibiting their configuration after it, and showing the column of steam rising from the volcanic vents. These illustrations are very instructive, and will be highly esteemed by students of volcanic action.

JUPITER WITHOUT SATELLITES.

On the 21st of August the remarkable spectacle of Jupiter without his attendant satellites gratified the eyes of numerous observers. In London the weather was scarcely propitious, as a number of clouds were flitting slowly across the sky, and, at convenient hours, only occasional glimpses of the planet could be obtained. In some other localities a cloudless sky offered greater facilities, but those who were only favoured with intermittent views had much reason to be gratified with the singularity and beauty of the spectacle.

Of course the phrase, "Jupiter without satellites," is not literally true. The satellites had not forsaken their primary, but, by a series of remarkable coincidences, they all ceased for an hour and three-quarters to occupy visible positions at his sides; so that, in any telescope not powerful enough to show the shadows, or the bodies of those that were on his disk, his luminous globe appeared wandering alone.

Jupiter is an enormous planet, the largest of our system, being 1300 times as big as our earth, and having a diameter of no less than 87,000 miles. Mr. Breen, in his "Planetary Worlds," makes the following concise remarks respecting the four satellites of this wondrous globe. He says, "The three inner satellites move all very nearly in the plane of the equator; but the fourth is slightly inclined to it. In consequence of this, and their proximity to Jupiter, the three first satellites are eclipsed at each revolution, which does not happen to the fourth, as it can pass above or below the shadow. Passing between Jupiter and the sun, they likewise produce solar eclipses, and their shadows on the disk can be seen in the form of round dark spots, and in powerful telescopes even the satellites themselves are visible. Some very curious laws have been detected by the combination of the motions of the three interior satellites, and it is impossible that they can all be eclipsed at the same time. On some extraordinarily rare occasions, however, Jupiter has been seen without any satellites. They are not necessarily *eclipsed* on that account, as they may pass either before or behind the disk. The three interior satellites return to nearly the same position in respect to Jupiter in a period of 437 days 4 hours."

Jupiter is composed of much lighter materials than our earth, his density being 243 when that of the Earth is reckoned at 1000; but from his great size he is able to exert a great power of attraction, and a body which would weigh 100 lbs. on the Earth would weigh 224 lbs. at Jupiter's equator, and as much as 276 at his poles. Jupiter's diurnal rotation takes place in a few minutes less than ten hours; so that his atmospheric currents resulting from rotation must be extremely violent—a fact which helps to explain the occasional rapid changes in his belts, which are supposed to be the body of the planet seen through his clouds, but which makes it more difficult to account for the frequent persistence of those belts in nearly the same condition for considerable periods. The first of Jupiter's satellites has a diameter of 2400, and is about the density of water; the second satellite is somewhat less in bulk, being 2190 miles in diameter, and thus resembles our moon in size: its density is greater than that of the other three, or of the planet himself; the third satellite is 3580 miles in diameter; and the fourth 3060 miles. Their distances from Jupiter's centre are, respectively, 278,542 miles, 442,904 miles, 706,714 miles, and 1,242,619. They revolve round their primary in periods varying from 1 day 18h. 27m. 33·505s., the time of the first, to 16 days 16h. 32m. 11·271s., the time of the fourth.

From the preceding facts, it will be seen why the positions of the satellites change so constantly and so quickly. On the 21st of August their motions were so curiously combined, that three satellites were on the disk of the planet at the same time, and a fourth behind it. The appearance of the first satellite gliding on to the disk at 10.4 P.M. was extremely beautiful as we observed it. The first contact, the gradual passage, the slight addition to the planet's margin as the last portion of the satellite's disk passed inwards, was beautifully shown in one of the Browning-With silvered-mirror telescopes, with a power of 120.

When the cloudless intervals permitted, the shadows of the three satellites (1, 3, and 4) on the disk were sharp, and as black as ink, contrasting boldly with the brilliant portions of the planet, and making the coppery tint of the belts more conspicuous by their deviation from the much darker shadow tones. Fortunate observers saw the entrance of the third satellite on Jupiter's disk at 8.14 P.M., eclipse of the second satellite, the entry of the fourth and first on the disk, preceded by their shadows, the passage off the disk of these satellites and their shadows, and also the reappearance of the second satellite from behind Jupiter. Few could expect to be so lucky as to see all the incidents, which a perfect continuance of fine weather could disclose; but a great many saw enough to make the evening of the 21st of August memorable in their astronomical experience. Near Dublin, the Hon. Mrs. Ward informs us the sky was propitious for nearly the whole time, though clouded when the fourth satellite left the disk, and the series of phenomena ended.

IRRITABILITY OF PLANTS.

BY M. CH. BLONDEAU.

(*From "Comptes Rendus."*)

We have undertaken, in the course of this year, a number of experiments on the irritability of plants, which show that the faculty which some of them, and especially the sensitive plant, possesses of executing movements which appear voluntary, may be suspended by many agents, such as ether, chloroform, carbonic oxide, and spirit of turpentine—all of which are known to act upon the nervous system of animals.

Amongst these experiments, one appears to us of sufficient interest to deserve the attention of the Academy of Science; it relates to the action of the electric current on the *Mimosa pudica* (sensitive plant).

We selected four plants perfectly developed, and so sensitive that the slightest contact, such as the friction of a fly's wing, caused their leaves to shut up, and the petioles (leaf stalks) to droop along their stems. Placing the pots containing these plants on an insulating stand, we attached to the two ends of their stems a small copper wire in order to pass through them the current from a single Bunsen's cell. After a few seconds, when the plants reopened their leaves, and erected their petioles, we caused the current to traverse them; but the leaves did not fold up, the petioles did not fall, and the plants seemed insensible to the electric action. We then varied the experiment, and instead of employing the direct current of the battery, we used an induced current obtained by the aid of a very small Ruhmkorff's coil. The results were then quite different. Scarcely had the current commenced when the leaflets began to fold together, and the leaf-stalks drooped down along the stems. These movements were quickly propagated from one end to the other of the plants. According to this experiment the plants are sensible to electric disturbances, and behave under such conditions like animals.

We then wished to see whether the application of the electricity for a longer or shorter time would give rise to any special phenomena, and we exposed three of the plants to electric action for varying periods. The first plant received the current from the Ruhmkorff coil for five minutes, and was then left to itself. For more than a quarter of an hour it remained in a state of prostration, but gradually its leaflets reopened, the leaf-stems lifted themselves up, and in about an hour it reassumed its natural appearance, and seemed none the worse for the shocks it had received.

A second plant was similarly treated for ten minutes, and then left alone. The state of prostration in this case lasted for an hour, and it was not till the expiration of that time that the leaflets began to open, and the leaf-stalks to rise, and these movements seemed to be accomplished with greater difficulty than in the preceding case. The plant was evidently fatigued, and did not fully recover for two hours and a half. The third plant was electrified for twenty-five minutes and then left to itself. In this case we waited in vain for its restoration—the prolonged electric action had destroyed its irritability, and even its life, for the next day we found it withered, and blackened, as if struck by lightning.

The fourth plant was reserved for an experiment which proves that electric disturbance acts upon plants, as it does upon animals. It is known that man, and other animals, exposed to the anæsthetic action of ether, become insensible to induction currents, even when strong. We desired to ascertain if it was the same with the sensitive plant. With this object in view we placed a plant under a bell-glass with two openings, through which two copper wires could convey the electric current to it. A few drops of ether were sprinkled in the glass, and in a short time the plant experienced the anæsthetic action of that substance, for when shaken it did not close its leaves, or manifest any sensibility. In this state we passed the induction current through it, but it gave no sign of sensitiveness. The petioles remained straight, and the leaflets continued open.

These fresh experiments came in aid of others which have been made on the same subject, and supply an argument in favour of those who consider the movements observed in these plants to be produced by the operation of organs analogous to those which animals possess.

ARCHÆOLOGIA.

The past month has witnessed the congresses, or annual meetings, of the three great ARCHÆOLOGICAL ASSOCIATED BODIES, the British Archæological Association, the Archæological Institute (the branch, or rather division, from the former), and the Cambrian Archæological Association, which was formed on the model of the first. We have stated, on a former occasion, that the three Associations had, quite unknown to each other, selected the same place of meeting, Hereford, for the present year; but that, as the Cambrian Association, by the prior publication of its claim, had secured the right to Hereford, the two others were obliged to seek their fortunes elsewhere. The British Archæological Association announced its intention of meeting at Ludlow, in Shropshire; and its congress was accordingly held during the week, from the 29th of July to the 3rd of August, under the presidency of Sir Charles H. Rous Boughton, Bart., of Downton Hall, near Ludlow—an old member, and one of the Vice-Presidents of the Association. The Archæological Institute (very unadvisedly, we think) chose to meet at Hull during the same week which had been previously chosen for the meeting of the older body, the British Archæological Association. The Cambrian Association met at Hereford from Monday, August 12th, to Saturday, August 17th, under the presidency of Lord Saye and Sele, who was compelled, by unavoidable causes, to depute his authority to the Rev. Archer Clive, of Whitfield. As a tolerably numerous meeting, which everybody enjoyed, and which gave satisfaction to all concerned in it, that of the Archæological Association appears to have been the most successful. It may be questioned if any one of these meetings has added to our archæological knowledge, or even if such meetings generally have that effect; but they are pleasant reunions, in which people who are more or less attached to the same pursuits meet and commune together. They have the tendency, perhaps, to make people talk on antiquities instead of studying them, or rather before studying; but this inconvenience is somewhat compensated by the circumstance that they excite a local feeling of interest in the numerous monuments of antiquity which still exist, and many of which have been exposed to the risk of destruction through local ignorance.

The meeting of the Cambrian Association was made the occasion of excavations into a very large TUMULUS at Thruxton, by the directions of the Rev. Archer Clive, of Whitfield, on whose estate it stands. Thruxton is a village about eight miles to the south-west of Hereford. The tumulus resembles the larger monument of the same class at St. Weonard's, farther to the south of Hereford, which was opened a few years ago under the direction of Mr. T. Wright, and an account of which will be found in the first volume of his "Essays on Archæological Subjects." Mr. Wright was at Thruxton two or three days before the meeting, after the men had been set to work excavating, and gave some directions, or suggestions, which seem to have been followed; but the examination has evidently been as yet very imperfect. There appears to have been in the centre of the mound a small dome of stones, which covered a mass of ashes, the result of the cremation of the dead body, just the same as was found to be the case in the great barrow at St. Weonard's. One or two pieces of pottery, Roman in character; parts of an iron horseshoe; and a portion of a glass vessel—the latter very improperly carried away by some accidental visitor—were among the remains found in the tumulus. It is to be hoped that whoever has the glass will immediately restore it, as it may be of very great importance in establishing the true character of the monument. All the evidence yet obtained leads us to believe that it belongs to the Roman period, and points to its identity of character with the tumulus at St. Weonard's, and several other large tumuli on this border. This at Thruxton, like many of the others, stands very near the parish church. This circumstance admits of an easy explanation. These barrows were, no doubt, in early times, looked upon with a large amount of superstitious veneration by the population of the neighbourhood, and people probably assembled at them at different periods. The early Christian missionaries sought to turn these assemblages of people to account by erecting their church near to the tumulus, and so draw the attention of the people assembled there to their preaching.

We are very glad to be able to announce that the excavations at Wroxeter, on the site of the ROMAN CITY OF URICONIUM, are recommenced. We owe this chiefly to the munificent liberality of Joseph Mayer, of Liverpool, who recently made a very handsome contribution of £50 to the excavation funds. It is to be hoped that others will follow his example, and that the good work will not again meet with so long an interruption; though it will never be carried to the extent which the history of our country requires, until the Government itself steps forward to supply sufficient funds. Through a mistake in the first measuring out of the land which the Duke of Cleveland granted for excavating, the greater part of the line of the Old Wall, or the wall which divided the Basilica from the Baths and other buildings to the south, was left out of the limits; the consequence of which was that some important buildings could not be explored in a satisfactory manner. This has now been remedied, and a large room has been opened, which fronted the Forum, and adjoined the room which has been called the enameller's shop. The portion of this room yet uncovered is of small extent, for it was found necessary to withdraw the men for the requirements of the harvest; but enough has been done to show that it is possessed of very considerable interest. It appears also to have been a workshop, for the remains of erections built of stone, somewhat like forges, have already been found; and amongst the loose objects scattered about the floor was the bowl of an iron ladle, which appeared to have been used for pouring out melted metal. Among the other articles which have been gathered from the small extent of excavation yet made, are a great quantity of earthenware and glass—some of the latter of very interesting character; and, among the pottery, two handsome ornamental bowls of Samian ware; two iron rings; a very curious finger-ring, made of amber; a bronze fibula; an ornamented bone roundel; a bronze scale-pan, with three equidistant holes; two hair-pins; a small pellet of enamel; a white disk of bone, like a button, but without a shank; nine Roman coins; and a piece of sandstone, with a fragment of an inscription. The buried part of the Old Wall has also been uncovered, and all that has been yet done, though very small in extent, gives promise of important discoveries.

A very remarkable discovery has recently been made on the site of Wigmore Abbey, in Herefordshire. In digging for some works of construction, the workmen came among some very extraordinary subterranean buildings, which soon assumed the form of a very large passage, wide and lofty, and was followed for, we believe, at least a hundred feet; and, with the old legendary notions about abbeys and castles, was assumed to be a passage for secret communication between Wigmore Abbey and Wigmore Castle, a distance of about a mile and a half. However, a little consideration was sufficient to convince us that it was simply the great drain of the important Abbey of Wigmore; and, as such, it is a very remarkable monument of the internal economy of these great mediæval establishments.

T. W.

PROGRESS OF INVENTION.

Improved Application of Superheated Steam.—It is found more economical, as far as fuel is concerned, to increase the pressure of steam by superheating it, than by causing the evaporation of an additional quantity of water. There is a limit, however, to the degree of temperature to which the superheated steam can be raised: since, if its temperature is too high, lubrication will be imperfect, or impossible, on account of the charring of the oil. Superheating is applied very effectually in a new engine recently constructed for the water supply of the city of Paris. This, like Woolf's engine, consists of two cylinders, the steam passing from one into the other; but instead of the steam passing directly from one cylinder to the other, after leaving the first, it is made to traverse tubes which are placed in the furnace near the chimney.

Thus, the steam is not only heated to the temperature it had when it entered the first cylinder, and therefore has no tendency to lose its vaporous form, but it is superheated, so as to have an increased pressure. And this restoration of heat, and superheating, is the source of the greater economy, as the heat required for the purpose costs nothing, being taken from the products of combustion just before they are about to escape into the chimney, and to carry off and waste any heat still remaining in them.

Combination of Horse and Steam Power for Locomotives on Ordinary Roads.—The great difficulty attending the introduction of steam on ordinary roads, as far as the public is concerned, is the danger of accidents of a most serious kind from the least interruption of attention on the part of the engineer in charge of the vehicle. On a curved or crowded road there must be constant changes of direction, without which collisions, or other dangerous effects, will certainly take place. With a vehicle drawn by horses, their intelligence, not less than that of the driver, is effective; and in cases in which the driver is negligent, or even incapable, from sleep, or some other cause, the horses may, and often do, bring the vehicle safe through every peril. This consideration has suggested the utilization of the intelligence of the horse—which, unlike that of the engine-driver, is undoubtedly ever occupied only with things present—by a means which M. Séguier has recently brought under the notice of the Academy of Sciences. The horse is to be attached to the locomotive, not for the purpose of giving the least assistance in drawing the vehicle, but with the sole object of aiding in its guidance: it will therefore undergo no fatigue. A shaft, which is placed in front of the steam-carriage, and to which the horse is yoked, is so connected with the steam machinery, that when the horse advances, the steam is turned on, when he moves back, it is turned off; and when he turns to either side, the mechanism required to turn the carriage in the proper direction is thrown into action.

Renovation of the Polished Surface of Glass.—Hydrofluoric acid in the form of gas, and that dissolved in water, has very different effects on glass. As a gas, it entirely removes the polish, rendering the glass incapable of transmitting the images of objects; as an aqueous solution, it removes the old surface, without destroying the polish, but, on the contrary, rendering it more brilliant. For this purpose a very dilute acid must be employed; if tolerably concentrated, it will eat a hole in the surface of the glass on which it is placed; but this hole will have a brilliant appearance. This property, possessed by hydrofluoric acid in solution, has suggested it as an excellent material for cleaning glass which has been tarnished by time or bad usage.

Application of Electro-Magnetism to the Manufacture of Iron.—It has been found by recent experiments that electro-magnetism can be used with excellent effect in the manufacture of iron; the process being facilitated, and rendered more perfect, while, at the same time, fuel is economized. An opening is made in the smelting furnace, and opposite to this opening is placed an electro-magnet, which is excited by a current that is made to traverse the iron while in a state of fusion. Numerous gas bubbles are produced, and the resulting iron is harder and more tenacious than what is manufactured in the ordinary way.

Application of Sulphuret of Carbon to the Extraction of Oleaginous Matters on the Large Scale.—In France there are two great sources of waste of oleaginous and fatty substances. Vast quantities of oil remain in the olives, however much they may be pressed; and enormous quantities of soap, after having been used in the silk manufactories, pass off into the rivers and are lost. Both these sources of waste are now about to cease, on account of the industrial applications of sulphuret of carbon—a substance which possesses an extraordinary power of taking up fatty matters, from which it is separated with great facility by distillation. As long as it was dear, its application in this way was impossible; from improved methods of manufacture it is now become extremely cheap; and almost none of it is lost during its application even on the large scale. The sulphuret of carbon is allowed to flow through the olives, partially exhausted by pressure, to a still, whence it passes to a new quantity of olives; the process being continuous, and so perfect that the very presence of the sulphuret is not to be perceived in the establishment. The olives, completely exhausted by the sulphuret, are far more effective as manure than those from which the oil has been only imperfectly separated. Applied to a saving of the soap refuse of the silk manufactories, several thousands of tons of that valuable material will be recovered annually. Large quantities of the regenerated soap have already come into use.

Further Utilization of Aluminium Bronze.—Bronze containing ten per cent. aluminium and ninety per cent. copper, has been found to possess the invaluable property of being almost indestructible in the working parts of machinery exposed to great wear and tear. This is illustrated by a purpose to which it has recently been applied in France. Paper, and especially when coated with dried gum, is rapidly destructive of the best cutting instruments, and the parts of the machine connected with them. Holes for rendering French postage-stamps easily separable, one from another, are made by an instrument having three hundred needles, that descend through the five layers of postage-stamps lying under them into holes which have been carefully made in a steel plate placed beneath. In one day, the steel plate is worn to such a degree that afterwards, instead of the holes being punched in the paper, the latter is merely crumpled into the holes in the plate, and more or less injured. A plate of aluminium bronze having been substituted for the steel plate, it was found to last for fifteen hundred days without requiring any repair, having received daily one hundred and twenty thousand blows. Hitherto the utility of aluminium bronze was limited by the difficulty with which it was soldered; ordinary solder does not answer for the purpose. It has, however, been found, that one piece of aluminium bronze may be easily and firmly united to another, or to iron, either cast or malleable, by means of a mixture of common tin solder and an amalgam of zinc and mercury. The proportions may vary from equal weights of tin solder and amalgam to one part amalgam and three parts tin solder.

Preservation of Liquors containing Alcohol.—Liquors, such as beer, containing comparatively small quantities of alcohol, have a great tendency to natural fermentation. It has been found that this tendency may be lessened, and even destroyed, by a judicious application of heat. The higher the temperature, the more effective it is; but unless kept within certain limits, the flavour will be deteriorated, or even destroyed—a disagreeable one supervening. It is enough if a temperature at all higher than 45° Cent. is reached; but that between 28° and 58° must be allowed to continue for as short a time as possible, since the various temperatures between these points are exactly those most favourable to the development of natural fermentation. The temperature should be raised as rapidly as possible to between 48° and 58°, which should be maintained for at least twenty, and at most sixty, minutes; after which the cooling should be rapid, and the liquor should then be transmitted to barrels which have been previously filled with carbonic acid.

New Application of Electricity.—It is necessary that the person attending on a power-loom should carefully watch and remedy the breaking of a thread; and as several looms may be in charge of one attendant, it would be very useful that his attention should be directed to a broken thread. This is now done with great simplicity and certainty in the case of the stocking-machine, by means of electricity; and there is no reason why the same contrivance should not be applicable in other cases. A small lever rests on the thread, and retains its position as long as the thread is whole. But the instant the thread breaks, the lever falls, and completes connection between the poles of a galvanic battery, which excites a small electro-magnet, and sets a bell-ringing apparatus in action. This attracts the notice of the attendant, so that the broken thread is instantly made whole again.

The Latent Image.—The photographer had long been surprised at, but unable to explain, the existence of the latent image; and its development has never failed to astonish the uninitiated—its appearance being something resembling the effects of magic. Its nature, thanks to Mr. Carey Lea, is no longer a mystery; and its existence is shown to be due to well-known optical principles. There are certain substances which, in contact with organic matters (thus, iodide of silver), undergo a marked chemical change when exposed to the action of light. It was considered that the presence of the luminous body itself was required to produce this effect, which is not, however, the case. It has long been known that certain substances are capable of absorbing light and again emitting it—some in a few seconds, some during a much longer period. It is true that this fact was remarked only regarding the luminous rays; but we might infer it from analogy with regard to the actinic rays also; and there is no question of it regarding the calorific. It explains, indeed, the fact, that an engraving exposed for a few minutes to light, and then placed in contact with sensitized paper in the dark, will give rise, on development, to an image. Applying this principle, we shall find that a latent image must result when iodide of silver, for example, is exposed to light along with some substance capable of absorbing light, and retaining it for a sufficient length of time, and is then, before the light has been all emitted, placed in contact with the requisite organic matter. The conditions necessary for the production of the chemical changes indispensable to the obtaining a picture are fulfilled; since the iodide of silver and the organic matter are simultaneously in presence of light, though not of the luminous body.

Electric Condition of Different Parts of the Earth.—It has been found that, if one extremity of a long wire is inserted in the earth at one place, and the other in the earth at another place which is higher than the former, a current of electricity will constantly traverse the wire from the lower to the higher level. This fact has been recently explained by M. Matteucci, and his explanation has been experimentally illustrated by him. It is a consequence of the positive electricity constantly carried towards the poles by the wind, and the inductive action of this electricity on the earth. The stratum of air near the earth, especially over seas and lakes, is continually being neutralized, but the neutralization goes on more slowly and imperfectly in mountainous and even slightly elevated regions. Hence the mountain and the air in contact with it are in opposite electrical states of greater intensity, and thus it is that clouds are so strongly attracted by mountains. The mountain and the plains are negatively electrified, but not in an equal degree; and if their electricity is not in a static condition, a conductor must lead a current from one to the other. They are not in a statical condition; for neutralization of the air in contact with the earth is constantly taking place, and electrical equilibrium is therefore constantly being disturbed. This is illustrated by M. Matteucci by a very simple and satisfactory experiment. He places a globe, made of porous earth or of wood, covered with moistened blotting-paper, on an insulating stand; fixes a small metallic disk on the highest part of the globe, and in contact with the moistened blotting-paper, and a similar disk from fifty to ninety degrees from the first; then, having connected the plates with a galvanometer, he electrifies the globe. No current is, under these circumstances, indicated by the galvanometer; for the electricity of the globe is in a static condition. He next suspends, by an insulator, a small, slightly concave metallic plate over the higher disk, and about an inch from it. This concave plate represents the atmosphere; and if it is placed in connection with one conductor of the electrifying machine, and the globe with the other conductor, so as to oppositely electrify the globe and the plate, the galvanometer will, on turning the electrifying machine, at once indicate the presence of a current. The electric condition of the globe is different at different parts; and it is no longer static, for the electricity of the globe is constantly passing to and neutralizing that of the plate. It is not always necessary that the extremities of a long insulated wire, inserted in the earth, should be at different levels, in order that a current should be developed in it, since the positive electricity of the air increases as the poles are approached; and hence, in a similar way, the negative electricity of the earth produced by inductions. There is, therefore, usually a difference of intensity between the earth at the poles and at the equator; and as the electric state is not static, a wire in a direction from the equator to either pole should indicate a current, which experiment shows actually to take place.

PHOTOGRAPHIC MARINERS' COMPASS.—A simple means of registering a ship's course by photography has recently been invented. The instrument employed is the compass by which the vessel is steered, modified for the purpose. A small aperture is made in the line representing the north on the card, and in it is placed a lens. Under the card is sensitized paper, which is made, by clockwork, to pass along with a regulated speed. Were the vessel constantly to move in the plane of the magnetic meridian, the paper, after development, would show a straight line, of a length dependent on the time of the voyage; but every deviation to the east or west will be marked, by the light which illuminates the compass, on the paper, which moves under the aperture in the card, the latter being immovable. If the paper is divided by transverse lines, the length of time during which the vessel was steered in any particular direction will be indicated by the corresponding deviations from a line corresponding with the intersection of the planes of the magnetic meridian and the horizon.

LITERARY NOTICES.

OUTLINE LUNAR MAP. Zones II. and IV. Areas IV. α and IV. ζ, with Catalogue of two hundred and three objects, the whole deduced from Photographs, Observations, and Measurement, by W. R. BIRT, F.R.A.S. Under the direction of the Lunar Committee of the British Association. (From the Report of the British Association for the Advancement of Science, for 1866.) (Printed for private circulation.) —Mr. Birt, the Secretary of the British Association Moon Committee has evidently made his arduous and laborious task a labour of love, and the positions of the great map comprised in Zones II. and IV., areas IV. α and IV. ζ, now issued together with the elaborate, accompanying, and explanatory, pamphlet, bear ample testimony to the value of his work. The pamphlet states that "the scale of two hundred inches in the moon's diameter appears to be the *smallest* that can be used with advantage in the present state of selenography." This dictum embodies the deliberate opinion of the distinguished astronomers who form the committee, and must therefore be received with great respect. No doubt much may be said for it; but as few observers have any opportunity of seeing portions of the moon on anything like so large a scale, and as the majority of observations are necessarily made under a magnification which is only a small fraction of that supposed by a map of the lunar disk nearly seventeen feet in diameter, the scale selected is not without serious difficulties. It certainly gives plenty of room for "inserting synonyms" and "numerical data," but renders objects seen under moderate powers difficult of identification, and tends to induce observers to draw them on a scale disproportionate to the amount of detail actually seen. The "best possible scale," for the purpose will be estimated differently by various observers; but all agree in appreciating Mr. Birt's work, which is to supply a series of lunar map sections, carefully drawn to scale, and exhibiting contour lines of the various formations.

The nature of each object is indicated by a symbol which is explained in the Report of the Moon Committee for 1865, and there is no attempt at a minute exactness not possible until a much larger accumulation of facts has been made. Mr. Birt rightly describes his charts as "a guide to observers in obtaining data for the construction of a complete map." He adds, "at present the engraved portions of the map are in *outline*, and will doubtless require *considerable modification*, as observers work at the subzones which they may select." Mr. Birt also recommends observers to tint or colour their subzones, so as to make craters and other objects more conspicuous than they are in the simple red outlines which he provides, and which are printed in that colour to distinguish them readily from any corrections or additions which observers may make in black ink. It would require a series of elaborate notices to do justice to the numerous suggestions and important bits of information which Mr. Birt supplies concerning the zones and areas comprised in his map, and we can only observe that they are calculated to render most valuable aid to lunar students.

It will be very interesting to compare the physical geography of the earth and moon, and to notice how the distribution of hollows, elevations, etc., vary in the two bodies whose surfaces have assumed their existing forms under such different conditions as are expressed by the presence, and absence, of water and air, and numerous observations will be found in Mr. Birt's pamphlet, which will materially facilitate researches of this kind. We would take this opportunity of urging the British Association Committee to lose no time in providing Mr. Birt with a telescope of suitable dimensions. The small instrument which he is at present using is not half the diameter of that which he ought to have to justify his drawing his contour lines on so large a scale, and can supply no means of testing the observations of difficult objects that may be communicated to him by other observers.

Auvergne: Its Thermo-mineral Springs, Climate, and Scenery. A Salutary Retreat for Invalids. By Robert Cross, M.D., Edin. and Heidel, F.R.C.P., Ed., and M.R.C.S.E., Author of "Physiology of Human Nature. (Hardwicke.)—Geologists have long been familiar with the Auvergne as a district remarkable for its illustration of volcanic action, and for the numerous extinct craters which it contains. A few tourists are likewise familiar with its magnificent scenery, and now comes an accomplished physician to recommend it to the attention of invalids for its baths and medicinal springs. From the analyses of the various waters which Dr. Cross cites, there can be no doubt of the high claims of the district to share with better known localities in the treatment of the swarm of patients who anxiously seek to recruit their health with prescriptions prepared in Nature's pharmaceutical laboratories; and we confess a strong sympathy with the æsthetic sensibilities of those who prefer to be made well in beautiful localities. Rheumatism can rejoice in brimstone, scrofula and cancer can be mollified with arsenic, and weak digestions excited by salines and tonics in this wondrous land of extinct volcanoes, where the subterraneous fires are constantly employed in boiling invisible pots, and effecting combinations which would puzzle the apothecary to imitate, and which we do not doubt possess peculiar efficacy in a host of other ailments. Dr. Cross discourses on these subjects with the tact and moderation of a man of science, and his elegant little volume is embellished by views of the principal places where accommodation for invalids can be obtained. He also supplies a useful body of "guide-book information" in a gentlemanly and scholar-like style. As an illustration of the efficacy of arsenic in the treatment of cancer he mentions the following case which occurred in his own practice, the patient alluded to having suffered from that malady, though the consultation he describes was necessitated by other symptoms, which suggested the idea of arsenical poisoning, and this was confirmed by an examination of the paper of her bed-room recently renovated. Removed to another apartment she recovered slowly from its effects. "Meanwhile the pain, hæmorrhages and fetid discharge of her original complaint had been so completely suspended, that her attention had been entirely directed to her new malady; the arsenical disease had, in fact, superseded the cancerous. As the former, however, subsided, the latter came again into activity; and being now far advanced, very soon afterwards came to a fatal termination." The doctor adds, that he intends to suggest a trial of the Bourboule springs at an earlier stage of a similar complaint. At St. Nectaire the baths are supplied with an apparatus for the employment of carbonic acid douches, "found efficacious in neuralgic affections and muscular rheumatism." Some of the Auvergne springs resemble those of Germany, Royal being like Ems, St. Nectaire like Carlsbad, and many resembling Vichy; Puy la Poix are similar, but more powerful than the sulphur springs of the Pyrenees; but the arsenical water of Bourboule, Dr. Cross considers to be without a rival in their peculiar way.

Symon's Monthly Meteorological Magazine. August, 1867. (Stanford.)—The first article in this number relates to the excessive rainfall of July 26th, which is stated to have been as remarkable as any that has occurred of late years, "Excepting the remarkable case in 1857, when on August 6th a waterspout burst over Scarborough, and the rain-gauge which held nine inches was filled and found running over; and 1864, May 20th, when at West Retford, Notts, 3·10 inches fell in $2\frac{1}{4}$ hours, we can recall no rains more noteworthy than those which have lately fallen." Mr. Symon adds, "the facts appears to show that the heaviest fall was an excessively local one of about five inches, extending along the north side of the North Downs from Farningham nearly to Sittingbourne; Rochester, Chatham, and Strood, being on the northern limit of excessive fall. It was accompanied by a violent thunder-storm, which was most severe between Faversham and Canterbury; thirty-two sheep were killed by lightning near the latter city. About the same hour it was raining very heavily at Deptford and Greenwich, where about four inches of rain fell. Nearly four inches fell at Billericay, in Essex." Mr. Symon's also informs us that nearly twice as much rain fell at Deptford as at Camden Town; and he notes other cases in which the variation was similar between places only a few miles off. Amongst the correspondence to the "Meteorological Magazine," Mr. Blackmore, of Teddington, remarks, that the storm of the 26th was prenotified by the remarkable appearance of the sky on the evening of the 24th, when the south-east sky exhibited "a beautiful fan of blue divergent radii rising 30° above the horizon, streaking across the redness like a windmill with blue sails to it." Mr. Symon says that a friend sent him a sketch of a similar appearance seen in Kentish Town on the 25th.

NOTES AND MEMORANDA.

Verification of Sextants.—It is a disgrace to the mercantile marine that the majority of the sextants with which their captains are supplied, and on which their safe navigation often depends, are of the most worthless description. First-class opticians, of course, supply reliable instruments, but ordinary sextant making has sunk so low as to resemble the worst sort of tailors' slop-work, and the operatives engaged in this wretched business are miserably paid. The British Association Observatory at Kew supplies the means of curing this evil, by testing the instruments, and the apparatus now employed for this purpose, designed and constructed by Mr. F. Cooke, is described in the "Proc. Roy. Soc.," No. 94.

Experiments with the Rigid Spectroscope.—Some time ago, we described the general construction of the rigid spectroscope, made by Mr. Browning for Mr. Gassiot, in order to test a suggestion of Mr. Balfour Stewart, that the position of spectrum lines might be slightly affected by changes in terrestrial attraction consequent on approaching to or receding from the poles. The instrument was sent out in the surveying-ship "Nassau," and Mr. Gassiot has recently communicated to the Royal Society the report of Captain Mayne, together with remarks thereon by Prof. Stokes and Mr. Balfour Stewart. The report says that the micrometric reading increased as the barometer fell, and *vice versa;* it was also affected by temperature. After deducting all other ascertainable sources of change, it seems as if the difference of the earth's attraction between lat. 45° and the equator may change the readings for the yellow of the spectrum to an extent equal to about $\frac{3}{4}$ of the interval of the D lines. Prof. Stokes thinks this slight change may arise from other causes than difference in gravitation; and Mr. Stewart, though regarding it as arising from that source, does not consider the experiments conclusive. Further information is therefore looked for with much interest, as, when stripped from technicalities, the question to be decided is, whether or not light is to be regarded as the vibrations of an imponderable material.

Constitution of Sun and Stars.—Mr. G. J. Stoney has a remarkable paper in "Proc. Roy. Soc.," No. 94, disclosing speculations on this subject, to which he assigns varying degrees of probability. He remarks, that if, as is probable, the sun's atmosphere decreases in temperature from within outwards, the gases with the lightest particles will be uppermost, and the heavier ones lower, and these layers of gases will be of different temperatures, hydrogen being the coldest. Observation, he thinks, confirms this view, "the rays of hydrogen, sodium, and magnesium emanate from a region so cold, that the lines of these elements in the sun's speculum are intensely black;" while "calcium, iron, and the rest, while they produce only black lines in the violet and indigo, give rise to lines which are sensibly less dark in the blue, and to lines which emit a still more considerable light in the green, yellow, orange, and red—those colours in which a body gradually heated begins to glow. Hydrogen and iron are the two most abundant constituents of the sun's outer atmosphere, and play in it the same part which nitrogen and oxygen do in the earth's." The photosphere consists of two strata, the outer one of cloud, that is solid or liquid matter in minute division, and denser than the atmosphere in which it is dispersed. Cooling by radiation, these clouds rain down their materials as our water clouds do theirs. This cooling he believes to give rise to a layer of minimum cloud temperature, the strata above and below being hotter. "About the middle of the hot stratum over the photosphere, outside which the temperature decreases almost continuously to the limit of the iron atmosphere." Outside this, in another stratum, he thinks the temperature falls short of the heat of a Bunsen burner; and outside this again, "through the immense height which is tenanted by sodium, magnesium, and hydrogen alone, the temperature goes on decreasing, till it becomes excessively cold." "Within the luminous clouds the temperature very rapidly waxes, and the density too appears to receive a nearly sudden increase, all gases with a vapour-density more than about eighty times that of hydrogen are imprisoned within the shell of clouds by the comparative chill which there prevails co-operating with the force of gravity exerted by the sun." Applying these theories to the stars, Mr. Stoney observes, that "when gravity on a star is feebler than on the sun, either from the mass of the star being less, or from its being so dilated by heat that its outer parts are further removed from its centre gases, which by reason of the mass of their molecules are imprisoned within the photosphere of the sun, will, when less attracted downwards, be able to stand the coolness of the shell of clouds, and pass beyond them. Thus mercury, antimony, lithium, and bismuth, all of which have too high a vapour density to exist in the sun's outer atmosphere, show themselves in Aldebaran." Stars in which the temperature is lower, or gravitation acts with more force, will attract down dense materials from their outer atmosphere, and constitute the class of intensely white stars with a bluish tinge like α Lyra and Sirius. Hydrogen has so low a molecular mass, that it is thought no star exerts attractive force enough to compel it to limit to temperatures which would make it appear bright when placed upon the background of their photospheres, and hence, where hydrogen appears at all, its spectrum lines are intensely black. To account for the colours of double stars, he supposes that collisions of stars take place, and that the two stars thus meeting, emerge from the frightful conflagration that ensues as one star, or as two, having orbits that would lead to fresh collisions, or passage through each other's atmosphere, in the course of which the weaker, or companion star, would be deprived of its lighter gases, and thus emit only the colours proceeding from denser gases, blue, violet, and green.

The 92nd Planet.—On the 26th July, Dr. Peters, of Hamilton College Observatory, Clinton, U.S., discovered this body, which is of the 11th mag. It has been named Undina.

Roman Surgical Instruments.—M. H. Scoutetten describes to the French Academy a collection of surgical instruments found at Herculaneum and Pompeii. He says three hundred specimens have been collected, representing sixty different forms of instrument. Amongst others, he mentions sounds of excellent curves, and specula with two and three valves. Having obtained permission of the Italian Government, he has had photographs made of the instruments, and also of a fresco, representing a surgeon removing, with a strong pair of pincers, an arrow from the thigh of Æneas. Ascanius stands by weeping; a group of warriors make up the background; and Glory, represented by a female figure holding flowers in her hand, approaches the hero.

Pascal and Newton.—A curious controversy is going on in the French Academy of Sciences, concerning the authenticity of a number of letters, on the strength of which M. Chasles and those who agree with him believe that Pascal communicated to Newton certain ideas which led to the discovery by the latter of the law of universal gravitation. Sir D. Brewster, in a communication to the Academy, pointed out reasons for considering these documents as forgeries. One of them purports to be from Anne Ayscough, the mother of Newton, thanking Pascal for his kindness to her son. At its date Newton was only four years old, and his mother had married again to a Mr. Smith. Pascal is also made to write to Boyle on the 16th of June, 1654, stating that he had received from Newton a treatise on the Infinitesimal Calculus. Newton was at that time only eleven, and, as Sir D. Brewster observes, knew nothing of such matters. It was not till 1661 that he began the studies which made him famous. M. Chasles endeavoured to defend the authenticity of the letters; but M. Faugère, having compared writing known to be that of Pascal with that ascribed to him in this correspondence, corroborates Sir D. Brewster's assertion of forgery. M. Bénard, in a letter to the President of the Academy, asserts that "the documents produced by M. Chasles are certainly fabrications, and clumsy ones." He asks, among other things, how Pascal could, on the 2nd of January, 1655, calculate the mass of Saturn by help of the revolutions of a satellite which was not discovered until the 25th of the month following? The question is referred to a Commission.

Fall of Aerolites in Algiers.—On the 9th of June (1867), about half-past ten p.m., a bright light of a bolide was seen in the plain of Tadjera, by observers at various distances from each other, who also heard sounds like cannon-firing. At Bou Saâda, M. Correard, of the 3rd Tirailleurs, says the bolide appeared about 60° above the horizon, traversed 20° or 25° in from five to eight seconds, directing its course from S.E. to N.E., and ceasing to appear at 40° above the horizon. It looked about three times as big as Venus, and had a luminous train. When it burst, fragments of meteoric matter are said to have fallen, and some pieces were afterwards picked up which were believed to have come from it, as they differed in appearance from other meteoric fragments which have been found, though very rarely, in the same locality.

A Pretty Experiment with Water.—M. J. Plateau says that a cylinder of water may be made to transform itself into isolated spheres by the following means:—Take a cotton thread, about one-thirtieth of an inch in diameter, and about half a yard long; moisten it carefully by rubbing it with water; attach a small weight to one end; hold the other end in the hand, and let it sink straight down in a vessel of water. Then draw it up steadily, and the cylindrical layer of water adhering to it will divide into little globes like a string of pearls. A similar experiment may be made with oil.

SPONGE

Euplectella speciosa

THE INTELLECTUAL OBSERVER.

OCTOBER, 1867.

VENUS' FLOWER-BASKET—EUPLECTELLA SPECIOSA.

BY HENRY J. SLACK, F.G.S., SEC. R.M.S.

(*With a Coloured Plate.*)

The shores of the Phillippine Islands yield the exquisite object which has been well called Venus' Flower-basket, and which is known to science as a *sponge*, to which the name *Euplectella speciosa* has been appropriately given. The ordinary observer, familiar only with the sponges in domestic use, or with somewhat similar structures of branched and finger-like forms frequently found on the beaches of frequented watering-places, will be much surprised at finding the name of *sponge* applied to the elaborate network of the *Euplectella*, which looks like an exceedingly delicate fabric of some such material as biscuit china, and which might readily be taken for a coral, although an investigation of its structure would show that it was entirely different from any polyp formation. Our engraving represents one of the finest of the British Museum specimens, but the following description is chiefly taken from a specimen in the writer's possession, which he was able, at no small risk of its destruction, to examine more carefully than could be effected in any public institution.

The naturalist groups together a number of bodies varying considerably in appearance, in structure, and in material, under the designation *sponge*. Sponges are, however, all alike in certain general characters. They all consist of a living mass of delicate gelatinous fleshy material, called *sarcode*, and of a framework or skeleton, with certain appendages, which is either horny (keratose), calcareous, or silicious. The common toilet sponge belongs to the horny series, and the Venus' Flower-basket is the most exquisite of the silicious.

Whatever may be the form of the sponge skeleton, or of the spicules of various shapes which belong to it, or are embedded in the soft flesh, it is by, and in, that flesh, that they are all produced. In the silicious series, the glossy threads, or spicules, have a very small channel running through them, and they are formed, not in one piece, as a glass-blower spins his so-called hair, but by a series of additions, arranged as concentric layers, each layer being a deposit from the living *sarcode*.

In the *Euplectella* the structure bears, at first sight, an aspect of basket-work, and imagination might picture the young mermaidens varying their legendary occupation of combing their sea-green hair, by employing their finny fingers in weaving together the glittering threads of which it is composed. It is, however, not a product of any mechanical plaiting, but of organic life and growth, and a microscopic examination at once distinguishes it from any structure put together by the intertwisting of separate fibres. To view the *Euplectella* under the microscope without breaking it to pieces requires a good deal of trouble, and a little skill; but it is very advisable to examine it in an uninjured condition, as well as to study details of structure in fragments that may be broken off. From the size of the *Euplectella* it cannot be examined if laid across the stage of Ross's large and fine microscope, as that instrument, so admirable in most other particulars, has not enough rack-room to raise a low-power object-glass to the focussing height above so thick an object. Smith and Beck's pattern is superior in this respect, and in our investigation we employed both. To view the *Euplectella* under the Ross binocular, we rigged up a temporary stage of card under the brass stage of the instrument, and then got on pretty well with three inch, and one and a half inch powers. Further examination was made with a monocular Smith and Beck, the delicate sponge being placed across the stage, and supported by a box at each end.

A good specimen, fully grown, of the Venus' Flower-basket will be rather more than a foot long, and about two inches in diameter at its widest end. It takes, as our plate shows, the curve, and somewhat the form, of a cornucopia. At the base it is covered with a quantity of silicious hairs, part of which the natives have a knack of removing before sending it to Europe. The natural position of this sponge is upright, and it probably grows on a soft sea-bed. At nearly equal distances, say from one-eighth to three-sixteenths of an inch apart, vertical bundles of silicious threads rise from the base, and are continued to the top of the structure, and at right angles to these we observe a series of horizontal rows, crossing the former and giving rise to square meshes of considerable regularity. Slanting fibres cross the corners of these squares, and give a more or less rounded appearance to the central apertures;

while from near the base to the top, elegant frills or furbelows rise at their intervals, composed of interlacing fibres. These frills rise gently from the general surface, and stand out from it to a distance of from one to three-eighths of an inch. They have a general disposition to form diagonals to the square meshes, which they cross in graceful undulations. They are wider at the base than at the top, and no doubt materially strengthen the delicate structure which they adorn. In the writer's specimen they are in two sets, one at right angles to the other, and must be regarded as beautiful instances of decoration, arising out of a construction evidently intended for the useful purpose of increasing the resisting power of an extremely light framework.

The first aspect of the *Euplectella*, under low magnification, leads to the notion that the vertical and horizontal bundles of silicious threads are simple cylinders, more or less closely packed together; but a closer investigation shows that they are more complex. It is common to find two or more, as it were, soldered together, and the external ones, especially, frequently throw out branches and prolongations, which form junctions with other threads far and near. These junctions are sometimes smooth, and at others marked by slight rounded prominences. A thread will often proceed for some distance as a simple cylinder, and then divide, either with a bold furcation, or forming two nearly parallel threads, joined at intervals by cross pieces. Many instances may be observed of little projections from such threads looking at each

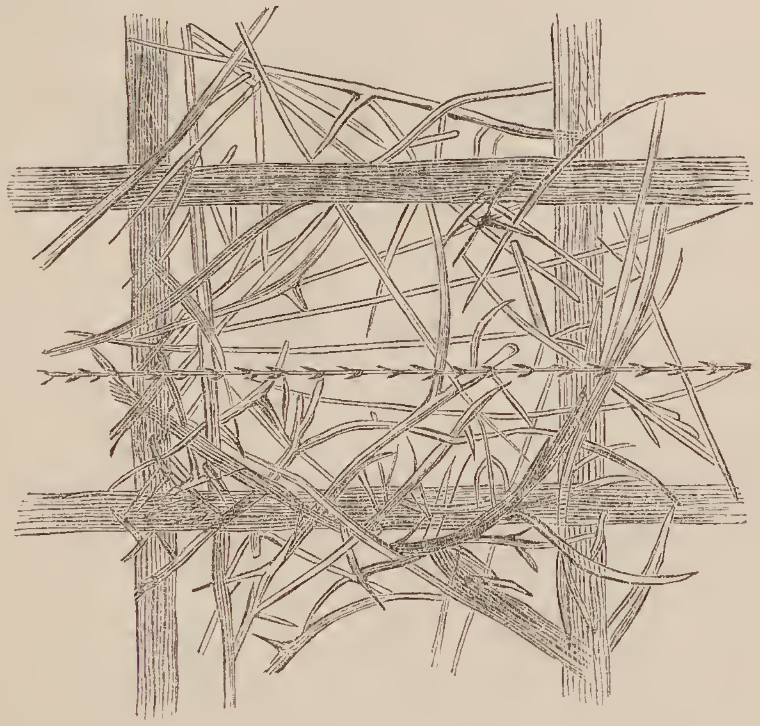


FIG. 1.—Portion of Network of Skeleton of *Euplectella speciosa*, magnified.

other across the narrow gulf, but not quite meeting, as if their growth were arrested or incomplete. The threads that take slanting directions across the corners of the square meshes are much branched and forked, and frequently spicules with cross heads may be seen. There are also numerous jagged threads, not belonging to the main structure, but appended to it, and often terminating in a knot of recurved hooks, like certain walking-sticks cut from thorns. Spicules, of a more elaborate pattern, probably belong to the sarcode, are perhaps more frequent in rough dingy-looking specimens than in those which have been bleached and cleaned.

Fig. 1 (p. 163.) represents a portion of the net-work, reduced one-half from the original drawing, made with a magnification of about 17, and selected to represent the general character of the threads crossing the square meshes. In this sketch the horizontal and vertical threads are depicted as simple cylinders, which appearance they often present under low powers for considerable distances.

Fig. 2 is a reduction from a sketch made under higher magnification (× 40), from a portion that well shows the way in

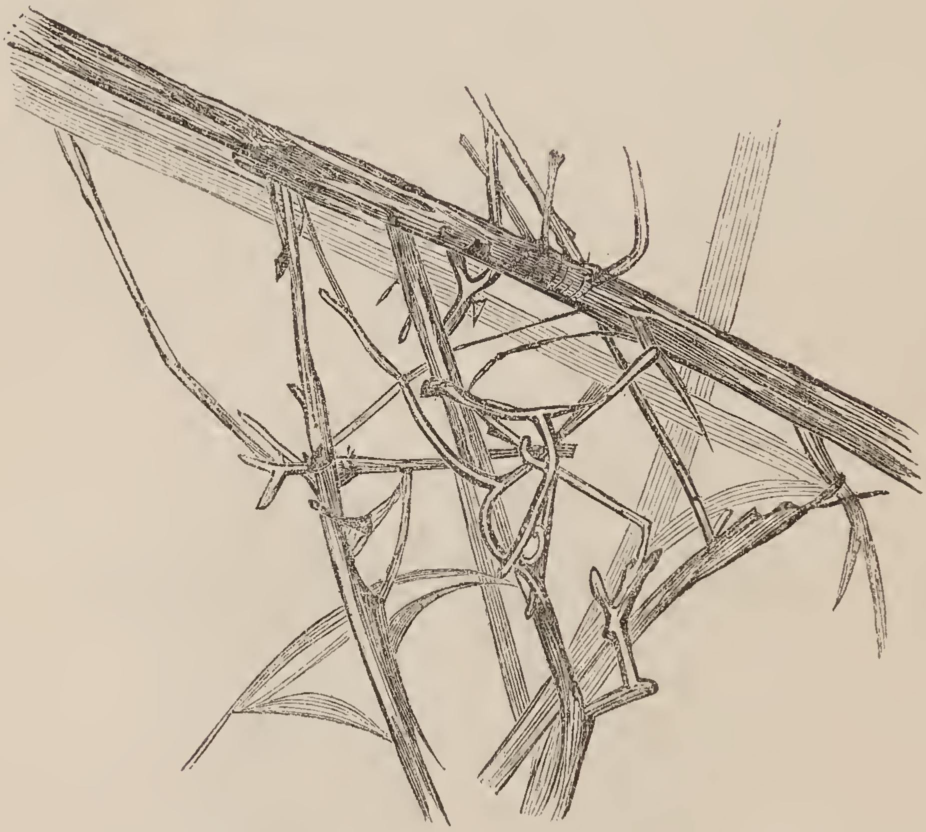


FIG 2.—*Euplectella.*—Magnified portion, showing organic junction of fibre.

which fibres from the main bundles form junctions with fibres springing from other parts.

Fig. 3, reduced one-half from a sketch made with magnification of 17, exhibits the structure of the frills or furbelows.

The top of the *Euplectella* is covered in full-grown specimens, with a network of threads soldered together, and crossing at various angles, making three and four-sided meshes of different sizes.

When single fibres are separated from the *Euplectella*, they are found to possess a considerable degree of elasticity, in this respect resembling spun glass, and they may be bent, to some extent, without breaking. Holding a fibre in a spirit

FIG 3.—Frill or Furbelow of *Euplectella speciosa*, magnified.

lamp causes it to split, and fly to pieces, but if the process is carefully managed, and the burnt portion is examined under the microscope, the character of its formation, by the superposition of concentric fibres will be discovered. Likewise, if a number of ends of broken threads be examined, some will be found to exhibit the aspect of a series of tubes, like the draw tubes of a telescope, one entering into the other.

The production of such an exquisite and complicated framework as the Venus' Flower-basket, by precipitation of silex in a film of sarcode, is, in the highest degree curious and instructive. Probably purely chemical laws of precipitation, under certain conditions, combine with those other laws—whatever they may be—which determine the vital processes of the organization.

The base of my specimen has a rounded form, and is shaggy with the white hair-like fibres, amongst which are entangled a mass of minute shells, foraminifera, mud particles, and sundry spicules; but I have not in the base, or anywhere else, found any of the elegant flower-like four-rayed spicules figured by Dr. Bowerbank, and which probably belong to the sarcode, and have been washed away from mine, and other sponges that have been carefully cleaned, in order to exhibit the beauty of the skeleton in a more perfect way.

Towards the base of the writer's specimen the vertical bundles of fibres separate and form a loose mass, readily capable of holding extraneous matter, and anchoring the entire structure. The fibres at this end are all, or nearly all, more or less jagged, so much so that they feel rough to the touch. In this respect they differ from the smoother fibres of the *Hyalonema*, which do not hackle together or combine in any way, but are like a slightly twisted bundle of glass hairs.

The *Euplectella* was supposed, until lately, to be very rare; but now stories are told of its being frequently found and offered cheaply at Manilla. It is to be hoped that some naturalist on the spot will inquire into its mode of growth, and send us specimens, preserved, as far as possible, in their natural state. When covered with sarcode they might be less beautiful than in the artificially-prepared state in which they usually reach us, but many important particulars can only be ascertained by studying the sponge in that condition. When portions of clean *Euplectella* fibres are under the microscope they shine with a glassy lustre with reflected light, and exhibit the transparency of glass hairs when transmitted light is employed. Spicules, properly so called, do not seem to enter importantly in the construction of the frame-work—at least it would be scarcely correct to give that name to very long fibres which have thorny projections, or to other long fibres united by various silicious processes to similar fibres in their vicinity.

The high refractive power of the silicious threads gives rise to the opaque porcellanous aspect which the *Euplectella* exhibits when seen from a little distance. It is the most elegant of known sponges, and will be the delight of judicious collectors, even though a larger supply of specimens should reduce its price.

DRESS ACCORDING TO STATUTE.

BY FRANCIS W. ROWSELL,

Barrister-at-Law.

To all who desire to paint accurately on the mental retina a historical picture of the past, the study of the dress in which the byegone people clothed themselves, must be as interesting as the study of the buildings in which they lived, or of any other strictly personal thing belonging to them. Without a knowledge of the kind and quality of the clothes worn by our ancestors, any idea we may form of them as units in the everyday, working world, must necessarily be imperfect; we may read of men, of their sayings and doings, of their lives, and of the effect they had upon the lives of those who were coeval with them; but in the absence of means for bringing vividly before our minds the image of their persons, they will be to us as so many lay figures, entities, not persons, wanting those very essentials which alone enable the historian to create before the mind's eye of his readers a word-picture which shall truly and properly describe the men of the old order. For this reason, if for no other, the study of costume cannot fail to be deeply interesting to the historical student. Does not "the apparel oft proclaim the man?" and is not the garb of a people, especially in certain classes, a pretty sure indication of their style and character? But when it is found that, this reason set aside, the article of dress appears again and again in the statute-book as a subject not unworthy the consideration of the legislative wisdom of the country, one feels bound to inquire somewhat closely concerning it, placed as it is on the same level with great questions of finance, religion, trade, and war. As a matter of fact, the article of dress does appear constantly in the statute-book as a subject of legislation, and it is the purpose of the writer of this article to pursue somewhat closely an inquiry into the sartorial question which appears to have exercised our forefathers so severely. In doing so he will be guided solely by the light which the statute-book affords, assisted where that fails by those equally trustworthy records, written for the most part by contemporaneous authors, and now published anew to the world by the Master of the Rolls, after a sleep, in which their existence was endangered, for several centuries in the old libraries of our oldest colleges.

Long before the political economists of the day took notice of the clothes in which men dressed themselves, the clergy had had the subject under their consideration, and had not ceased to inveigh against extravagance of apparel, not so much because it was wasteful, as because it was the child of personal vanity, and as such opposed to the simplicity of the Christian rule of life, and to the direct teaching of Him who compared Solomon in all his glory to the lily of the field, and found him wanting in beauty beside it. Again and again the monkish writers speak earnestly and heartily against the fops of their day, mentioning as a matter of the gravest importance that they wore tunics with deep sleeves, and mantles with long trains, like women; that the peaks of their shoes were of enormous length, stuffed with tow, and twisted into fantastic shapes; that their hair, divided in front, fell down upon their shoulders in ringlets, having also false curls added, to make them look more like women. "Effœmenati" is the title by which the monks call them, and they do not hesitate to attribute to them vices of the most abominable kind. Some allowance should doubtless be made for Saxon monks, who wrote about Norman gallants, and later on, when this national distinction was done away, for the antipathy which the children of light might be supposed to have for the moth-like children of this world; but Norman monks also declaimed against Norman gallants, and the clerical anger, whether found in Norman or Saxon breast, was, beyond all question, genuine; though it sometimes went above the mark, and made itself ridiculous by the extravagant way in which it beat the air. That it was genuine is abundantly proved by many things, and notably by the sermons, poems, speeches, and exhortations of divers kinds, with which the clergy belaboured their flocks at the time the great pestilence, known as the Black Death, swept away more than half the population of England. On this occasion it was many times preached that the sinful wastefulness of men and women in respect of their dress was among the chief offences for which the wrath of God had come upon the land. Giving the go-bye to his wrath because of the bad drainage, the filthy condition of houses, the confined and unwholesome streets, and the other accessories of fever, the clergy fixed upon excess in apparel as being most displeasing to God. Against silk hoods and party-coloured coats, deep sleeves, and narrow waists; against garments which were indecently short, according to the censor's notions of decency; against pointed shoes and bushy beards, the voice of the clergy was loudly raised in notes of entreaty and warning. Women as well as men came in for their share of blame, and bold, unwomanly imitation of men's attire drew forth as eloquent denunciations as the unmanly practice of men who aped the dress of women.

The following passage from the "Eulogium Historiarum"—an anonymous but trustworthy chronicle, not only testifies to the extravagance of dress in the year 1361, in spite of the warning given twelve years before by the Black Death, but mentions the names of some of the garments most affected by the dandies of the period, and gives a very fair description of the dresses commonly worn. The pious, if somewhat narrow-minded, writer finishes his account by expressing a fear "lest the dire punishment of the Lord should follow such wickedness."

"In this and the preceding year the whole people of England went mad in the matter of ornamental dress; firstly, they wore large over-tunics, cut short at the loins; some of these were as long as to the heel, not open in front as becomes men, but distended in pleats about the arms, after the manner of women, so that they who see them from behind must think them to be women rather than men. This garment is called, and rightly, in the vulgar tongue, 'goun,' and well is it so called, for 'goun' is derived from 'gounyg,' which, properly speaking, is 'wounyg,' or 'open shame.' They have also little caps fastened under the chin, buttoned after the manner of women, and having at the top part, in the round, philacteries studded with gold, silver, and precious stones.

"They have also another silken garment, called a 'paltok,' which is rather suitable for a cleric than a layman; yet is it said in the book of Kings that Solomon in all his life never wore such a thing. They also have drawers in two parts, stiffened, which they fasten with braces to their 'paltoks,' and which are called 'harlots.' . . . . They have gold and silver belts, enriched at great cost, the best being of the value of twenty marks; inferior ones, such as esquires and other freemen would wear, at the price of a hundred shillings, or five marks, or even twenty shillings, and all the while the buyers have not twenty pence in their purse."

The writer speaks of those who wear such things as being "idlers and vapourers rather than men, actors than knights, mummers than esquires. At court they are lions, but hares in the field; they are slow to give, swift to take; eager for trifles, but wearied by prayer!"

In the course of time the professors of a political economy, which saw in the impoverishment of the extravagant an injury to the nation at large, justifying its conclusion, perhaps, by the fact that much of the money spent in finery went out of the country, which received nothing valuable in return, and appealing to the experience which taught that an example of prodigality in the upper classes is sure to be followed more or less ruinously through all the minor classes in the community, took notice of excess in apparel, and joined with the professors of religion in condemning those who enlarged the hem of their garments, and carried the price of a county in the clothing that was on their backs.

In the fifteenth year of Edward III., there was, as we learn from the "Brute Chronicle" (attributed to Douglas of Glastonbury), a great rage for dress, and the fashions of the same :—"And in this tyme englisshe men so myche haunted and cleved to y^e^ woodness and foly of y^e^ straungers, y^t^ yey ordeyned and chaunged hem every yeer diverse shappes and desgisynges of clothyng." This is only the record, simple and terse, of what had been taught and preached against for many years previously, and is the straw showing which way the wind blew when the statute, passed towards the end of Edward's reign was framed. By the thirty-seventh year of Edward III. the Parliament, or grand council, that governed the land, was ready to consider a project which should have the effect of checking the extravagance of the people in the matter of dress, and in that year accordingly, they agreed to a law which they fondly hoped would have that effect. They saw the money which fops spent—the money which might possibly be their own, to do as they liked with, or which it might be, was wrung "from the hard hands of peasants by indirection," going steadily out of the country, and they saw the youth and promise of the land "rot inwardly, and foul contagion spread;" they saw no prospect of manufactories, worked by native industry, rising in the land, nor did the habit and custom of the age suggest a policy which would give birth to such manufactures. Perhaps, too, in an assembly composed of those who, for the most part, were fine birds without needing fine feathers to make them so, the fact of extravagance in plumage was so senseless, and withal so serious, observable as it was, not only in the upper, but in the inferior classes also, that *ipso facto,* they were resolved to put a legislative curb upon it. Accordingly we find an Act passed in 1363—the Act 37 Edward III., c. 8, to restrain "the outrageous and excessive apparel of divers people, against their estate and degree," which is the first of the series of sumptuary laws, if we except a law made in the eleventh year of Edward III., by which the use of fur was prohibited to all persons, except the King, the Royal family, and those who possessed £100 a year derived from land.

The passage already quoted from the "Eulogium Historiarum" throws some light on the circumstances under which the Act was passed. The following are the principal provisions of the statute, with its brief preamble :—

"1. For the outrageous and excessive apparel of divers people, against their estate and degree, to the great destruction and impoverishment of all the land: it is ordained that grooms, as well servants of lords as they of mysteries and artificers, shall . . . . have clothes for their vesture or hosing whereof the whole cloth shall not exceed two marks (26*s.* 8*d.*), and that they wear no cloth of higher price, of their buying nor otherwise, nor nothing of gold, nor of silver embroidered, aimeled, nor of silk, nor nothing pertaining to the said things; and their wives, daughters, and children of the same condition in their clothing and apparel, and they shall wear no veile, ne kerchief, passing twelve pence a veile.

2. People of handicraft and yeomen are not to wear cloth of more than forty shillings the whole of it, 'by way of buying nor otherwise,' nor may they wear precious stones, 'nor cloth of silk nor of silver, nor girdle, knyf harnessed, ring, garter, nor owche, ribband, chains, nor no such other things of gold nor of silver,' nor any embroidered work or silk. The wives and children of such persons to be liable to same restrictions, it being also expressly forbidden them to wear a kerchief of silk, or of anything but '*yarn made within the realm*, nor no manner of furr, nor of budge, but only lamb, coney, cat, and fox.'

3. Esquires, and all gentlemen under the estate of a knight, and not having land or rent of the value of £100 a year, were to wear suits costing no more than 4½ marks (£3). They were not to wear any 'cloth of gold, nor silk, nor silver, nor no manner of clothing embroidered, ring, broche, nor owche of gold;' they were to use 'nothing of stone, nor no manner of fur.' The wives and daughters of these gentlemen were under similar restraint, an injunction being added against their having 'any turning-up or purfle.' But esquires having two hundred marks a year and upwards in land or rent might 'take and wear clothes of the price of five marks (£3 6s. 8d.), the whole cloth, and cloth of silk and of silver, ribband, girdle, and other apparel reasonably garnished of silver. Their wives and children might also wear 'furr turned up of miniver, without ermine or letuse,' but they might not wear any precious stones, except upon their heads.

4. Merchants, citizens, and burgesses, artificers, people of handicraft, as well within the City of London as elsewhere, having goods and chattels to the value of £500, they, their wives and children might dress as esquires, etc., and their belongings, who had 'land to rent to the value of £100 by the year;' and those who had goods and chattels to the value of £1000 might dress as esquires and gentlemen who had rent in land to the extent of £200 a year.

5. Knights who had land or rent within the value of £200

by the year (?) might wear six-mark cloth, but 'of none higher price.' They might not wear cloth of gold, nor cloak, mantle, or goun that was 'furred with miniver,' nor sleeves of ermine, nor anything that was set with precious stones, excepting the head-dress; they were not to use any 'turning up of ermines, nor of letuses, ne clieres.' All knights and ladies having land or rent exceeding the value of 400 marks by the year, and not more than £1000 a year, might wear what they liked, except ermine and letuse, and apparel adorned with pearls and precious stones, though they might wear jewels in their head-dresses.

6. All clerks whose degree in college or church, and the clerks of the king whose position required the use of fur, might do according to the constitution of their society. All other clerks having 200 marks a year out of land might do as knights having the same rent; and clerks having less than this amount from rent were to be subject to the same restriction as esquires with £100 a year of rent. It was also provided that 'all knights and clerks who by this ordinance may wear furr in winter, shall wear lawn in summer.'

7. Carters, ploughmen, drivers of the plough, oxherds, cowherds, shepherds, deyars (dairymen) and swineherds, and all other keepers of beasts, threshers of corn, and all manner of people of the estate of a groom attending to husbandry, and all other people that had not forty shillings of goods, "shall not take nor wear no manner of cloth, but blanket and russet (wool) of twelve pence; and shall wear the girdles of linen according to their estate; *and that they come to eat and drink in the manner as pertaineth to them, and not excessively.*"

The penalty provided as the sanction to this elaborate law was forfeiture to the king of all the apparel worn "against the form of this ordinance."

There seems to be some doubt whether this statute was not repealed the year after it was passed, though Hawkins and several other editors of the statutes are of opinion that it was not repealed till the 24 Hen. VIII., c. 13, and finally and completely by 1 Jac. I., c. 25. There is certainly in the words of the short second chapter of the first statute passed in 38 Edward III. something more than a suggestion that the law of the previous parliament was meant to be repealed, but the meaning is not clear, and the wording being very ambiguous, any conclusion arrived at from it must be very far from satisfactory. The preamble to the first sumptuary law of Edward IV., which is given further on, would lead one to suppose that Edward III.'s statute had not been repealed, but had only been inoperative because it had not been put in action.

That a law of the kind should have been inoperative cannot be a matter of surprise to us moderns, who not only have the light of experience to teach us the futility of such laws, but who approach the subjects of them in a spirit altogether different from that which possessed our ancestors. They, however, were perfectly honest in their wish to stop the waste of unproductive spending, and they believed the measure they agreed to would attain for them their wish. Very short experience served to convince them, that whatever law might put an end to waste and prodigality in dress, the law they had made would not do so. The statute was evaded, was set at naught openly, those who should have been most jealous to guard it in its integrity setting the example of driving right through it. The undefined sanction of the law, and the want of proper machinery with which to work it, might have done something towards making the statute a dead letter, but the primary cause of the disregard with which it was treated was to be found in that peacock vanity of human nature which loves to see itself in gay clothing, and in motley wear to "play fantastic tricks before high heaven."

Within twenty years after the passing of the statute, at a time, certainly, when the sun of Edward III. was about to set, and that of a gay, glitter-loving prince was about to rise, we find that excessive richness in clothing and appointments, and the vagaries of the fashions, again attracted the attention of writers and public men, who, both cleric and lay, including Chaucer, inveigh most strongly against them. A curious poem, written in alternate lines of English and Latin, upon the corruptions of the times, by an unknown author, mentions many of the extravagancies of the period. Dandies wore stuffing on their shoulders to make them look broader than they were made by God. They wore high and wide collars, which made their necks look as if ready for the axe; and the long spurs on their heels, and the long pointed shoes stuffed beyond the toes, and fastened by little silver chains to the knees, prevented them from kneeling at prayer time. They could not bend their knees but with difficulty; when other men knelt, offering prayers to Christ, these stood at their heels, not able to bend their legs. They avoided bending, lest they should damage their hose. Here is a specimen of the ballad, and the passage of it from which the above information is gathered :—

> "Bredder than ever God made,
> *humeri sunt arte tumentes;*
> Narowe they be, they seme brode,
> *vana sunt hoc facite, gentes.*
> They bere a newe fascion
> *humeris in pectore tergo;*

Goddes plasmacion
non illis complacet ergo.
Wyde coleres and haye
ei gladio sunt colla parata;
Ware ye the prophecye
contra tales recitata.
Long sporys on her helys,
et rostra fovent ocrearum.
* * * *
Qwen oder men knelys,
pia Christo vota ferentes,
Thei stond at here helys,
sua non curvare valentes.
For hortyng of here hosyn,
non inclinare laborant;
I trowe, for here long toos
dum stant ferialiter orant."

Other writers mention, in language equally strong, the shortcomings and excesses of gallants' clothing at this time. The author of the poem on the deposition of Richard II., in the first volume of the "Political Songs and Poems" (published by the Master of the Rolls), thus speaks of the unscrupulous thriftlessness and folly of the courtiers of that prince. He says they beg and borrow

"of burgeis in tounes
ffuris of ffoyne
and other ffelle (skin) whare,
and not the better of a bean
thouz they boru evere.
And but if the slevis
slide on the erthe
thei wolle be wroth as the wynde,
and warie hem that it made;
and zif it were elbowis
adoun to the helis,
or passinge the knee,
it was not accounted;
and if Pernelle preisid
the plytis bihynde (the pleats behind)
the costis were accountid,
paye whan he myzth.
* * * *
and if Ffelice ffonde
ony ffaute thenne of the makynge
yt was ysent sone
to shape of the newe."

The writer also speaks of "a wondir coriouse crafte" lately introduced, whereby the cloth was slashed "alle to pecis," so that seven good sewers could not in six weeks sew up all the seams if they tried.

Chaucer, writing De Superbiâ, in the "Persone's Tale," written about the year 1392–3, says, "Seint Gregoire saith that precious clothing is coupable for derthe of it, and for his schortnes, and for his straungeness and disgisines, and for the superfluite, or for the inordinat skantnes of it; allas! many man may sen as in oure dayes, the synful costlewe array of clothing, and namely in to moche superfluite, or elles in to disordinat skantnes.

"As to the firste synne in superfluité of clothing, which that makid is so dere, to harm of the poeple, not oonly the cost of embrowding, the guyse endentyng or barring, swandyng, palyng, or bendying, and semblable wast of cloth in vanité; and ther is also costlewe furring in here gounes, so mochil pounsying of chiseles to make holes, so moche diggyng of scheirs, for with the superfluité in lengthe of the foresaide gounes, traylinge in the donge and in the myre, on hors and eek on foote, as wel of man as of womman, that al thilbe trayling is verraily (as in effect) wasted, consumed, thredbare, and rotyn with donge, rather than it is geven to the pore, to gret damage of the forsaide pore folk, and that in sondry wise. . . . . To speke of the horrible disordinat scantnes of clothing as ben these cuttid sloppis or anslets, that thurgh her schortnes ne covereth not the schamful membre of man, to wicked intent."

It seems that the tightly-fitting dress was considered to be very wicked; the same was thought of a practice in vogue, by which the clothing of the body was party-coloured, being half of it red and the other blue, or of any other colours. The "Persone" is not less severe with women than with men: "Now, as of the outrageous array of wommen, God wot, that though the visage of some of hem seme ful chaste and debonaire, yit notifye they in here array of attyre, licorousnesse and pride."

An anonymous writer on the corruption of public manners in the reign of Henry VI., begins his poem by an address to

"Ye prowd galonttes hertlesse,
With your hyghe cappis witlesse,
And your schort gounys thriftlesse,
Have brought this londe in gret hevynesse.

"With youe longe peked schone,
Therefir your thrifte is almost don,
And with your long here into your eyen (eyes),
Han brought this land to gret pyne."

Though these attacks were made from time to time on the extravagance and folly of the day, no legislative action was taken for a hundred years after the passing of the first sumptuary law. From the pulpit the clergy denounced those habits which they believed would call down the wrath of God upon the land, and less extensively, by means of written books, they warned the people; but the law already in the statute-book being inoperative, no fresh law was enacted, embracing the whole subject of dress, till the third year of Edward IV. After the troubles in Richard the Second's reign, an act was passed, forbidding husbandmen and labourers to wear sword, buckler, or dagger, but this was not so much in restraint of extravagance as a police regulation, being tantamount to an order for the disarming of those who had lately been so troublesome and formidable. A statute of the 20 Richard II. also particularized those who only might wear another's livery, but this too was rather meant to put a stop to those Capulet and Montagu faction disturbances, which were so rife among the followers of the English noblemen.

The 3 Edward IV., c. 5, recites, "Item prayen the Commons in the said Parliament assembled to our said sovereign lord the king to reduce to his gracious remembrance that in the time of his noble progenitors divers ordinances and statutes were made in this realm of England for the apparel and array of the Commons of the said realm, as well of men as of women, so that none of them ought to use nor wear any inordinate and excessive apparel, but only according to their degrees, which statutes and ordinances notwithstanding, for default of punishment and putting them in due execution, the Commons of the said realm, as well men as women, have worn and daily do wear excessive and inordinate array and apparel, *to the great displeasure of God and impoverishing of this realm of England, and to the enriching of other strange realms and countries to the final destruction of the husbandry of the said realm.*" It is then ordered that no knight under the degree of a lord, nor his wife or child, shall "wear any manner cloth of gold, or any courses wrought with gold, or any furr of sables," under a penalty of £20. No knight bachelor, nor his wife, to wear "cloth of velvet upon velvet," except such knights as be of the Order of the Garter; and none but a lord to wear purple silk, under a penalty of £10.

2. No esquire or gentleman under the degree of a knight to wear any "velvet, satin branched, nor any counterfeit cloth of silk resembling to the same, or any courses wrought like to velvet or to satin branched, or any furr of ermine."

3. No man having less than £40 a year to wear any "furr of martrons (Funes), letuse [pure gray or pure myniver]."

4. No widow having less than £40 a year to wear any "coverchief whereof the price of a plite shall exceed the sum of iij shillings, four pence."

5. Persons with less than forty shillings a year were not to wear any "fustian, bustian, nor fustian of Naples, scarlet cloth in grain, nor no furr, but black or white lamb." Yeomen were

forbidden to use "any bolsters or stuffing of wool, cotton, or cadas, or any stuffing in his doublet, but only lining according to the same." Servants also were not to wear cloth which cost more than "two shillings the broad yard."

6. "And because that coverchiefs daily brought into the realm do induce great charge and cost in the same, and in effect in waste," it is forbidden to sell within the kingdom "any laun, niefles, umple, or any other manner of coverchiefs whereof the plite shall exceed ten shillings."

In order to promote the use of a dress which should be in the popular opinion more decent, and which should not involve the objections pointed out by the critics in "The Persone's Tale," and in the various political poems that have been quoted, at the same time that perfect liberty to do as they liked was reserved to the persons most likely to offend, it was ordered by this statute that no person under the degree of a lord should wear any goun, jacket, or cloak, "unless it be of such length that the same may cover his privy members and buttocks," nor wear "any shoes or boots having pikes passing the length of two inches."

In the year 1482 the previous sumptuary laws were repealed, and the 3 Edward IV., c. 5 was re-enacted with greater stringency, the reason given in the preamble being that, through excess and wastefulness of apparel, the "said realm was fallen into great misery and poverty, and like to fall into more greater, unless the remedy therefor be sooner."

It is needless to adduce the evidence of writers and chroniclers of the time to show that male and female vanity managed to evade the law, though it were never so stringent. There was a difficulty about bringing the delinquents *coram judice*, none but the ill-natured, or the pedantic, or the crotchety, would inform against them, and magistrates, unless they were of the same kidney with the prosecutors, would be slow to punish what was, after all, but the harmless expression of a vanity that was shared by judge and prisoner alike. As a matter of fact, the law was continuously disregarded, as in the nature of things it must have been; and though Empson and Dudley doubtless drew some of the fines, with which they enriched their master's treasury, out of the pockets of the dandified, and those who got themselves up regardless of cost—following the example set them by their master in the case of the Earl of Oxford and his liveries—the administrators of the law generally winked at the struttings of the jays who decked themselves in peacock's feathers.

Henry the Eighth, however, in the first year of his reign, tried his hand at a statute which was meant to carry out the objects attempted in vain by the acts of his predecessors, and his doing so was quite in keeping with the rest of his domestic policy, which strove to give him a power and domination that should be felt in every relation, no matter how trifling or how personal. 1 Henry VIII., c. 14, "An Act agaynst wearing of costly apparell," forbad any but the king and his family to wear cloth of gold, of purple colour, or of silk of the same. None less than a duke might wear any cloth of gold of tissue; none less than an earl might wear sables; and none less than a baron might wear cloth of gold or silver, or "tynsen satten," or silk or cloth mixed or embroidered with gold or silver. None less than a lord or knight of the garter might wear woollen cloth made out of the kingdom, or wear any velvet of "the colour of crymesyn or blewe;" none less than a knight (excepting some of the royal servants and the judges) might wear velvets and furs; "nor no person (might) use or wear satten or damaske in their doblett, nor sylke or chamlett in their gowens or cootes, not having for life £20 a year in lands;" no one "under the degree of a gentleman" might wear "foreign fur"; no servant was to be dressed in cloth that cost more than twenty pence a yard. Knights only might wear "guarded and pinched (pleated) shirts of linen cloth." Servants in husbandry were not to have cloth of which the piece was more than ten pence a yard. This statute was not to apply to women, ambassadors, heralds, players in interludes, nor to soldiers.

In the sixth year of Henry another and more stringent law was passed, which, having been found insufficient, was repealed, and re-enacted more thoroughly in the following year. The preamble of this statute recites, that "Forasmuch as the grette and costly array and apparel used within this realm contrary to good statutes thereof made, hath been the occasion of great impoverishing of divers of the king's subjects, and provoked divers of them to rob and to do extortion, and other unlawful deeds, to maintain thereby their costly array." In the 24 Henry VIII., another sumptuary law was passed, by which the costume of everybody was regulated, as it was supposed, definitely; and it did suffice, as far as any law could suffice, till the reign of Philip and Mary, in the first year of whose reign was passed "An Acte for the Reformãcon of Excesse in Apparaile," by which the restraints on dress were made less comprehensive, though imprisonment was added to fine as a means of enforcing compliance with such orders as were retained. There was also a clause not unworthy the sex of the sovereign who assented to the law:—"Provided also that women maye weare in their cappes, hattes, gyrdells, and hoodes as they or any of them might use and weare lawfully before the making of this Act." An Act of Elizabeth, intended, it is imagined, to check unthrift, declared that any one who sold foreign apparel to persons having less than £3000 a year in land or fees, except for ready money, should lose the price of the same, no matter how it might have been secured.

By the 13 Eliz., c. 19, the last of the sumptuary laws, it would seem that though caps had been at one time a general article of attire, they had gone greatly out of fashion, causing thereby a grievous falling off in the cap-making business. This business seems to have been powerful enough to procure, as did the button-makers at a later date, special legislation in its favour. The above-named Act recites the evils that have arisen from the decay of the cap-making trade by the disuse of caps, and requires that every one above six years of age, except ladies, peers, and those who have twenty marks a year out of land, or who have "borne any office of worship in any city, borough, town, hamlet, or shire," shall wear "upon the Sabothe and Holy Daye . . . one cappe of woll knytt, thicked, and dressed in England," or be fined three shillings and four pence a day. This act was, however, repealed in the thirty-ninth year of the queen.

These various laws regulating the kind and quality of the apparel which men of all sorts and their belongings might wear, continued to be in existence, if not in operation, till the advent of James the First to the throne. By the 1 James I., c. 25, they were repealed, and folks were left to follow the bent of their own fancy, being bounded only by the same restraints as kept them from entering into any other extravagance. Not any attempt has since been made to revive sumptuary laws, though so late as the seventh year of George I. an Act was passed "to preserve and encourage the woollen and silk manufactures of this kingdom, and for more effectually employing the poor by prohibiting the use and wear of all printed, painted, stained, or dyed callicoes in apparel or household stuff, furniture or otherwise," excepting only "such callicoes as shall be dyed all blue." In the same session was passed the famous Act which prohibited the use of any buttons made of cloth, serge, or other stuffs, the object being to keep up the monopoly which workers in silk and mohair had established.

THE GRAVE-MOUNDS OF DERBYSHIRE, AND THEIR CONTENTS.

BY LLEWELLYNN JEWITT, F.S.A., ETC., ETC.

The ancient grave-mounds of Derbyshire lie, for the most part, scattered over the wild, mountainous, and beautiful district known as the High Peak—a district occupying nearly one-half of the county, and containing within its limits many towns, villages, and other places of extreme interest. It it true that here and there a grave-mound exists in the southern or low-land portion of the county, but, as a rule, they may be almost said to be peculiar, and confined, to the northern, or hilly, district, where in some parts they are very abundant. Indeed, there are districts where there is scarcely a hill, even in that land where,

> "Hills upon hills,
> Mountains on mountains rise,"

where a barrow does not exist or is not known to have existed. In passing along the old high road, for instance, over Middleton Moor by way of Arbor-Low,* Parcelly Hay, High Needham, Earl Sterndale, and Brier-Low, to Buxton, or along the high roads by way of Winster, Hartington or Newhaven, the practised eye has no difficulty in resting on the forms of grave-mounds on the summits of the different hills or mountains whose outlines stand out clear and distinct against the sky.

The situations chosen for the burial of the dead by the early inhabitants of Derbyshire were, in many instances, grand in the extreme. Formed on the tops of the highest hills, or on lower but equally imposing positions, the grave-mounds commanded a glorious prospect of hill and dale, wood and water, rock and meadow, of many miles in extent, on every side, stretching out as far as the eye could reach, while they themselves could be seen from afar off in every direction by the tribes who had raised them, while engaged either in hunting or in their other pursuits.

In Derbyshire the grave-mounds are called "Lows" or "Barrows;" *Low* being so very usual a term in the district that wherever met with, it may be taken as a sure indication of a barrow now existing or having once existed at the spot. As a proof of this, it will only be necessary to say that at about two hundred places in Derbyshire alone, and at about half that

* Of this stone circle, the next in importance to Stonehenge, an account will be given in a future number.

number on the neighbouring borders of the adjoining county, Staffordshire, which bear the affix of *Low,* barrows have already been opened, or are known to exist. For my present purpose, the names of Arbor-Low, Kens-Low, Ringham-Low, Blake-Low, Fox-Low, Gib-Low, Green-Low, Great-Low, Grind-Low, Cal-Low, Chelmorton-Low, Casking-Low, Larks-Low, Thirkel-Low, Ribden-Low, Har-Low, Bas-low, High-Low, Foo-Low, Lean-Low, Huck-Low, Borther-Low, Dow-Low, Totman's-Low, Staden-Low, and Stan-Low, will be quite sufficient to give as illustrative examples. To some of these I shall again have occasion to refer.

The grave-mounds of the district of which I am speaking may, naturally, be divided into the three great periods; the Celtic, the Romano-British, and the Anglo-Saxon. Of these by far the greatest number are Celtic, whilst the least number are Romano-British. It is my intention to divide my subject into these three periods, and, while speaking of the characteristics of each, to classify and describe the contents of the barrows and to point out, briefly, such circumstances of interment, and such evidences of customs, which they may present and which may appear to be of sufficient interest and importance for my purpose.

THE CELTIC PERIOD.

The barrows of the Celtic, or ancient British period vary in their form and size as much as they do in their modes of construction, and in their contents. Sometimes they are simply mounds of earth raised over the interment; sometimes heaps of stones piled up over the body; and sometimes again a combination of cist, and earth, and stone. Generally speaking, the mounds are circular, rising gradually and gently from the level of the ground towards the centre, but in some instances the rise is somewhat acute. Now and then they are oval in form. Where elliptical barrows occur (generally known as "long barrows") they are, I have reason to believe, not matters of original design, but of accident, through additional interments; and I much doubt the propriety of archæologists at the present day, continuing the very questionable nomenclature adopted by Sir R. C. Hoare and others. An examination of a very large number of barrows leads me to the opinion that the original form of all was circular, and that no deviation from that form, and no difference in section, can be taken as indicative of period or of race.

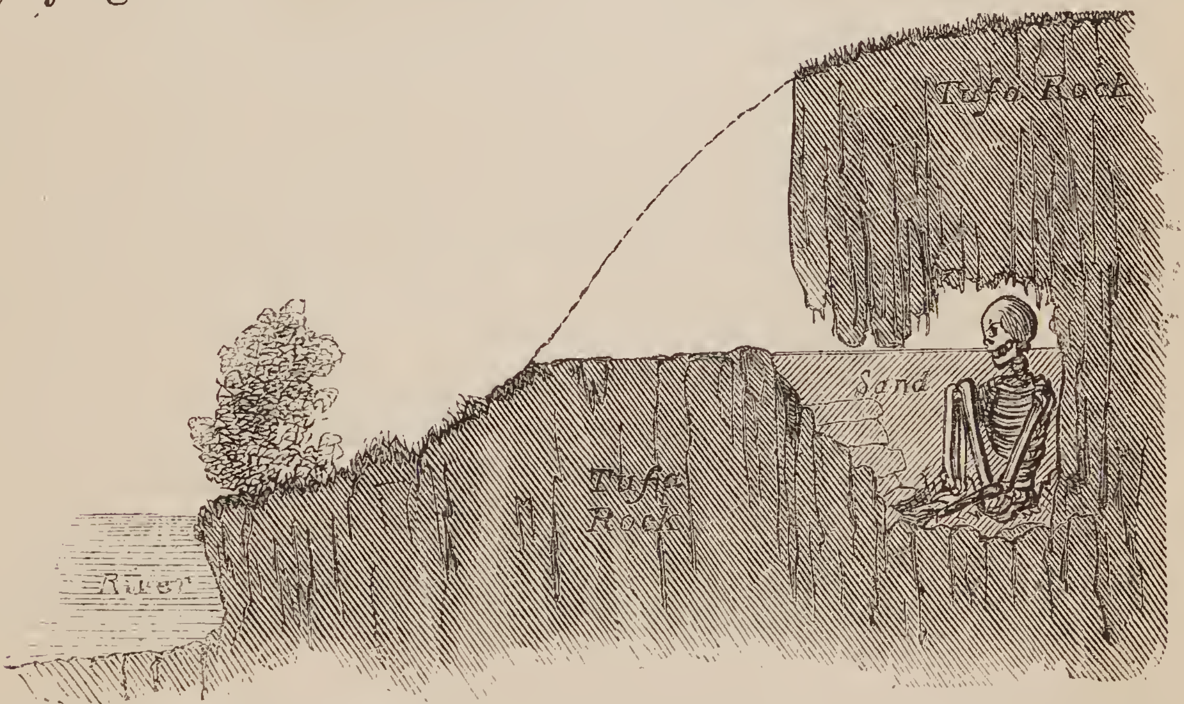
The Celtic barrows of Derbyshire contain interments both by inhumation and cremation, and the modes of interment vary very considerably. Where interment has been by inhumation, the body is mostly found in a contracted position on its side, (more commonly the left than the right side); the knees drawn up near to the chest, and the heels to the thighs; the elbows near the knees and the hands in front of the face; the head inclining somewhat forward. This position, which, as I have said, is the most usual one, will be best understood by reference to the accompanying engraving, which shows an interment found in a barrow on Smerril Moor, opened by my much

lamented friend the late Mr. Thomas Bateman. In this case, the body had been laid in an irregularly formed cavity on the surface of the natural rock, on a bed of clay, over which, as usual, the mound was formed of loose stones, and mould. Behind the skeleton, as will be seen in the engraving, was found a remarkably fine "drinking cup," along with other articles, about which I shall have occasion to speak.

Occasionally the body lies at full length, but this is quite the exception to the rule. In one or two instances in Derbyshire, as in Guernsey, the skeleton has been found in a contracted upright position in the stone cist of a barrow. This position will be seen in the annexed engraving which accurately represents the section of the barrow when the superincumbent earth and stones had been removed.

This barrow was situated at Parcelly Hay. The body had been placed in a small oval excavation in the solid rock, about three feet in depth and the same in its longest dimension. This cist had been loosely covered with large flat stones over which the mound had been raised. Above this, which was the

primary interment of the barrow, another interment, with the body lying in the usual contracted position on its left side, had



been made. (Of this barrow an excellent account is given in "Crania Britannica.")

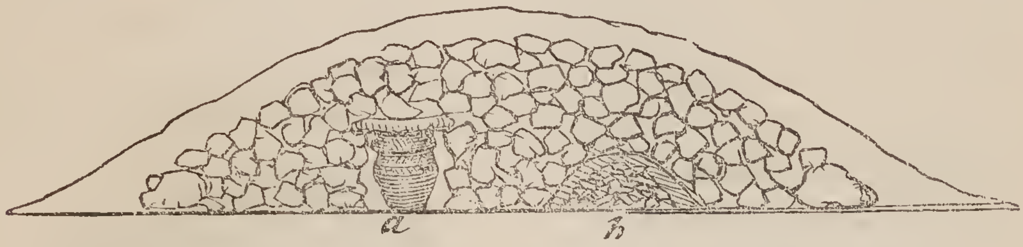
Another excellent example of this very unusual mode of interment was discovered by some tufa-getters, and examined by Mr. Bateman, in Monsal Dale, and is shown on the preceding engraving, which exhibits a section of the rock, etc.; and shows the position of the skeleton, and the manner in which the cavity containing the body had been filled up with the river sand. The body in this case as in the last, had been placed in the cavity in a sitting position, and must have been so placed from an opening in front. The cavity was ten or twelve feet above the bed of the river Wye, and above it were some five feet in thickness of solid tufa rock, while, from the face of the rock, the cavity was about twelve feet. The body may therefore be said to have been entombed in the middle of the solid rock. The roof of the cavity when found was beautifully covered with stalactites. The skeleton was that of a young person, and near it was found a flint and some other matters. The cavity was filled to part way up the skull with sand.

When the interment has been by CREMATION, the remains of the burnt bones, etc., have been collected together and placed either in a small heap, or in a cinerary urn, which is sometimes found in an upright position, its mouth covered with a flat stone, and at others inverted over a flat stone or on the natural surface of the rock. This position, with the mouth downwards, is, perhaps, the most usual of the two. The place where the burning of the body has taken place is generally tolerably close to the spot on which the urn rests, or on which the heap of burnt bones has been piled up. Wherever the burning has taken place there is evidence of an immense amount of heat being used; the soil, for some distance below the surface being in many places burned to a redness almost like brick. Remains of charcoal, the refuse of the funeral pyre, are very abundant, and in some instances I have found the lead ore, which occurs in veins in the limestone formation so completely smelted with the heat that it has run into the crevices among the soil and loose stones, and looks, when dug out, precisely like straggling roots of trees.

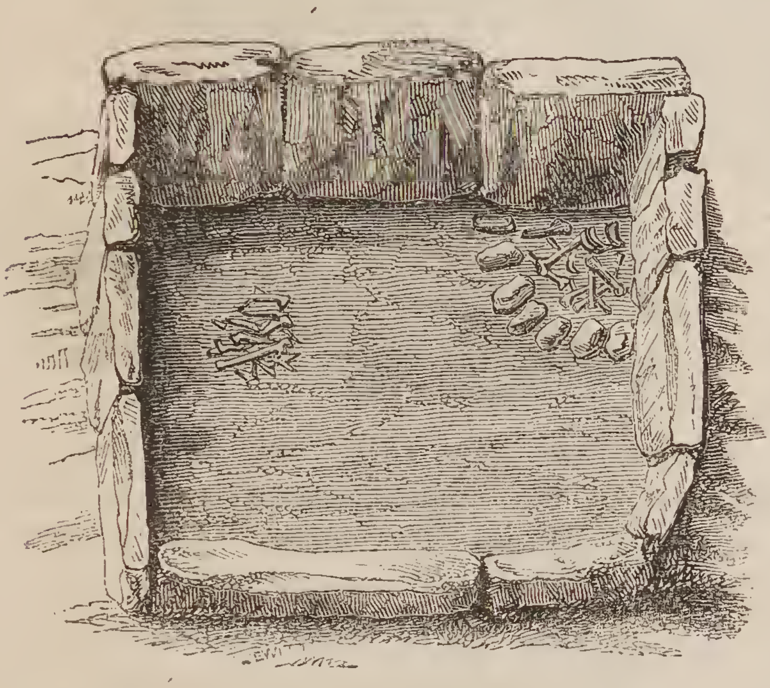
Is it too much to suppose that the discovery of lead may be traced to the funeral pyre of our early forefathers? I think it not improbable that, finding the liquid metal ran from the fire as the ore which lay about became accidentally smelted, would give the people their first insight into the art of making lead—an art which we know was practised early in Derbyshire and other districts of this kingdom.*

* Lead mines there are in Derbyshire worked at the present day which were worked, at all events, in the Romano-British period. Roman coins, fibula, and other remains are occasionally found in them.

To resume. The positions I have spoken of in which the cinerary urns and heaps of burnt bones have been usually found, will be best understood by the accompanying engravings. The first represents a section of a barrow in which, at

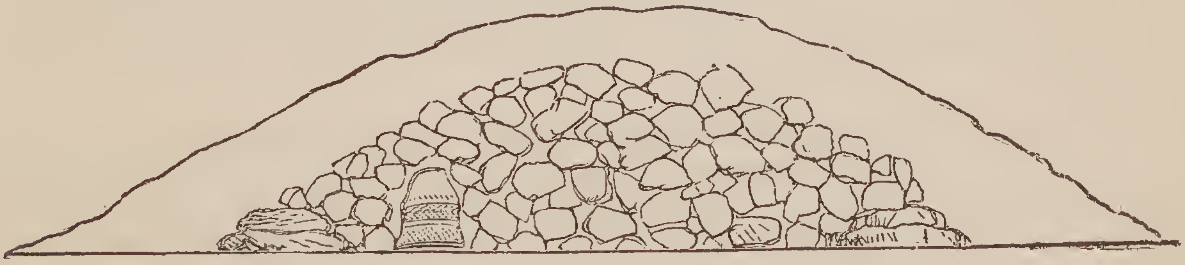


a, is shown a sepulchral urn in an upright position, capped with a flat stone; and at *b* a heap of burnt bones piled up in the usual fashion, and first covered with earth and then with the loose stones of which the whole barrow was composed.



The next engraving again, shows, within a cist, in a barrow on Baslow Moor called "Hob Hurst's House," two heaps of bones, the one simply collected together in a small heap, and the other guarded with a row of small sandstone "boulders," all of which had been subjected to fire.

The next illustration gives a section of the Flax Dale barrow at Middleton by Youlgreave, which shows the inverted position of the sepulchral urn. This barrow was formed on a plan commonly adopted by the ancient Britons, and will therefore serve as an example of mode of construction as well of the inverted position of the urn. A circle of large rough stones was laid on the surface of the ground, marking the extent of the proposed mound. Within this, the inter-



ments, whether in an urn or not, were placed, and the mound was then raised of stones to the required height, and afterwards covered to some thickness with earth, and thus the outer circle of the barrow was considerably extended, as will be seen by the engraving.

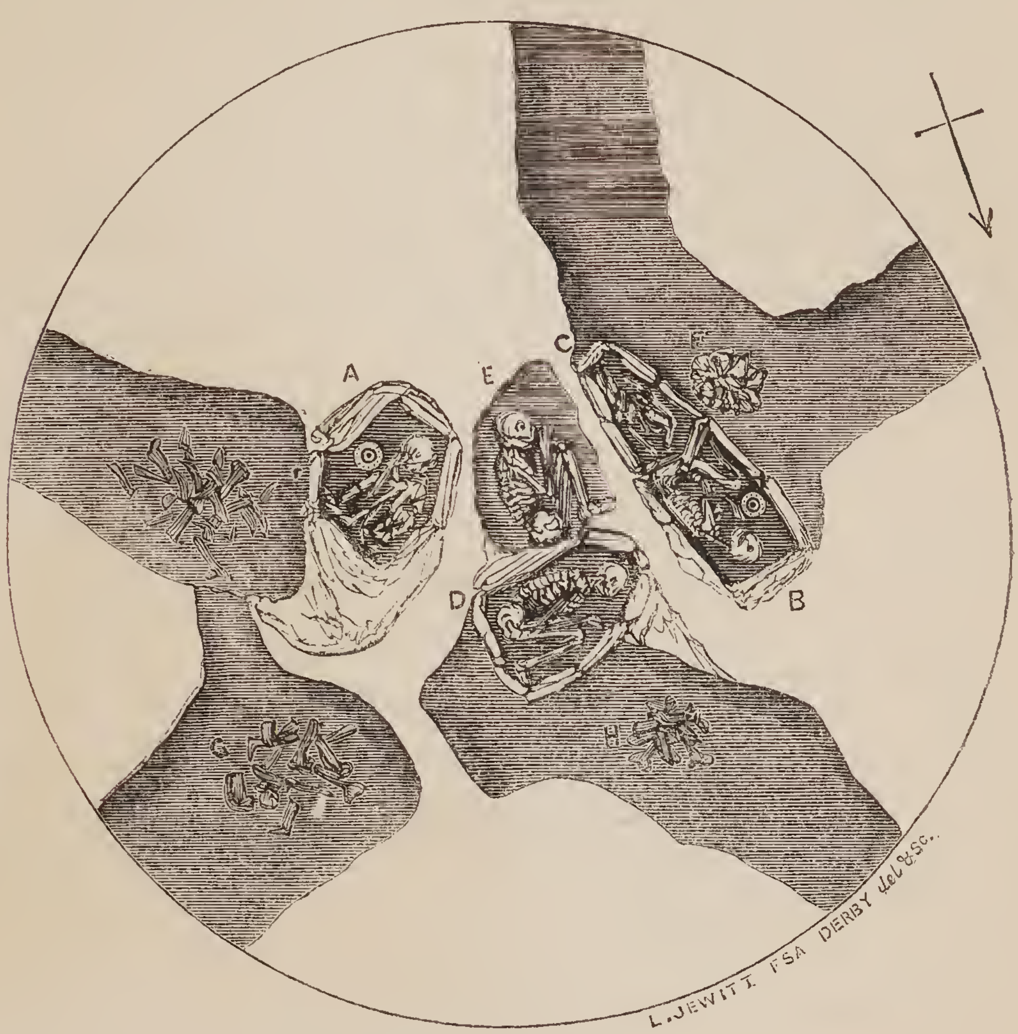
Another excellent example of the inverted position of the sepulchral urns is here given, from one of the cists in Rolly-Low, near Wardlow. I have chosen it because when found by Mr. Bateman, it had received a considerable fracture on one side, and thus showed the burnt bones which it contained, through the aperture.* The urn was about sixteen inches in height, and twelve inches in diameter, and was ornamented in the usual manner with indentations produced by a twisted thong. It was inverted over a deposit of calcined human bones, among which was a large red deer's horn, also calcined. The urn was so fragile, as to be broken to pieces on removal.

It is not unusual in the Derbyshire barrows for the interments to be made in stone cists, and these of course, vary both in size and in form, according to the nature of the spot chosen, and to the requirements of each particular case. The cists are usually formed of rough slabs of limestone or grit-stone, set up edgeways on the surface of the ground, so as to form a sort of irregular-square, rhomboidal, or other shaped compartment. In this the interment, whether of the body itself or of the urn containing the calcined bones, has been made, and then the cist has been covered with one or more flat stones, over which the cairn of stones has been raised. Some barrows contain several such cists, in each of which a single, or in some instances a double, interment has been made. An excellent example of this is afforded by the accompanying engraving, which shows the ground plan of a barrow opened by myself, and my friend Mr. Lucas,† on Hitter Hill. The shaded portions of the plan,

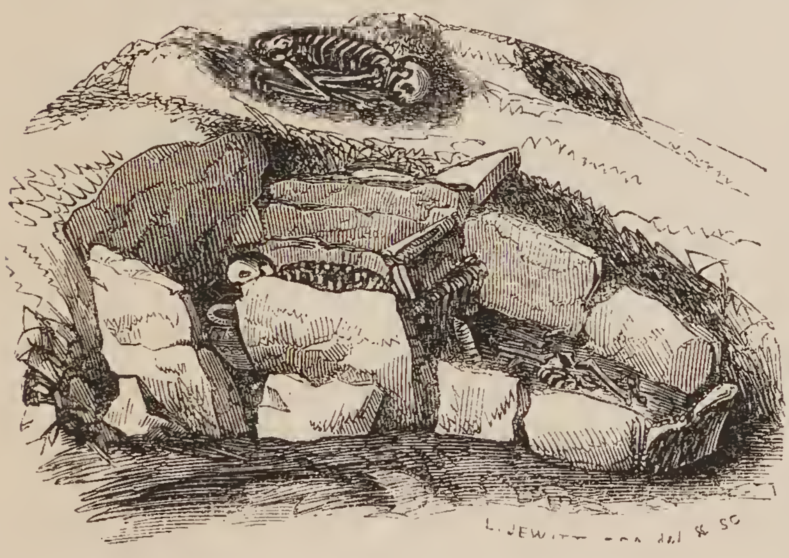
* Although I am describing the position in which the urns have been placed, it must not for a moment be supposed that they are often found in a perfect state, or in the position in which they have originally been placed. On the contrary, the urns are usually very much crushed, and not unfrequently from pressure of the superincumbent mass of stones and earth, are found on their sides, and crushed flat.

† For an illustrated account of this barrow see "The Reliquary, Quarterly Archæological Journal and Review," vol iii. p. 159, et. seq., from which these engravings are borrowed; and "Crania Britannica."

show the extent of the openings we made in the barrow, and A, B, C, and D, show the stone cists containing interments of which

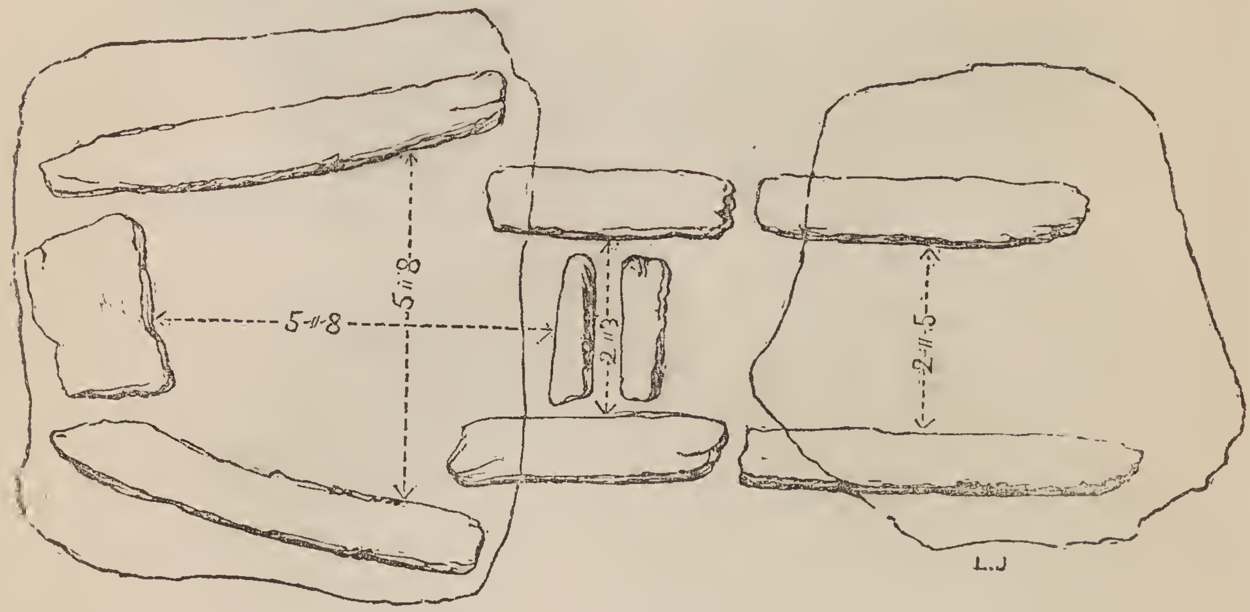


I have been speaking. Two of these cists (B and C) are also shown on the annexed vignette. With the skeleton in cist B, here shown, a beautiful and highly ornamental "food vessel" was found, to which I shall have occasion later on to refer. Occasionally, when the natural surface of the ground was not sufficiently even or solid for the interment to be as conveniently made as might be wished, a flooring of rough slabs of stone was laid for the body to rest upon.



Chambered tumuli of somewhat similar construction to the one at New Grange, in Ireland, exist in Derbyshire, and are of the most interesting character. The principal of these megalithic structures remaining, are the one at Minning-Low, and the one known as the "Five Wells," near Taddington.

The first of these contains in the centre, and in four places within the area of the circle, large cists, or, as they now appear from the soil being removed from them, large cromlechs exactly of the same construction as that well-known Druidical structure, "Kits-Coty-House," and numberless others.* They are formed of large limestones (the general formation of the district), and have all had covers, or cap-stones of the same, but only two with these cap-stones perfect now remain. The accompanying plan of some of these cists gives the situation of



the stones forming the sides of the large chamber; of the passage leading to it; of the slabs which closed its entrance; and of the covers or cap-stones. The chamber is rather more than five feet in height, and the largest cap-stone about seven feet square and of great thickness. A kind of wall similar to those which have been found to encircle some of the Etruscan tumuli, forms the circle of this mound, which rises to a height of more than fifteen feet from the surface of the ground. The "Five Wells" tumulus contains one of the most perfect examples now remaining of this kind of arrangement. "It consists of two vaults or chambers, situated in the centre of a cairn, about thirty yards in diameter, each approached by a separate gallery or avenue, formed by large limestones standing edgeways, extending through the tumulus, respectively in a south-east and north-west direction." Another five-chambered tumulus is Ringham-Low, which has, as yet, been only partially examined.

In some instances, the barrows are formed almost wholly of earth, and where they contain examples of urn burial, or of cremation without urns, the indications are frequently very striking. It not unfrequently happens that the spot where the

* As a rule the structures known as cromlechs, Druidical altars, etc., are these large sepulchral cists from which the earth forming the mound has at some time been removed.

funeral pyre has been lit can very clearly be perceived, and, as I have said before, in these instances the ground beneath is generally burned to some considerable depth. Where it was intended that the remains should be collected together, and placed in an urn for interment, I apprehend, from careful examination, that the urn being formed of clay—most probably, judging from the delicacy of touch, and from the impress of fingers which occasionally remains, by the females of the tribes—and ornamented according to the taste of the manipulator, was placed in the funeral fire and there baked, while the body of the deceased was being consumed. The remains of the calcined bones, the flints, etc., were then "scraped" up together and placed in the urn; over which the mound was next raised. When it was not intended to use an urn, then the remains were collected together, piled up in a small heap, and covered to some little thickness with earth (and occasionally small stones). Another fire was then lit on the top of this small mound, which had the effect of baking the earth, and enclosing the remains of calcined bones, etc., in a kind of crust resembling in colour and hardness, a partly-baked brick.

Having now spoken of the principles of construction of the Celtic grave-mounds of Derbyshire, and described the various modes of interment which they exhibit, I shall in my next paper proceed to describe the pottery and the objects of flint, bone, and stone, which they contain.

(*To be continued.*)

THE NOVEMBER SHOOTING STARS.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

(*With a Plate.*)

It is probable that there will be this year an exhibition of the November shooting stars, though it is uncertain whether the phenomenon will be so well seen in Europe as it was last year. As a *display* the shower is not likely to be so splendid as it was in 1866, since on November 14th of the present year, the moon will be nearly full. However, there can be no doubt that the November meteors will be looked for again with great interest, since the discoveries which have been made respecting the orbit in which they move, have presented them to us in a new aspect.

When the shower of November last was under discussion, it was very noteworthy how indistinct were the views of many persons—I may even say of many *astronomers*—respecting the relations of the earth's globe, as it travelled onwards rotating in its orbit, to the meteor stream which it encountered. I do not here refer to the doubt and obscurity under which the question of the path actually pursued by the meteors rested at that time. The investigation of this question was one of extreme difficulty, one which taxed—and not lightly—the powers of the highest modes of mathematical analysis. But many appeared to find considerable difficulty, or failed altogether in forming an estimate of the circumstances under which the meteors became visible to us. The existence of a "radiant point" from which all the shooting stars appeared to travel, in whatever part of the sky they made their appearance, was a phenomenon which — although in reality it inferred the solution of the problem of the meteors' origin—yet presented difficulties to many observers. The questions that were asked and the suggestions that were offered on this and kindred points, were many and amusing. One observer, noticing the comparative absence of meteors from the immediate neighbourhood of the "radiant point," suggested in explanation of the peculiarity, that the earth was passing through a sort of tunnel traversing a bed of meteors; thus in the path along which the earth travelled, there were no meteors or few—previous passages along the same track having cleared the way—but many meteors grazed the earth's atmosphere, the bore of the tunnel only allowing the solid globe of the earth to pass freely. And, indeed, the supposition that shooting stars are only seen when *grazing* our atmosphere has been commonly entertained and expressed even by astronomers of eminence. Sir

John Herschel, for example, speaks of meteors as "bodies extraneous to our planet, which only becomes visible when in the act of grazing our atmosphere." The idea, however, is wholly erroneous, as we shall presently see. Another remarkable question which was asked soon after the occurrence of the November shower, served still more clearly to exhibit the indistinctness of the views commonly held; meteors having been seen at Cape Town at the same hour (actual time) as in England, it was asked how the same meteors could be seen in both places, unless they had travelled as satellites round the earth? An eminent chemist, who has lately published a work on meteors, speaks of the received opinion of the cosmical origin of meteors, as, after all, merely conjectural, and he evidently leans towards the theory that they are satellites of the earth. Lastly, in Guillemin's "Heavens," a view is expressed (and illustrated by an elaborate figure), which is wholly inconsistent with observed appearances. I refer to the notion that a single stream of bodies could give rise to both the November and August showers.

It is evident, therefore, that there is room for a careful examination of the actual state of things during the occurrence of the November shower. By considering the position of England on the rotating earth, during the time of the display, we shall be able to form clear views on this point.

I must first, however, mention briefly the true meaning of the existence of a "radiant point." Once this phenomenon is established, *all doubt whatever* respecting the cosmical origin of a shooting star shower disappears. It is not true that the theory of a cosmical origin is now a conjectural one; it is established on a thoroughly firm basis. The phenomenon of a radiant point proves in fact *this*, that the paths in which the meteors intersect our atmosphere, are all parallel *in space* throughout the time that the shower is visible. Now the display lasting several hours, during which the earth moves through a large angle round her axis of rotation, it is quite clear that the display cannot have a terrestrial origin, since if it had, the direction of the shooting stars might be *expected* to change *correspondingly*, and *would certainly* not change after so artificial a manner that for several places at once the effects of the earth's rotation would be *exactly compensated*. An equatorial telescope, for instance, is made by clockwork always to point to the same star, but we know that no telescope fixed *at random* and moved at a *random rate* would do so. Just, therefore, as a person seeing the same star for a considerable time through the tube of a telescope, knows certainly that he is looking through an equatorial rendered artificially independent of the earth's rotation—so, seeing shooting stars moving always from a fixed point among the stars, we know for certain that the direction of their motion is independent of the earth's rotation, and therefore—there being no possibility of an artificial arrangement corresponding to that of the equatorial—that the shooting stars come from external space. The notion of a lunar origin, and the satellite theory of meteors are similarly overthrown, though indeed, at the present day, no competent person entertains either of these views, which are for other reasons, wholly untenable. When the occurrence of a "radiant point" is coupled with "annual periodicity and independence of geographical position, referring us at once to the place occupied by the earth in its annual orbit," the most sceptical (or, in this case, we must say those least able to appreciate the mathematical demonstration of the meaning of a radiant point), must be led "directly to the conclusion that the earth is liable to encounters or concurrences with meteor streams in their progress of circulation round the sun."

It must be mentioned that the earth's motions have their effects upon the apparent motion of bodies moving in space. The motion of rotation, however, may be neglected in comparison with the motion of revolution and the proper motion of meteoric bodies. Travelling in space, under the sun's attraction, they cannot, at the moment of encountering the earth, be moving with a less velocity than that due to a body moving circularly round the sun at the earth's distance (a rate very slightly less than the earth's) and they may have a velocity nearly half as great again as this. Between these values their velocity necessarily lies. Further, their velocity, relatively to the earth, must lie somewhere in value between the sum and difference of their actual velocity and the earth's, or between zero and about forty-five miles per hour; the first value giving the extreme case of meteors travelling in the same direction, and at the same rate as the earth; the second giving the case of meteors travelling in a parabolic orbit, and encountering the earth *directly*, just when they are *in perihelion*.

I have mentioned these limits and considered the nature of meteors' motion relatively to our earth, because it is on this relative motion that the position of the "radiant point" depends. If we suppose the earth reduced to rest, and her motion, *reversed*, added to the motion of the meteoric stream, we get the same *relative* motion, and the same *radiant point* as under the actual circumstances of the case. For clearness of explanation let us suppose this to happen, and that on the night of November 13—14 the earth's motion of revolution is non-existent (her motion of rotation continuing, however), and that the meteors are sweeping towards her from their radiant point (*i.e.* at a rate and in a direction resulting from the

Fig. 1

Fig. 2

The Earth: viewed from the Radiant-Point of the November Meteors

1. 12^h 15^m G.M.T. 2. 2^h 15^m G.M.T.

combination of their own actual motion, and the earth's motion applied in a reversed direction).

These suppositions being made, we can have no difficulty in selecting a suitable point of space from which in imagination to view our earth. The "radiant point" is clearly the proper point to select. If the reader, therefore, will suppose himself somewhere in space, between ϵ and μ Leonis, and armed with sufficient optical power, he will be prepared for the examination of the illustrative Figs. 1 and 2. In these the earth is supposed to be viewed from such a direction; in Fig. 1, at about a quarter past twelve, and in Fig. 2, at about a quarter past two, Greenwich solar time, on November 14th, in any year. The shaded half of each hemisphere is the portion turned from the sun, the apparent boundary of this portion being a straight line, because the radiant point (as respects its *longitude*) is situated very nearly in the direction towards which the earth is moving at the time. But since the radiant (as respects *latitude*) was raised some 10° to the north of the ecliptic, the north pole of the earth is brought more into view than it would be to an observer placed at a point towards which the earth is actually moving at the time. In fact, the presentation of the earth towards the radiant point happens to be almost exactly the same (as to inclination of the polar axis) as the presentation of the earth towards the sun at the time of summer solstice. Without entering further into these points, it will suffice to say that Figs. 1 and 2 are the results of mathematical calculation and careful construction—not imaginary figures set down partly at random, as is too often the case with illustrations of this sort. I am particular to mention this, because when it is known that an astronomical picture represents actual facts, as closely as possible, the student will undertake the study of the picture with some hope of information and instruction, whereas the study of illustrations (so-called) not carefully constructed—and nine out of ten figures in our works on popular astronomy fall under this category—is often worse than unprofitable.

Around London and Calcutta in Map 1, and around London and Cape Town in Map 2, oval and circular spaces are indicated. It is necessary to explain the meaning of these. Assuming the depth of our atmosphere to be about seventy miles—or, at any rate, that meteors are not commonly visible at greater heights—it is easily shown that the segment of atmosphere cut off by a plane touching the earth at any point, has a circular base about 1,500 miles in diameter. Thus neglecting the effects of refraction which would slightly increase the dimensions of the segment, we have this result, that no meteor can be seen from any point of the earth's surface further than 750 miles from the point over which such meteor is vertical. We have very strong evidence, showing that 70 miles is about the height at which meteors appear, the evidence of meteors appearing at a greater height being very doubtful. Hence, when a meteor is seen low down towards the horizon, it may be confidently assumed that the point over which this meteor is vertical lies within 750 miles of the place of observation. Now the ovals and circle in Maps 1 and 2 mark the limits of the space over some point of which a meteor must be vertical to be seen from the centre of the space. For instance, a meteor appearing at a point vertical over Madrid, or Turin, or Berlin, or Stockholm, might *just* be visible from London, appearing just above the horizon; but a meteor vertical over Gibraltar, or Rome, or St. Petersburg, would not be visible in England.

Now, if we consider Map 1, we shall see that about two hours before the time indicated by that map (a quarter past twelve at night), London is just becoming visible on the edge of the earth's disk; but the edge of the oval space round London comes into view more than an hour earlier—that is, at about nine o'clock. This is the earliest hour at which a member of the November system can by any possibility be seen in London. Meteors seen at this hour would be momentarily visible in the eastern horizon, moving upwards. When London comes to the border of the visible hemisphere, meteors may be looked for over the whole space between the eastern horizon (that is from south, through east to north) and the zenith, travelling (more or less) upwards unless they appeared nearly towards the north or south, when their motion would be horizontal. When the whole of the London oval space is in view, meteors may be looked for over the whole heavens. A little consideration will show that at and after this time, conspicuous meteors will be seen more plentifully over the western half of the heavens. If the mere number of meteors indeed, were alone considered, the contrary would be the case. But the paths of meteors being from a point east of London (it is clear that both in Map 1 and in Map 2, we are looking at London from the east), they would have in general an apparently westward motion, and all those having long visible tracks would be towards the west.

It is also evident from Figs. 1 and 2, that meteors increase in number (*cæteris paribus*) as England, through the earth's rotation, approaches the centre of the disk visible from the radiant point, or—which amounts to the same thing—as the radiant point rises above the horizon. It is clear, for instance, that the oval space round England in Fig. 2, is greater than the oval in Fig. 1; and that at an hour later than that indicated in Fig. 2, the oval is yet greater. The oval round England is greatest at about a quarter past six, when the meridian of London is a diameter of the disk. The effects due to this cause of variation ought to be considered in estimating the actual changes in the richness of the shooting star-stream as the earth traverses different strata. For instance, the increase which actually occurred after midnight, last November, was partly due to this cause, while the diminution which took place subsequently to 1h. 30m. or 1h. 45m., was partly checked by this cause.

Let us stay for a moment to compare with the effects just considered, those occurring in other latitudes. It is clear from Figs. 1 and 2, that countries in northern latitudes are more favourably situated than countries in southern latitudes, as respects their chance of seeing the November star-shower. Thus, if we consider the short part of the arc traversed by Cape Town, which lies within the darkened part of the disk, it is clear that the *á priori* probability that observers there will see the phenomenon is small. The hour at which Cape Town reaches the diametral meridian being about 6h. 15m., Cape time, it is clear that the moment at which Cape Town enters on the part of the disk visible from the radiant point, is about 2h. 15m. The oval round Cape Town begins to enter this part of the disk rather more than one hour earlier. Thus, unless the phenomenon occurs between about one o'clock and day-break (it will be seen that Cape Town enters the enlightened half disk, or, in other words, *the sun rises* there soon after five), it will not be seen at all at Cape Town; and that it should be well seen, it is necessary that the epoch of maximum richness should occur between 1h. 30m. and 3h. 30m. Cape time. It happened last November, that the shower reached its maximum at 2h. A.M., Cape time, and was, therefore, well seen there.*

In tropical regions north of the equator, which enter on the hemisphere turned towards the radiant during the continuance of the shower, the display is likely to be grander than elsewhere, since the circular space around any point in such regions would be seen as an oval of much less eccentricity than that round places in high latitudes, during a part at

* For the same reason that meteors are more commonly seen in northern latitudes from July to December, they are more commonly seen in southern latitudes from January to June. An examination of Figs. 1 and 2 will illustrate the cause of this peculiarity, viz.:—the presentation of the northern and southern poles respectively towards the direction of the earth's motion. It is worthy of notice that Mr. Maclear records the observation of several meteors last November, before the hour at which Cape Town (or the space included within the oval in Fig. 2) entered on the hemisphere turned towards the radiant; or, in other words, before the radiant rose above the horizon: but none of these belong to the November system, as is evidenced by the direction of their motion.

least, of their passage across the darkened part of the disk. At Calcutta, for instance, the boundary of visibility is appreciably circular (as shown in Fig. 1) a short time before sunrise. At this hour, last November, the shower had not reached its full splendour, and therefore, the richer part of the display was not seen in Calcutta. In Nubia, Egypt, Asia Minor, and Greece, the shower was more favourably seen. Mr. Schmidt, for instance, reported a very rich display at Athens, reaching its maximum at 2h. 15m. local time, or about 12h. 45m. Greenwich time; very nearly the hour illustrated in Fig. 1. The display in India (at Kishnagur, fifty miles from Calcutta) began before four o'clock, and continued till daylight. At 4h. A.M., Calcutta mean time, which corresponds to 10 P.M., Greenwich time, London had not yet reached a position for a favourable view of the display.

It will be seen from Figs. 1 and 2, that during nearly the whole time that the display continued, last year, in England, every visible shooting star was travelling towards the earth's surface, *not* grazing the atmosphere. Thus no shooting star which fell within the oval line marked round England in Fig. 1, or in Fig. 2, could have failed to reach the earth's surface, unless dissipated in the upper regions of air. And, indeed, independently of the consideration of the November shower, and its radiant, it is quite clear that of meteors which pass into an atmosphere, by far the larger number travel in a line which produced meets the earth's solid surface. For, in whatever direction a meteor stream is travelling, the earth, seen from the radiant point of the stream, must present an appearance corresponding to that illustrated in Figs. 1 and 2. The pole may be more or less bowed towards, or from, the direction in which the meteors are travelling (relatively) towards the earth, and other countries than those presented in the figures, may be turned towards the meteor-flight; but a circular disk, apparently fringed with a comparatively narrow border of atmosphere, must in every case be presented towards the meteor-stream. Only those meteors which impinge on this fringe, a circular ring 70 miles wide,* can possibly free themselves by passing through (or grazing) the atmospheric envelope. All those meteors which are making for the apparent disk of the solid earth, a circle, nearly 4,000 miles in radius, must inevitably reach the earth, either in a solid form or in the form of meteoric dust, after being dissipated in their passage through the upper atmospheric layers. Assuming that every meteor making for the fringe escapes, which is,

* Of course, not in reality such a ring, but apparently so viewed from the radiant point of the meteor-flight; and intercepting the same proportion of meteors as if actually so.

however, utterly improbable, it may easily be calculated that for every meteor grazing our atmosphere (at a height not exceeding 70 miles), twenty-eight travel directly towards the earth's surface. But the proportion must in reality be very much greater, since our supposition implies the possibility of a meteor travelling through the air in a direction actually tangent to the earth's surface, or passing through about 1,450 miles of air, including the densest strata. Since meteors seldom penetrate to a vertical depth of more than twenty or thirty miles, without dissolution, it is very unlikely that meteors travelling parallel to the horizon should penetrate to a vertical depth even of ten or fifteen miles—since, to do so, their actual path through the air would be many times longer. Assuming that meteors could escape after penetrating in this manner to a depth of twenty miles, we should have, for every meteor so escaping, almost exactly one hundred whose substance, whole or dissolved, would reach the earth. Even escaping meteors would never again appear as members of the November shower, since their orbit, after grazing contact of the kind supposed, would be very different (owing chiefly to their loss of velocity) from that they originally pursued.

In the fact that such multitudes of meteors have, during so many and such brilliant displays of November showers as have been recorded, been stolen by the earth from the stream to which they belonged, serves to afford some conception of the immense number of meteors forming the November stream. Yet clearer views will be formed on this point if we consider the evidence we have respecting the length, breadth, and thickness of the cluster, during the passage through which the display is visible. I have not space to dwell here on Adams' investigation of the meteoric orbit. But it is necessary to point out that we must now greatly increase our estimate of the length of the cluster causing the November showers. The recurrence of displays during two or three consecutive years was simply accounted for on the theory of a nearly circular orbit, without assuming for the cluster a length of more than a few millions of miles. Now that we know that the meteor-flight travels in an orbit of great eccentricity, and with a period of $33\frac{1}{4}$ years, we know that the portion passed through by the earth in one year is several hundreds of millions of miles away, when the earth next passes through the meteor orbit. Hence the recurrence of displays leads us to estimate the length of the cluster by hundreds of millions of miles, instead of by mere millions.

Next, for the breadth of the stream. On this point we have no exact information. It is sometimes assumed that the fact that the display may be seen in one hemisphere, while in another it is not seen (as last year, for instance, in America), points to a limit of breadth. But this is not the case. If we consider Figs. 1 and 2 we shall see that America was on the sheltered side of the earth during the whole time of the display. When America had come to the side turned towards the radiant, the earth's globe had, in all probability, passed through the meteor-stream. So that the limits of the *thickness*, and not of the *breadth* of the stream, were indicated by the non-visibility of the meteors in America. Before the display had begun in England, the meteors, were seen from Kishnagur, fifty miles north of Calcutta, and they continued visible until the time of sunrise there. This would assign a breadth of *not less* than 4,000 miles to the stream. But as, throughout the continuance of the display, the earth was crossing the breadth of the stream at the rate of about 1,000 miles an hour, we can assert positively that the breadth of the stream exceeded 6,000 miles. In reality, however, a very much greater breadth may be assigned, with great probability, to the meteor-stream. For if we consider the nature of the stream and the manner in which it has been probably generated in the track of Comet I., 1866, we shall see the great probability that its breadth exceeds its thickness. For the causes tending to make meteors leave the mean plane of motion, are much less efficient than those tending to distribute the meteors over that plane. Now the earth, during the time of the display, was crossing the *thickness* of the meteor-stream at the rate of about 18,000 miles an hour. Therefore, since the display lasted at least six hours (counting from the time of its being observed in India, when England was, as yet, on the earth's sheltered side), we cannot assign to the stream a less thickness than 100,000 miles. The breadth is probably at least ten times as great.

It may be assumed as certain, that it is the passage of the earth through the *thickness* of the meteor-stream which limits the duration of the display.

I shall conclude by quoting two observations, showing that the fine powder in which meteors reach the earth may be detected. Dr. Reichenbach collected dust from the top of a high mountain, which had never been touched by spade or pick-axe; and on analysis he found this dust to consist of almost identically the same elements as those of which meteoric-stones are composed—nickel, cobalt, iron, and phosphorus. Again, Dr. Phipson notes, that "when a glass, covered with pure glycerine, is exposed to a strong wind, late in November, it receives a certain number of *black angular particles*," which "can be dissolved in strong hydrochloric acid, and produce yellow chloride of *iron* upon the glass-plate." I quote these observations on account of the interest attaching to them; *not* as evidence to show that the majority of shooting stars never pass out of the earth's atmosphere. Such evidence is not required—the fact being mathematically demonstrable.

THE LARGEST BLOOD DISCS KNOWN—SINGULAR CAPTURE OF A CANADIAN REPTILE, MENOBRANCHUS LATERALIS.

A WEEK or two since we received by post from Canada two glass slides containing numerous blood discs of large size, which at once reminded us of those of the Lepidosiren, but on comparison were found much bigger. A few days later came the following interesting letter from a Canadian subscriber, who has not favoured us with his name, but to whom we beg to express our thanks. The *Menobranchus* of which he speaks belongs to an interesting group, the Ampibia, possessing permanent gills, and comprehending the Proteus, Siren, etc.

The letter runs as follows:—

"I take the liberty of sending you two slips of glass, upon which you will find specimens of the blood discs of *Menobranchus lateralis*, one of the salamander family, inhabiting Lake

BLOOD DISCS.—1. *Menobranchus lateralis*. 2. Siren. 3. Man. × 300.

Ontario. It is remarkable for being furnished with both lungs and gills, so as to be able to live either on land or in the water. It is seen occasionally ashore, but usually prefers the water. It much resembles a similar animal found in the Lake of Mexico (*Axolotlus pisciformis*), but differs from that species in the number of its toes, of which it has four on each foot, and in having no toe-nails. There is a good likeness of this reptile in the "Encyclopædia Britannica," vol. xix., 8th edition; but it is in reality considerably darker than the picture. They are not often seen here. I have known only five or six taken alive in thirty years. The specimen of which I send you the blood discs was taken by a water-snake, which brought it ashore, and had it half swallowed, when in his turn the snake was captured by a spectator. When I saw them the snake (about four feet long) had disgorged his prey, which was covered with blood and dust, and apparently dead. On being placed in a vessel of water, the lizard immediately revived, and then appeared to be furnished with three branchial tufts on each side of his head, which were dusky on the upper side, but the fine filaments with which they were thickly tufted were of a dark red colour. They pulsated with a vigorous stroke about fifty times each minute, but would occasionally cease awhile when the animal was disturbed. Every minute or two he raised his head above the water, and opening a pretty wide mouth, took a gulp of air, which he afterwards expelled from the gills when under water. He was about thirteen and a half inches long and two broad, and was the largest I have seen of this kind.

"The morning after his capture it became apparent that the wounds inflicted by the snake would soon cause his death. The branchial motion had wholly ceased, and the reptile made a respiration of air only occasionally. When he appeared dead I made a small opening in his breast, and got some of his blood, which I hope that you will be pleased to have an opportunity of examining. The blood discs are of a very great size, so as to be visible to the naked eye. I have a slide of the discs of the Siren mounted by Topping, and sent to me as the largest known. They are not, however, half the size of those which I send you, measuring on the long diameter $\frac{1}{775}$, and on the short diameter nearly as much, while the discs of the *Menobranchus* measure $\frac{1}{364} \times \frac{1}{775}$, and the respective areas are in the proportion of 12 to 25. These measurements refer to the largest discs; those of a medium size measure $\frac{1}{443} \times \frac{1}{775}$.

"The Siren is not a native of Canada, but of South Carolina, twelve degrees of latitude south of this place.

"A CANADIAN SUBSCRIBER.

"CANADA, 26*th August*, 1867."

MAN AND THE PLEISTOCENE MAMMALS OF GREAT BRITAIN.*

(Read at the Congrès Paléoethnologique.)

BY W. BOYD DAWKINS, M.A., F.R.S., MEMB. CORRESP.

THE remains of man have been found in various parts of Great Britain, associated with the remains of many of the post-glacial group of mammals, both in bone caverns and in river deposits. The implements found in the latter are precisely of the same character as those from the banks of the Somme, while, on the other hand, those in the caverns are smaller, and approach nearer to those found in the cave of Moustier than to any others. We will first examine the mammals proved to have coexisted with man during the time that ancient gravel and loam beds were being swept down by rivers that now flow at a lower level.

So far back as the year 1715,† a spear-head of flint was discovered, along with the remains of a mammoth, in the gravel of the Thames, near Gray's Inn Lane, in London, and is preserved in the British Museum. No particular notice was taken of this discovery until the year 1860. At the end of the last century, implements of a similar kind were found at Hoxne, in Suffolk,‡ and from that time down to the present numerous traces of man have been found in the same layer, along with the remains of mammoth, deer, and horse. Until, however, the discoveries of M. Boucher de Perthes called the attention of English savants to the existence of man in the post-glacial epoch, no notice was taken of the earliest known implements that man left behind him in the gravel. In the year 1861,§ Mr. Wyatt found, along with the remains of man, in the gravels of Bedford, the cave bear, bison, stag, reindeer, *Elephas antiquus*, hippopotamus major, and tichorhine rhinoceros. Among the fluviatile shells was a fresh-water mussel, extinct now in Britain, *Unio Batavus*, but which still lives in the Oise. The remains found by Dr. Blackmore at Salisbury, and described by Mr. Evans in his paper on flint implements in 1864,|| were not derived from the same bed as the implements, but from one of a different character occurring at a lower level. They cannot, therefore, be cited as proving the coexistence of man with the extinct mammalia in Wiltshire.

* The French title of this paper was, "Sur les Mammifères Pleistocènes Trouvés avec L'Homme dans la Grande-Bretagne."

† "Archæologia," 1860-2. ‡ "Archæologia," 1800.

§ "Quart. Geol. Journ.," vols. xix. xx. || Quart. Geol. Journ.," vol. xx.

These three localities are the only places in Britain where implements of man have been found associated with the extinct mammalia in post-glacial river deposits.

We come now to the evidence afforded by the caverns, which proves how essentially man formed one of the group of mammals existing in post-glacial times. In 1832, the Rev. Mr. McEnery began his excavation of Kent's Hole, near Torquay, Devonshire, and discovered numerous flakes of flint and spear-heads of the small flattened type found in the cave of Moustier. There were also roughly-chipped thin oval fragments of flints, of the type commonly called sling-stones. They were underneath the stalagmite, and associated with the remains of the following animals :—the cave lion, the sabre-toothed lion, the cave hyæna, wolf, fox, ermine, badger, cave bear, brown bear, otter, urus, Irish elk, stag, reindeer, mammoth, wild boar, *Hippopotamus major*, *Rhinoceros tichorhinus*, tailless hare, water-rat, *Arvicota pratensis*, *Arvicota agrestis*, hare, and rabbit. The occurrence of the great sabre-toothed lion in this deposit is so remarkable, that Dr. Falconer could not bring himself to believe that this Pliocene animal had really been found in the cavern, and he supposed it to have been mixed up, by some accident, with the remains from Kent's Hole, in Mr. McEnery's collection. That, however, the three canines upon which the determination of this mammal has been made were actually found in Kent's Hole, is proved by McEnery's manuscript, as well as by the condition of their matrix. He describes them, with other animals, from a portion of the cavern that he calls the Wolf's Passage, found underneath the stalagmite, with thousands of teeth of hyæna, horse, and rodents. Unfortunately, the account of the exploration of this cavern was not published until 1859,* and consequently the idea of the presence of the works of man with the remains of Pleistocene mammals, under circumstances which would prove that he lived in Pleistocene times, was not brought home to the minds of English savants until nearly thirty years after the discovery. In 1840,† however, Mr. Goodwin Austin put on record that he had obtained from the same cavern the works of man from undisturbed earth under stalagmite, mingled with the remains of extinct mammals. Public attention was not directed to the occurrence of flint implements in caverns until 1858, when the Royal Society, stimulated by the fruits of the

* "Cavern Researches," by the Rev. J. MacEnery, edit. E. Vivian, 8vo, 1859, p. 32 :—"To enumerate the amount of fossils collected from this spot (Wolf's Passage) would be to give the inventory of half my collection, comprising all the genera and their species, including *cultridens* (Machairodus). The jaws of the elk, horse, and hyæna were taken out whole. The teeth of the two last were gathered in thousands, and in the midst of all were myriads of Rodentia."

† "Trans. Geol. Soc.," Ser. II., vol. vi., p. 433.

labours of M. Boucher de Perthes, undertook the exploration of the cave of Brixham, also near Torquay, Devonshire, Dr. Falconer, F.R.S., and Mr. Prestwich, F.R.S., being on the exploration committee. Their labours resulted in the discovery of flint flakes associated with the remains of the following animals, which have been determined by Mr. Busk:—cave lion, cave hyæna, fox, wolf, cave bear, brown bear, *Ursus priscus*, stag, roe-deer, reindeer, mammoth, horse, woolly rhinoceros, tailless hare, and teeth of arvicolæ. Mr. Busk has lately proved that the *Ursus priscus* of Goldfuss, quoted by Schmerling, from the caverns of Liege, is identical with the grizzly bear of the Rocky Mountains (*Ursus ferox*); so that we have another mammal to be added to the American group of animals that lived in France, Germany, and Britain with man.

Dr. Falconer and Col. Word, about the year 1858,* explored the caverns of Gower, in South Wales. They discovered vast quantities of flint flakes associated with the remains of the cave lion, cave hyena, fox, badger, cave bear, brown bear, grizzly bear, bison, Irish elk, stag, reindeer (*Cervus Guettardi* and *Cervus Bucklandi*), *Rhinoceros tichorinus* and *Rh. leptorhinus* of Owen (*Rh. hemitœchus*, Falc.). The association of these two latter animals in the same undisturbed earth proves that they cannot be considered as characteristic of two different geological epochs. In the year 1859,† I, together with Mr. Williamson, had the good fortune to explore a cavern at Wootrey, a village near Wells, in Somersetshire, that afforded, among vast stores of the remains of mammals, abundant traces of the presence of man. The cave opened on a ravine side; and at the time we began our excavations it was completely blocked up with earth. Lying on the floor, in the large chamber at the entrance, which was about eight feet high, about thirty feet wide, and very well lighted, were the remains of the fires and the feast of some ancient tribe. Among the calcined bones was one of rhinoceros, which, from its dark, carbonized character, must have been burnt while containing gelatine. In three distinct groups we found the implements that had been left behind, consisting of flint flakes, lance-heads of the type found at Moustier, sling-stones, and various fragments of flint that had been used for cutting. The presence of several flint cores proves that the manufacture of flakes had been carried on in the cave. There were also two arrow-heads found, without barbs; the one of chert, and the other of bone; the two lower angles of the latter being bevelled off. Unfortunately, both these were lost before they were engraved. There was also an implement of pyramidal

* "Quart. Geol. Journ.," 1860, vol. xvi., p. 489.

† "Quart. Geol. Journ.," 1862, vol. xviii. p. 115; 1863, vol xix., p. 261.

form, with a flat base and cutting edge all round, somewhat similar to a cast, in my possession, of one from the cave of Aurignac. All these were found either on or within two feet of the floor of the cave. They were imbedded in red earth, containing large stones, and enormous quantities of the remains of mammalia. Above the flint implements, in some places, were layers of comminuted bone and coprolites of hyæna; and in and around these was the greatest quantity of bones. These layers indicated old floors. I continued the excavations up to the year 1866, and the list of mammals which I have determined is second only to that of Kent's Hole. It comprises cave lion, cave hyæna, wolf, fox, badger, cave bear, brown bear, grizzly bear, urus, bison, Irish elk, stag, reindeer, mammoth, horse, *Rhinoceros tichorhinus*, *R. leptorhinus* of Owen, water-rat, and lemming.

There was clear evidence that the cavern had been inhabited by hyænas, and that the animals to which the remains belonged had fallen a prey to them. The traces of old floors above the flint implements prove that they inhabited it after the departure of man. Such as this is the evidence of the coexistence of man with the Pleistocene mammals, afforded by the contents of caverns in Britain. The small proportion which those caverns that contain the traces of man bear to those in which no traces of him have been found, shows that he was small in point of numbers as compared with most of the other animals.

Out of the thirty caverns explored in Great Britain, the contents of which I have classified, four only have yielded human remains; while out of forty river-deposits containing mammalia, only three have furnished any trace of man. Had man been very abundant in those days, we might certainly have hoped to have found his implements more widely spread, and especially as they were fashioned out of a material that is almost indestructible. That, however, he formed an integral member of the post-glacial fauna of the Pleistocene, is proved by the following table, in which I have arranged in order the animals found with man in old river-beds and in caverns, and the animals from river-beds and caverns in which he has not been found. The correspondence of these four columns show that the deposits from which the animals were derived are of the same geological age. The *Bos longifrons*,* which has been inserted among the British fossil mammals by Professor Owen, is purposely omitted, because there is no evidence that the animal was living at the time in Great Britain :—

* "Quart. Geol. Journ.," 1867, vol. xxiii. Brit. Foss. Oxen.

THE RELATION OF THE ANIMALS FOUND ASSOCIATED WITH THE REMAINS OF MAN IN THE CAVERNS AND RIVER DEPOSITS TO THE BRITISH POST-GLACIAL FAUNA.

	River deposits with remains of man.	Caverns with remains of man.	River deposits without the remains of man.	Caverns without the remains of man.
Homo, L.	*	*		
Rhinolophus ferrum equinum. Leach				*
Vespertilio noctula. Schreb.				*
Sosex moschatus. Pall				
S. vulgaris. L.		*		
Talpa Europæa. L.				
Ursus arctos. L.		*	*	*
Ursus spelæus. Gold	*	*	*	*
Ursus ferox. Lew. et Cl.		*		
Gulo luscus. Sab.				*
Meles taxus. L.		*		*
Mustela erminea. L.		*	*	*
M. putorius. L.			*	*
M. martes. L.				*
Lutra vulgaris. Erxl.		*		*
Canis vulpes. L.		*	*	*
C. lupus. L.		*	*	*
Hyæna spelæa. Gold.		*	*	*
Felis catus. L.		*		*
F. antiqua. Cuv.				*
F. spelæa. Gold		*	*	*
Machairodus latidens. Owen.		*		*
Magaceros Hibernicus. Owen.		*	*	*
Alces malchis. Gray				*
Cerbus tarandus. L.	*	*	*	*
C. capreolus. L.		*		*
C. elapus. L.	*	*	*	*
Ovibos moschatus Bl.			*	
Bos primigenius. Boj.		*	*	*
Bison priscus. Owen	*	*	*	*
Hippopotamus major. Desm.	*	*	*	*
Sus scrofa. L.		*	*	*
Equus fossilis. Owen		*	*	*
Rhinoceros leptorhinus. Owen.		*	*	*
R. tichorhinus. Cuv.	*	*	*	*
Elephas antiquus. Falc.	*		*	*
E. primigenius. Blum	*	*	*	*
Lemmus sp. Link			*	
Lepus cuniculus. Pall.		*		*
L. timidus. Erxl.		*		*
Lagomys spelæus. Owen		*	*	*
Spermophilius erythrogenoides. Falc.				*
S. citillus. Pall.			*	
Arvicola pratensis. Bell		*		*
A. agrestis. Flem.		*		*
A. amphibia. Desm.		*		*
Mus Musculus. L.				*

Such as there were, the animals with which the first man was surrounded, the mammoth, the horse, and the bison were most abundant; the reindeer was far more common than the red-deer, and that again than the roe. The Tichorhine rhinoceros was more widely spread than the Leptorhine, and the hippopotamus than the wild boar. The cave lion and cave hyæna, wolf and fox, were moderately abundant, while the badger and brown bear were comparatively scarce. Among them man appears for the first time in the world's history, scantily armed, and few in numbers, and by the exercise of that intellect which separates him from the rest of the animal world, asserted himself their king. His craft proved stronger than their strength, and his cunning sharper than their claws or teeth. In his time Great Britain formed part of the continent, and the Thames flowed northwards to join the Rhine and Elbe in forming an estuary in the latitude of Berwick. The climate, also, was so severe, that glaciers descended from the mountains of Cambria, Scotland, and Wales, and the reindeer and musk-sheep could live in the lowlands. Then all these conditions passed away, the land became depressed, until Britain was insulated, and the waves of the Channel rolled over what was before the great feeding-ground of the Pleistocene herbivores, and the climate became warmer, until the arctic mammalia were obliged to retreat northwards. Coincident with this was the disappearance of the characteristic Pleistocene mammalia from the restricted area of Great Britain, and with them all traces of the first man, who spread over France and Italy,* using the same implements, and therefore possessed of the same habits, passed away.

* This occurrence of implements of the Amiens and Abbeville type associated with the remains of extinct mammalia in Italy, is proved by the discoveries of M. Louis Caselli, President of the Society of Immaculate Conception, in the gravel of Ponte Mammolo.—*Correspondance de Rome*, 4th May, 1867.

THE AIR-VESICLES OF BLADDERWORTS (UTRICULARIA).

BY J. B. SCHNETZLER.

[In England we have, amongst our wild flowers, three Bladderworts—*Utricularia vulgaris*, or Bladderwort, growing in stagnant water; *U. intermedia*, a rare plant; and *U. minor*, or lesser Bladderwort; and many of our readers will be glad to repeat the observations contained in the following paper, which is translated from the "Archives des Sciences."]

The genus *Utricularia*, or Bladderworts, comprises aquatic plants found in the stagnant water of ditches, marshes, etc. The leaves are submerged, and divided into fine threads, furnished with vesicles, or utricles (*asci*), to which De Candolle ascribes the following characters :—

These utricles are rounded, and furnished with a species of movable operculum, or lid. In the youth of the plant, they are full of mucus heavier than water, and the plant, weighed down by them, remains at the bottom. Towards the season of flowering, the leaves secrete a gas which enters the utricle, and drives out the mucus, opening the lid for its escape. The plant is thus supplied with a quantity of air-vessels, which elevate it gradually, and cause it to float on the surface. The process of flowering takes place in the free air; and when it is finished, the leaves again secrete mucus, which replaces the air in the utricles, weigh down the plant, and cause it to descend again to the bottom of the water, where it ripens its seed in the situation in which they should be sown.*

In spite of the labours of Göppert,† Benjamin,‡ Schleiden,§ Schacht,|| Reinsch,¶ there is not yet a complete agreement of botanists as to the origin and morphological signification of these aerial vesicles. Before the publication of the works cited, they were usually regarded as a modification of the parenchyma of the leaves, which follows the numerous ramifications of the veins, under the form of a narrow band, and which by dilating from time to time produced the utricles.

Schleiden, who studied the development of these little organs, saw them appear at the angles of the division of the leaf under the form of little bodies like horns (*cornets*), supported on short pedicels. The lower side of the horn, and the

* De Candolle, "Physiologie Vegetale," t. xi., p. 87.
† "Botanische Zeitung," 1847, p. 721. ‡ Ibid., 1848, p. 17.
§ "Grundzüge der Wissenschaft, Botanik," 388, iv. Auff.
|| "Beitrage zur Anatomie," etc.
¶ "Denkslinflen der K. Bair. Bot. Gesettschoft," 1859, B. iv. 153.

lower margin of its opening, which itself scarcely increased in size, developed themselves much more than other parts; so that the complete utricle formed a small rounded body, laterally compressed, prolonging itself on the upper surface or on one side of the pedicel, and producing on the other side an opening in the form of a funnel, projected into the interior of the utricle, and having its exterior aperture closed by a fringe of hair attached to the upper margin. The interior surface of the funnel is adorned with differently shaped and elegant hairs, disposed in regular order. All the interior surface of the utricle is likewise covered with hairs composed of two cells, each of which is prolonged into two appendages of unequal length (Schleiden, *loc. cit.*).

Benjamin explains the formation of these utricles by supposing an arrest of development in certain segments of the leaves; instead of elongating themselves, they increase in breadth; a constriction takes place, forming a narrow neck, and they appear as little globular bodies, attached by a short pedicel to the vein of the leaf. According to Benjamin, we can follow these phases of formation by examination of a single leaf from its base to its summit. The utricle, at first filled with protoplasm, becomes, by the rapid absorption of this fluid, a reservoir of air, and, stretching in all directions, gradually assumes its ultimate form, which somewhat resembles a stomach, the pedicel taking the place of the pylorus, and the opening of the caudiac orifice. The mouth of the utricle he represents as a valve opening inwards. . . .

Schacht regards those organs of the Bladderworts, which most botanists consider leaves, as leaf-bearing branches, which, in their young stages, are rolled up, like the fronds of ferns; under this crook, their leaves are formed in succession, and in their axils small conical bodies appear, composed of little cells, like the beginning of a bud. These small bodies soon exhibit at their rounded extremities little cavities, produced by an arrest of the development of their cells, the margins of which grow, and the little cellular body, at first sessile, afterwards exhibits a prolongation at its base in the form of a pedicel. The lateral walls of the young utricle develop more and more, and the air cavity becomes bigger, the margins of the lateral walls incline towards each other, and fold inwards, while the original aperture closes. The original opening is, in fact, a valve, formed by a fold of the margin of the aperture; and the beard which, according to Schleiden, closes the opening, is found later on the external surface. . . . Thus Schacht considers the utricles as modifications of the ramifications of the axis, and not of the leaves.

In April, 1867, I studied the formation of the utricles of the lesser Bladderwort (*Utricularia minor*), in the Marsh of Jogny, below Vevey. Schacht, who studied the formation of the utricles in the common Bladderwort (*U. vulgaris*), admits their formation in the axils of the leaves, and considers them analogous to buds. We see, indeed, between the ramifications of the leaves little bodies appear, composed of conical cells, with their free extremities slightly rounded. These little bodies, at first sessile, soon raise themselves on pedicels, the cells of which afterwards differentiate themselves into an external layer, corresponding with the layer of parenchyma, which follows the veins of the divided leaves, while the interior cells of the pedicel put themselves in communication with the cells that form the tissue of the veins, of which they at last appear to be a continuation. Whilst the pedicel thus becomes a prolongation of a leaf segment, the little globular body which it supports appears to us as a portion of the parenchyma of the same leaf. The walls of the little cellular body, whose extremity becomes hollowed out as a little cup, continue to grow while those of the hollow remain stationary. They at length unite, and close the cavity.

In the utricles thus formed in the lesser Bladderwort, there may be seen, towards the so-called embouchure, certain prolongations, or feather-divided appendages, like the capillary segments of leaves, properly so called; so that a perfect utricle looks like an expansion of the leaf parenchyma, supported on a vein which prolongs and ramifies itself beyond the utricle. The end, at first open, afterwards closes by two unequal folds of the walls, and thus form a sort of funnel covered with hairs, at the bottom of which the folds show themselves as two dark bands, bearing linear hairs, while those at the mouth are usually capitulate.

If the utricles, at the commencement of their formation, show themselves at the angles of the leaf segments, their position is by no means constant, when we examine them at a more advanced stage, in which the leaf itself is modified. The "globules with pedicels" of Benjamin are often found a good way from the angles of the segments; on the lesser Bladderwort they may even be seen at the extremities of the leaf divisions. We cannot therefore infer from their position any analogy with buds.

From the foregoing remarks it will be understood that the "globules with pedicels" of Benjamin, and the small horn-shaped bodies of Schleiden, are only intermediate phases of the utricles.

An anatomical examination of the perfect utricle confirms this view. The walls of the utricle are composed of two layers of angular cells, which have at first a clear green colour. In the intercellular canals small conical cells are seen at an early period, which terminate inside and out by a little rounded cell. The interior cell forms, at a later stage, the base of the quadrifid hairs spoken of by Schacht. This author does not mention the exterior cells, which are always seen in great numbers, even on the young utricles of the lesser Bladderwort, under the form of small flattened globes, which, at a subsequent period, are often split in two. These globules are also met with on other parts of the segmented leaves, when they appear like little mushrooms, with their stems buried in the cellular tissues. The external globule becomes filled in time with a brown substance. Schleiden* observed these flattened cells on the exterior of the utricles, but he does not mention those on the leaves; their presence on the leaf, properly so-called, appears to me an additional proof that the utricle is only a modification and expansion of the parenchyma. The quadrifid hairs which garnish the interior of the utricles bear some resemblance to the stellate hairs often found on the inner surface of the air-vessels of the water-lilies. The intercellular spaces of the leaves of the Bladderwort contain much gas, which makes them look black under the microscope; the black band thus occasioned is prolonged through a pedicel as far as the utricle. In plants exposed to light I have often observed a strong disengagement of oxygen gas, bubbles of which rose through the water for a considerable time, forming an almost continuous thread. These gas bubbles were disengaged at the angle of two leaf segments, not far from the utricle. Similar bubbles are also disengaged at the ends of the capillary segments of the leaves. As to the mushroom-shaped cells, of which the pileus, a little constricted in the middle, is often divided into two, they seem to me to occupy the place of stomata, and to act as glands. They exhibit, in fact, a great analogy with the glands often found at the base of viscid leaves of *Pinguicula vulgaris*, which terminate in a brown, rounded pileus, like that of a small mushroom, whilst the stems are colourless, like those of the Bladderworts. The mucilage which covers the surface of the leaves of *Pinguicula* correspond also with that which fills the cavity of the young utricles. We have already seen that the utricles exhibit at their commencement a very pale green colour, which, at a later period, becomes deeper. The Bladderworts taken from the Marshes of Jogny on the 18th of October, 1866, still exhibited a number of green utricles; but the greater part were dark violet or blue.

In these coloured utricles the angular cells of the interior layer, which are usually hexagonal, contain a coloured liquid,

* "Grundzüge," 4th Edition, 397.

passing from rose-lilac to violet-blue, giving the cells the aspect of painted glass, surrounded by silver threads. The cells which closed the intercellular canals were either red or dark blue, and surrounding them were other cells of reddish tint. At the same period I found in the segments of the leaves, by the side of green cells containing grains of chlorophyll, cells filled with a pale red fluid. The cells of the external layer of the utricles contained chlorophyll grains, grouped along their walls, whilst the interior was colourless. The cells of mushroom form had their buttons always brown.

The change of colour in the wall-cells of the utricles in which we see the green pass into rose, lilac, violet, and blue, depends evidently on a chemical action which has some relation to their contents and functions. It must be observed that the colouration of the interior cells is due to a liquid, whilst the granules of chlorophyll have disappeared, or did not exist. These granules appear to have been exposed to a dissolving action, and to an agency which has changed their colours. The red colour of cellular liquids is usually ascribed to a free acid, and the blue tint to the presence of an alkali. In the utricles of the lesser Bladderwort all the transitions may be seen, from bright red to dark blue. The cavity of the utricles contains at the beginning a mucilaginous liquid of a neutral reaction, and it is in this liquid that, at a later period, we see a little bubble of gas, which gradually increases as the liquid diminishes. We may easily satisfy ourselves of the presence of this liquid by changing the position of the utricle, when the gas bubble will be seen to reach the highest level by passing through a viscous matter, which opposes a certain resistance to its passage. In the month of June and July the vesicles are nearly filled with air. The plant then rises to the surface of the water, and the stalk which, in the lesser Bladderwort, bears from two to five pale yellow flowers, stands up in the air, and two unilocular anthers spread their pollen over the stigma of the pistil, out of contact with the water.

The ascensional force thus developed is very considerable. Reinsch* estimates the mean contents of a utricle as 2·57 cubic millimetres, and its weight as 0·6 milligrammes, and the ascensional force of a single utricle will be equal to 1,964 milligrammes. There are about 597 utricles on a principal stem, giving an ascending or floatation power of 0·778 grammes for an entire plant. Reinsch reckons a total of 4·44 grammes. (Reckoning four branches it would be 3·112 grammes.) Now the weight of the head of flowers which rise above the water is 0·295 grammes; there is thus a considerable excess of power capable of maintaining all the flowers above the water

* "Mickroscop."

at the period of fecundation. After this is completed the utricle gradually fills with liquid; the specific gravity of the plant increases, and it descends slowly with its fruit, sinking below the level of the water, and the seeds fall from their capsule in the soil in which they are to germinate. We find amongst authors a difference of opinion as to the position of the Bladderworts in the water before flowering. Some regard them as attached to the soil by slight roots; others, like Reinsch, consider them to be floating plants. They are at first really attached to the soil at the bottom of the water; but the air vesicles which develop on their leaves gently drag them out of the mud, and in this action I see the true use of the utricle, for the entire plant floats very well in the water, and rises to the surface.

I placed a tuft of Bladderwort while the vesicles were still green in a large vessel of water, and found this to be the case. The water snails in the same vessel eat up all the vesicles, and the plant still floated.

Bladderworts are not the only plants in which movements are produced by disengagements of gas. In *Hottonia, Aldrovanda* and *Trapa natans*, we observe at the flowering season slow movements which displace the entire plant, while in other aquatic species, such as *Nymphea, Vallisneria, Ranunculus aquatilis*, etc., it is only certain parts which elongate themselves. In the Bladderwort and *Aldrovanda* it is the air vesicles which diminish the specific gravity, uproot it from the soil, and cause it to ascend. In the *Hottonia*, air cells are found amongst the leaflets, and in the petioles of *Trapa natans* air cavities are formed before inflorescence.

Sometimes a plant cannot completely detach itself from the soil, and the grains of pollen are then preserved from contact with the water by another method, and one conspicuous instance may be cited of an evolution of gas, which, instead of moving the plant, plays a more direct part in the process of fecundation. In the Lake of Escoubous, at the top of the High Pyrenees, 2,052 metres above the sea-shore, a remarkable variety of *Ranunculus aquatilis* grows, and form extensive beds, anchored to the bottom of the water by rootlets, which push their way among a thick carpet of dark green tremelloid ulva. In this situation, contrary to the laws which determine aquatic plants to seek the free air to accomplish their inflorescence and reproduction, it remains constantly submerged, far from the banks, where the sharpness of the frosts might destroy it, and far also from great depths, where it would not find light enough for its growth. It spreads out its finely divided leaves, and its white corollas, gilt at the bottom, and the processes of fecundation and reproduction take place without moving to the surface. An air bubble, produced by a vegetative process, is detained amongst the petals, and in this bubble the anthers deposit their pollen.*

The evolution of gas in close cavities, which we see in a certain number of aquatic plants, before the opening of their flowers, is evidently connected with what is called vegetable respiration. During this process, the plant not only takes carbonic acid from the air or the water; it absorbs oxygen at all parts, which combines with certain vegetable matter, and forms carbonic acid. The chemical action of solar light excites the decomposition of the carbonic acid, which is absorbed, as well as of that which the plant forms, the carbon being combined with the elements of water and nitrogenous bodies, while the oxygen is discharged. Stomata appears to play an important part in respiration, although, according to the researches of Duchartre, there is no fixed relation between the number and size of the stomata, and the quantity of gas which the plants disengage under solar influence.

In certain trees of a dry and coriaceous tissue, there is an inverse relation between the number of stomata and the feebleness of the gaseous evolution; but that which proves that the gas evolved by the plant does not come from the stomata only, is that we see it disengaged from the cells of the epidermis of the upper surface of leaves of plants which have no stomata in that position, when we plunge them under water. We have noticed a similar evolution of gases from the submerged leaves of Bladderworts. In aquatic plants which are entirely submerged, the leaves have no stomata, and absorption and exhalation take place from the whole surface of the epiblema. The experiments of MM. Cloez and Gratiolet show that the decomposition of carbonic acid by the green parts of submerged plants only takes place under the influence of light. In darkness, contrary to what takes place in aerial plants, no carbonic acid is produced. A certain temperature is also necessary for the process. It does not begin below 15° (C), when the temperature is increasing, and cannot continue below 10°, when it is decreasing. The gas evolved by the plant contains a little nitrogen besides the oxygen.

If we proceed to apply the preceding observations to the leaves of the Bladderworts, we find them in water which is usually very rich in carbonic acid, which is absorbed by the leaves; and, under the influence of light, oxygen, and a little nitrogen are disengaged. These gases are also found in the aeriferous canals which traverse the leaf segments, and they escape from different points as small bubbles. We have seen these bubbles escape through the walls of the utricles, which

* Guérin "Dict. d'Hist. Nat." *t.* viii. p. 465.

appear to oppose some resistance to their transit, and may be stretched in consequence. The utricles, floating freely in the water, become the seat of endosmotic and chemical actions, especially when the surrounding water has a temperature of from 16° to 15° (C). The utricles enclose at the beginning a mucilaginous liquid, in which a gas-bubble soon appears, and increases in size: this is the oxygen evolved under the influence of light and heat. The plant disengages itself from the soil, and mounts towards the surface; the secretion of gas becomes more abundant, and the flower-stems are raised above the water. The oxygen secreted in the air-vesicles seems to exercise a chemical influence in changing the colour of the cell-walls, which become rose, lilac, and blue. The colouration of the envelope affects the internal processes of the cell. We know that in organs not coloured green, like the petals of a flower, there is no evolution of oxygen, but an absorption of oxygen and an evolution of carbonic acid. This gas does not leave the utricle, but is probably assimilated there; the utricle becomes again filled with mucilage, and water which it absorbs augments in weight and causes it to descend. Thus the utricles have a respiratory as well as a hydrostatic function.

GRUITHUISEN'S CITY IN THE MOON.—JUPITER'S SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

We will now, in continuation of our subject, direct our attention to the region lying S. and S.W. of the great clefts recently described.—*Dionysius* (25), a small crater (14 miles across, Lohrm.), lying on the shore of the *M. Tranquillitatis*, and having perhaps 3800 f. of depth, or more than enough to hide the peak of Snowdon, is chiefly remarkable on account of its brilliancy, amounting to 7° for its interior, and 9° for its wall. Yet it is not to be seen in the earth-shine, probably, as B. and M. remark, on account of its small dimensions. It would be an interesting and not unpromising investigation, to ascertain whether this is the true cause, and attended with no great trouble, as it would not be difficult to select other small craters which are perceptible on the dark side, and whose magnitude would be comparable with that of Dionysius. I have never made the attempt, but trust some of my readers may have at once sufficient instrumental power and leisure to take it in hand. We have seen that changes of colour, of which little explanation can be given, frequently come on with the advancing lunar day; and there is no antecedent improbability in the idea that similar periodical alternations may be in progress during the lunar night. *Dionysius* has been selected by Birt as a standard of magnitude among craters of a similar character.—*Ariadæus,* and *Ariadæus* a, are a pair of craters at the W. end of the great cleft which bears that name.* *Silberschlag,* a crater $9\frac{1}{4}$ miles across, and of $8\frac{1}{2}°$ of brightness, appears, with those already mentioned, in the diagram of this region in our August number. There also we shall find *Agrippa* (26), a fine ring, somewhat elliptical, 27 miles broad, carrying a peak S., and interrupted by a little crater N.; in the steepest parts its interior slope amounts to 60°; and it ranges on the W. 6900 f., and 1000 f. more on the E., above the interior. It has several terraces, and a central hill.—*Godin* (27) has a narrow but very steep ring of 8° light, equally deep with *Agrippa* (Schr. makes it deeper), and of a somewhat quadrilateral form: its breadth is 23 miles. It is connected with *Agrippa* by ridges running in an oblique S.S.W. direction, a peculiarity of which other instances might be given. Several very defined craters lie in the neighbourhood. E. of *Godin* we find a small but very brilliant crater, *Rhæticus* b, which attains 9° of luminosity. *Rhæticus* itself, which will be found in our recent diagram, is an irregular ring, chiefly distinguished as being bisected by the lunar equator, and as being one of the few spots to which both Sun and Earth may be vertical; all these being, of course, comprised in an elliptical area, whose centre is that of the Moon, and its boundary the extreme amount of libration (which is greater in longitude than latitude), as referred to the centre of the Earth (not to the observer's position, in which it may be increased by parallax). Very strange, certainly, would be the aspect of the sky to any one of ourselves, if we could conceive ourselves transported there;—the Sun describing a slow but cloudless course from rising to setting, through the vertical region of the sky, and often through the zenith itself; and the Earth oscillating around that point for a short distance successively in every direction—an enormous globe, waxing and waning with all the features of the Moon, and turning every part in comparatively rapid rotation to the eye of the spectator. The *Rhæticus* of

* It should have been stated in our last number that the minute prolongation of this cleft, noticed in p. 97 as having been discovered by Gruithuisen, has been seen on several occasions by Messrs. Birt and Freeman.—I may be permitted also to take this opportunity of rectifying two former mistakes, which have been obligingly pointed out to me by Messrs. Knott and Proctor. The first occurs in Int. Obs. vii. 134, where the R.A. of the Great Star of 1572 has been given at 4h. 19m. 57·7s., instead of 4° 19′ 57·7″ (= 0h. 17m. 19·8s.): the difference also from Hind should have been, not 3m. 10s., but 3′ 10″.—The other is in Int. Obs. x. 148, where, instead of *density* of the ring of Saturn, it should have been *mass.*

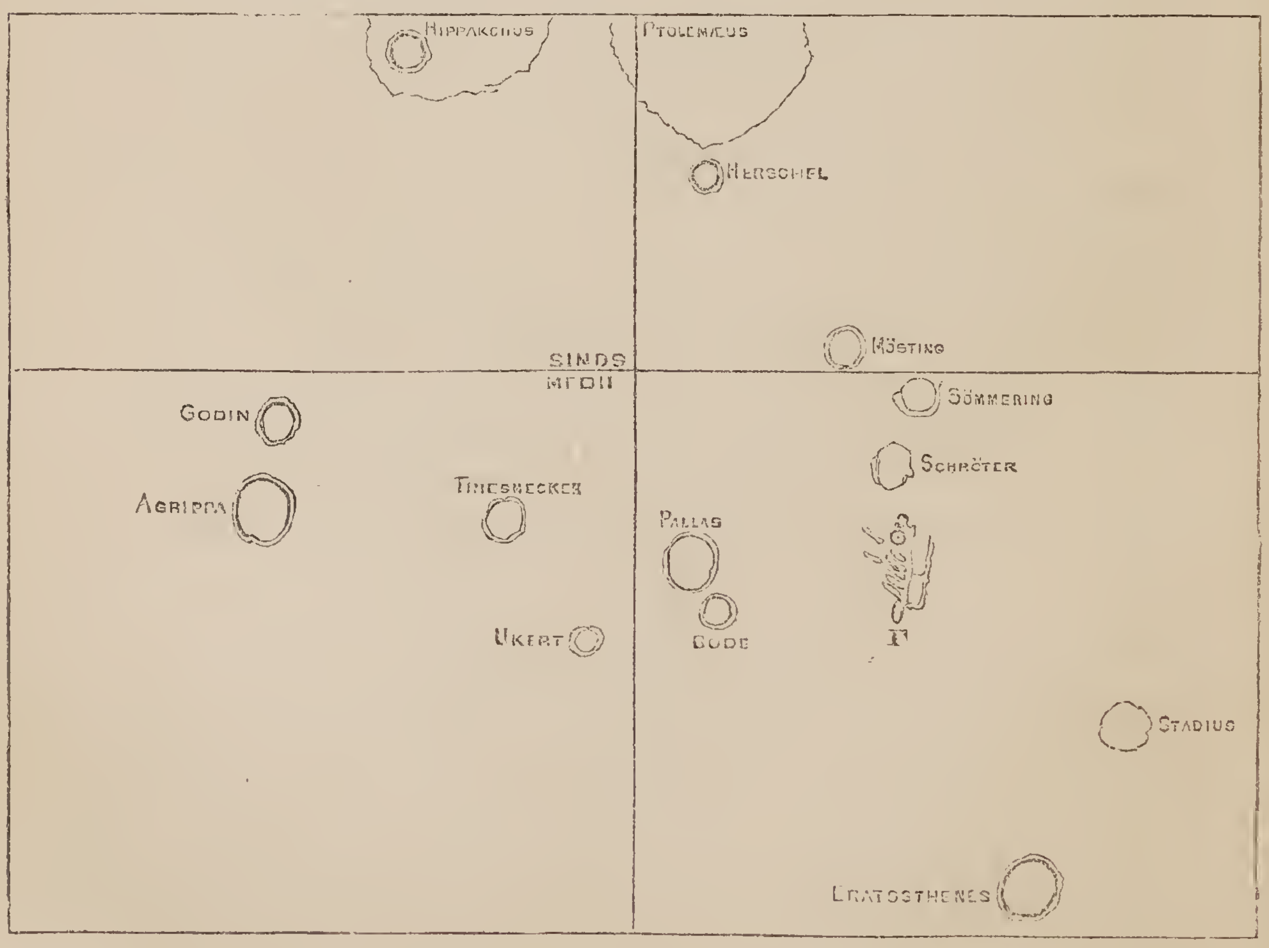
Riccioli, it should be observed, lies further E., but its name was transferred to this spot by B. and M., in despair of its identification. This, no doubt, may have been impracticable, so far as it depended upon the relief of the surface, and an apology is thus obtained in this case for a change, generally speaking to be avoided; but the original *Rhœticus*, which has only recently been recovered by Knott, is a grey opening among the luminous rays issuing from the S.W. side of *Copernicus* (30), and consequently only to be recognized, where B. and M., no doubt, did not think of looking for it, under high illumination. Three contiguous dark spaces of a circular form were figured here by Hevel, and denominated *Lacus Herculei*: from Riccioli they received the separate names of *Rhœticus*, *Stadius*, and *Dominicus Maria*, occupying respectively the E., S.W., and N.W. angles of the triangular area in which they are grouped. They are not difficult objects in the Full Moon, *Rhœticus*, in particular, which is the darkest, and is divided centrally by a more luminous ray; yet still they are now, especially the other two, so unimportant in character, being merely duller patches in a labyrinth of bright streaks, and so much less conspicuous than very many other anonymous objects, that a suspicion may reasonably arise, whether they were not, at the date of those early observations, of a more decidedly contrasted grey hue than at present. Should there be anything in this, it would of course involve a consequence of some interest—that the streak-system of Copernicus is, in this place at least, on the increase; and when we bear in mind the very small amount of our actual knowledge as to the local colouring of the Moon, we shall feel that attention may be suitably directed to this spot, where identification and comparison are proportionally easy. Instances may be given in which variations of brightness in high illumination are probable —*Linné*, and a bright spot in *Werner*, may be specified; and it is time that observers should take this curious point in hand. On the earth, analogous changes, no doubt, may be perceived, but they would result from that cultivation of which we have no suspicion in our satellite.

It is in this ancient *Rhœticus* that we are to look for one of the curious "rampart-works" discovered by Gruithuisen. His sketch, in the "Astronomisches Jahrbuch" for 1828, represents a comparatively regular white figure in a longish grey area, consisting of one vertical stripe, bent to the left at the top, where it terminates in a small hill casting a shadow; ending in something like a little crater, with internal and external shade, at the bottom; and crossed at an angle of about 60° by four similar bright streaks: the figure might have been worth copying, but that he complains, in the next volume, of its inaccuracy, there being one transverse line too many on W. side, and all of them being too bright: it had, he says, been very seldom visible, and "selenospherically obscured" for the last year. This astronomer assuredly thought, and published, an uncommon amount of nonsense. If we are to believe him, there is not a trace, ancient or modern, of volcanic action on the Moon, the so-called craters having been formed by the fall of enormous fragments from space (colossal aerolites), whose points still project above the once-plastic surface in the form of central hills. The Moon had been first a comet, then an asteroid, afterwards a satellite, and had been once covered with a primeval sea, deeper than its highest mountains, on whose features strong marks of degradation remain. He considers the clefts as indications of animal existence, and looks upon some of the smaller ones, which show no embanked edges, and may be 30 to 80 feet in depth, as being probably broad, straight clearings through forests, and forming connections of the nature of roads between all the fertile regions of the lunar surface. The "Selenites" themselves, he owns, we could hardly expect to distinguish individually on their journeys, but does not think it impossible that large bodies of them might be detected in these roads by their difference of colour, especially if meeting and separating again. The regular straight ridges which he describes he does not seem to refer to fortification, but inclines to the idea of their being the roofs of long inhabited halls, and thinks some of the minute crater-chains, of which such wonderful examples are to be found between *Eratosthenes* (29) and *Copernicus* (30), are dwelling-places:—with other dreamy matter of a similar kind. Yet this man made good use of a keen eye and sharp instrument, and saw much, and if he had spared us his inferences, would have been accepted as an observer of no little weight. I have not been able to ascertain whether his intended work, "On the Habitability of the Moon, and Traces of its being Inhabited," which was prepared in 1825, but, from his desire of greater completeness, remained in MS. in 1836, ever saw the light: and I have not had access to his observations in Kästner's "Archive," a German scientific periodical of that day; but it would seem worth the while of some astronomer who has more time at his command than falls to the lot of everybody in these days of speedy progress, to collect and compare his observations, and sift out what may be really worthy of preservation. The occasional verification of some of his assertions sufficiently proves that he was not uniformly mistaken: and we have no reason to suspect him of falsifying the evidence which he turned to such absurd account.

But it is time to return from the ancient *Rhætieus*, which, in fact, lies beyond our proper bounds, to the spot so called by B. and M., with which we complete our survey of the First Quadrant of the Moon.

We commence the second, at the centre of the disk, with the *Sinus Medii,* G on our Index-map. This is an undefined tract of level ground, of little comparative importance, excepting from its lying in the visible centre of the hemisphere. It contains only two small craters, and a few short and low ridges; but varied illumination produces much change in its shading. From its position relative to the Sun and Earth, this is the point of the Moon which receives the greatest share of illumination; here, with the exception of a few polar summits, is the *minimum* of darkness, and eyes like ours would be able at all times (except during a total eclipse) to read writing of a moderate size. Here, too, the smallest possible margin is left for deception; the changes of libration and phasis have the least effect upon the prospect; and it is accordingly especially adapted for the study of those who make the discovery of physical change their object: it is unfortunate, our authors might have added, that the region is little marked by any interesting peculiarity.

Such, however, is not the case with the district lying E. and N.E. of it, some of the features of which are so curious, that the accompanying diagram is introduced to assist in its



identification. The Moon's centre is here indicated by the two crossing lines, of which that from right to left is the equator, the other the first meridian. E. of this point we notice an imperfect ring, *Sömmering*, touching the equator: N. of this is a somewhat similar object, the *Schröter* of B. and M., forming the principal feature in "a labyrinthine mass, the complete disentangling of which could scarcely be successfully accomplished with the most powerful telescope. The countless multitude of hills which fill this landscape appears, even in favourable circumstances, almost like a mere fine luminous dust." Most of the elevations, however, show connection in chains, affecting a general parallelism with the tolerably distinct boundaries of the district, which consists exclusively of the minutest and most difficult groups. There is no great amount of elevation, especially for the Moon: some points in the outer border of the mass may reach 2600 f. The interior hills are very difficult of measurement: Γ, central, and by far the highest, may lie 2500 f. above a valley 9 miles E. The majority of the eminences range from 1000 down to 130 or even 70 f. The least visible of them lie eastward; but they are probably steep-sided, as, even when the detail is confused by too high an illumination, they never give the impression of a plain, notwithstanding their grey colour; and this tone may be due to the great multitude of minute and separately undistinguishable shadows. Craters are rare amongst them. Such is the account of B. and M., who add in a note, that notwithstanding their especial care, which they hope a comparison of their Map with the sky will prove, they could never perceive the slightest traces of the fortress-like ramparts which had been so much paraded for a length of time. Lohrmann, they add, had met with no more success; his figure, indeed, was very unlike theirs, but under the circumstances this could not be matter of surprise. L.'s design is certainly not merely very dissimilar, but poor in detail, and his complaints of difficulty are evidently very sincere.

If we now turn to the origin of these remarks, it is as follows. 1822, July 12, Gruithuisen discovered in the region before us what he considered to be a colossal structure consisting of regular and obviously artificial ramparts, to which he gave the name of *Schröter* (subsequently transferred by B. and M., when they could not find his object, to the crater so designated in our diagram). Its extent was about 23 miles each way, but it was very dark, and situated in one of the darkest parts of the Moon, and was visible only on the terminator. Its general outline accurately faced the points of the compass, there being a central ridge from N. to S., from which branched off at an angle of 45° on either side, a number of parallel walls, like the the veins of an alder or rose-leaf, running respectively S.E. and S.W. Those running S.E. flattened gradually down: but those on the other side formed, with a second oblique rampart, lying as it would seem N.W. and S.E., enclosed spaces, which in his view would be thus sheltered from the N.N.W. polar wind. From 3 to 4 years later he and Schwabe detected external prolongations of several of these S.W. walls, that were in like manner stopped by another closing ridge. In 1826 Schwabe saw 5 fresh walls of this kind, some only of which Gr. could make out. The latter considered it remarkable that previous to the discovery of these new ramparts, a small ring was distinctly visible on their site, occasionally almost obscured by fog, of which not a trace could be subsequently perceived; and it was equally remarkable that in 1822 he always saw a small rampart completing the outline on the E., which afterwards disappeared, and beyond the E. ramparts a hill, the centre of 5 radiating ridges like a star, which have so totally vanished since, that the slight vestige of a roundish height alone remains. The regular figure itself he often found so covered with what seemed foggy clouds, that only unconnected traces of the ramparts could be seen, and the general form was lost; and such he supposed must have been the case at the time when Lohrm. drew the region before he heard of Gr.'s discovery. On the contrary the surrounding natural features have always remained the same; the high hill on the N. which terminates the central wall (Γ, of B. and M.); the somewhat smaller hill by which the great closing rampart running from S.E. to N.W. is cut off; and the little ring (a of B. and M.) in which the straight central rampart and the closing rampart terminate—though within this ring he had perceived many variations. Such was the curious figure which was at the time so celebrated in Germany, and which was seen by many continental observers, including Prince Metternich, who perceived it on the first news of its discovery, while "on the other hand the learned John Bull here went away empty, and behaved himself about it as his nature inclined him;" a somewhat ill-natured criticism, for which, however, there certainly was some foundation in the inattention of our observers; at the present day, it is satisfactory to feel assured that no such taunt could be with justice directed against us. This was the figure of which B. and M. could not find a trace, when they constructed their Map—though it is somewhat singular that the ridges which they have drawn on this spot are not unlike it in character—a circumstance which seems to have quite escaped them. At a later day, however, the comparative accuracy of Gr. as an observer was to be established, even on their own not very willing testimony. They state that, 1838, May 2 and 3, a long and hitherto vainly expected opportunity arrived of examining this curious region, in which, from the longitude and latitude given by Gr., they concluded that his fortification was to be looked for; and this time, by means of the great Berlin achromatic of $9\frac{6}{10}$ in. aperture, they were successful. Two principal directions of the long ridges abounding in the district were very evident, one in the meridian, another intersecting it from N.E. in an angle of 50°. In the first direction are two low, but partially steep chains, bearing several insulated summits, which connect (a) and Γ at their ends; to the second belong, among others, 4 cross banks which connect these two chains by oblique lines, so as to enclose 5 longish valleys in succession, each about 9m. long by $3\frac{1}{2}$ wide. The uniform height of the side and cross walls, and the similarity in form and size of these hollows give an aspect of regularity to this figure, which is increased when they are filled with shadow, and the dividing ridges appear as bright, straight, narrow lines. It is, however, evident that we have only a product of nature in view. Many equally regular arrangements are to be found in the Moon, of which a remarkable instance has already been described in the environs of *Aristoteles*, and the magnitude of any one of these valleys is sufficient to include the greatest cities of the earth. (London, however, should have been excepted.) They further remark that a 3rd meridian chain (on E.) unites itself with the second (or central one), before it reaches Γ, and forms a valley with it, less precipitous than the others. Their diagram shows it also connecting itself with the central chain near its middle; and gives two strong prolongations, each composed of more than one ridge, of the oblique walls towards S.W. Thus the main features of the figure are well made out; the observers however have not stated, what must undoubtedly have been the case, that their own smaller instrument would have fully sufficed for the recovery of the object in a suitable position. It only remains for us to remark what has been seen in our own country.

The earliest verification, so far as I know, was effected by Knott, 1861, Mar. 19, when the details of B. and M. were very fairly caught with a $7\frac{1}{3}$-in. object-glass; and they were subsequently made out even at some distance from the terminator.—1862, Feb. 7, I had a good view of it with my $5\frac{1}{2}$-in. object-glass, with a power of 170, definition being flaring and unpleasant, but not bad. It was not very close to the terminator, which was then bisecting *Timocharis* (34), and grazing the E. edge of *Eratosthenes* (29). The central ridge connecting Γ and (a) was very apparent. E. of it I could distinguish little, but on the W. I was able to reckon 4 oblique walls, the first starting from Γ, to which a 5th very short one might be added close to (a), if I was correct in thinking that the central ridge branched out right and left at its N. end, instead of running up to that ring. The whole agreed more with Gr.'s description than B. and M.'s figure, in the progressive shortening of the oblique walls, towards the N., so as to give fairly one-half of the design of a tapering leaf. But my remark at the time was, "the whole object looked coarse, and though curiously arranged, would never have given me the idea of an artificial production." The following night I could still make it out as a previously known figure, and could even count up four valleys in feeble relief. The crater (a) appeared to contain another interior ring, concurrent with the larger one on its E. side. The terminator lay at this time a very little beyond the E. end of *Clavius* (50), and wall of *Bullialdus* (60), and its own diameter beyond *Copernicus* (30). From this it appears that it is by no means a difficult object, and may be made out under much higher illumination than Gr. would have led us to suppose: and it is worth looking for, not merely for its curious parallelism, but still more as very suitable for studying the question, which after all seems open to further enquiry, of temporary atmospheric obscuration. It is situated in a region where the effect of variations in perspective foreshortening from libration may be neglected, and since none of the principal lines run in the parallel of latitude, there is little reason to anticipate illusion from the change of the direction of illumination due to the lunar seasons. Any permanent features ought, therefore, to be always equally visible in corresponding circumstances: the direct observations of the discoverer, and the fruitless searches of L., and B. and M., who not only examined but drew the region in detail, would lead to a suspicion that they are not so. Future study only can decide; and if it should be found that there are variations, not explicable by changes in the angles of illumination and vision, we must look further for the cause. The existence of a lunar atmosphere is denied upon arguments of much cogency; but the question cannot be considered as finally at rest; and the region before us may be found especially suited for its decision, since from its low-lying, and at the same time irregular and complicated character it may be supposed highly favourable for the exhibition of atmospheric influence. As such, its strict examination is commended to those who love to trace the footsteps of the Maker of all things in the manifold exercise of His creative power.

TRANSITS OF JUPITER'S SATELLITES.

Oct. 1st. II. egress, 7h. 26m., Ditto shadow, 9h. 8m.—3rd. III. egress, 7h. 51m. Ditto shadow ingress, 7h. 52m. Ditto ditto egress, 11h. 29m.—6th. I. ingress, 9h. 25m. Ditto shadow, 10h. 22m. I. egress, 11h. 44m. Ditto shadow, 12h.

42m.—8th. I. egress, 6h. 11m. II. ingress, 6h. 56m. I. shadow egress, 7h. 10m. II. shadow ingress, 8h. 55m. II. egress, 9h. 49m. Ditto shadow, 11h. 46m.—10th. III. ingress, 7h. 44m. IV. egress, 10h. 7m. III. egress, 11h. 22m. III. shadow ingress, 11h. 53m.—13th. I. ingress, 11h. 13m. Ditto shadow, 12h. 18m.—15th. I. shadow ingress, 6h. 46m. I. egress, 8h. 0m. Ditto shadow, 9h. 6m. II. ingress, 9h. 22m. Ditto shadow, 11h. 34m. II. egress, 12h. 15m.—17th. III. ingress, 11h. 20m.—22nd. I. ingress, 7h. 30m. Ditto shadow, 8h. 42m. I. egress, 9h. 50m. Ditto shadow, 11h. 1m. II. ingress, 11h. 50m.—26th. II. shadow egress, 6h. 22m.—27th. IV. shadow ingress, 9h. 21m.—29th. I. ingress, 9h. 22m. Ditto shadow, 10h. 37m.—31st. I. egress, 6h. 9m. Ditto shadow, 7h. 25m.

OCCULTATIONS.

Oct. 15th. *f* Tauri, 4 mag. 7h. 38m. to 7h. 45m.—16th. θ^2 Tauri, 4½ mag., 7h. 25m. to 8h. 9m. θ^1 Tauri, 4½ mag. 7h. 33m. to 8h. 80 Tauri, 6 mag., 7h. 55m. to 8h. 36m. 81 Tauri, 5½ mag., 8h. 6m. to 8h. 51m. 85 Tauri, 6 mag., 8h. 33m. to 9h. 27m.

THE LUNAR ECLIPSE OF SEPTEMBER 13.

BY JOHN BROWNING, F.R.A.S.

During this eclipse several facts were noted that, carefully considered, may, I think, tend to elucidate the interesting problem of the condition or constitution of the Moon's surface. Few questions are more interesting to astronomers, and few seem more difficult of solution.

It is because of their indirect bearing upon this question that I think the points I am about to describe merit particular attention. On the 13th of September the sky during the day was overcast, and it remained thick until shortly before nine o'clock. Then, quite suddenly, it became exceedingly clear, and remained so for the greater part of the night. After the very unfavourable weather astronomers have lately had to contend with, and the tantalizing obscurity which prevailed on the night of the disappearance of the whole of Jupiter's satellites, except in large telescopes, the effect of this almost unlooked-for clearness was most cheering. This exceeding clearness probably materially modified the results that were afterwards obtained.

According to calculation, the eclipse must have commenced at 9.43, for at that time the Moon entered the penumbra of the earth's shadow; yet, three-quarters of an hour after this, no diminution of luminosity in the Moon could be detected.

At length, at about 10h. 30m., a slight shade was seen stealing gently over the Moon's disk, commencing at the limb in the N.E. quadrant. This shading steadily increased in intensity until eleven o'clock. At this time a darkening of the limb in the N.E. became distinctly perceptible. Three minutes earlier the Moon had entered the umbra of the Earth's shadow; still, though I was watching most anxiously at the telescope, I could not detect the exact instant at which this, the second stage of the eclipse, began.

The darkness kept creeping over the disk, veiling first one and then another well-known object, until it had covered about one-third of the Moon's surface. When it had reached thus far, many of the craters on the dark limb became distinctly visible. I noticed also that some of the ray-streaks *projected within the shadow.* At the maximum of eclipse, which occurred at 12.26, three-quarters of the disk seemed darkened; the exact amount was 0.693, the whole disk being 1.

The full disk of the Moon could at all times be dimly made out, the edge of its disk, even the portion most deeply immersed in the shadow, being much brighter than the other portions in shadow, and being, in fact, *encircled by a narrow line of light.* An observation in close relation to this was made during a late solar eclipse by a very careful observer, Captain Noble. This gentleman noticed that the limb of the Moon, though not the body, was visible, extending some distance beyond the solar disk. What is the meaning of this peculiar appearance? It seems the very reverse of what we might expect to obtain. At the time of an eclipse the Moon is in opposition, and it is, of course, at the full. Under these circumstances we might expect that the centre of the disk would be the most luminous, and that there would be a degradation of light towards the edges.*

The planets Mars, Saturn, and Jupiter also exhibit an increased luminosity at the edges of their disks. This is accounted for by supposing that they are surrounded by clouds. The whole matter would be explained if we could suppose that any vapour exists in the atmosphere of the Moon. Everything, except the appearance I have been describing, points to the contrary conclusion.

A peculiarity of the light reflected from the Moon's surface,

* This singular action of the edge of the disk appears to extend to the actinic rays. In one of Mr. Warren De La Rue's exquisite photographs of the full Moon, I noticed that some of the grey plains were continued to the edge of the disk. Frequently they almost touched the edge, but the extreme edge was always marked by a narrow line of light.

apparently in direct contrast with that to which I have just referred, is, that Mr. De la Rue finds that he cannot photograph with facility within some distance from the edge of the terminator. Objects that present the same luminous appearance to the eye as those in the middle of the illuminated portion of the disk, are yet only impressed with a very feeble degree of intensity upon the photographic plate.

Can these facts be of any assistance in reasoning upon the character of the surface of our satellite? For my own part I do not think any person who has been in the habit of observing the Moon with an instrument of large aperture will be able to accept the glacial theory.

When using a telescope of ten or twelve inches aperture, protecting the eye from the great glare by a single-reflecting prism solar eye-piece, the Moon's surface is seen to be almost entirely covered with markings of a considerable variety of tone and colour, many of these frequently changing in a few days, both in shape and hue. Even with an instrument of six inches diameter, some of these changes are easily perceptible.

During the late eclipse, I devoted especial attention to the colour of the Moon. It is a generally received opinion, that when the obscuration has proceeded to the extent of two-thirds or more of the surface, the obscured portion of the Moon appears of a strong coppery red, and that the edge of the shadow on the surface appears of a very decided blue.

In Mr. Norman Lockyer's translation of Amédée Guillemin's "The Heavens," and in Keith Johnston's "Atlas of Astronomy," diagrams of lunar eclipses are painted in chromo-lithography in the colours I have stated. My observations were made with Mr. Barnes's 10½-inch silvered-glass speculum, furnished with a reflecting prism, and an achromatic eye-piece. During the whole time of the eclipse, I could never detect any trace of colour upon the Moon, except what I ordinarily see there. Looking through a four-inch refractor, I also observed the same freedom from colour just noted.

The colour stated to be seen on the part of the Moon under eclipse is usually ascribed to the refraction of some of the solar light as it passes through our atmosphere. I venture to suggest that, when the colour is visible, absorption plays an equally important part in producing it. This absorption would affect principally the blue rays of the spectrum, and it would be very small whenever our atmosphere is free from mist. Now, on the night of the 13th, as I have before said, the air was remarkably clear, and this may possibly enable us to account for the Moon's singular freedom from the colours which seem to have been observed upon it on previous occasions.

Still, as lunar eclipses are tolerably frequent, and, unlike solar eclipses, are visible over half the hemisphere of our globe, I cannot but conclude that such a total absence of colour during eclipses of considerable extent are very rare.

ON COLOURS SEEN DURING THE LUNAR ECLIPSE, SEPT. 13, WITH REMARKS ON THE PRECEDING COMMUNICATION.

BY HENRY J. SLACK, F.G.S., SEC. R.M.S.

It was with much surprise I heard from Mr. Browning that his views of the late lunar eclipse through Mr. Barnes's 10¼-inch telescope, so far from disclosing any decided chromatic effects, led him to express a positive opinion as to their absence. I watched the same eclipse at intervals through a telescope similar to that of Mr. Barnes's, with a silvered mirror, but of smaller size (6½-inch), and furnished like his with a right-angled prism, to direct the cone of rays to the eye-piece. On referring to my notes I find the following:—"As shadow came over Aristarchus, that crater remained visible, and rather bright, until shadow advanced to near Eratosthenes, when it required sharp looking for to see it. The shadow was inky purple, and the sky colour in the neighbourhood dusky red. As shadow passed over different portions of the Moon, the darkness varied considerably, being much less over highly-reflecting portions than over the seas, which became very dark. After twelve the eclipsed limb grew noticeably redder, and objects likewise became gradually more visible. The red, coppery tint chiefly affected the lower part of the obscured limb, but was visible further in, gradually blending with the inky tints presented by the umbra at its advancing edge. By twenty minutes past twelve the increased visibility of obscured parts very striking. 12.26, eclipse at its height, and visibility of objects in obscured parts much greater than at an earlier period. As the Moon passed out of shadow, a brightening took place in opposite directions at the two edges of the limb, and bluish tints of brighter hue became conspicuous, contrasting with the reds." I added to this, "Red colour less conspicuous in telescope than in opera-glass with two-inch lenses." My wife's report of what she saw generally agreed with mine, but she noticed a *greenish* tint at the beginning of the eclipse in the penumbra, and did not see the *blue* as much as I did towards its termination. I think her eye is more sensitive than mine to the peculiar greens sometimes seen on the Moon, and which are very rarely distinct to me.

I should not have thought so much of the discrepancy between what we saw and what Mr. Browning saw about five hundred yards N.E. of us, if we had not ascertained by comparisons that our perceptions of colour and his are pretty much alike. Can it be that the difference arose chiefly from his employing a much larger aperture? And does the eye become insensible to small quantities of red, when accompanied by a good deal of white light? Presuming the Moon during eclipse to emit red and white, or whitish-yellow, light, the larger aperture would collect more of both, but it does not follow that *both* would look more intense to the eye; the red might be overpowered as the white light increased, although its *proportion* to the white light might be the same. My opera-glass, which is unusually free from chromatic errors, made the Moon look much redder than the telescope, and Mr. Barnes's instrument being much larger than mine might have still further diminished the red aspect.

In the presence of Mr. Browning I made several experiments with red objects under the microscope, such as transparent pieces of dark orange-red glass, a red leaf of a fuchsia, and a red postage-stamp. The glass, as a transparent object, changes hue considerably as the amount of white (or yellow white) lamp light thrown through it is varied. The postage-stamp goes through similar changes as an opaque object, being very brilliant, and something between blood-colour and magenta, in full oblique illumination, and turning deeper and with a different hue as the amount of incident light is decreased.

To return to the Moon, we noticed, as Mr. Browning did, the remarkable distinctness and light tone of the margin of the eclipsed portion.

THE ABYSSINIAN EXPEDITION.

BY PROFESSOR D. T. ANSTED.

The expedition now leaving the shores of England, and the armed forces preparing to penetrate Eastern Africa from the side of India under the British flag, having for their primary object the rescue of a few Europeans (only three of them Englishmen) from the clutches of an African tyrant, cannot but add something to our knowledge of a district hitherto only visited by isolated travellers at long intervals. As the army is to be accompanied by a scientific staff to report on the geography, geology, and natural history of the countries visited, there is the more prospect of at least some return for the blood that must be spilt, and the treasure expended in the attempt.

It is not proposed here to consider the political aspect of the question involved, but as most of our readers will probably be glad to have some general notion of the physical geography of the country, we venture to collect together in a few pages a brief notice as to what Abyssinia is like, when and by whom it has been traversed, what is its climate, what are its resources, and what may probably be the difficulties the expedition will have to meet and overcome. A little information of this nature will serve to prepare us for the more accurate and extended information we may shortly expect to receive.

Abyssinia occupies an extensive tropical plateau, lying, for the most part, between a narrow strip of low land, forming the south-western shore of the Red Sea, and the important eastern branch of the Nile called the Blue Nile, whose sources were visited by Bruce. It is a compact four-sided area, lying between 9° and 16° N. lat. and 35° and 43° E. long. The coast of the Red Sea fringing it, and now partly occupied by Turkey, is about 600 miles in length from the Straits of Bab-el-Mandel to the northern extremity of Abyssinia. The other boundaries are Nubia to the north and west, and the Galla tribes towards the south. Within the country there are numerous streams, all feeders of the Nile; those to the north entering far to the north by the Albara, one of its main tributaries, and those to the south running directly into the Blue Nile. There are two lakes, one (Lake Tsana or Dembea) about sixty miles long, full of islands and abounding with fish. This is near the south-western part of the country, and not far from Gondar, the capital. It is also close to the sources of the Blue Nile. It is surrounded by a wide expanse of flat lands highly cultivated. The other lake is less important for its size, and is said to consist of a large extinct volcanic crater.

The shores of the Red Sea are low, swampy, and unhealthy, but the breadth of the low land is small, nowhere exceeding 100 miles, and towards the northern part of Abyssinia not more than sixty. There are several bays and roadsteads along the coast, but they afford few good harbours for large vessels, nor are they much known. Of the whole number Massowah is considered to be the one most available for the purposes of the proposed expedition. It is situated almost at the northernmost extremity of the country, and is eminently unhealthy in summer, but fortunately the distance from safe and healthy highlands is extremely small.*

* Of modern travellers in Abyssinia, Bruce was one of the earliest and most adventurous. He crossed from Sennar on the Blue Nile eastwards to Gondar.

There are few towns of the smallest importance in Abyssinia. Gondar, once the capital, is believed to be abandoned. Sokota to the south-east, Angol and Antalo to the east, Axum to the north-east. These are names of towns that appear on maps, but seem hardly to admit of description. The population has been estimated at between four and five millions, but this is probably a gross exaggeration. The inhabitants are the degenerate descendants of a civilized people, partly Jewish, partly Arab, partly Egyptian, who have once been Christians and still call themselves so, retaining the forms of a Christian church with many Jewish and Mohammedan customs. They are governed by a tyrant, now well known to us by name as Theodore II. He was born in 1818, and has led a turbulent existence, his so-called subjects being often in rebellion.

Much of the eastern side of Africa consists of a vast elevated plateau. Towards the northern part this presents the appearance of a ridge or wall of nearly 8000 feet, rising immediately from the sea, and often rapidly. When the plateau is reached, which is generally not without some difficulty, there is no corresponding descent on the side towards the interior of the continent. The summit of this great elevation is not indeed level, but it is everywhere very far above the sea. It is, however, frequently intersected by wide and deep ravines, sometimes descending 3000 feet to river valleys, and such valleys are not only very numerous but characteristic of the whole country of Abyssinia. Their breadth is sometimes more than twenty miles. The lofty plateau is so broken, and the gorges so deep, so numerous, and so wide, that the traveller is induced to fancy that the intervening ridges are detached mountains, or mountain systems, and describe them accordingly. There is no doubt, however, that there are lofty mountains in the interior, rising to at least 15,000 feet. The plateau is to some extent covered with lava, and on the coast hot springs have been observed, no doubt connected with the presence of the same rock.

The climate of Abyssinia is universally described as moderate, and, indeed, pleasant, and, with few exceptions, healthy. The nights are very cold, and the days, especially in summer, are hot, but the heat is nowhere excessive. There are rainy seasons, and the summer is generally dry, but in this respect there seems also no excess. During the four first months of

Salt followed at the commencement of this century for the east coast, but did not reach far into the interior. Dr. Beke has made several trips from the east, and penetrated far into the country. Two Frenchmen, Ferrel and Galinier, reached Gondar from Massowah (Red Sea) by another route. Mr. Mansfield Parkyns did not reach Gondar, but crossed, after reaching Adoua (half way), to the Nile below Sennar. There have been other travellers, but these have been the most adventurous.

the present year, at Magdala, where our fellow-countrymen are confined, the heat at sunrise was never less than 41° Fah., the usual range being from 44° to 55°. At noon the lowest point reached in the four months was 57°, and the highest 84°, from 60° to 80° being the general range. At sunset the extreme range was between 51° and 67°. There was rain on 19 days only out of the 120, and then chiefly at night. The air was generally calm. The sky was slightly clouded during January, March, and April, but clear in February. As Magdala is quite in the south, far in the interior of the country, and stands on an elevation by no means excessive compared with the general plateau, this may probably be taken as a fair estimate of the general weather of the winter and spring. Nearer the coast the rains are probably heavier, and the temperature more excessive, but there is nothing to render it likely that any serious difficulties will be incurred, either from heat or malaria, during the dry season. In May, however, the heavy rains begin, and from that time to October the country is less healthy.

It seems to be determined, from observations made by actual survey, that the best point to enter Abyssinia for a warlike expedition from India will be the island and port of Massowah, near Annesley Bay. The island is described by Mr. Mansfield Parkyns* as "a mere rock of coral, scarcely a mile long, and half that in breadth, without a vestige of vegetation to enliven its bare face" (Vol. i., pp. 77, 80). The climate in summer is detestable. Moncooloo, on the mainland, is about four miles from the anchorage of Massowah, and somewhat cooler and less unpleasant than the island. From this place the first terrace on the way up to the great plateau of Abyssinia is reached at Ailat, a distance of twenty-seven miles nearly due west. The plain of Ailat is already nearly 800 feet above the sea, and is reached with comparative facility by a gradual rise to an elevation of 989 feet, and then a descent of 200 feet. Water is obtainable about half way from a natural spring, but may always be found by digging a few feet. This terrace of Ailat is about five miles broad, and covered in winter with the richest verdure. Here are hot springs, that have been used from time immemorial for curative purposes, and are still frequented.

Without going so far as Ailat, it is easier to enter the high lands by branching at a certain point, and then the road is well marked by a number of stations, not more than ten miles apart, as far as Kiaguor, sixty miles from Moncooloo, and on the main plateau of Hamozeya, above 6000 feet above the sea. About thirty miles beyond is a very healthy spot, with a very

* "Life in Abyssinia," 2 vols, 1853.

strange name (Koodou-felassy on the maps), where every natural facility is afforded for a depôt. From here also several roads diverge, and this is the spot to which supplies from the interior seem naturally to come. It may be regarded as an admirable place for a first rendezvous, and might be reached in nine days by an army from Moncooloo.

Adowa is the next station, and is fifty miles beyond. It is reached after crossing the valley of the Mareb, one of the smaller of the deep and wide gorges alluded to. Adowa is upwards of 6000 feet above the sea, and is comparatively large, being the capital of the province of Tigré; and from this town the communication beyond would have to be made under any circumstances, as the various roads from the coast, of which there are several, all converge to it. The information concerning the roads up to this point has been obtained with a special view to the expedition, and is quite definite. There is a much shorter route from the head of Annesley Bay by Mahio and Dixan, traversed by Dr. Beke, and a third route, travelled by M. Munziger, which also appears to be practicable.

Up to this point it is not probable that any serious opposition could be made to an advancing army, but from here to Magdala, whether by way of Gondar, following the track of Ferrel and Galinier, or by a route more to the east, followed by Dr. Beke, to Debra Tabor, there seems as yet no settled plan of route. The distance hence to Debra Tabor cannot be much less than two hundred miles by any route, and may be more. To reach it, either the Taccazy River must be reached and ascended towards its source, or the eastern tributaries must be crossed, and the towns, Abiyad (40 miles), Autolo (30 miles), Samrie (15 miles), and Sokota (40 miles), made successive stations. Under any circumstances, there remains a considerable extent of little known and unknown country to be got over before Debra Tabor is arrived at. It may be that, along this line, the supply of water may fail, but this is not probable, judging from what is actually known of the country.

Debra Tabor would seem to be an important station, and a healthy and convenient summer resort. It is a town, built on an escarped hill, or fragment of table-land, not very accessible. It has been the habitation of the king during many of the discussions relating to the captives, and would probably have to be reached and taken. At a place called Gaffal, three miles from the town or mountain of Debra Tabor, Mr. Rassam speaks of there being an "European quarter," but does not describe it. Beyond the escarpment, to the west, there is a vast depression in the plateau of nearly a thousand feet, to the level of Lake Tsana, a little to the north of which is Gondar.

Magdala, the place of actual imprisonment, is described as fifty miles south-east from Debra Tabor, on a difficult road. It is on a plateau consisting of a small tongue of high land, about a mile long, and half a mile wide, level at the top, and only approachable from one extremity. A number of similar plateaux surround it, and they are described by Mr. Rassam as being formed (probably capped) with columnar basalt. They are separated from the country to the north by deep ravines and an intervening ridge, involving a double descent and rise within a comparatively short distance. There is reason to suppose that the way to Magdala from Sokota through the Lasta country, without approaching Debra Tabor, may be much easier and more accessible by an armed force than that described by Mr. Rassam as having been followed by him when obliged to go from Debra Tabor to the place of his present imprisonment in company with the king.

South of Magdala we are already in the country of the Gallas, well-known for their ferocity, and of Shoa, one of the most interesting countries of the Abyssinian highlands. It is not likely that the expedition could do more than reach and destroy a few of the hill forts, of which Debra Tabor and Magdala are examples. Nor does it seem that this task will be very difficult.

There is much natural wealth in Abyssinia. Dr. Beke describes good coal worked fifty miles from Gondar, to the west; and iron ore of extraordinary richness and excellent quality would seem to be so abundant in certain districts, that the whole country for long distances shows marks of it that cannot be overlooked. Copper also is talked of, although hitherto the localities where any available quantities may exist are not described. Gold is certainly abundant. Besides these and other metals, sulphur is plentifully distributed, and various salts are alluded to, some of which are present in vast quantities. The plains, enjoying different temperatures, according to their height above the sea, are capable of yielding crops to almost any extent, and the soil is almost universally good. Thus all the products of temperate, warm temperate, sub-tropical, and tropical climates appear united, and it is only for man to say what he desires to ensure possession.

The following extract from an able report by the late Consul, Walter Plowden, Esq., made to the Foreign Office in 1855, will show how rich is the country, and how melancholy the state in which it remains :—

"The flat lands round Lake Tana (Isana or Dembea) are kept as pasture for cattle, or partially sown with grain, but are adapted for the cultivation of rice, sugar-canes, and indigo.

"The cold plains and mountains are fitted for the productions of northern latitudes. The more temperate provinces would yield pepper, spices, and coffee, and the hottest districts give crops of cotton. Barley, wheat, peas, oats, beans, maize, millet, linseed, saffron, and some grain unknown to us, are cultivated with little trouble. A small potato called 'dennich,' and the root of a very nourishing banana, form great part of the food of some districts.

"At present not a fiftieth part of the surface is cultivated, while Edjow and other provinces produce two crops per annum on the same ground.

"Fruit-trees—the plum, the orange, the lemon, and the peach—grow wild in the jungle; the vines are luxuriant, and the quality of the wine excellent. Numerous streams everywhere irrigate and adorn this agreeable land, whose rich meadows, lowing herds, sparkling waters, golden harvest, and shady trees often present a scene of European beauty to the traveller." ("Correspondence respecting the British Captives in Abyssinia, presented to the House of Lords, 1866, p. 7.)

NOTE.—It may be interesting to the reader to be reminded in a few words of the history of the quarrel between Abyssinia and England. It is as follows:—Captain Cameron succeeded Mr. Plowden as Consul at Massowah, in February, 1861. At that time civil war had broken out in the country. Early in 1863 a letter from King Theodore to Queen Victoria was received and forwarded, in acknowledgment of some present that had been sent to the king, on account of kindness shown to the late Consul Plowden; and an embassy to England from Abyssinia was suggested in this letter. It was not till May, 1864, that a reply was despatched from England, Mr. Rassam, then Assistant Resident at Aden, being appointed to convey it. In February, 1864, however, news had arrived in England that Mr. Cameron, with seventeen other Europeans (chiefly missionaries and their families), were imprisoned at Gondar. Mr. Rassam in due time reached the king, and obtained release of the captives in March, 1866. They were, however, almost immediately recaptured, and, with Mr. Rassam himself, have since been in close confinement at Magdala.

ARCHÆOLOGIA.

THE great archæological event of the month has been, doubtless, the opening of the BLACKMORE MUSEUM, IN SALISBURY. The munificent founder of this interesting institution, Mr. William Blackmore, is a native of the city of Salisbury, though he has been established during, we believe, the greater part of his life in Liverpool and London, where he has amassed the wealth which has enabled him to confer this great benefit on the place of his birth. In a very excellent address delivered on the occasion we are briefly describing, Mr. Blackmore gave a history of the formation of his museum. In a visit to New York towards the end of the year 1863, he found the remarkable collection of the primeval antiquities of the valley of the Mississippi, formed by two world-known American antiquaries and explorers, Mr. E. G. Squier and Dr. E. H. Davis, for sale and undisposed of, and he bought them. They had been well described in one of the publications of the Smithsonian Institution, and Mr. Blackmore was well acquainted with their interest and value. This collection formed the nucleus of Mr. Blackmore's gatherings in archæological science; but as everything must have its limit, he gave his attention chiefly to a certain class of antiquities, which is now known by the not very good name of prehistoric, but would, perhaps, be better termed primeval. This was the term adopted at its commencement by the British Archæological Association for the earliest division of the archæological periods. It is hardly necessary to add that Mr. Blackmore's museum has become one of the most valuable collections of these primeval antiquities which are known to exist, and every one who looks over the catalogue of its contents will acknowledge that Mr. Blackmore pursued a wise judgment in restricting himself to a period, or rather, to a class. Had it been an indiscriminate collection of anything archæological that could be picked up, it would, perhaps, only have classed with the now numerous local museums which are almost unknown to science, but, as it is, it will be well-known to everybody that all who wish thoroughly to study the primeval antiquities of the western world, must go for their most valuable materials to the city of Salisbury. With so noble a museum in his possession, Mr. Blackmore was naturally anxious to prevent all chance of its being eventually dispersed by giving it some permanent habitation. Naturally, the British Museum presented its claim first; Liverpool, too, had many claims on Mr. Blackmore's consideration; but he resolved, we think rightly, on giving the work of, we may, perhaps, say, his affection, to the place of his birth. It is another example of that fine old mediæval feeling which has led so many great men to seek to identify by their munificent foundations their name with the town which gave them existence. We need only point to another example of this spirit in Mr. Joseph Mayer, who, in this same year, has transferred his own noble museum to the town of Liverpool. Mr. Blackmore has not only placed his museum in his native city, but he has built there a very handsome building, at his own expense, for its reception, and the conditions attached to the foundation are, that it shall be opened to the public without charge. The property is vested in three trustees, the founder, Mr. William Blackmore, his brother, Dr. Blackmore, and his brother-in-law, Mr. E. T. Stevens. One of the conditions of the trust is, that "should it be found that the people of Salisbury are insensible to the value of the museum, or indifferent to the means of study which it affords them, the trustees may, if they think fit, remove it to some place where it would be better appreciated and more thoroughly studied." This is a case which we think hardly likely to present itself. At present the museum is open free of charge every day in the week, except Saturday, from two to five o'clock P.M., and on Monday evenings from seven to nine P.M.

Some researches have recently been made on the site of the ROMAN LEAD-MINING WORKS, on the MENDIP HILLS, in Somersetshire. It appears that the Roman miners had nearly exhausted the mines in this district, and that modern mining has consisted chiefly in extracting the rather large amount of metal left in the refuse of the Roman smelters, through their imperfect smelting. The Roman cinders were found to contain, as is the case in other parts of our island, where the Romans obtained lead or iron, large per-centages of lead, varying from five or six in the slime of old washings, to ten and even fifteen in the other refuse. A field of about fifteen acres, on the Mendip Hills, four or five miles above Blagdon, belonging to Colonel Mackenzie, of Clifton, was remarked for the circumstance that neither cattle nor sheep could live upon the coarse grass which grew upon it. It bore the rather significant name of the Town Field, which arose, no doubt, from the foundations of buildings found in some parts of it. Curiosity having been excited by these circumstances, the ground has been dug into in several places, and it was found that not only was the soil largely impregnated with lead, but lumps of very rich ore and pieces of manufactured lead were found in the earth. With this encouragement, the exploration was continued, and many articles of Roman manufacture were found, among which were enamelled bracelets, a couple of richly chased gold rings, and large quantities of broken Roman pottery of various kinds. It is further stated that there were also found pieces of pots into which they ran the lead, with portions of the lead on them, and some of the furnaces, built of stones, in which the ore was smelted. Two or three well-made drains were found three or four feet underground, intended, no doubt, to carry off the sewage from the houses. Much of the earth has been found to be so rich in lead that it will pay well for working, in the course of which we may expect further interesting discoveries.

A question has been raised as to the sepulchral character of the great CIRCLES OF STONES, such as STONHENGE, AVEBURY, etc., and Mr. William Cunnington, the well-known secretary of the Wiltshire Archæological Society, stating that he had made numerous excavations within the circles at Avebury, and found no traces of sepulchral interment, and that in Scotland similar searches had been made with the great circle known as the "Stones of Stenness," in Orkney, with a similar result. We would suggest that in both cases the search was made rather under a misunderstanding. Had there been any sepulchral deposit in any of the great monuments of this class, we presume that it would probably have been above ground, and not beneath—perhaps in something resembling a cromlech, covered by a mound, which in the course of ages has been, through some cause or other, cleared away. We should not advise digging in the expectation of finding an interment of human remains, but with the hope of finding some articles of man's making which may throw light on the date of the erection of the monument. We confess, however, that though the origin and design of these great monuments is still a profound mystery, we can hardly imagine, from their magnitude, that they are sepulchral.

Mr. Roach Smith has given, in his "Antiquarian Notes," in the "Gentleman's Magazine" for September, an account of the remains of ROMAN TOWNS IN FRANCE, which we strongly recommend to all readers. It is written in the clear and instructive style for which that eminent antiquary is well known. These notes are the result of an antiquarian excursion in France, made during the month of August. At Champlieu, on the edge of the forest of Compiègne, are found the very remarkable remains of a town, the name of which is not known, with a theatre and temple, which have been entirely laid open, and have presented a very large collection of sculptures, and monuments of various descriptions, the more interesting of which are deposited in the great museum formed by the present Emperor, in the palace of Compiègne. Among these Mr. Smith points out agricultural implements in iron, utensils for cooking and other domestic purposes, personal ornaments in vast numbers, and especially the gilt leaden tickets for the theatre, at Champlieu just mentioned, which are circular in form, with figures of deities, and one or two inscribed with the word MEDIO and numerals, referring, as he supposes, to a central position in the grades of seats. At Mont Berny, near Pierrefonds, on the road from Champlieu to Soissons, another Roman town has been uncovered, and the ruins are again of a most interesting character. Mr. Smith calculates that the excavations already extend over about twenty acres, and this is only a part of the extent of the town. The rooms laid open, he says, may be reckoned by hundreds, some of large dimensions, many of middling size, but the far greater number small. The Roman name of this town is also entirely unknown. The objects found in the course of the excavations are deposited with those of Champlieu, in the museum of Compiègne. Mr. Roach Smith's excursion extended to Soissons, the *Augusta Suessionum* of the Romans, and to Laon, the *Lugdunum* of the Remi of Gallia Belgica.

It is perhaps worth our recording that early SEPULCHRAL INTERMENTS, consisting of cinerary urns of rather rude construction, sunburnt, and not made on the potter's wheel, have recently been found at Wavertree, near Liverpool. They are described as discoloured by smoke, as though burning matter had been put into them.

SEPULCHRAL DEPOSITS, undoubtedly OF THE ROMAN PERIOD, have also been discovered in digging for brick-work in a valley between Dover and Folkstone. They consisted of three urns, of rather unusual form, a skull, round which was a circlet of bronze, two tazzas, or cups, and a few brass coins of Severus, Constantine, and Posthumus. In one of the urns, which had been broken and mended with rivets before it was used for this interment, a bronze fibula was found. Another was ornamented with bands alternating with rows of knobs.

T. W.

PROGRESS OF INVENTION.

Utilization of Woollen and other Rags.—Hitherto, rags have been, with the exception of woollen, employed only in the production of paper, and other matters not constituting articles of clothing. Woollen rags have been formed into *shoddy*, a wool which has been rendered of an extremely short staple—and therefore is inferior as a material for textile fabrics—by the mode employed for tearing the rags asunder. A large amount of the shoddy found in commerce is little more than a woollen powder: yet there is no reason why the staple of the wool obtained from worn-out textile materials should not be nearly as good as it ever was, nor why the same wool should not be manufactured advantageously over and over again; in which case our stock of materials would, in practice, be greatly increased, and clothing, for the poor at least, be greatly and most beneficially reduced in price. Ingenuity has at length discovered a means of not only preventing the destruction or serious damage of a vast amount of wool, but also of disintegrating, without injury, other textile matters, and separating the woof from the warp, when this is desirable from their being of different colours or materials. After the fabric has been separated into threads, these are opened by suitable apparatus, so that the wool, or other fibre of which they are composed, is not broken or damaged. The contrivance used for the purpose is simple, and mainly consists of hooks judiciously ranged.

Substitution of an Electric Current for a Fulminate, with Fire-arms.—An application of electricity, more curious perhaps than useful, has recently been made in France. Instead of placing a fulminate within the cartridge, and thus rendering it liable to explode accidentally, a very fine platinum wire is inserted into it. This, by a simple mechanism, is connected at pleasure with two very minute galvanic batteries, which are enclosed in the stock, and becoming incandescent, explodes the powder. The arrangement acts extremely well; but, for various reasons, it does not seem likely to be ever employed in practice, except perhaps for artillery.

SCIENTIFIC MEETINGS.

The British Association met this year at Dundee, on the 3rd of September, and on the whole its proceedings were very successful, though its managers having mistaken the spirit of flunkeyism for that of science, had elected a President without information or attainments corresponding with his position, and the subject of their choice, the Duke of Buccleuch, was unable to prepare anything that could fairly be called an "address." One of the most important items in the Report of the Society related to the arrangements which the Board of Trade have sanctioned, and by which the Kew Observatory becomes the centre of a system of observations, constituting a "Meteorological Department," to be supported by the Government, and to furnish materials for publication.

The Council of the Royal Society, on the 13th of December, 1866, nominated the following Fellows of the Society as the Superintending Meteorological Committee: General Sabine, Pres. R.S., Mr. De La Rue, Mr. Francis Galton, Mr. Gassiot, Dr. W. A. Miller, Capt. Richards (hydrographer of the Admiralty), Col. Smythe, and Mr. Spottiswoode; and on the 3rd of January, this Committee appointed Mr. Balfour Stewart as its Secretary, on the understanding that he should, with the concurrence of the Kew Committee of the British Association, retain his present office of Superintendent of the Kew Observatory.

It is proposed to have observatories in the following places: Kew (central observatory), Falmouth, Stonyhurst, Glasgow, Aberdeen (probably), Armagh, and Valencia.

Different branches of science were fairly represented in the different sections, the general arrangements being the same as last year, except that the Anthropologists, with whose shallow pretensions the public are now pretty well acquainted, were not allowed a separate section for their chief occupation of abusing the negro. In the Physical section, Dr. Moffatt detailed some experiments and observations on phosphorus, and stated that phosphorus in a non-luminous state did not produce ozone, and looking at the sea as the chief source of that substance, he asked if it could not be ascribed to marine phosphorous which seems a doubtful opinion. Mr. Spiller described the employment of superphosphate of lime in aqueous solution for the purpose of hardening Caen stone. It acts upon the carbonate of lime forming Badiker's salt, 2 Ca O, H0, P0, +4 Ag. The igneous rocks of Scotland formed the subject of Mr. Geikie's address in the Geological section, and Dr. Sharpey gave a slight sketch of sundry physiological investigations. In the department of Anatomy and Physiology, Dr. Richardson recounted his ammoniacal theory of the coagulation of the blood. The address of Sir Samuel Baker in the Geographical and Ethnological section contained nothing worthy of note. In the Economic Science section Prof. Levi read the report of the Committee on the Uniformity of Weights, Measures, etc., in which the completion of the mural standard was announced. The Committee recommend making the metrical system compulsory, at no distant period. In the Mechanical Science section, Mr. Fernie read a paper on the iron and steel shown at the Paris Exhibition. He thought England had not been surpassed by France in any department. He mentioned a process of stamping, by which a complicated article, composed of several pieces were welded together, and stated that one English house had specimens equal to the French. The manufacture of steel in large masses by Krupp, and the Boceum Company, excelled anything of the kind done in England, the work of the latter being especially worthy of notice. Sir John Lubbock delivered an able address on the antiquity of man.

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BARBETS, AND THEIR DISTRIBUTION.

BY P. L. SCLATER, M.A., PH.D., F.R.S.,

Secretary to the Zoological Society of London.

(With a Coloured Plate.)

In my notice of the Bell-bird and its allies,* I spoke of the difficulties hitherto experienced in the introduction of living representatives of the great fruit-eating families of birds of the tropics into this country, which, however, we had recently succeeded in overcoming in several instances. A case in point is that of the Barbets—a tolerably numerous and well-defined group of zygodactyle birds inhabiting the tropics of both hemispheres, of which, as far as I am aware, no living example had ever been imported into Europe prior to the arrival of the specimen figured in the accompanying illustration. This bird, although not by any means one of the largest or finest of the "Bucconidæ," as the family to which it belongs is termed, is of interest as representing a form hitherto unknown in our aviaries, and as being endowed with special modifications of structure to adapt it to a peculiar mode of life. First, therefore, I will state what is known of the life history of the present species, and its immediate allies. Then I will endeavour to point out some of the principles which are exemplified by the geographical distribution of the group to which it belongs.

The Blue-cheeked Barbet was first described by the veteran ornithologist Latham in the latter end of the last century, and provided with the not very specially appropriate name *Asiatica*. Latham regarded it as a kind of Trogon, and, as Trogons were in those days supposed to belong to America exclusively, called it the "Asiatic Trogon, *Trogon Asiaticus*." This specific name, however, being the first given, we are compelled, in compliance with the general usage of natural-

* Intell. Obs., vol. x., p. 401.

ists, to adopt for the bird, referring it at the same time to the correct genus *Megalæma*. Subsequently to Latham's description this Barbet was figured by the French naturalist Le Vaillant in the second volume of his large illustrated work "On Paradise Birds and Rollers." It has likewise been provided with other names by different writers on ornithology, with an account of which we need not trouble our readers.

The native country of the Blue-throated Barbet is the eastern portion of British India. It is found throughout Lower Bengal, and extends northwards along the sub-Himalayan region, as far as the Dehra Doon and Kumaon. Eastwards it occurs in Assam and Sylhet, but is stated to be rare in Arracan and Tenasserim.

Within this area the present bird would appear to be rather an abundant species, and to have attracted the notice of many of the Indian field-naturalists, who have furnished us with some interesting observations on its habits. Professor Sundevall, whose notes on the birds met with in the vicinity of Calcutta have been translated by the late Mr. Strickland, tells us that this Barbet is common near that city in the months from February to May, and feeds on berries, which were always found broken in its stomach. It is a solitary bird, and like others of the same genus, remarkable for its loud note, which "may be expressed by *rokurog! rokurog!* the middle syllable being uttered in a higher key than the other two. Both sexes cry in the same manner, sitting still, with outstretched neck; at intervals they were seen to spring aside, or transversely across the branch, with considerable activity."

Major Pearson remarks that this species is common in Bengal, but less so in Orissa, and that he did not observe it at Juanporè. "It has a peculiar habit, when perched, of bowing the head, accompanying each motion with a single note resembling the word *hoo*. It has two broods—one in the month of May, the other in November."

Mr. F. Buchanan Hamilton, in his MS. notes quoted by Mr. F. Moore, states that the Bengalee name of this bird is "*Bassunt bari*," or "Old Woman of the Spring," probably from the noise that it makes at this season of the year. He gives its food, as "wild figs, plantains, and other fruit."

Lieutenant-Colonel Tickell, a well-known Indian field-naturalist, has described the nest of this bird as hemispherical, composed of dry grass, and placed externally upon a tree. But there can be no doubt that he has been misled on this point, for all the Barbets nest in holes of trees, and, like other birds that lay their eggs in similar situations, produce white eggs, and it is hardly possible that this species should prove an exception. Indeed, we are told by another equally trustworthy observer,* that the Blue-cheeked Barbet "excavates holes in trees for its nest."

Besides the Blue-throated Barbet, some eight or nine species of the same genus are found in India. About fifteen others are known, all of which inhabit different portions of the "Indian Region," that is South-eastern Asia and the large adjacent islands of Sumatra, Borneo, Java, and the Philippines. There are also found within the same area two other nearly allied forms of slightly different structure, namely, *Psilopogon*, with one species peculiar to Sumatra, and *Megalorhynchus*, with two species found in Malacca, Sumatra, and Borneo. We have thus altogether about twenty-six known Indian species of this family, which in their habits and mode of life do not materially differ from *Megalæma Asiatica*.

In the forests of Africa we again meet with numerous representatives of the same family, belonging, however, according to the best authorities, to genera different from those of Asia. These are the Barbets of the genera *Barbatula*, *Gymnobucco*, *Læmodon*, and *Trachyphonus*, which are distributed over the wooded districts of Abyssinia, and the adjacent portions of East Africa, are found throughout the tropical forests of Western Africa, and extend southwards nearly to the vicinity of Cape Town. The well-known African traveller and naturalist, Theodor von Heuglin, has written an excellent article upon the Barbets of Eastern Africa, in the "Ibis" for 1861,† and M. Jules Verreaux, of the Jardin des Plantes, has given a complete list of the known African species of the family, in the Zoological Society's "Proceedings" for 1859.‡ From these authorities it would appear that there are at present known about twenty-five African Barbets belonging to the genera above mentioned. We have no such accurate account of the habits and manners of these birds as of the Indian Barbets; but from the following general remarks of Heuglin there would appear to be little deviation on these points. Of the Barbets of Eastern Africa, Heuglin says: "With the exception of the *Trachyphoni*, the *Capitonidæ* are not shy birds, though quiet and solitary, and always keeping to the high trees and bushes. The *Trachyphoni* are frequently seen in the plains, and although also shy, are of a much more lively and wandering nature than the *Pogonorynchi* and *Barbatulæ*. The note of the *Trachyphoni* is loud and very melodious; they run (though in a different way from Woodpeckers) up and down the trunks of trees, feeding upon insects, berries, and fruits, as they hop

* Buchanan Hamilton.

† See his article on new or little-known birds of Eastern Africa, "Ibis," 1861, p. 121.

‡ P. Z. S., 1859, p. 393.

from branch to branch. Their flight is short, but rapid; their course consisting of a series of numerous undulations. I never saw any of the species of this group on the ground. I am not acquainted with the mode of propagation of these birds, except that *Trachyphonus margaritatus* builds in holes of trees, and lays white eggs, usually from four to six in number. In the months of October and November, I have often seen half-fledged young ones of this species clustering together, in the peculiar way that may be observed in some of the European genera (*Parus*, for instance), and sitting on the smooth side of the small branches, chirping as they await their parents. With raw flesh and hard and soft-boiled eggs, I have kept some of them a long time in confinement."

"The *Capitonidæ* of North-eastern Africa are not exactly migratory, though they appear at the time when the Sycamores (*Ficus sycamorus*) are ripe in countries where they are not generally met with."

On crossing over the Atlantic to tropical America we again meet with Barbets of organization and habits nearly similar to those of the Old World, but neither so widely distributed nor so abundant in species as their brethren of Africa and Asia. Only two forms of American Barbets are yet known to science, namely the genera *Capito* and *Tetragonops*, the former with fourteen and the latter with two species.* The latter is the most aberrant form of the whole family—that is, that which departs farthest from the general character of the group—and shows many points of resemblance to the Hill-toucans (*Andigenæ*). There can be no question, indeed, that the Barbets are closely allied to the Toucans (*Rhamphastidæ*), and should be placed next to them in the natural series; and to those who hold the doctrine of the derivative origin of species, it is interesting to note that the most Toucan-like Barbets inhabit the same region as the most Barbet-like Toucans.

It appears, therefore, that in the case of the Barbets, we have an instance of members of the same natural family of birds being met with in the tropics of both the Old and the New World. And this is a very noteworthy fact, for it must be recollected that, as a general rule, the avi-faunas of these two regions—that is, the general series of the birds which inhabit them respectively—are perfectly distinct from one another. Not only are the species—if we except some few wandering forms of nearly universal distribution—invariably distinct from one another, but in nearly every case these species are referable to different genera, and, as a general rule, it may even be stated that the most characteristic birds of these two regions

* See the Author's articles on the American Barbets, in the "Ibis," 1861, p. 182; 1862, p. 1; and 1864, p. 370.

belong to different families. For example, humming-birds (*Trochilidæ*) are very numerous all over the Neotropical Region—under which name are comprised Central and Southern America—but are quite unknown in Asia and Africa. In the same category we may place the toucans (*Rhamphastidæ*), Jacamars (*Galbulidæ*), motmots (*Momotidæ*), puff-birds (*Bucconidæ*), curassows (*Cracidæ*), tinamous (*Tinamidæ*), and numerous other families which are more or less generally distributed throughout Central and Southern America, but are not found in the tropics of either Africa or Asia. In the same way, the bee-eaters (*Meropidæ*), hornbills (*Bucerotidæ*), rollers (*Coraciidæ*), sugar-birds (*Nectariniidæ*), honey-guides (*Indicatoridæ*), orioles (*Oriolidæ*), and other families, are characteristic groups of the ornithology of the Old-World tropics, but are not known to exist in the New World. The cases where members of the same natural family of birds are met with in the tropics of both hemispheres are mostly those in which the families are of extended geographical distribution. For example, the falcons (*Falconidæ*), owls (*Strigidæ*), swifts (*Cypselidæ*), swallows (*Hirundinidæ*), and thrushes (*Turdidæ*), are widely diffused families, which are represented in every part of the earth's surface, and are abundant in the tropics of both the Old and the New World. In the same category may be placed most of the families of waders and water-birds, which are usually of very wide range—in some few cases even the same species occurring in every part of the world. But it is quite an exceptional case for a family of birds confined to the tropics to be found in both hemispheres, and besides the Barbets, the only well-defined families presenting the same phenomenon of distribution are the parrots (*Psittacidæ*) and the trogons (*Trogonidæ*). Members of both of these groups, as in the case of the Barbets, are found in the tropics of Africa and Asia as well as in those of America.

Now, assuming the derivative origin of species—that is, the descent of the various members of natural groups (whether we call them genera or families) from a common ancestor at a more or less distant epoch, let us see what deductions may be derived from these facts of geographical distribution.

In the first place, looking to the general diversity of the avi-faunas of the tropics of the two hemispheres, it is evident that the lands which constitute their seats must have remained, as they now are, for a long period of ages, separated by an extensive barrier of ocean. Upon no other hypothesis than this can the number of extensive groups peculiar to each of them, and the general dissimilarity of the two avi-faunas, be explained.

But on the other hand there must have been a time when these two regions, now so widely separated, were linked together by an intervening band of tropical land. In no other way can we account for the presence of Barbets and trogons in the tropics of each hemisphere. It is hardly possible to imagine that the common ancestors of these two families, which from their whole organization are essentially denizens of the tropics, were themselves extra-tropical. In the case of the parrots, however, we have probably to deal with a very ancient and long-enduring stock, which may have been formerly cosmopolitan,* and members of which are even now found in the temperate regions of the southern hemisphere.

ON THE STRUCTURE AND MANNER OF GROWTH OF THE SCALES OF FISHES.

BY JONATHAN COUCH, F.L.S., C.M.Z.S., ETC.

Of the vast number of the known species of fish, amounting to several thousands, a large proportion have the body covered, and in numerous instances the head also, with scales; which, for the most part, are so arranged, as to form an armour of defence, as well as an adornment of beauty, that grows with their growth without an increase of number, and by its permanency differs in essential properties from those scales—not very unlike in appearance, and even in some of their uses—which clothe the bodies of reptiles; but which latter, when once formed, are incapable of growth. To enable them to be accommodated to the increase of bulk of the animal, these latter must be thrown off, together with the skin that bears them, to be succeeded by another crop, which is altogether new—a circumstance that does not take place in any species of fish with which we are acquainted. There is, therefore, a much closer relationship between the scales of fishes, of which we have now to treat, and the spines and plates, however otherwise unlike, which we find scattered over or covering the bodies of some other families of fishes, especially as regards their mode of increase in size—a fact to which, on another occasion, our attention will be directed, as showing an example in which an apparently different result is obtained by a simple

* Groups of general distribution over the whole world's surface, such as the falcons (*Falconidæ*), and the ducks (*Anatidæ*), are called "*cosmopolitan*." Groups confined to the tropics, rich as the barbets, trogons, and parrots, may be called "*tropicopolitan*." Another class of natural groups is confined to the northern portion of each hemisphere, and may be termed "*arctopolitan*." Such are the awks (*Alcidæ*) and the grouse (*Tetraonidæ*).

variation in the order of proceeding. But for the present our inquiry is addressed to that kind of organization which we designate a scale, and of which the intimate structure and manner of growth have obtained little notice from naturalists, although in their nature they are well worthy of inquiry. The illustrious Cuvier had directed his attention to the subject, and with some degree of success, as was certain to be the case with whatever he took in hand. But it is apparent that his observations are not in all cases to be relied on; and from what appears in the translation of his "Animal Kingdom," there seems reason for believing that they were not made over a wide extent of the families of fishes that had passed under his notice. But the interest of this subject is such as to deserve a more intimate examination; and so much the rather, as in its pursuit we may find it to assist us in ascertaining something of the affinity of what might appear distantly removed species; and also it may point out some adequate explanation of the fact, that some sorts of fishes, even in families well supplied with this clothing, have them altogether concealed within a smooth and soft skin, and others nearly related to them are altogether destitute of them. In this latter case we may remark, that in many instances the internal and external layer of the skin are separated by a thickened layer of what may be termed a *retè mucosum*, or soft cellular network; in which case the surface of the body remains moist for a longer period when it is exposed to the air; and this may be the cause why some fishes are capable of living long when out of their native element. Experiment has shown that there are fishes which speedily become lighter in weight when exposed to air, while others diminish but little. There is reason also for believing that if some fishes, when out of the water—of which, as an instance, some of the blennies may be mentioned—be frequently wetted over the surface of the body, to the exclusion of the gills, the skin alone will perform a function that shall long sustain the life. It would even appear that such is the case also with some fishes which cannot properly be said to be without scales, although generally so regarded—as the common eel, in which they lie embedded beneath the surface, but are visible on close inquiry, and of which a satisfactory magnified representation is given in the Honourable Mrs. Ward's "Microscope Teachings," Pl. V., Figs. 8, 9; but nothing similar has been discovered in a fish so closely resembling it as the common conger. It is in remarkable contrast with this that the power, one of the Gadoid fishes, becomes deprived of its scales very readily; while the ling, which belongs to the same family, is not furnished with scales, so far as we are able to ascertain; and the megrim, or scaldfish among the flat fishes

(*Pleuronectidæ*), is rarely seen with a scale on it, while others retain them firmly, and again others of the same family are not possessed of any. The anchovy loses its scales so readily, that Belon, who was an observant naturalist, believed it to be without them. The herring also, and pilchard, will lose them without much violence, but the shads, which are of the same family, retain them rather firmly. But whether held loosely or firmly, in every case the scales of a fish are clothed to their free borders where there are such, with the common skin, of which a duplication is carried over that border to the lower surface, so far as it remains free; by which it is arranged that each scale becomes enclosed within a case or cell, of which the anterior border is overlapped by the next preceding one, and the firmness with which it is held depends chiefly on the extent to which it is thus overlapped. The cuticle which covers the more exposed and looser portion of the scale is sometimes exceedingly thin, and therefore feeble; but it is the portion of the surface which furnishes the colour, and from which, in some degree, the substance of the scale obtains its nourishment and growth, although this latter is chiefly from a lower and less coloured portion of the case or cell. In some instances the scale itself, and also its covering skin, are so transparent, especially in individuals of early growth, that an exudation and deposit beneath it becomes conspicuous through its substance, of which we shall produce some examples. But the growth or expansion of a scale, as the fish advances in size, is the more material property of its nature; and this, on close examination, will be found to have its source of nourishment and increase from about the middle of its surface, and from which it spreads itself on all sides, although in a greater degree to its free edge and its root, which latter lies forward in the direction of its body. It is at about this middle portion of the scale, but varying a little in situation in different species, that we discover an organized disk, into which, as we can perceive in the larger scales of fishes, there are vessels inserted, and those not always of a very minute size; but those that pass to each surface of a scale may be distinguished from each other, as well in arrangement as capacity; and it is from this circumstance we draw the conclusion that the scale itself consists of a double layer, like that of the nail of the human finger and toe; although, in the generality of instances, the structure is too fine to allow of our obtaining a positive proof of the fact.

The examples which will be selected for description will illustrate these remarks; but although there is a general resemblance in the marking of the scales of each species, the outline of their shape is found to vary much according to the part of the body from which they are taken. Those which clothe the back, and especially nearest the head, are the smallest, and they are often oblong and crooked; and those along the line of the belly, especially in the pilchard and sprat, are of singular shape. Our examples, therefore, as offering the best illustrations of the growth and character, are taken from the side, where the outline is the most regular and the structure most easily discerned. In general, the scales of the lateral line are nearly alike in each family, but with a subordinate variation that renders them in some degree peculiar to the individual species, as we shall notice in the common sea-bream, *Pagellas Centrodontus*. The special purpose of the structure which so generally marks the scales of the lateral line is to secrete and pour out a peculiar fluid, that is intended to lubricate the general surface, so as to enable the fish to pass the more smoothly through the water, and perhaps also to secure it from any ill effect of the fluid in which it swims; and it is observed that this mucous does not speedily diffuse itself amidst the surrounding water. Those fishes which have few or no marks of this structure in a lateral line, or which seem to require an additional supply of this lubricating fluid, are also provided with additional pores about the head and mouth for the same purpose.

Of the scale of the perch, *Perca fluviatilis*, a representation is to be found in the work "Microscope Teachings," Pl. V., and also of the sole, *Solea vulgaris*. The scales of the perch are of good size in proportion to that of the fish, for the most part wider than long, with a disk rather obscurely marked, more than three-fourths of the length towards the free edge, and from which pass backward toward the covered portion or roof five or six lobes, of which those toward the border are the widest; those in the middle narrow, with their narrowest portions meeting close together at the disk, and all of them showing separating marks of growth. At the free edge are short fine points, from each of which passes back to near the disk a line, of which each is marked with a cross line in succession, as if each had advanced by successive starts of progress. This disk, therefore, appears to form the centre of all its growth, as well in regard to length as breadth, as we shall see it does in every other instance, and conspicuously in that of the *Sciœnae (S. Aquila)*. The scales of this latter fish are large, so that in a full-grown example one of them would cover a florin; but in their shape, or on different parts of the body, they vary more than in most of our native fishes. Many of them taken from one fish appear as if they had been injured, and had recovered the injury as by some natural process of vitality. The disk, which is slightly nearer the free edge than to the root, is large, and covered with apparent orifices, which do not penetrate through the scale; and toward the free edge there are numerous lines or ridges, which come from the disk, each of them being joined to the next by a cross line in regular order. This series of lines ends abruptly at each border of the scale, where it is narrower than in the middle, and from this ending begins a series of fine lines, which encircle the disk, from which portion of these lines the perforations are continued in the same manner as on the disk itself. From the disk again there passes toward its root a large number of diverging lines, of which some are divided in their progress, and each of them is separated from the next by a narrow channel; but such of these diverging lines as are nearest the lines of the border which encircle the disk, end as they approach to them. On all the scales of this fish that came under observation there were apparent marks of the suspension of growth and its renewal; and, in one instance, the disk appeared to extend over the whole breadth of the scale. A large number of fine circular lines, of which about fifty were counted, pass round the disk, and are also marked on or across the diverging lines, or sections, that are carried to the covered root. When fresh from the fish these scales were observed to be smeared or lined with a silvery pigment. The description now given at some length of the scales of the *Sciæna* will apply in its principal character to those of a large number of fishes of somewhat similar shape, with the addition that in several of them, as the river perch, the raised lines or minute ridges which pass from the disk to the free edge, are carried still further forward, so as to form a serrated border, which constitutes a rough surface over the otherwise smooth skin. Such is minutely the case in the comber, *Serranus cabrilla;* the common sea-bream, *Pagellus centrodontus;* surmullet, *Mullus surmuletus;* piper, *Trigla piper;* conspicuously in the top-knot, *Rhombus hirtus,* where the border of the scale is turned outward; but this spicular arrangement is so minute in some species, as the shad, *Clupeidæ,* that its existence might be questioned. The object of it seems to be to afford an additional bond of security to the scale, for the skin is found to pass over these projecting points.

The disk which is thus the centre of extension in growth is not always exactly at the middle of the scale, as it is in the old wife, *Cantharus griseus,* where it reaches across its extent; and the scad, *Caranx trachurus,* top-knot, saury, *Scomberesiox saurus,* and many others; especially including the whole of the cod-fish tribe, the hake; but in many cases, as the perch and sea-bream, the disk is much nearer the free edge, in which case the growth towards the more concealed root must proceed to a larger extent, and perhaps more rapidly than toward the free border. The raised lines or sections which proceed toward this covered portion of the scale, and to which reference has already been made, are sometimes carried out in a crenated form, as in the sea-bream, and conspicuously in the perch, as also in the *Labridæ* or wrasses, where the common wrass, *Labrus balanus* shows a large number of them, together with an extensive disk; but in some instances those on the side are more lengthened out, and in others, as the pike, *Esox lucius*, and piper, *Trigla piper*, where the number is only three, the middle segment extends beyond the others. The atherine, *Atherina presbyter*, can scarcely be said to have more than one, but the scale of this fish is marked with a structure that forms a special character in another genus, the *Clupeidæ*, the herring, and pilchard, to which, therefore, that fish may seem to bear some distant affinity. It consists in some well marked hard lines, which, behind the disk, pass from one border to the other, but apparently with particular reference to a middle longitudinal depression. These somewhat waved crossing lines are so formed in their intimate structure, that when the scales are in partial decomposition, the separated portions cease to adhere to each other, except where they are brought together at the longitudinal depression which proceeds from the disk.

The scales of the lateral line are those only which require further general remark, and their organization is for the particular purpose of being the channels through which a lubricating fluid shall be conveyed from a secreting order of vessels beneath them to the outer surface. This channel usually lies along the middle of the scale that bears it, with its opening directed toward the tail of the fish; at near its extremity this is often divided into branches, as in the case in the *Sciæna*; but even in the same fish all these branched channels are not exactly alike, and in the sea-bream they have some curious arrangements of direction; their direction being on the upper border of the lateral line, but covered by the scale next before each one, yet through which it may be seen, while the orifice points to the lower border, where it is bent a little, by which means the thin edge of the coverring scale slightly covers the order of the tube. It is thus that the lower side of the tube is above the apparent lateral line, although close to it.

That the conclusions here advanced on the intimate structure of the scales of fishes, and their mode of growth, as well as the affinity of their structure, have not been obtained from very limited observation, will appear from the following list of species that have been subjected to examination; which with some further particulars of their peculiarities, are given in the order in which they were studied, but with the exception that those of the same genus are now classed together.

Trigla cuculus.—The scales appear obscurely, as if in rows, almost perpendicular to the sides, and not appearing to overlap each other; and yet they lie much as in other fishes, but with the widest part concealed by the skin; so that only the outermost portion appears. On the upper part of the body each alternate row is more raised than the next; but in some parts irregularly so.

In *T. lineata* these lines of scales are much more strongly marked than in *T. cuculus*, as well by their colour as linear arrangement, and in both cases more plainly when they have become dry.

T. gurnardus, T. piper.

Ammodytes Tobianus.—This fish is placed next to the gurnards, because of the somewhat similar arrangement of its scales with that of *T. lineata*, but the rows are more oblique.

Labrus balanus.—A particular formation in the scales of this family is, that not only is the (commonly finely-coloured) skin carried under the fore edge of each scale, but in the form of a membrane it is extended a little beyond it. This covering skin is rather loosely attached to the surface in which it is enclosed; but it is held firmly by a band or process which proceeds from a stout and tough membrane that lies on, and is firmly fastened to, the flesh beneath. In *L. coquus* they are still adhering by a process below them, as in *L. balanus*, although more feebly.

L. cornubicus.

Mullus surmuletus.—The scales are but loosely fastened, and yet the strongest bond is on the under surface of the disk; and toward the free edge there are perforations, and vessels that pass toward the root; among which are two that are larger than the others, and which lie along the lines or channels of the hindmost crenations. These vessels are not clearly marked in all the scales; but it cannot be doubted that they exist in all, and thus they serve to demonstrate, as in other instances, that the centre of action is in the disk. Of the gorgeous colours of this fish, which are in perfection only in life, the yellow of the lines, and also a tinge of red, are in the skin covering the scales, the yellow being especially over the disk; but there is a strong border of bright red in the skin beneath, toward the free edge, and which shines through the transparency of the scale. The more vivid colour of the yellow is also below the scale.

Pagellus centrodontus.—The scales in some degree resemble those of the surmullet, but are smaller; and those of the lateral spot are somewhat different from the others in some particulars beyond the colour.

Clupea pilchardus.—In all the examples examined there has been found a peculiarity of which there has not been seen anything like it in other sorts of fish, but the nature of which appears exceedingly obscure. It is, that below the lower portion of many of the scales, and not of all, and not always in exactly the same place, there has been a separate very small scale—one or more, even to three or four. They resemble in a considerable degree, both in size and figure, as well as in organization, the scales of the trout; and they never occur behind the middle of the covering scale, while the latter are as firmly fixed as any of the others. One of these small scales only was seen to have points at its edge.

Cluper harengus, Engraulis encrasicholus, Alosa finta; A. squamopinnata, mitri.

Serranus cabrilla, Sebastes norvegicus.

Esox lucius.—A peculiarity is, that the lobes of the crenations at the inner border on the left overlap each other.

Belona vulgaris.—Although the bones of this fish are naturally green, the scales are not so, except from the colour of the skin that covers them.

Pleuronectes punctatus, Rhombus vulgaris.

Salmo trutta.—The scales, as in all of this tribe, are small and thin, with a shining pearly look; the cause of which is not in the scale itself, but it proceeds from a bright deposit or lining on the lower surface, and may be easily removed. Such is the case also with some other fishes, and in the young salmon it appears to be formed at that period of its growth when a migration to salt water has become necessary to its well-being. The scales of *S. trutta* are attached chiefly, if not solely, at the disk, and that not firmly. *S. Fario.*

Scomber vulgaris, Sc. scriptus, Nobis, Ausonia Cuvierii.

Brama Raii.—In the axilla of the pectoral fin is an arrangement of scales formed in the likeness of a moveable cover, and which in size and shape differ from those of the rest of the body.

Naucrates ductor.

Among the fishes of the genus *Gadus* the scales are small, and of the simplest form, which does not require particular remark.

Several kinds of fishes, also, from the Upper or White Nile, have been studied, with the same object, of observing the peculiarities of their scales; but in this they do not differ from our common kinds.

THE GRAVE-MOUNDS OF DERBYSHIRE, AND THEIR CONTENTS.

BY LLEWELLYNN JEWITT, F.S.A., ETC., ETC.

(*With a Plate.*)

(*Continued from page* 189.)

THE FLINT implements found in the Derbyshire grave-mounds are extremely varied in form, and many of them of the most exquisite workmanship—such indeed as would completely baffle the skill, great though that skill undoubtedly is, of "Flint Jack" to copy. The arrangement, classification, and nomenclature of flints is at present so uncertain, and so mixed up with absurd theories, that it is difficult to know how to place them in a common sense manner. All I shall attempt to do in this present paper—which is intended to describe, generally, the relics to be found in the barrows of Derbyshire, and not to be a disquisition on flints alone—will be to give examples of some of the more usual forms which have from time to time been found, so as to facilitate comparisons with those of other counties and countries. Of *arrow* and *spear-heads* and "*dagger-blades*," almost every known form have, at one time or other, been exhumed in Derbyshire. The engravings here given will pretty well show the most general and best developed shapes. The first represents three barbed arrow-heads, and a dagger-blade, (6 inches long) from Green-Low. The arrow-heads are of the most general types of the barbed variety, but they are not unfrequently found of a longer, and consequently more taper, form. The dagger-blade is of what is usually called the "leaf-shaped" type, and is the prototype of the bronze dagger of a later period. Another, and of perhaps much finer form, is shown on the accompanying plate, Fig. 1. It was found at Arbor-Low in June 1865, and is $5\frac{7}{8}$ inches in length and nearly $2\frac{1}{4}$ inches in width in the centre. In its thickest part it is scarcely

$\frac{3}{8}$ of an inch in thickness, and is chipped and worked with the utmost nicety to a fine edge. It will be noticed that its sides as they begin to diminish, are deeply serrated for fastening with thongs to the haft or handle.* The next illustration shows three of the most usual types of the leaf-shaped arrow-heads—which are here, in each instance engraved of their full size. On our plate is also shown (Fig. 2) a remarkably elegant example. A small disk of flint is also shown on the same plate. The form of this variety of flint instrument (the leaf-shaped arrow-heads) it will be seen differs considerably, ranging from the acutely angled and sharply pointed shapes to those

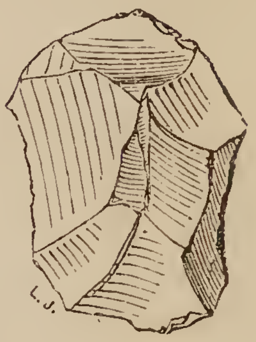
of a nicely-rounded and egg-shaped form. Pl., Figs 4 and 5 are two characteristic examples of peculiarly-formed flints, which are not unfrequently found in Derbyshire, but the use of which has not at present been satisfactorily ascertained, and which I believe have seldom before been engraved. In a classification of the flints of Derbyshire, and a comparison of their forms with those of other districts, which I am engaged upon, I hope to throw considerable light on the different types, their peculiarities and uses.

Another description again, which appears more intended for throwing than for any other purpose—and which with its sharp cutting edges, and the unerring aim of the Briton must have been indeed a deadly weapon—is frequently found, and is shown on the plate Fig. 6. It is a simple circular lump of flint, an inch and half, or a couple of inches, or more, in diameter; flat on one side, and chipped into a roundness on the other. Scrapers, too, are very generally found, and are of the usual forms.

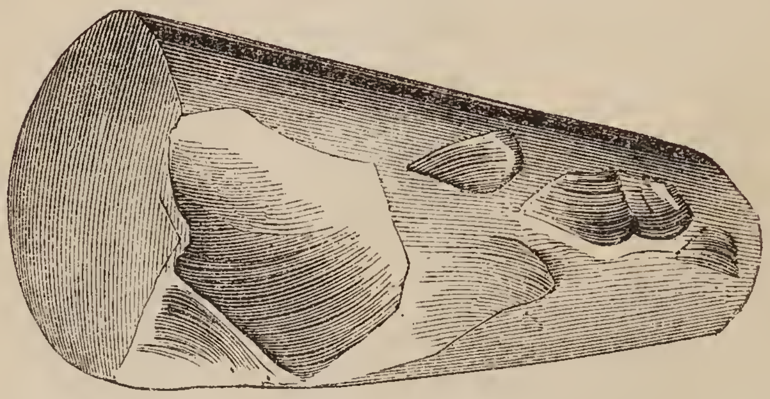
Flakes, of various sizes and forms constantly occur. These

* This fine specimen is in possession of my friend Mr. Lucas.

are frequently called flint knives, or scrapers, but the term is so

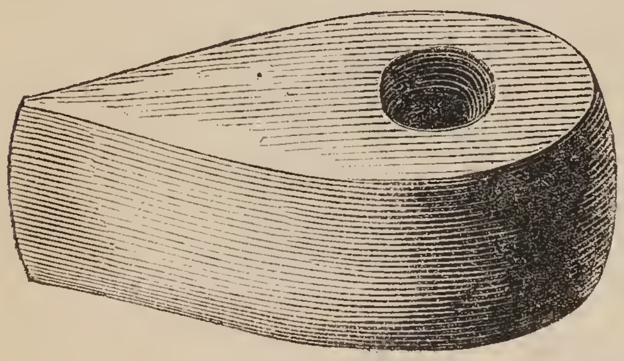


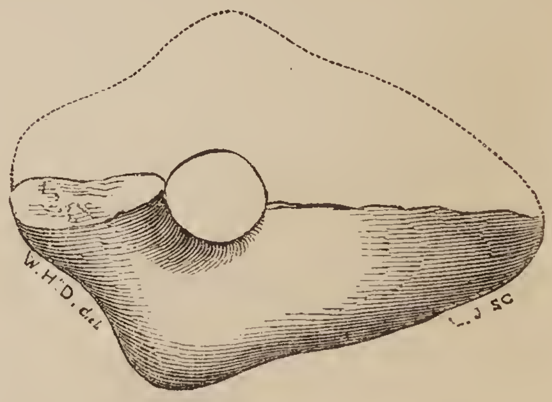
indefinite that it is for the present better discarded than retained. Flint celts are occasionally found. An example here shown was discovered in a very interesting barrow, called Gospel Hillock,



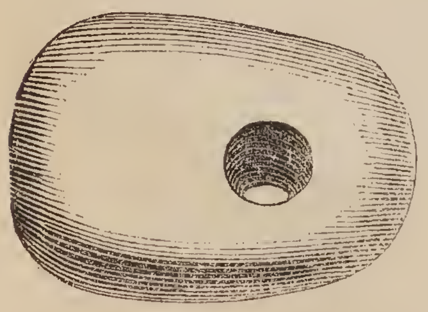
at Cow Dale near Buxton,* by Captain Lukis. It measured $4\frac{1}{2}$ inches in length.

The Stone implements consist of celts or adzes, and hammer-heads; the usual form of the Derbyshire stone celt is much the same as the flint example just given, but other shapes do occasionally occur. The examples here given, show three of





the forms of hammer or axe-heads, or mauls, which are found.



In size, these implements vary from three to eleven inches in length.† The usual materials of which they are composed are basalt, quartz-pebbles, argillaceous slate, jasper, green and black schist, sandstone, etc.

Whetstones, spindle whorls, balls of

* See the "Reliquary," vol. viii. (1867).

† The largest found in Derbyshire of which I possess any record, measured 11 inches in length, $4\frac{3}{4}$ inches in width, $3\frac{3}{4}$ inches in depth, and weighed $10\frac{3}{4}$ lbs.

FIG. 1.

FIG. 4.

FIG. 5.

FIG. 3.

FIG. 2.

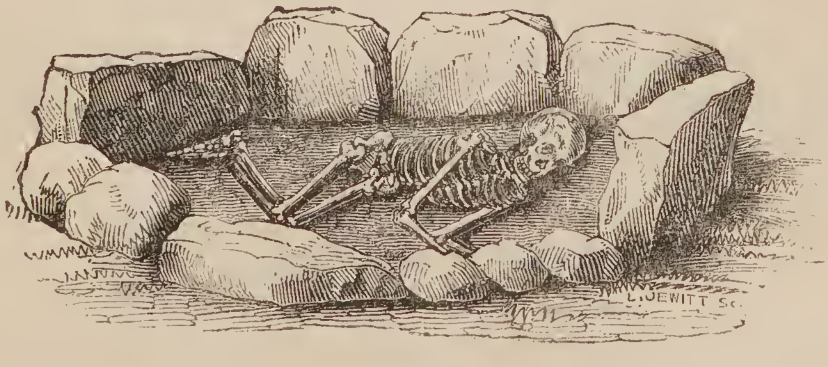
FIG. 6.

FLINT IMPLEMENTS FROM DERBYSHIRE.

sandstone, querns, triturating stones, capsular stones, and other objects are also found.

In Jet, the articles found, consist of beads, rings, studs, necklaces, etc., and some of these are of the utmost beauty. Of these, perhaps the finest examples which have been exhumed are those found by Mr. Bateman at Middleton Moor, at Grind-Low, at Windle Nook, and at Cow-Low.* The accompany-

ing engraving represents the first of these which was found in a barrow on Middleton Moor (near Arbor-Low). In this barrow



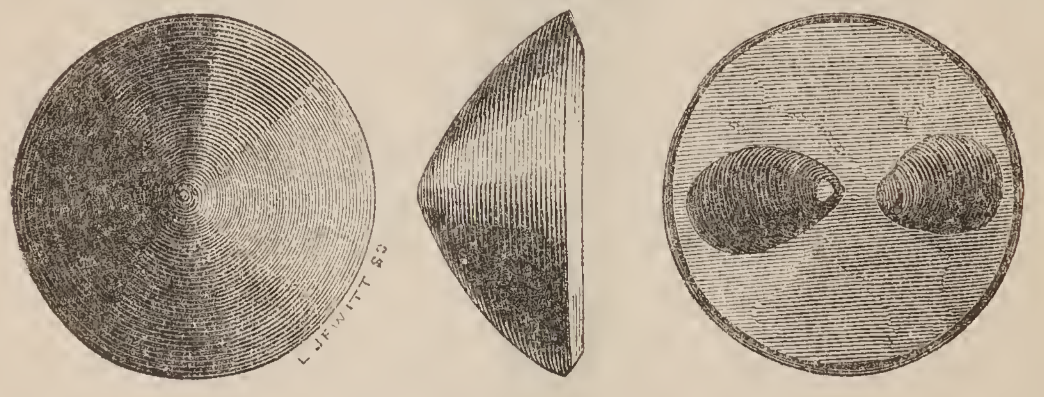
the primary interment was enclosed in a rude stone cist or

† These four examples are engraved in Mr. Bateman's "Catalogue of Antiquities" and "Ten Years' Diggings."

enclosure (here shown) formed of ten rough limestones, and consisted of "a female in the very prime of life and a child of about four years of age; the former had been placed on the floor of the grave on her left side, with the knees drawn up; the child was placed above her, and rather behind her shoulders; they were surrounded and covered with innumerable bones of the water-vole, or rat, and near the woman was a cow's tooth, an article uniformly found with the more ancient interments." Round her neck was the necklace engraved above. It was formed of variously shaped beads and three ornaments of jet and bone, curiously ornamented. The various pieces of this elaborate necklace count 420 in number—348 being thin laminæ, 54 of cylindrical form, and the remaining 18 being conical studs and perforated plates, some of which are ornamented with punctures.

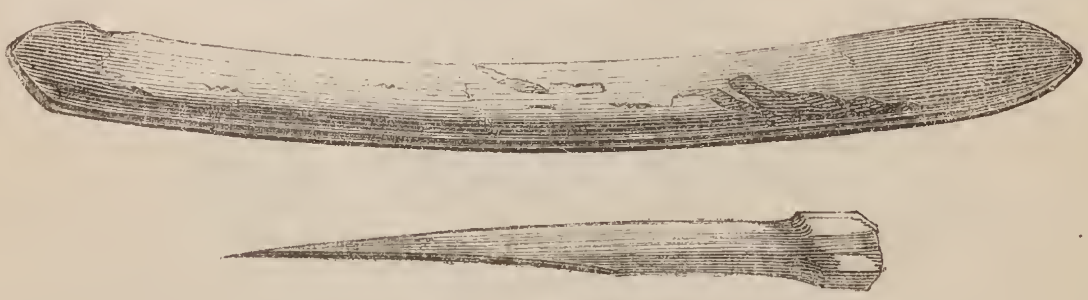
The skull of the woman was so perfect in condition, and was so excellent an example in every respect, that it was chosen as the type of the ancient British female, for figuring in that magnificent work (from which our engraving is taken) by Drs. J. Barnard Davis and Thurnam, the "Crania Britannica,"—a work which is invaluable to ethnologists, and to archæologists in general.

Of Jet studs, the example here given from Gospel Hillock



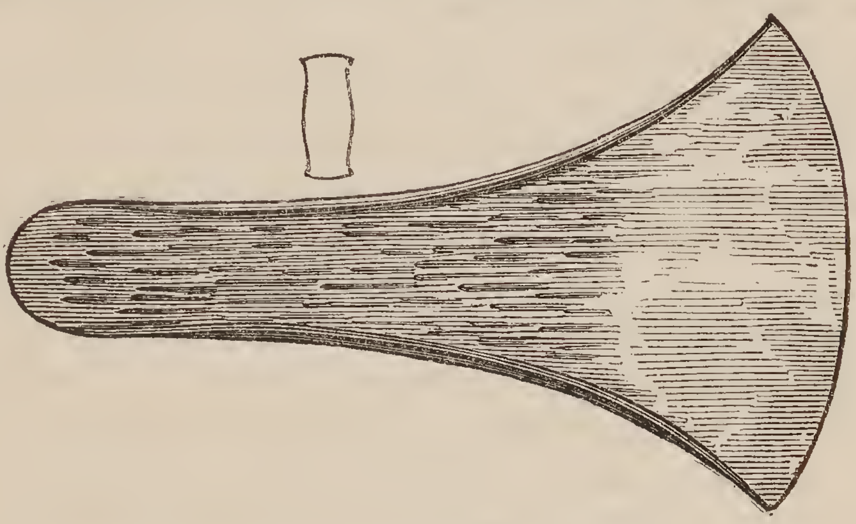
will convey a good idea of the most usual type. It was found along with the flint celt already described.

The implements of BONE found in the Celtic grave-mounds of Derbyshire, consist chiefly of modelling tools, (supposed to



be used in the manufacture of pottery), pins, studs, and other personal ornaments, lance-heads, spear-heads, whistles, (?) mesh-rules, hammers and beads.

In BRONZE the articles found are celts, daggers, awls, pins, etc. Celts are, however, but seldom met with in barrows, although frequently ploughed up in the course of agricultural operations. Palstaves and socketed celts, etc., are also occasionally picked up. The ordinary form of celt, will be best understood by the engraving here given from an excellent example found in Moot-Low near Dove Dale. One of these celts, of precisely similar form to this one, found in a barrow at Shuttlestone, has been the means of throwing considerable



light on the mode of interment adopted. The barrow contained "the skeleton of a man in the prime of life and of fine proportions apparently the sole occupant of the mound, who had been interred whilst enveloped in a skin, of dark red colour, the hairy surface of which had left many traces both upon the surrounding earth and upon the verdigris or patina coating, of a bronze axe-shaped celt and dagger, deposited with the skeleton. On the former weapon, there are also beautifully distinct impressions of fern leaves, handsful of which, in a compressed and half-decayed state, surrounded the bones from head to foot. From these leaves being discernible on one side of the celt only, whilst the other side presents traces of leather alone, it is certain that the leaves were placed first as a couch for the reception of the corpse with its accompaniments, and after these had been deposited, were then further added in quantity sufficient to protect the body from the earth."* With the skeleton, besides the celt, were a fine bronze dagger, with two rivets for attachments to the handle which had been of horn—the impression of the grain being quite distinctly perceptible; a small jet bead; and a circular flint. The celt had been, as was evident from the grain of wood still remaining, driven vertically into a wooden handle for about two inches of its length.

The bronze daggers which the barrows of Derbyshire have afforded, vary in length from three to five and a half inches; the larger ones being about two and a half inches in breadth,

* "Ten Years' Diggings."

at their broadest part, where the handle has been attached, from whence they taper gradually down to the point. They are sometimes ribbed or fluted. In most instances, the handle has been attached by three rivets; in some cases, however, only two have been used, and occasionally there is evidence of the attachment being effected by thong or other ligature. The handles were of horn or wood, and were usually semi-lunar, where attached to the blade; in one instance, however, the blade has a "tang" or "shank" which has fitted into the square-ended handle, to which it has been fastened by a single peg. The blades occasionally present contestible evidence of long use, having been worn down by repeated sharpenings. In the instance of the dagger found at Stanshope, which had been fastened to the handle by a couple of rivets as well as by ligatures, evidence existed of its having been enclosed in a sheath of leather, and this example also presented the somewhat curious feature of impressions of maggots, which had probably made their way from the decaying body into the inside of the sheath, between it and the blade, and had there remained, and thus gradually become marked upon the corrugated surface of the bronze.

It is worthy of careful remark, that in no Celtic barrow as yet opened in Derbyshire, of which any record is preserved, has a single article of gold been found. A torc and one or two articles of gold have been turned up by the plough, but none have been exhumed in barrows. It is also worthy of particular note that not a single ancient British coin has yet been known to have been found in the county.

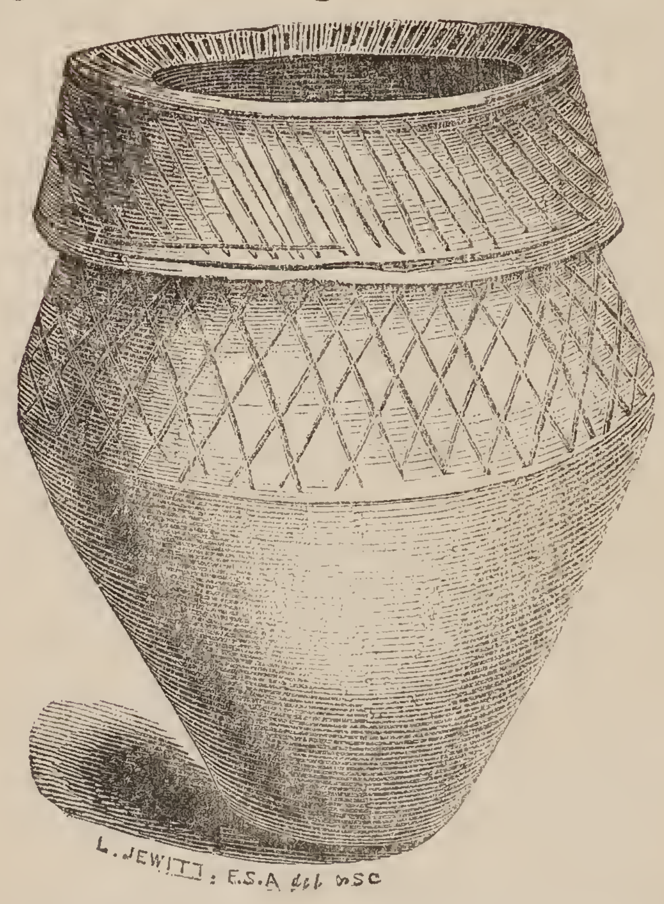
One of the principal features of the Celtic grave-mounds of Derbyshire is the POTTERY, and of this I will now proceed to speak. The pottery of the ancient British period may be safely arranged in four classes,* viz.; 1. *Cinerary Urns* or *Sepulchral Urns,* which have contained, or been inverted over, calcined human bones. 2. *Food Vessels* (so called) which are supposed to have contained an offering of food, and which are more usually found with unburnt bodies than along with interments by cremation. 3. *Drinking Cups,* which are usually highly ornamented. 4. *Incense Cups* (erroneously so called, for want of more knowledge of their use), which are very small vessels found only with burnt bones (and usually containing them) within the large cinerary urns. The pottery was, without doubt, made on, or near to, the spot where found. It was, there is every probability, the handiwork of the females of the tribe and occasionally exibits no little elegance of form and no small degree of delicate

*For articles upon this subject see the "Reliquary, Quarterly Archæological Journal and Review," vol. ii. pages 61 to 70; and Mr. Bateman's "Ten Years' Diggings."

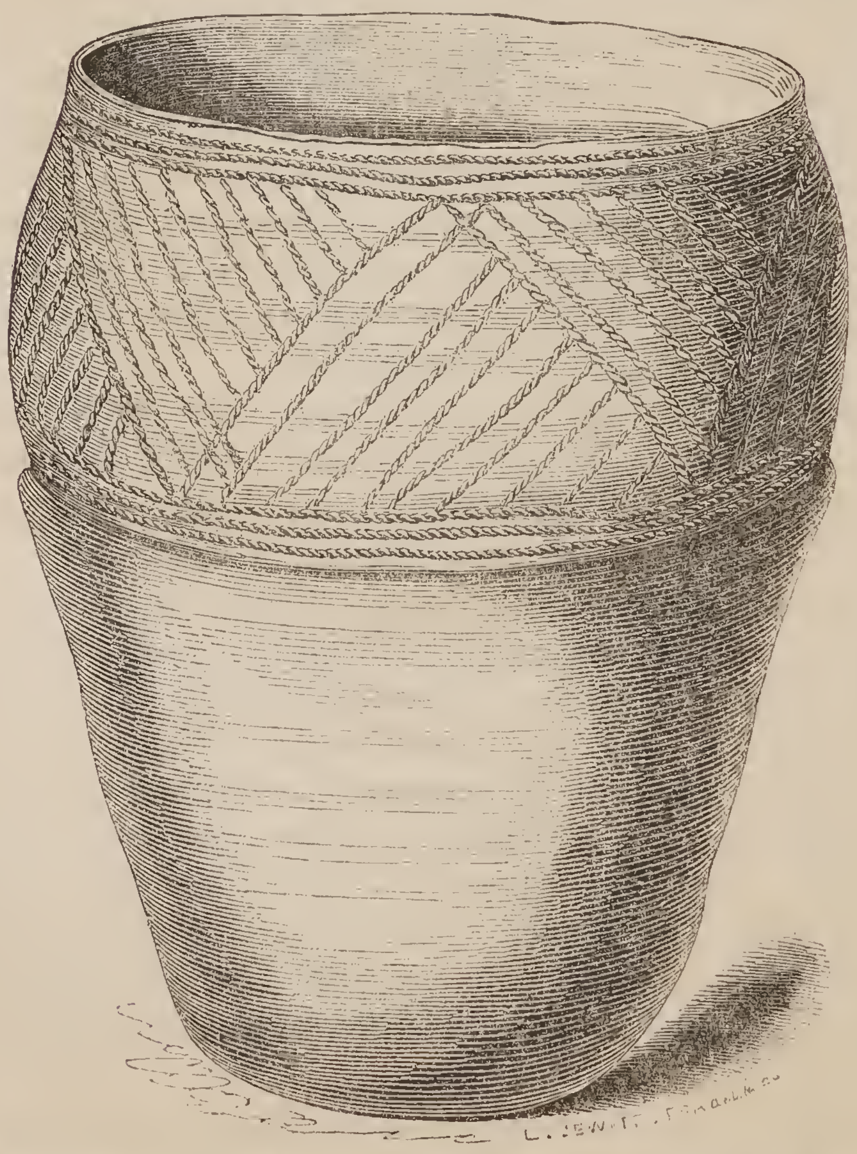
ornamentation. The urns, of whatever kind they may be, are formed of the coarse common clay of the district where made, occasionally mixed with small pebbles and gravel; they are entirely wrought by hand, without the assistance of the wheel, and are, the larger vessels especially, extremely thick. From their imperfect firing, the vessels of this period are usually called "sun-baked" or "sun-dried" but this is a grave error, as any one conversant with examples cannot fail, on careful examination, to see. If the vessels were "sun-baked" only, their burial in the earth—in the tumuli wherein, some two thousand years ago, they were deposited, and where they have all that time remained—would soon soften them, and they would, ages ago, have returned to their old clayey consistency. As it is, the urns have remained of their original form, and although from imperfect baking, they are sometimes found softened, they still retain their form, and soon regain their usual hardness. They bear abundant evidence of the action of fire and are, indeed, sometimes sufficiently burned for the clay to have attained a red colour—a result which no "sun-baking" could produce. They are mostly of an earthy brown colour outside, and almost black in fracture, and many of the cinerary urns bear internal and unmistakeable evidence of having been filled with the burnt bones and ashes of the deceased, while those ashes were of a glowing and intense heat. They were, most probably, fashioned by the females of the tribe, on the death of their relative, from the clay to be found nearest to the spot, and baked on or by the funeral pyre. The glowing ashes and bones were then collected together, and placed in the urn, and the flint implements and occasionally other relics belonging to the deceased, deposited along with them.

The *Cinerary*, or *Sepulchral, Urns* vary very considerably both in size, in form, in ornamentation, and in material—the latter, naturally, depending on the locality where the urns were made—and, as a general rule, they differ also from those of most other districts. Those which are supposed to be the most ancient, from the fact of their frequently containing flint instruments along with the calcined bones, are of large size, ranging from nine or ten, to sixteen or eighteen inches in height. Those which are supposed to belong to a somewhat later period, when cremation had again become general, are of a smaller size, and of a somewhat finer texture. With them objects of flint are rarely found, but articles of bronze are occasionally discovered. The general form of the cinerary urns of the Derbyshire barrows, will be best understood from the annexed engravings.

Their principal characteristic is a deep overlapping border or rim, and their ornamentation, always produced by indent-ing, or pressing, twisted thongs into the soft clay, or by simple



incisions, is frequently very elaborate. It usually consists of



diagonal lines arranged in different ways, or of "herring-bone" or zig-zag lines, or of reticulations. This ornamentation is usually confined to the overlapping rim and the neck, and to the upper edge of the rim.

Of other shapes found in Derbyshire barrows, and which, as I have said, are unusual in that county, the preceding and the next engraving will serve as illustrative examples. The ornamentation on each is by the pressing of twisted thongs into the pliant clay. The overlapping rim, it will be seen, does not occur on these examples, one of which has the peculiarity, in its central band, of four perforated loops or handles. In this

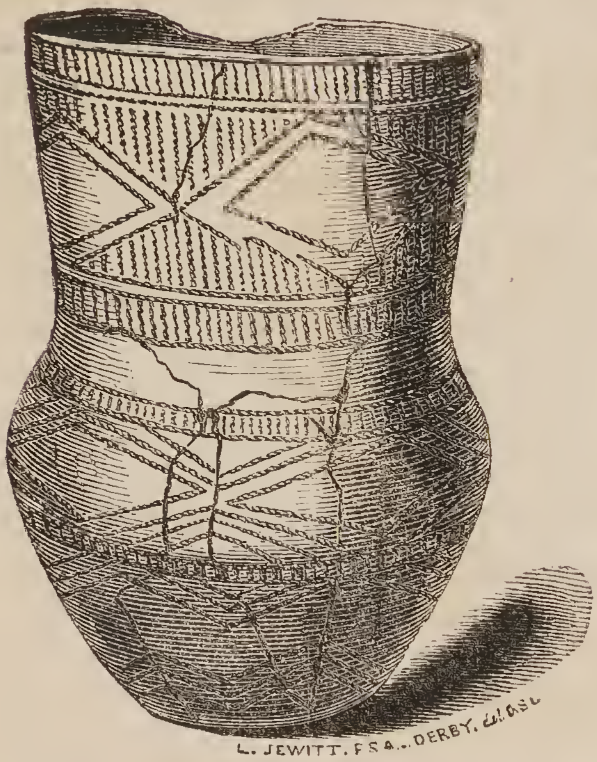
latter urn a beautiful " incense cup " (?) to be hereafter spoken of, was found. Possibly these urns were the work of the females of a migratory tribe which was passing through, or making a settlement in, Derbyshire.

The *Food Vessels*, so called, vary considerably both in form, and in size, and in ornamentation, from the very rudest to the most elegant and elaborate. They are generally wide at the mouth and taper gradually downwards from the central band. They are found both with interments by inhumation, and by cremation—more frequently the former than the latter—and are generally placed near the head of the skeleton. They are generally of from four to six inches in height, and the ornamen-

tation is produced by twisted thongs and other indentations. The form of some of these highly intenting vessels will be best

understood by the engravings here given. The "food vessels" are usually burned to about an equal degree of hardness with the cinerary urns.

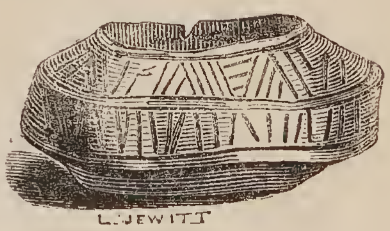
The *Drinking Cups* are the most highly and elaborately ornamented of any of the varieties of fictile art found in the Derbyshire barrows. They are found with the skeleton, and are usually placed behind the shoulder. In size they range from about six to nine inches in height. They are tall in form, contracted in the middle, globular in their lower half, and expanding at the mouth. Their ornamentation, always elaborate, usually covers the whole surface, and is composed of indented lines placed in various ways, so as to form an intricate pattern ; and



other indentations. The engravings show two excellent examples,—the first from the Hay Top barrow, and the second from a barrow at Grind-Low.

The so called "*Incense Cups*"—a name which ought now to be discarded—are diminutive vessels which, where found at all (which is seldom) are found *inside* the sepulchral urns, placed on, or among, the calcined bones, and generally themselves also filled with burnt bones. They range from an inch and a half to about three inches in height, and are sometimes highly ornamented, and at others plain.

The three examples here shown, respectively from barrows on Baslow Moor, on Stanton Moor, and at Darley Dale, will



give a good general idea of these curious little vessels which may probably not have been "incense cups" but small urns to receive the ashes of an infant—perhaps sacrificed at the

death of its mother—so as to admit of being placed within the larger urn containing the remains of its parent. The contents of barrows give incontestible evidence of the practice of sacrificing not only horses, dogs, and oxen, but of human beings, at the graves of the ancient Britons. Slaves were sacrificed at their master's graves, and wives, there can be no doubt were sacrified and buried with their husbands, to accompany them in the invisible world upon which they were entering. It is reasonable, therefore, to infer that infants were occasionally sacrificed on the death of their mothers, in the belief that they would thus partake of her care in the strange land to which, by death, she was removed. Whether from sacrifice, or from natural causes, the mother and her infant may have died together, it is only reasonable to infer from the situation in which these "incense cups" are found, (either placed on the top of a heap of burnt bones or inside the sepulchral urn containing them) and from their usually containing small calcined bones, that they were receptacles for the ashes of the infant, to be buried along with those of its mother.

(*To be continued.*)

THE STRUCTURE OF THE ANNELIDS, WITH A CRITICISM ON QUATREFAGES.

By Edouard Claparede.

M. Claparede has kindly sent us a pamphlet on the above subject.* It is taken from the introduction to a work on the Annelids of the Gulf of Naples, now in the press under the auspices of the *Societé de Physique et d'Histoire Naturelle de Genève.* M. Claparède spent six months at Naples during the winter of 1866-7, and found the locality extremely favourable for the study of Annelids. He observes that his remarks were facilitated by the recent publication of two works, one by M. Ehlers, and the other by M. Quatrefages; although, in addition to other defects, he found the book of the latter full of typographical errors to an extent "passing imagination," and likewise of false citations. Only one part of M. Ehler's work has appeared. It relates to certain Nereids of the Adriatic, and does not correspond with the generality of its title—a "Treatise on the Annelids." What M. Ehler has done, M. Claparède pronounces to be a "model of exactitude." "L'Histoire Naturelles des Annelés," of M. Quatrefages, is a treatise on the Polychætian Annelids, in which the author endeavours to fulfil two purposes—a natural classification,

* "De la Structure des Annélides, note comprenant un examen critique des travaux les plus recents sur cette classe de vers. Genève, Ramboz."

based upon anatomy, and an enumeration of synonyms. In referring to the writings of others, M. Claparède states that M. Quatrefages has "often consulted plates without taking the trouble to read the corresponding text." One instance of this occurs in a mis-description which he gives of Claparède's genus *Pygaspio*, and other instances are given. While admitting that M. Quatrefages's work may be read with advantage, M. Claparède cannot admit that it represents the present state of science, as regards the anatomy and physiology of worms. "Unfortunately, notwithstanding his numerous and profound researches, the author of the 'Histoire Naturelle des Annelés" has too often forgotten that he had predecessors, and that contemporaries were exploring the same ground with an ardour equal to his own." The "personality of M. Quatrefages"—the ridiculous egotism in fact, so noticeable in his works—"is always foremost, even in the narration of facts known twenty or thirty years before his own scientific *début*. . . . How many errors would have been avoided if the author had conscientiously studied the works of Rathke, Della Chiaje, Grube, and others; if he had taken into account the studies of histologists, such as Kölliker, Leydig, etc., he would not then, as he has sometimes done—in the structure of the branchiæ, for example—have made science retrograde to the epoch of Pallas." "Why did M. Quatrefages, who is so well acquainted with Annelids, describe genera and species from specimens preserved in alcohol in the Paris Museum? He must know the uselessness of such a course, and that Annelids can only be properly studied at the sea-side with the help of living specimens. To describe as he has done, *alcoholic varieties,* is to embarrass science with a *caput mortuum,* which it will take years to get rid of."

"*Regions of the Body and Appendages.* After much discussion concerning the value of the external portions of the bodies of Annelids, most recent authors have adopted the nomenclature of M. Grube, who gives the name of *buccal segment* to the segment carrying the mouth, and that of cephalic lobe (*Prœstomium,* Huxley) to all that is in advance of it. . . . . M. Quatrefages, taking up opinions previously advanced by Rathke, considers the cephalic lobe and the buccal segment as together forming the head, but he does not adhere strongly to this view, as he most often gives the name head to the cephalic segment only."

"He has tried to introduce a simplification in the nomenclature of the appendages of the cephalic region, by giving the name of *antennæ* to all the appendages springing from the cephalic lobe, that of *tentacles* to those of the buccal segment, and that of *tentacular cirrhi* to those of the first feet, when they exhibit in a marked manner characters which distinguish them from their homologues belonging to the hinder feet."

"This nomenclature, which at first appears a happy one, has many inconveniences, and is frequently inapplicable to particular species. In the first place, the appendages of the cephalic lobe are sometimes quite different from each other in formation, as well as in structure, on which account most authors have given them different names. What a difference, for example, there is between the palpi (*lateral antennæ*, And. and Ed. Qtfg.) and the frontal antennæ of the Lycoridians. The first are fleshy, many-jointed, partially retractile, filled by the prolongation of the largest nerve in the body; the second are filiform, simple, non-retractile, poor in nerves. An equal distance separates the palpi (Kimberg, and all recent authors) and the true antennæ of the Aphroditians. . . . A second inconvenience of M. Quatrefages's nomenclature is its inapplicability in all the cases in which the anterior segments are very condensed, and in which it is not possible to determine to which segment a pair of appendages belong. . . . The learned Academician, enamoured of his theory, suppresses by a stroke of his pen the buccal segment of the major part of the Sigalionides—at least, he ascribes to them only "an indistinct buccal ring, deprived of appendages." Nothing is, however, more distinct than the buccal segment of these worms, only it carries a pair of feet with their bristles, and cannot be a buccal segment according to the theory of M. Quatrefages. Unfortunately, the author does not know that all the Polynoes have bristles on the segment which he regards as buccal, and that it would be necessary to imagine for them a distinct buccal segment without appendages."

"M. Quatrefages, however, gives a rule difficult of application, but still a rule for the determination of segments and their appendages. The cephalic lobe and the antennæ, he says, receive their nerves from the cerebral ganglion; the buccal segment and its tentacles, from the œsophagal connections; the tentacular cirri, from the ventral ganglionic chain. This proposition cannot be maintained in the face of modern embryology. Schaum had already asserted that, throughout the articulata, each segment is characterized by the possession of a ganglion, and from this principle he denies that the head of the Anthropoda is formed of many united segments. This doctrine was immediately refuted. In fact, the nervous system differentiates itself relatively very late among the Articulata. On the contrary, the appearance of segments—protozonites, as they are called—is, in many cases, the result of one of the first modifications of the blastoderm. These primitive segments unite in groups, and frequently solder themselves together long before the differentiation of the nervous system; and when this system is developed, the number of ganglions is not necessarily identical with that of the primitive segments. Amongst Annelids, in particular, the formation of a nervous system sometimes follows pretty closely that of the segments—among the embryos of the *Capitelles,* for example—but it is usually later. I do not dispute that among many Annelids the birth and distribution of nerves conform to the rule of M. Quatrefages. But we see that in certain cases it is not the buccal segment only, but also some of the following segments, which receive their nerves from the œsophagal connexions. It is so among certain Aphroditians, Hesionians, etc. . . . . I employ the name *Antenna* for all the appendages of the cephalic lobe; but when two of these appendages spring from the inferior portion of the lobe, and present special anatomical and physiological characters. I, in common with the majority of authors, call them *palpi.* The modified cirri of the buccal and following segments are called in this memoir *tentacular cirri.*"

"Without wishing to dilate on the conformation of the feet of the Annelids, I would indicate the relation of the bristles to the tissues environing them. Some authors consider them as enclosed in a pocket which is merely an invagination of the teguments, and others think they are engendered in an internal follicle, and only arrive in a secondary way at the surface. This second opinion is correct. Among the Hesions and others, for instance, the whole bunch of bristles come in a compact form out of a single pedal opening, but in other cases each bristle has its own special aperture. This is especially the case with the flabelliform tufts. The issuing pore of each bristle is not *preformed.* The bristle makes its own perforation, which is easy when the tissues are soft, but it is not so when the worm is protected by a resisting cuticle, and when the bristle, armed with hooks in different directions, might entangle themselves in the tissues, and produce serious rents. In these cases the extremity of each bristle is surmounted with a small provisional apparatus, terminating in a very keen blade, destined to cleave a free way for the bristle, and to avoid tearing. The form of this cutter varies much with that of the bristle, and especially of the hooks, whose passage must take place without tension of the adjacent parts."

Teguments and Muscular Apparatus.—"The teguments are composed of two layers—one internal and cellular (*Corium,* Rathke, *derme,* Quatrefages), corresponding to the sub-cuticular or chitinogenous layer of other Articulata; the other extra-cellular, the cuticle (epidèrme, Rathke, Qtrfg.) sometimes very delicate, sometimes composed of a thick layer of chitin. Up to the present the teguments have only been carefully studied by Kölliker, to whom we owe many excellent papers on the histology of the Annelids, which are unfortunately quite unknown to the author of the "Histoire Naturelle des Annelés."

"The superficial layer deserves the name which Kölliker has given it. In a histogenetic point of view it belongs entirely to the category of cuticular formations. The subcuticular layer (*hypoderm*, Weissman) which secretes it—often called with Kölliker epithelium—in most cases does not enable us to recognize the boundaries of its constituent cells. The nuclei appear sown with great regularity in a continuous granular layer, as M. Bauer has seen in certain Arthropoda. Whenever the cuticle attains a certain thickness it is seen to be ornamented with two systems of striæ at right angles to each other, or more frequently at about 70°, as noticed by M. Kölliker. The tubular pores (*porenkanale* of the Germans), wherever they exist, are disposed in lines conforming with the striæ. M. Kölliker has been struck with the difference of these pores from each other. Often, he says, they correspond only with a subjacent cell, and he asks if these openings are really homologous with the tubular pores of the Arthopoda, and do not rather resemble the openings of cutaneous glands discovered by Leydig in the Piscicoles, or the hairs of insects and crustaceans. To these questions I can reply in a positive manner that both sorts of pores exist amongst the Annelids. Those which serve for the outpouring of certain secretions appear to exist in all species. In large species they are sometimes of considerable diameter, but usually very limited. Sometimes they are found united in groups. The canalicular pores are much smaller, much nearer together, and have no resemblance to glands. They are only found in species which have a thick skin, and not in all of these. . . . The subcuticular layer—the derme of M. Quatrefages—appears always to contain glandular follicles, and that in all parts, even in the cirri and antennæ. These follicles empty themselves externally by means of the glandular pores. Some only secrete a thick liquid, others engender bundles of little rods (batonnets), and these I have named *bacilliparous follicles*; others only secrete granules."

M. Claparède explains that the bibliography of these bacillary corpuscles is very rich, and he wonders that it has altogether escaped the notice of M. Quatrefages. "Certain families," he says, "have their teguments literally covered with bacciliparous follicles, even in the cirri and the antennæ. This is especially the case with all the Aricians and Spiodians, and a great part of the Chætopterians. Their abundance is likewise remarkable in a crowd of Phyllodocians, and in certain Hesionians. Among the latter especially, their grouping and their relation to the external pores is very remarkable. The formation of these organs is still entirely problematical. I have sometimes compared them to the cells full of needles of the Turbellarians, and to the stinging organs of the Acalephs, etc., but this is mere hypothesis."

"Tubular glands full of spherical granulations have been pointed out by us in divers Annelids. Sometimes they reach considerable dimensions, particularly among the Lycoridians, and in this case the glomration formed by the junction of glandular tubes was known to old authors and considered to be a sac. M. Quatrefages knew of one of the passages in which I had spoken of these organs, and cited an analogous observation of M. Keferstein, but by a singular blunder, he makes us describe circumvolutions of blood vessels when we spoke very positively of glandular branches (*boyaux*). . . .

Muscular system.—The muscles of Annelids exhibit extraordinary varieties in their histological character. Sometimes they are composed of parallel fibres quite destitute of a nucleus, and at others of fibre-cells furnished with large nuclei. The existence of these fibre-cells of a muscular character in Annelids has been, it is true, denied by M. Schneider; but "although this *savant* is right in the majority of cases, we shall see that the rule suffers certain exceptions in the pharynx of some Nereids, tentacles of many Terebellians, etc. Sometimes the muscular fibre separates into two distinct layers, one axial, the other cortical, as Leydig first observed."

"The 'Historie Naturelle des Annelés' describes between each segment a sort of tendinous raphis, in which the muscular fasciæ insert themselves. These raphids have no existence. It is easy in longitudinal sections of Annelids to see that the longitudinal fasciæ are continued without interruption the whole length of the worm. This is what Blainville, Della Chiaje, Rathke, Meckel, etc., observed. Muscular plates more or less complete, sometimes divide the previsceral cavity into several chambers. Thus the Ophelians, Polycirridians, and many Terebellians, the Aphroditians, and the majority of the wandering Annelids have three divisions in the perivisceral cavity, the Glycercians two, etc."

Digestive Organs.—M. Quatrefages has endeavoured to establish a new nomenclature for different parts of the alimentary tube, the necessity for which may be disputed. Why, for example, in the Syllidians give the name *dental region of the proboscis* to the organ with glandular walls, which does not form part of the proboscis, and contains no teeth.* The

* In a note, M. Claparède says that M. Quatrefages has enumerated certain Syllidians as having teeth in this region, but has mistaken the species, which belong to quite different families.

names employed by other authors such as fleshy portion of the pharynx (M. Edwards), gizzard (Williams), proventriculum (Oersted), appear very preferable. Are there sufficient reasons for rejecting the names *ventricle* and *glands of the ventricle*, employed first by Rathke in reference to the Nereids, and repeated by his successors? Is it necessary to replace them by œsophagus, and salivary glands? . . . Salivary glands are usually more or less connected with the buccal cavity, while the glands in question are often twenty or thirty segments behind it. In certain Annelids the posterior region of the intestine following the biliary region, presents a special appearance. Its walls appear filled with cells containing curious concretions, without doubt destined to be eliminated with the fœces. I call this portion of the intestine the *urinary region*, though it does not appear to contain uric acid."

The Perivisceral and Circulatory System.—We owe to Quatrefages and Williams, especially to the former, a profound study of the perivisceral cavity and of the lymph which it contains. The perivisceral cavity is lined with a delicate membrane which is only demonstrable in large species, and which M. Quatrefages attributes the discovery of to himself. Had he searched the works of Della Chiaje and Rathke, he would have found the membrane and its name. The structure of this peritoneum (*tunica sierosa, tunica peritonieale* of Della Chiaje) is subject to great variation. In some species the perivisceral cavity is supplied with vibratile cilia borne by this membrane. Sharpey was, if I am not mistaken, the first to describe it among the Aphroditians, Williams afterwards observed it on the branchiæ of the Glycerians, and I described it throughout their perivisceral cavity. It was also noticed in the Tomopteridians. M. Quatrefages, who only cites *en passant* the observations of Williams, adds that this ciliary movement was known to him long ago in a number of Annelids, and that it may be seen in all species if any trouble is taken. This opinion is not correct. The immense majority of Annelids do not exhibit a ciliary movement in the perivisceral cavity, except at the entrance of the segmentary organs. I only know a perivisceral ciliation in the following groups:—all the Aphroditians, Glycerians, Polycirridians, Tomopteridians, and, lastly, in an abnormal Terebella—*T. vestita*. It is striking that all these Annelids, excepting the little Terebella and the *Aphrodita aculeata*, are totally destitute of vessels, and of these two exceptions, one, the Aphrodita, is an animal of rudimentary vascular system belonging to a vesselless family; the other, the Terebella, belongs to a family in general vascular, but of which, one tribe, the Polycirridians, is vesselless. In presence of these facts, I must regard the perivisceral ciliary movement as a vicarious circulatory function in animals having no true circulatory system." "The circulation of Annelids is carefully described by Quatrefages, rendering full justice to the labours of Milne Edwards. It is to be regretted he has not shown the same favour to Rudolph Wagner, and Rathke. The distinction which he has established between arterial and venous currents appears to me very just in its leading features. Other authors have had similar opinions—witness the name *nervarteria*, given by Della Chiaje to the ventral vessel, that is, to the aorta, in the sense of M. Quaterfages. The existence of blood corpuscles in the vessels of certain Annelids is now indisputable. M. Quatrefages admits three examples—the Glycerians, Phoronis, and Syllidians. In fact, among the first, the red corpuscles belong to the perivisceral cavity, and Phoronis scarcely preserves its place among the Annelids. But without speaking of the old observations of Rud. Wagner on a Terebella, confirmed by Kölliker, other examples might be cited. In this memoir blood corpuscles properly so called will be described in the Ophelians, Cirratulians, and Staurocephalians.

(*To be continued.*)

THE LUNAR ERATOSTHENES AND COPERNICUS.—JUPITER'S SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

Before quitting the neighbourhood of the "rampart-work" of Gruithuisen, we shall briefly advert to the region lying W. of it. Here we shall find a deep crater *Bode* (28), nearly 9½m. in diameter, whose wall of 8° of luminosity makes it a conspicuous object. A smaller crater, *Bode* A, lying at a little distance N.W., is equally reflective. Close to *Bode* on the S. is an irregular ring, called *Pallas*, and at some distance W., and in the First Quadrant, another, *Ukert*, which the extreme influence of S.W. parallelism in its neighbourhood has squeezed almost into a square form, and rendered its aspect quite different at the first glance from that of *Bode*. At the foot of its wall on the S.E. is a straight ravine, wider than the generality of clefts, running in a S.W. direction. This I have seen interrupted in the middle by a broad, shallow valley, so as to make it appear like a cutting through the wide bank on either side.

The *Sinus Æstuum* (our H), as limited by B. and M. (who, unlike Lohrmann, have excluded from it the hilly region around *Schröter*) is a depressed, but considerably reflective surface, unique in its way, according to them, from the absence of the slightest trace of a crater, as well as from its peculiarly level character; its smoothness being only broken by a few long but very low ridges issuing from *Eratosthenes* (29). The comparison of this district with one swarming with minute craters a little E. is extraordinary; and these forms, which would have been here most readily distinguishable, appear to be actually wanting. It must, however, be observed that their predecessor, Lohrmann, has delineated one very distinctly, of which, though his work was before them, they have taken no notice; and Mädler subsequently (1841), when in charge of the great Dorpat achromatic, perceived several not laid down in the map. L.'s crater I found very conspicuous with 5½ inches, 1861, April 18 and 20, May 17, as well as a second, and, perhaps, a third. These inconsistencies, but too frequently to be met with, introduce so much perplexity and obscurity into the question of lunar change, that we look forward with interest and pleasure to the survey now in progress under the auspices of the British Association, the results of which will certainly not be encumbered with similar ambiguities, at least on so considerable a scale.

Eratosthenes (29), a prominent crater, upwards of thirty-seven miles in diameter, and, therefore, equal in area to some of the smaller English counties, is, as our guides express it, the mighty keystone of the *Apennines*, and probably (as they think) the site of the outburst of that unknown violent agency which raised the summits of *Bradley* and *Huygens*. But for the nearness of the still more imposing *Copernicus* (30), it would certainly be the most remarkable feature of the neighbourhood. It is, however, very inconspicuous in full illumination. A great mountain occupies its centre, and the interior of the ring is supported by strong, broad terraces; the former, according to Schr., divides into two branches, and the latter, on the E. side, are in part separated by distinct ravines; a fact which deserves the attention of selenologists, as possibly throwing some light on the mode of their formation. The ring is brightest on E. Here its summit lies 15,800ft. above the gulf, while on the opposite side it only attains 10,900ft., that is, is only a little overtopped by our Etna! Schr. had given these measures considerably less, and probably too small. Lohrmann mentions two peaks, N.W. and S.W., the former the point of junction of the narrow prolongation of the *Apennines;* E. of this point he has placed a small deep crater on the top of the wall, which B. and M. have lowered to the inner terrace; he also speaks of several broad and generally parallel terraces descending as by steps on the exterior, and extending furthest S. The height of the wall from the outside is given by B. and M. as 3200ft. W., 7400ft. E., showing, with as fair a degree of accordance as may be expected among such irregular surfaces, an interior depression of about 8000ft. This is something entirely unparalleled on the earth, and, at first sight, in connection with the vast extent and height of the ring, would seem to remove the phenomenon out of the reach of terrestrial analogy; when, however, the very different amount of gravity on the Moon, and possibly a very different degree of resistance from cohesion, are taken into consideration, it does not seem necessary to abandon the idea of volcanic action.

On one occasion (1789, Sept. 12), when *Eratosthenes* was a little less than its own diameter removed from the terminator, Schr. observed that a zone forming the extremity of the shadow which then nearly filled the cavity, being the portion which lay on the interior slope of the ring, and, according to his figure, amounting to nearly ¼ of its whole extent, was noticeably less dark than the rest. This he supposed to be the effect of the commingling of the true shadow with the penumbra, or partial darkness, which arises from the apparent breadth of the Sun, and, therefore, borders every shadow in the solar system, where the Sun subtends a sufficient angle to make it perceptible. This is, of course, the reason why the shadows of all objects in terrestrial sunshine are ill-defined in proportion to their distance from the body which casts them; and this hazy-looking edge, which would be of great breadth on Mercury, where all the shadows would be extremely *woolly*, and imperceptible on Uranus, where they would be almost critically sharp, would, on the Moon, be sensibly equal to what we see on the Earth. But it is most improbable that such could have been the cause of what Schr. observed. The lunar penumbra is, indeed, rendered visible as a narrow border* of diminished brightness where the terminator passes through surfaces making a very small angle with the rays of the rising or setting sun, while they are fully exposed to the direction of our sight; such as the grey levels of the *M. Serenitatis, Imbrium, Vaporum*, and others; or flat-topped elevations of any height; but where the surface is inclined towards the incident ray, as is evidently the case of the inner slope of a crater-ring after sunrise or (as in this case) before sunset, the penumbra could not possibly attain the projected magnitude described by Schr.†—Schmidt (who

* Schmidt gives its theoretical breadth 8″ on the terminator; but practically it will be much less, as the diminished illumination would not be perceptible till a considerable portion of the solar disk was concealed.

† On a former occasion the same observer has recorded a somewhat similar but much fainter grey border along the edge of the shadow, then become very narrow, within the crater *Eudoxus* (17). But in that case, being on the side of the cavity next the Sun, instead of the opposite, the appearance might be readily explained as a true penumbra, or illumination by a portion only of the solar disk, apparently enlarged and rendered more visible by its falling on the gentle slope of the foot of the wall.

does not, however, refer to this) was not unacquainted with such appearances, having noticed them several times in craters (he especially mentions *Copernicus, Theophilus, Zach,* and *Sacrobosco*), where an ill-defined edge of brownish grey rendered the length of the shadow difficult of measurement, while other perfectly similar craters in the same neighbourhood were free from any such peculiarity. For an explanation he sees no need of having recourse to penumbra or atmosphere; it might be sufficiently accounted for by a multitude of colossal blocks on the crest of the ring, whose narrow lines of shadow cast upon the opposite wall, with their intervening streaks of light, being separately undistinguishable by us, would produce the confused general impression of a diluted border. In this case, he refers to some terrestrial correspondences, such as the shadow of a row of close-set iron spikes on the top of a door or wall, seen from a suitable position and distance; or the shadow of a fringe of ice-ruins and rock-pinnacles falling on a snowy slope, which he once remarked in great beauty from the Wengern Alp; the edge of a mountain shadow, elsewhere sharp, becoming very indistinct when projected on the very obliquely slanting snows of the Silverhorn and Guggi glacier, the employment of a common eye-glass showed the cause to lie in the confused impression of many long, narrow, separate streaks of shade. (We may observe, by the way, that the eye for terrestrial scenery, evident in this great observer, qualifies him in a high degree for the analogical interpretation of the varied aspects of the Moon.)

But though this is a plausible elucidation, it may not be the true key to the mystery. To the objection that it would be difficult to account in this way for so broad a zone of duskiness as Schr. has represented, falling, too, upon a slope inclined in the wrong direction, it might be answered that his drawing was too rough to be trusted in minute details, and that he seems to have satisfied himself too easily upon the subject. But it is evident that more has yet to be explained, and that the point deserves study. Though there is no improbability in the idea that the summit of a ring should be crested with a row of natural battlements or pinnacles; yet these, if close enough to produce a confused half-tone in the part of the shadow cast by the ridge where it lies facing the sun, would in every other position overlap one another so much in perspective as to intercept too much light, and produce a full and defined shade. Here, therefore, a very powerful instrument would so far decide the question that an equal intensity of half-tone along the whole border of the shadow would negative Schmidt's solution. And so would any want of periodical recurrence in the phænomenon—a point which seems to have escaped attention. Of course, in any comparison of observations, a very close similarity of conditions would be required; but this being fulfilled, the non-appearance of the border would so distinctly point to some unexplained and possibly unsuspected cause, as to invest the inquiry with peculiar interest. Any observer making an especial study of the edges of the interior shadows of great craters might not regret the loss of time in the end.

The position of *Eratosthenes* is in the midst of landscapes of very contrasted characters—the level *Sinus Æstuum,* the towering *Apennines,* the vast extent of the *Mare Imbrium,* and a most remarkable honey-combed district which we shall find to the E. The line of the *Apennines* may be considered as continued through it in that direction by a broken range of hills, of which the extremity, of great steepness on every side, especially N,—the η of B. and M., attains according to them 4000ft.: Schr. had given it 250ft. more. Running S. from the E. side of the wall is a more considerable range, reaching near its beginning, according to Schr., 9500ft., and leading down to a large ring named *Stadius* by B. and M. when they failed in identifying, as has been mentioned, Riccioli's spot of that name. This, 43 miles in diameter, and therefore surpassing in that one respect its overpowering neighbour *Eratosthenes,* is a strange contrast to it in other ways, the embankment, on which they have figured two or three minute craters, being as a whole scarcely 130ft. high, the mere outline of a wall, so as to have escaped the attention of B. and M. for three years. Its surface is not depressed, and the question may possibly suggest itself, Have we here all that remains visible of a great ring, whose height without and depth within have been subsequently reduced to these trifling proportions by a circumfusion and penetration of matter, once fluid or plastic, but now consolidated? The inquiry is thrown out as a mere suggestion for examination and thought, with the sole addition that there are very many other parts of the lunar surface where such a suspicion might as naturally arise. B. and M. remark in its interior only some ridges and one small crater, probably less elevated even than the ring. Of this more hereafter. We next cross the curious district already alluded to, and to be described at a future time, to the magnificent *Copernicus* (30), one of the most imposing and best-developed specimens of its class. There are many its equals or superiors in size and depth in other parts of the Moon, but few more remarkable at once in themselves and their situation; its structure is very perfect, and its insulated position, and the absence of any material foreshortening, exhibit it to especial advantage. The diameter of its colossal wall is about 56 miles. This wonderful rampart, which does not deviate much from a circular form, bears a comparatively narrow crest, very brilliant, even to 8° and 9°, in full illumination; under especially favourable conditions it appears like a string of pearls, and on one occasion B. and M. believed that they counted upwards of 50 of these probably very minute summits. The highest point on the W. attains 11,300ft., on the E. it is only about 300ft. lower, as measured from the depth below. Schr. had given 9,600ft. The whole breadth of the wall is considerable, and its structure is very complex; nowhere, perhaps, on the lunar surface is the terrace-form more obvious, though some of the ridges can hardly come under that designation, being divided by deep gorges from the central crest. This circumstance, and the serpentine form of some of them, had been noticed by Schr., and beautifully represented by Sir J. Herschel in his "Outlines of Astronomy," where the portrait, though anonymous, may be easily recognized. Between the innumerable ridges which break up the inner slope on the N., Schr.'s 27ft. reflector showed him about 20 minute hills. He remarks that if the interior were inhabited by creatures like ourselves, their journeys would be attended with much difficulty; "but Omnipotence knows no bounds in the manifold organization of its creatures." There is a considerable central mass, consisting of six separate summits, of which two overtop the rest; the small one between them, discovered by Schr., could not be found by him upon a subsequent occasion, but appears in the drawing of H.

Schmidt, who considers this ring as combining all the characters of the class to which it belongs, will hardly be contradicted when he says that "careful studies of this incomparably beautiful and magnificent image alone fully counterpoise those of a hundred other craters." On E. he found the inclination of the crest and some of the terraces amounting in places to 50° and even 60°—a fearfully rapid acclivity—which towards the foot sinks down to 10° and 2°; and on this side he considered it about 12,500ft. high; the W. peak is some 1000ft. loftier still, rising nearly 7000ft. above the convex terraces at its base, themselves ranging 6000ft. above the interior. The latter, he says, is probably concave; the two principal central hills attain, E. 2400ft., W. 2000ft. Even these must require a considerable climb, and command a magnificent view of the surrounding rampart, at a distance of twenty-eight miles on every side. The same observer remarks the absence of minute outbursts on and within the wall, and, also, the general raising of the ground for a long distance—no less than one hundred miles from E. to W., which may be detected when *Copernicus* lies 5° to 10° from the terminator—a very interesting fact, as showing the wide outspreading and probably deep focus of the mighty force, which ultimately burst, at this spot, out beneath the open sky. We may observe, too, that this probably shows the condition of the surface at that time, neither so hard as to be inflexible under pressure from beneath, nor so plastic as to return to its original level when the eruption came to an end; or, perhaps, that the latter action continued so long that the upheaved area stiffened by degrees into its present form. The exterior height of the wall can hardly be measured with any certainty, the end of the shadow falling on this gradual and very irregular slope; Schmidt gives it, however, on E. about 4300ft. The central hills, it will be observed, lie far below the exterior surface; a fact the general prevalence of which upon the Moon had been already noticed by Mädler. A great part of this surrounding area was found by Schr. to be covered with an innumerable multitude of greyish ridges, especially S. and S.E., there being fewer N. and E., and scarcely any W. (a fact, we may observe, possibly connected with the greater height of the ring on that side, and if so, showing their posterior formation). These exhibited to him, though not as distinctly as the streams around *Aristillus* formerly described, a radiation from the centre. A portion of them has been represented by Herschel, and described as "evident indications of lava-currents streaming outwards in all directions." To travellers from among ourselves, what could be more marvellous than the gradual ascent for some twenty miles among these colossal remains of the ancient fires, while every position of vantage showed us far ahead the abrupt and irregular edge of the crater towering up through many points of the horizon, and assuming as we neared it the most imposing dimensions; this once reached and climbed—a matter no doubt of severe and continued toil—what a display of creative power would burst upon the view; terrace beyond terrace beneath our feet, sloping rapidly down to an enormous amphitheatre as deep, perhaps, as the peak of Mont Blanc is raised above the valley of Chamouni, and encompassed by a circular cliff, the prolongation of our own standing-ground, the opposite side of which would be as distant from our eye as Oxford is from London! But to realize the process by which that gigantic caldron was formed, and the scene which it presented when it was in full action, whatever the nature of that action may have been, surpasses the liveliest human imagination. When at length we could withdraw our eyes from the gulf beneath us, filled perhaps in part with the blackest shade, and could survey the neighbourhood around us, we should find that it comprised much that elsewhere would be deemed of a highly remarkable character; from the rapid rounding off of the lunar globe, the horizon becomes much more contracted than on the Earth, and the prospects are comparatively limited even from the loftiest summits; but this defect must be somewhat compensated by the perfect clearness of the air, if so it may be termed, and in the present instance, our range of sight to the W. and N.W. might probably comprise the outline of a most peculiar district, already more than once adverted to, and with some yet untold peculiarities of *Copernicus*, to be described hereafter.

TRANSIT OF JUPITER'S SATELLITES.

Nov. 2nd. II. shadow in transit, 6h. 9m. to 9h. II. leaves disk, 6h. 28m.—7th. I. in transit, 5h. 42m. to 8h. 2m. I. shadow ditto, 7h. 1m. to 9h. 20m.—8th. III. shadow leaves disk, 7h. 36m.—9th. II. in transit, 6h. 8m. to 9h. 2m. II. shadow enters, 8h. 48m.—13th. IV. shadow leaves disk, 8h. —14th. I. in transit, 7h. 36m. to 9h. 56m. I. shadow enters, 8h. 57m.—15th. III. leaves disk, 6h. 15m. III. shadow enters, 8h. 3m.—16th. I. shadow leaves disk, 5h. 45m. II. enters, 8h. 44m.—21st. I. enters, 9h. 31m.—22nd. III. enters, 6h. 36m. —23rd. I. shadow in transit, 5h. 21m. to 7h. 40m. I. leaves disk, 6h. 20m.

OCCULTATIONS.

Nov. 6th. λ Aquarii, 4 mag. 10h. 29m. to 11h. 38m.—78 Aquarii, 6 mag. 11h. 56m. to 12h. 47m.—8th. 10 Ceti, 6 mag. 7h. 6m. to 8h. 21m.—12th. 48 Tauri, 6 mag. 11h. 15m. to 12h.

CHARACTERISTICS OF ROTIFERS.

BY HENRY J. SLACK, F.G.S., HON. SEC. R.M.S.

(*With a Plate.*)

THE following paper contains the substance of a lecture delivered by the writer before the Old Change Microscopical Society on the 18th October, and is intended to serve as an introduction to the study of a group of small animals, which from their variety and beauty have always been favourite objects with microscopists of all grades, from young beginners to profound students of natural forms.

We may begin by asking, What is a rotifer? And the answer to this inquiry is rendered somewhat difficult by the important differences exhibited by different members of the group of beings usually designated by the term. If a botanist were asked, What is a *chrysanthemum*, or "golden flower?" he would enumerate a number of qualities amongst which the colour indicated by the name would not be found, because it belongs to individuals and not to the entire group. In like manner a *rotifer*, or "wheel-bearer," may be a creature which does not exhibit the least semblance of wheels or organs presenting an appearance of rotation, and a considerable number of so-called *Rotifera* only retain the name because it has become a popular one, and because they possess other organs and structure more or less closely resembling those of the common rotifer, from whose aspect the whole group was designated.

Formerly, rotifers were spoken of as Infusoria, but Ehrenberg distinctly pointed out the superiority of their organization, and observed a great number of important facts concerning their structure and modes of life. In dealing with this, as with other groups, Ehrenberg no doubt made many mistakes, some arising from erroneous interpretations of what he did see, and others resulting from the imperfect instruments at his command, but it is unfair to notice the errors of this distinguished microscopist without remembering with gratitude the enormous amount of his labours, and the success that has attended a great portion of his investigations.

Returning to the question, What is a rotifer? let us endeavour to obtain a reply by bringing together certain facts pertaining to the wheel-bearing group. Rotifers, then, are symmetrical animals, in which a dorsal and ventral, or back and front sides can be distinguished.* They have a flexible, strong skin, and

* Mr. Gosse says, "the dorsal aspect is always determined by the eye or eyes being turned towards that surface, by the stomach and intestine passing down it, and by the cloaca being on that side of the foot. The ventral aspect has the manducatory apparatus and the ovary."

in many cases enjoy the further protection of a sort of armour, which may be roughly compared to that of the turtle or tortoise, or of dwelling-tubes, more or less simple in construction. They have considerable powers of contracting or expanding their bodies, and in some cases can slide one portion inside another, like the tubes of a hand telescope. Their possession of a certain rank in the animal world is evidenced by a well-marked digestive canal, consisting of an oral or receiving orifice, an apparatus composed of hard materials for crushing and grinding food, popularly termed a "gizzard," though it is not exactly analogous to the grinding organ of birds, a gullet, a stomach supplied with secretions from glandular organs, and, except in one genus (*Asplanchna*), an intestine and anal orifice. The term "oral orifice" has been used instead of the "mouth," to avoid suggesting comparisons which might not be correct between the mouth of the rotifer and that of the higher animals of the vertebrate type. More or less surrounding the oral or receiving orifice, are groups of cilia, which in the common rotifer present the aspect of the well-known "wheels." Most rotifers, if not all, possess rudimentary eyes, either at an early period, or throughout their lives. They have all a distinct muscular system, and a nervous system, of which a large cerebral ganglion is frequently conspicuous. None of them possess a true blood circulation, but all have what is termed a "water-vascular system" of delicate canals, similar to those found in *Turbellaria*, to which the Planaria, well-known to microscopists belong, and in the Helminths, or intestinal worms—flukes, tapeworms, and threadworms. The functions of the water-vascular system are not positively known, but are conjectured to be respiratory and excretory. The contractile organ, popularly called the "heart" of rotifers, belongs to this system, and so do the "vibratile tags" easily seen in some species.

The rotifers were formerly considered to be hermaphrodites, but Mr. Brightwell and Mr. Gosse discovered distinct males of certain species, and it seems most probable that other males will be found in the course of further research. The rotifers usually obtained by microscopists are females, and their eggs and ovaries are frequently very conspicuous, the eggs often being enormously large in proportion to the dimensions of their parents. The common rotifer is an example of ovoviviparous generation, the egg with its living contents being commonly seen in the body of the parent, and the young coming forth as the exact image of its mother. In the common rotifer, and in many others when the eggs are sufficiently advanced, the jaws of the unborn infant may be seen vigorously working, the little red eyes brightly shining, and a strong ciliary current running down the gullet. Three kinds of eggs have been distinguished—common eggs, intended for immediate hatching; winter or resting eggs, designed for preservation probably till the next season, like the statoblasts of *Plumatella* and other Polyzoa; and male eggs. The winter or resting eggs are usually rough and large.

The known males are shortlived, and not provided with any digestive machinery. They seem to be simply locomotive organs of fecundation, whose services are occasionally required, the ordinary process of reproduction being carried on by the females alone, as is the case with those pests of the greenhouse and garden—the Aphides, or plant-lice. Such a method of propagation has more or less analogy to the multiplication of plants by buds or cuttings, instead of by germs fertilized by pollen and giving rise to true seeds.

The existence of eyes in rotifers has already been mentioned. They often exhibit the brilliance and tint of the ruby. and the single large eye of the *Brachions* may be specially noticed for its conspicuous beauty. In many rotifers the eyes vanish as the individual grows old, and it is often difficult to detect them. Dark ground illumination is frequently very useful for this purpose. The eye is probably of limited use, and may not form true pictures in the highest sorts of rotifers, though a refracting body or crystalline lens is said to be always present. There are many gradations in nature from eyes that seem only capable of making known the presence of light to those which form elaborate pictures on the retina, and by means of appropriate nerves supply definite information to the brain. Probably, the rotifer eye occupies one of the lower, though not the lowest position in the scale.

The calcar or spur of the common rotifer, often seen projecting like a pigtail, and similar organs on other species are probably *feelers*. They are tubular structures, fitted with a sort of moveable piston, terminating in a tuft of cilia. A sense of touch is probably diffused over the soft parts of the body, and the tentacles may be very sensitive to vibrations affecting the fluid in which the animal lives. It is also probable that the sense of taste exists in a rudimentary form, as it is very common to find rotifers rejecting particles which so far as size and consistency goes might be swallowed for food.

No perfectly satisfactory classification of rotifers has yet been proposed. Ehrenberg divided them into groups, founded upon his conception of the form of the rotary organs, but a modification or rather expansion of Dujardin's classification will be found more convenient for general use, and may stand as a provisional arrangement, pending a more thorough examination of the whole series. Dujardin calls rotifers *Systolides*, from the Greek, συστολη, contraction, but as many other creatures exhibit contractibility in as remarkable a way, the name has not usually been considered appropriate, and has not come into general use. He divides his *Systolides,* which include water bears, into orders, as follows:—1. Those which are *fixed* by the posterior extremity of their body. 2. Those which have only one mode of locomotion by means of their vibratile cilia, or the *swimmers.* 3. Those which have two modes of locomotion, and which sometimes crawl like leeches, and at others swim like the preceding, or *swimmers and crawlers.* 4. Those which are destitute of vibratile cilia, but provided with claws and are veritable *walkers*—water-bears. It is desirable to exclude the water-bears from the group, and we shall then have fixed rotifers, swimming rotifers, and swimmers and crawlers. These divisions, though not founded upon any deep considerations of structure, indicate obvious and important facts. The fixed rotifers comprehend the *Flosculariens,* which have long tufts of cilia, but no wheel-like organs, and the *Melicertians,* which have four lobes something like the petals of a flower, with cilia round their margins, exhibiting the rotatory appearances. The swimmers comprehend several genera, amongst which the *Brachions,* or pitcher rotifers, are conspicuous. Dujardin proposes two divisions of swimmers, one characterised by a general flexibility of the skin or integument, *Furcularians,* and the other, like *Brachionus, Salpina,* etc., having rigid carapaces or cuirasses. The swimmers and crawlers comprehend the *Philodines,* of which the common rotifer is the type. Many things might be said against accepting this scheme as a final arrangement of the group, but no harm can arise from its provisional use, provided that it is borne in mind that in addition to the modes of locomotion mentioned by Ehrenberg, *jumping* must be added as characteristic of several species, such as *Polyarthra, Triarthra,* and a few others. It would also be advisable to add to Dujardin's groups one of associated rotifers to include *Conochilus* and *Lacinularia,* which are inconveniently placed in his Melicertian family. There is an obvious and important difference between the permanent fixture, with confinement to one spot, of the *Floscules, Melicerta, Œcistes,* etc., and the free swimming of the associated groups of *Conochilus.* In both cases the creatures may anchor themselves by their tail-feet, but in one case there is permanence of abode and in the other a roving life.

The fixed rotifers differ very considerably from each other, and those which form simple tubes are easily distinguished from the *Melicertæ,* which are builders, constructing their abode of separate pellets moulded by an organ specially provided for the purpose, and placed in due order as a mason arranges his stones or bricks. There are also obvious and important differences between the ciliary apparatus of the *Floscules,* which exhibit nothing like rotation, and those of the *Œcistes, Limnias,* or *Melicerta,* which do show that remarkable phenomenon, and in which it is subservient to the collection of food. In fact, Dujardin's order of fixed rotifers is so far unnatural, that it groups together families that must be separated in any system founded more upon structure and less upon obvious peculiarities of external appearance.

If we followed Dujardin's arrangement, we should begin by speaking of the *Flosculariaus,* which would not have been called "rotifers" or wheel-bearers at all, if they had been the first of the group to attract attention. The most conspicuous and decided wheel-bearer is the common rotifer, in which the rotatory organs serve the two purposes of locomotive engines and food collectors, and probably, also, act in assisting respiration by bringing fresh currents of water to the delicate tissues of the creature. When it pleases this rotifer to anchor herself by her tail-foot, her mode of life for the time resembles that of *Œcistes* or *Limnias.* Her ciliary currents cause a convergence of whirlpools, which bring all sorts of particles, living or dead within her reach, and she selects some for reception and others for rejection. This being ended, we find her swimming, or crawling, frequently routing about with the snout-like extremity she presents when her wheels are withdrawn, and apparently exerting discrimination in the selection of places to examine, and of food to take in. From this active, many-motioned animal, with powerful, whirlpool machinery at her command, let us pass to the beautiful Floscule, one of the most exquisite of rotifers, when properly exhibited by dark-ground illumination. If our illuminating apparatus is nicely managed we see an extremely delicate and transparent cylinder like a confectioner's glass, surrounding the creature, and forming her house. Slowly she rises, looking so uncouth that her appellation of "beautiful" seems inappropriate. But we must not be in a hurry to condemn her. Most gracefully she throws out her five lobes, and opens from each one a long tuft of cilia, gleaming and glancing in the light of our apparatus. If we keep quiet, the fans remain expanded and still. Each of the long hairs or cilia, of which it is composed, appears capable of transmitting delicate vibrations, and we frequently see a whole group of them *twinkle* in succession like the small steel vibrators of a musical-box when the instrument is playing. The animal can direct her head to any quarter, she can change at will the position of her richly-ciliated lobes, and thus cause the inward current which she maintains by less conspicuous cilia to bring to her mouth the particles she requires. Here the long cilia may be roughly compared to the whiskers of the cat—they are collectors of a certain sort of information, not apparatus for catching food. If any object strikes rudely against the long hairs of the Floscule, she returns to her cell; and shaking the table will often induce her to do the same.

Let us now look at the *Stephanoceros*, the finest of all rotifers when seen in perfection, and a most voracious creature. Her cup-shaped body often seems nearly filled with green and golden monads and similar things she has swallowed. The dark ground illumination of the parabola or spot lens, in such cases, makes the creature look like a crystal goblet filled with emeralds and rubies. The five arms are something like the tentacles of the polyzoa, and they bear cilia at their edges. A little examination, however, shows us that the *Stephanoceros* arm cilia are not like those of a polyzoon in constant vibration, but more quiescent, like those of the Floscule. They are also much longer than those of the polyzoa—indeed, much longer than any of the drawings in ordinary books represent them, and much longer than any microscopist will have a chance of seeing them, who does not take great care of his illumination.

In *Melicerta* we come back to the wheel cilia, but the most noticeable peculiarity of this creature is her method of building her tube, which Mr. Gosse was the first to describe, though she was known to Leuwenhoek in 1703. Immediately below the angular chin of the *Melicerta* is a cup-like organ to which a ciliary current can bring particles to be "moulded with the help of some secretion into the pellets of which the little house is built up. Having formed her brick the *Melicerta* bends her head and deposits it in its place."

The tubes of the rotifers we have just considered are *constructions*, that of the *Melicerta* being an example of masonry, while those of *Floscule* and *Stephanoceros* are simpler, consisting of a gelatinous-looking exudation thrown off by the animal in the form of rings. In the case of *Stephanoceros* the successive portions are roughly joined, so that the divisions may be seen in the tubes of this species. In *Limnias* and *Œcistes* the tubes are gelatinous in aspect, and sticky on the outside, so as to cause the adhesion of extraneous particles. In the *Floscule*, the gelatinous-looking matter, whatever may be its chemical composition, is a very perfect transparent hydraulic cement, and the structure it forms is so thin and transparent as to be very easily overlooked.

If we pass from these tube-dwelling rotifers to the associated rotifers *Conochilus* and *Lacinularia* we do not find anything that can be fairly termed a tube. The rounded balls which they present to our notice, are composed of individuals more or less immersed in a gelatinous mass, from which they escape when inconvenienced, or enfeebled by the pressure and confinement of a live box or compressorium. Probably the greater part of this gelatinous mass has no important action in keeping the colony or family in union—that object seems to be effected by their tail feet, which hold on to a central portion of the gelatinous matter. The different members of a *Conochilus* or *Lacinularia* group are probably, in every case, all one family; but I am not aware that any one has succeeded in watching the whole process of the formation of a group of *Conochili,* though it is not uncommon to find in *Conochilus* balls individuals varying in size and apparent age. When a *Conochilus* group is broken up, the individuals gyrate about as if utterly destitute of self-control. They cannot walk or crawl, and their ciliary apparatus, unlike that of the free swimmers, is not adapted to execute the movements required by an independent being. When in a mass, the *Conochili* revolve, and roll through the water in various directions, and they must have some power of simultaneously modifying their ciliary action, or we should find them collected together on one side of a pond, or continually thumping against one *side* of a glass, which is not the case.

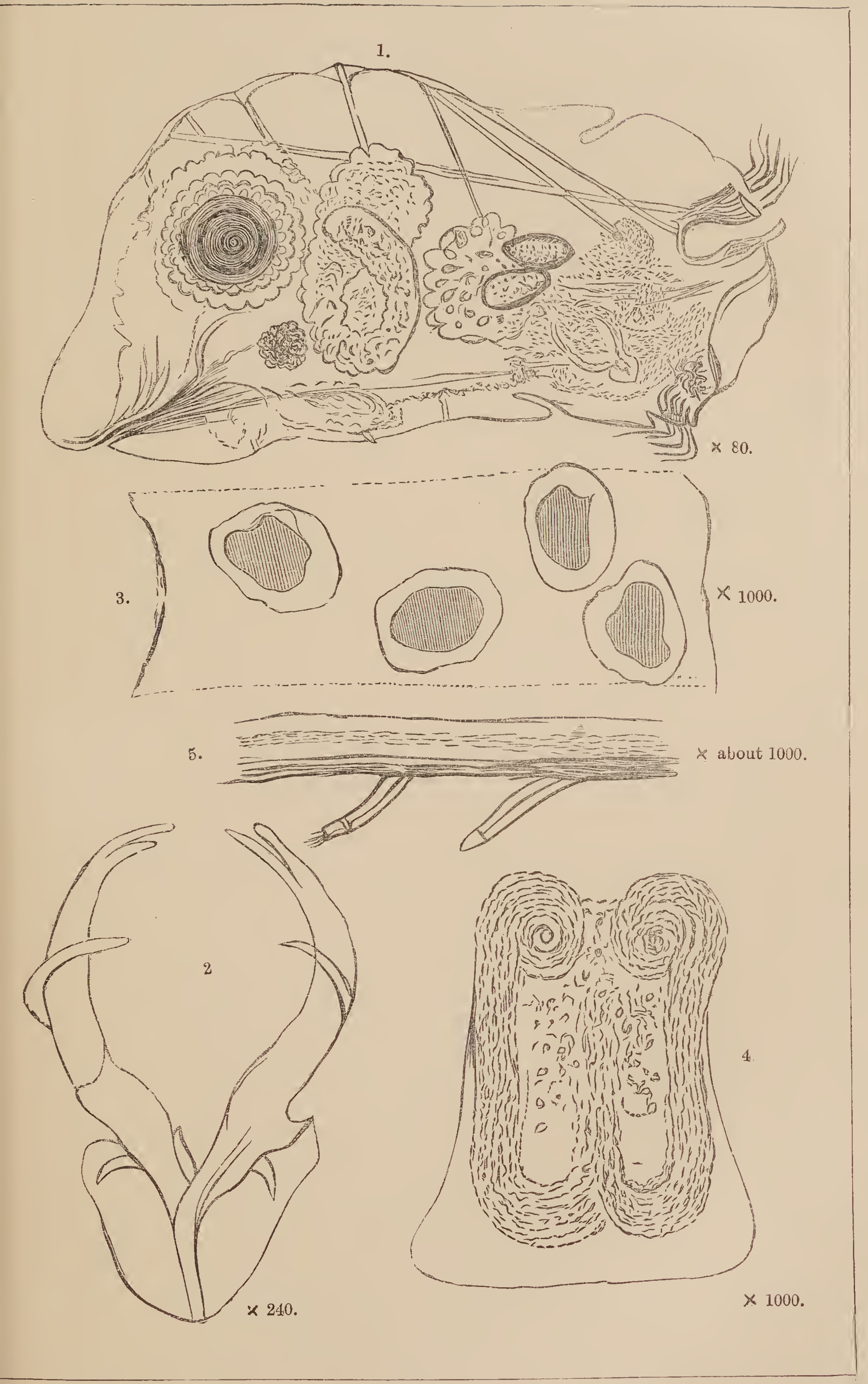
The *Conochilus* is a free swimmer for the greater part of its existence, if not for the whole of it; but *Lacinularia*—which I know only from report—appears to be stationary, except when a young associated brood leave the parent mass, and swim away in search of a fresh location. Single *Lacinularians* are not, it is said, in the habit of making solitary journeys, though they resemble very closely *Megalotrocha,* which is described in Pritchard as "white and free when young, and yellowish and attached in radiating clusters when old."

We may now consider Dujardin's "free swimmers," the first section of which are provided with a sort of armour, carapace, or cuirass. He names them from this circumstance "cuirassiers." They comprehend *Pterodina, Anourella* (or tailless), *Brachions* (with tails), *Lepadella, Euchlanis, Dinocharis, Salpina, Colurella, Ratula* (or rat-tail), *Polyarthra,* and *Triarthra,* the former with several sword-like appendages, whence Mr. Gosse has given it the name of "sword-bearer," and the latter with their long styles used for a jumping method of locomotion. *Asplanchna,* of which we shall have to speak presently, belongs to this group. Dujardin describes this order as composed of "animals of variable form, some round and flattened, others ovoid, and either almost cylindrical or compressed, but their length never being more than double their breadth, covered with a membranous cuirass." [The term "membranous" is objectionable, firm or hard would be better.] "The cuirass composed of one or two pieces often furnished with salient points, or appendages, either fixed or moveable, and which do not change their shape when contracted. The mouth, furnished with jaws, and preceded by a vestibule, the ciliated walls of which are more or less prolonged into lobes garnished with vibratile cilia presenting the aspect of toothed wheels in motion. Some tailless, others having simple or bifurcate tails."

We have to notice in this section the great variety of shape from the common *Brachion*, or pitcher rotifer, which may be roughly compared to a turtle in form, and which is furnished with a powerful tail, that it lashes about like a cat, to the elongated skeleton-like *Dinocharis*, or to *Triarthra* and *Polyarthra*, with their remarkable appendages. In the greater part of this group the cilia which give rise to the rotatory appearances are the chief instruments of locomotion; but those furnished with limb-like appendages use them as locomotive organs in addition to the cilia. *Salpina* is like a prismatic glass box; *Pterodina* like a soup-plate, with a head and tail projecting at opposite sides; and some of the others are very singular in aspect.

We are now engaged merely in getting a general idea of the whole group of rotifers, and pass from the Cuirassiers to the Furcularians, who constitute a distinct family of Dujardin's swimmers. He describes them as "animals with an ovoid or cylindrical body, very contractile and variable in form, covered with a flexible membranous tegument capable of making folds in regular longitudinal and horizontal lines, with a tail more or less long, and furnished with two fingers or styles." This family contains, amongst others, the *Notommata aurita*, or "eared" *Notommata*, so well described by Mr. Gosse, in the "Transactions of the Microscopical Society" (May, 1850), and which shows the water-vascular system and the muscular system in a very striking way. The term "tail" must not always be strictly understood, when speaking of rotifers. In the case of the *Notommata*, for example, Mr. Gosse points out that the so-called tail is a retractile foot with two pointed toes. The chief conditions of belonging to Dujardin's Furcularian family are, being swimmers, not having a rigid carapace, and not being able to crawl as well as swim. The lowest form of this family is almost worm-like (*Lindia torulosa*). Dujardin concludes his second order with the *Albertian* family, comprehending the still more worm-like *Albertia*, in which the ciliary apparatus is feebly developed, and which is a parasite in the intestines of earth-worms and snails.

Dujardin's third order and sixth family include the swimmers and crawlers, and comprehend the common rotifer and other species which strongly resembles it. He describes



ASPLANCHNA BRIGHTWELLII.

them as "animals with club-shaped bodies, able to contract themselves into a ball, and capable, when extended, of drawing in their anterior extremity, or protruding in its place a double lobe with cilia, presenting the aspect of two wheels in motion; terminating posteriorly by a many-jointed tail, the last joint carrying a pair of fleshy fingers or styles. Swimming by means of vibratile cilia, or crawling like leeches by alternately fixing the two extremities of the elongated body. Jaws stirrup-like. Two or more red eye points." We shall presently see the real nature of the jaws so described; but with the mention of the aspect of this family we conclude our brief review of some of the leading varieties of rotifer forms.

Let us now revert to the trochal disks and adjacent ciliary apparatus.

In the first place it may be generally remarked that the ciliary organs of rotifers are more complicated than they may appear at first sight, or than they are sometimes described. An immense difficulty in the way of understanding their real structure and action arises from the awkward perspective in which we usually see them. It is but rarely that we can look straight down upon them so as to see their ground plan at one glance. Ordinarily, we see an imperfect sectional view, as if we saw a perpendicular slice of a house exhibiting in section the front set of rooms, and with imperfect glimpses of other rooms behind. We have also to do with objects so minute, and with parts so transparent, that only the most careful focussing and illumination, conjoined with much thought, can enable us even approximately to ascertain the exact superposition of different structures and the way in which they co-operate with each other. Mr. Huxley's paper on *Lacinularia socialis*, in the "Transactions of the Microscopical Society" for Dec. 1851, will give us valuable help in this matter. The trochal, or wheel-disk of the *Lacinularia* is, according to his description, "wide, and horse-shoe shaped. . . . The edge of the disk has a considerable thickness, and presents two always distinct margins, an upper and a lower, of which the former is thicker and extends beyond the latter. The large cilia are entirely confined to the upper margin and seated upon it; they form a continuous horse-shoe shaped band, which, upon the oral side, passes entirely above the mouth. The lower margin is smaller, and less defined than the upper, its cilia are fine and small, not more than one-fourth the size of those of the upper margin. On the oral side this lower band of cilia forms a V-shaped loop. About the middle of this margin, on each side, there is a small prominence, from which a lateral ciliated arch runs upwards into the buccal cavity, and below becomes lost in the cilia of the pharynx. The aperture of the mouth, therefore, lies between the upper and lower ciliary bands." A simple set of wheel-cilia, always acting in the same way, would throw their whirlpool currents in one direction, but the addition of other cilia may readily enable the direction of the currents formed by the wheel-cilia to be changed, so as to suit the varying wants of the creature. The precise modes in which the wheel-cilia and the subordinate cilia are arranged vary considerably, but in every case in which I have been able to examine the ciliary apparatus under favourable circumstances, and with powers of from 600 or 700 to 1000 or 1500, I have found the quantity of cilia much larger than lower powers indicated, and the functions of the cilia, or of some of them, more varied than is commonly described. In examining a tube-dwelling species last year—the *Œcistes*, which Mr. Davis brought before the Royal Microscopical Society, with Beck's one-twentieth object-glass and powers of from about 900 to 1500—the wheel-cilia appeared as dense tufts, and many cilia were noticed in a position to assist in directing the chief currents, and which were not concerned in producing them. This creature repeatedly bent its head on one side, and, if I may use such a phrase, "licked" the matter adhering to a thread of conferva, with long cilia, apparently belonging to the wreath or to one of its rows. This licking action sometimes went on simultaneously with the rotatory movement.

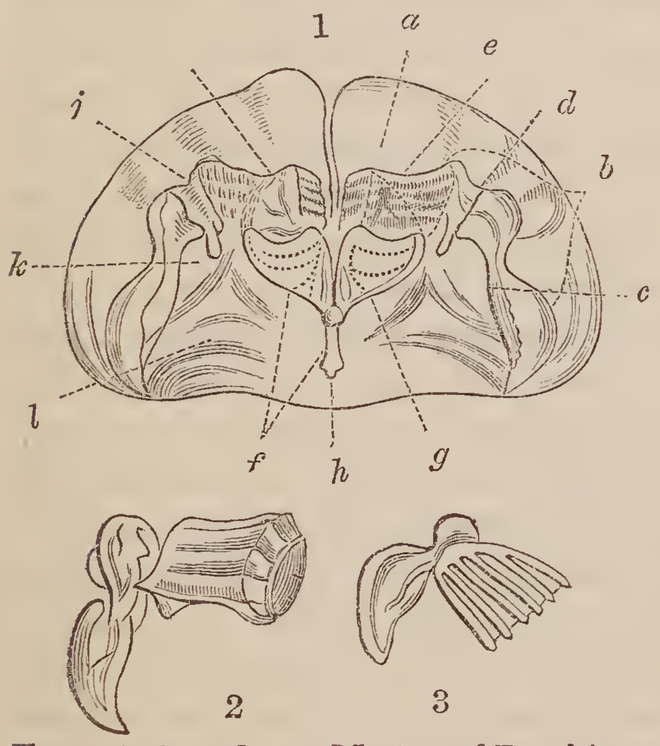
Placing a single *Conochilus* under a compressorium, and viewing it with a power of 1000, an inner row of cilia was seen to be engaged in conveying particles down the buccal canal.

In the common rotifer, when the creature is extended and its wheel organs retracted, it is common to see a few cilia moving about its mouth. It can alter the form of its anterior extremity to a considerable extent, and appears to have full control of the cilia it occasionally throws out.

With respect to the cause of ciliary movement, nothing positive is known, but some cilia appears to be always in motion, while others belong to a voluntary or quasi-voluntary system. The wheel appearance results from the rythmical motion of various cilia moving in succession. When the movements are not too fast, and a sufficiently high power is displayed, it appears that each cilium is thrown into progressing and retreating curves, just as a long thin wand of whalebone may be thrown into wave motions by the wrist. When a breeze moves over a field of corn the aspect of advancing or retreating waves is produced by the alternate bendings and straightenings of the corn stalks, and a somewhat similar set of movements progressing round a ring, gives rise to the appearance of rotation so strikingly shown by the common rotifer and its allies.

The transition from strongly vibratory cilia to the more quiescent cilia belonging to the *Floscularia* and *Stephanoceros* seems abrupt, if we turn immediately from active wheel-cilia to the latter forms, but an attentive examination of rotifiers will often reveal cilia acting so gently as to bridge over the difference of the two kinds, and probably if the long quiescent cilia were strongly agitated by any force applied to their proximate extremity, that is, to the end which is inserted in the animal, they might execute the wave motions of the other sort. The particles composing wheel-cilia must be in a state of strong tension, and this would seem to result, not from a mere mechanical arrangement, as in a piece of whalebone or a steel spring, but from a cause which ceases with the life of the creature. As soon as a *Conochilus*, for example, is dead, its ciliary wreath falls together, in a comparatively soft-looking and inert mass. On the other hand, cilia less distinctively associated with voluntary motion continue their action when torn away from the organism of which they formed a part.

After the wheel-organs of rotifers, their so-called "gizzards" are their most striking features. These remarkable structures were very imperfectly known until Mr. Gosse communicated to the Royal Society his admirable papers on the subject. Mr. Gosse employed a solution of caustic potash to dissolve—which it does instantly—the soft flesh of the rotifers, and then was able to obtain the manducatory apparatus or gizzard in a separate form. By managing the screws of his compressorium so



FIGS. 1, 2, and 3.—Mastax of Brachionus urceolaris (Gosse).

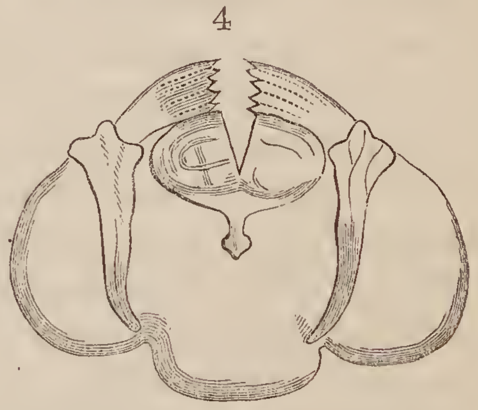


FIG. 4.—Mastax of Notommata clavulata (Gosse).

as to create water currents, he caused those organs to revolve in various directions, and with wonderful patience and skill made out details of structure and principles of action which had escaped previous observers. Mr. Gosse regards the gizzard as a *true mouth*, and he calls the muscular bulb containing the biting and grinding machinery a *mastax*. In *Brachionus urceolaris* and some of the *Hydatina* he finds the apparatus most highly developed, and we may select a *Brachion* as our leading example. The preceding figure (1) of the mastax of *Brachionus urceolaris*, is copied from Mr. Gosse, and it will be more easily understood if we placed near it another sketch, Fig. 4, copied from the same writer, of the gizzard of the *Notommata clavulata*.

In the *Brachion mastax* we see two, to use Mr. Gosse's words, "geniculate organs," *b*, which he likens to hammers working on an anvil, and names *mallei*, and a third, *f*, still more complex, the *incus* (an anvil). These three pieces are not arranged in the same plane: for the *mallei* approach each other a little dorsally, while the incus is placed on the ventral side of the centre, its stem pointing considerably towards the same side. . . . Each malleus consists of two principal portions articulated with each other by a powerful joint, which seems to be ginglymate in its character, admitting of motion in one plane only, . . . the inferior portion of the malleus, which I call the manubrium (handle), *c*, is an irregularly curved piece, shaped somewhat like the scapula of a mammal, knotted on its broad and flattened at its lower or fine end, where also it is twisted on one side, ridges run down it on both the exterior and interior surfaces, the head is obliquely truncate, and it is this oblique surface, *d*, that is joined to the superior portion, *e*, which, from its prevalent form in the other genera, rather than in this, I call the *uncus* (hook). . . . It consists of five or six finger-like processes (Figs. 2 and 3), set parallel to each other, and separated by narrow interspaces, which appear to be occupied by a thin membrane. . . . The incus, *f*, consists of distinct articulated portions. The principal are two stout *rami*, *g*, resting on what appears to be a slender pedicel (*fulcrum b*), but viewed laterally, the *fulcrum* is seen to be a thin plate to the edge of which the rami are jointed, so that they open and shut like a pair of shears. Each *ramus* is a thick somewhat trigonal piece with the outer side rounded, the upper side hollowed, and the inner side flat, and in contact with the corresponding face of its fellow, in a state of repose. The *uncus* of each *malleus* falls respectively into the concavity of *each ramus*, and is fastened to it by a stout triangular muscle." The two *unci* alternately recede and approach, and at the same time the motion is complicated by a twist of the *manubria*. "The incus also has considerable motion, sometimes the *fulcrum* is elevated, and the *rami* depressed, so that the former is invisible; the *rami* open and shut with the working of the *mallei*, being fastened to them by the strong triangular muscle above mentioned. . . . It is also evident that they have a motion of separating and closing independent of the *mallei*, though this is comparatively limited in extent, and not very often exercised. Again, when substances are brought into contact with the jaws, which for any reason are not acceptable, they are thrown up through the buccal funnel by a peculiar scoop-like action of the *unci*, which is very curious to witness."

A simplification of this description will obviously apply to *Notommata clavulata*, and to the jaws of the *Asplanchna Brightwellii*, shown in the plate; but it should be remarked that Mr. Gosse shows how strongly the jaws of the *Asplanchna* resemble the *incus* portion of the more complicated jaws of *Synchœta tremula* and *Diglena forcipata*, the *mallei* in *Asplanchna* being scarcely visible, and possessing no important function. Mr. Gosse's paper must be consulted to understand how the various parts are modified, or become obsolete in different genera; but it is advisable here to cite his popular explanation of the state of the organ in the common rotifer. He says, "Suppose an apple to be divided longitudinally, having the stalk attached to one half. Let this now be split longitudinally, so far as the stalk, but not actually separating any portion from it. Draw the two portions apart, and lay them down on their rounded surfaces. They now represent the quadrantic masses [composed of soldering together the *mallei* and *incus*], the stalk being the fulcrum, and the upper surfaces being crossed by the teeth. By the contraction of the muscles of which they are composed, the two segments are made to turn on their long axes until the points of the teeth are brought into contact, and the toothed surfaces rise and approach each other."

In the *Floscules*, Mr. Gosse finds the *mastax*, or bulb, wanting, "the dental apparatus, which is very small, springing from the paries (wall) of the stomach just below the second diaphragm."

The preceding quotations will serve as an introduction to the study of this, the so-called gizzard of rotifers; but it is important to state in connection with Mr. Gosse's opinion, that these organs are *jaws*, that he has witnessed their protrusion in *Furcularia*, *Pleurotrocha*, *Taphrocampa*, *Notommata clavulata*, *N. aurita*, *N. petromyzon*, *N. parasitica*, *Plagiognatha*, *Scaridium*, *Synchœta*, *Polyarthra*, *Diglena*, *Asplanchna*, *Mastigocerca*, *Monocerca*, *Salpina*, *Monostyla*, and *Anurœa*. As some of these are common species, Mr. Gosse's statements are easily verified by any student.

The stomachs and intestines of rotifers are richly ciliated, and near the stomachs may usually be seen bodies of considerable size, which appear to be organs secreting some fluid necessary to the process of digestion. In *Asplanchna*, the very curious circumstance occurs of a creature so highly organized being destitute of an intestine, or an anal orifice. The undigested portions of its food being cast out through the gullet and mouth. In this genus great voracity is exhibited, as may be imagined, from the quantity of other rotifers and objects of various kinds often seen in the stomach at the same time. The body of the *Asplanchna* and its integuments are very transparent, and the stomach usually yellow or brown, so that the little creatures are easily seen in a bottleful of water lucky enough to contain them. They afford excellent illustrations of ciliary stomach-currents. The whole stomach appears lined with cilia, and they produce, by a somewhat violent action, remarkable whirlpools amongst the particles of food. *Conochilus* will show the same thing in a less striking way. It is not so voracious, the cilia are more delicate, and the stomach not so filled with hard matters capable of turning the currents out of their path. Powers of at least 600 or 700 are necessary to see these phenomena well, and they require careful illumination. The ciliary currents in the stomach in *Asplanchna* are shown in the plate. The stomach-currents are plain in many of the *Brachions,* and their existence may be demonstrated with powers of about 200 to 250.

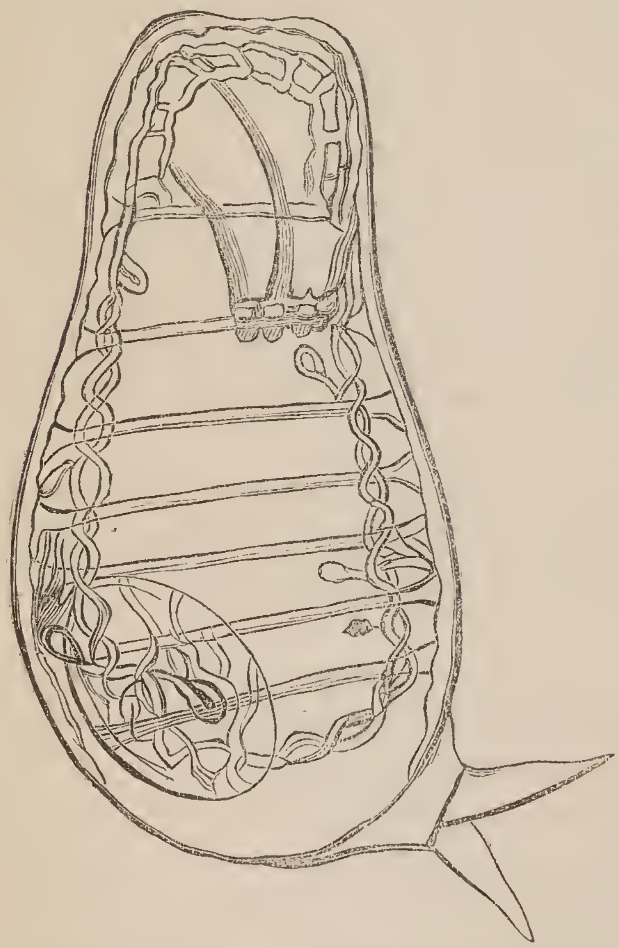


FIG. 5.—The Water Vascular System of Notommata aurita, showing the twisted tubes, vibratile tags, and contractile vesicle. Reduced from drawing by Mr. Gosse. Viscera omitted.

From the digestive apparatus we may proceed to the water-vascular system, which is probably, as before stated, respiratory and excretory. It consists of delicate bands or tubes, to which, in most cases, "vibrating tags" are attached. This system of apparatus is connected with the contractile vesicle popularly called a "heart," though no physiologist now considers it to be an organ of blood circulation. The annexed diagram shows the water-vascular system of *Notommata aurita,* as represented by Mr. Gosse ("Trans. Mic. Soc.," 1850). The stomach and other organs are not shown in this drawing. In *Asplanchna* I have noticed the tags, as shown in the accompanying plate, Fig. 5. They were ciliated at their ends, and exhibited a flickering motion in the direction of the dark line; and this was probably occasioned by an internal cilium like that which Prof. Huxley describes in *Lacinularia.*

I can only very briefly advert to the reproductive apparatus of rotifers. It has already been mentioned that the males of those species in which they have been discovered (about thirteen or fourteen) have but a brief existence. Mr. Gosse —to whom we owe most of our knowledge of them—could never preserve one alive for more than twenty-four hours. They are unlike the females in appearance, as well as in the absence of digestive organs, and they contain patches of opaque matter, which is white by *reflected*, and black by *transmitted* light. Mr. Gosse was so fortunate as to see one emerge from an egg of *Brachionus pala*, and was struck with its differing from the ordinary offspring of that creature.

The ovary of the female rotifer is remarkably conspicuous and of peculiar shape in *Asplanchna*, looking like a long cushion, bent in a more or less horse-shoe form. In the Plate, Fig. 1, the ovary is shown, and Fig. 3 is a portion of it magnified 1000 times linear, showing the germinal vesicles from which the eggs arise. In *Asplanchna* the internal apparatus has plenty of room, and is extremely moveable. When everything is in its usual position, the large stomach is seen hanging to the gullet, while the ovary bends like a horse-shoe, and partially surrounds it.

The nervous system of rotifers is probably simple, but as yet imperfectly made out. In *Brachionus* a large cerebral ganglion is seen easily behind the beautiful red eye; and in *Lacinularia*, Prof. Huxley describes a "bilobed homogeneous mass, resembling in appearance the ganglion of *Brachionus*, and running into prolongations below; but whether continued into cords or not he could not make out."

Many rotifers exhibit some symptoms of intelligence, as when the common rotifer goes groping about, or the tube-dwellers incline their heads towards particular objects. The *Metopidia acuminata* has a curved organ like half a pickaxe attached to its head, and works about with this, raking amongst rubbish, and selecting what it requires, somewhat like a French *chiffonier* with his hooked stick. If a number of *Brachions* are put in a vessel they soon come near each other, perhaps deriving some pleasure or advantage from the action of each other's whirlpools; but we must beware lest we ascribe too much *purpose* to movements which may be the involuntary results of circumstances, and it is curious that Mr. Gosse observed a *Melicerta* making and depositing her pellets, when her tube was broken, and she could place none where they could be of use.

The localities in which rotifers are found are chiefly in fresh and salt water, though some can live in damp moss. Some attach themselves to plants, others swim freely, and others lurk in sedimentary deposits. I have found the common rotifer in a slime which forms on the cotton thread of a Mason's Hygrometer, where the supply of food must have been exceedingly small. They get into the cells of certain mosses, into the tubes of confervæ, and Mr. Gosse described in "Mic. Trans., 1850," a form of *Notommata* (*parasitica*), inhabiting the sphere of *Volvox globator*.

The rank to be assigned to rotifers, or rather their place in the animal series, has been warmly discussed—most physiologists coinciding with von Siebold and Huxley, by whom they are associated with the *worms*, or rather with that portion which Mr. Huxley designates *Annuloida*. He says, "the terms of resemblance are these:—(1.) Bands of cilia resembling and performing the functions of the wheel organs are found in *Annelid*, *Echinoderm*, and *Trematode* larvæ. (2.) A water-vascular system essentially similar to that of the rotifers is found in *Monœcious Annelids*, in *Trematodes*, in *Turbellaria*, in *Echinoderm*, and perhaps in the *Nematoidea*. (3.) A similar construction of the nervous system is found in *Turbellaria*. A somewhat similarly armed gizzard is found in the *Nemertidæ*, and the pharyngeal armature of a *Nereid* larva may well be compared with that of *Albertia*. (5.) The intestine undergoes corresponding flexures in the *Echinoderm* larvæ. There are, therefore, no points of their organization in which the rotifer differs from the *Annuloida*."

It is an interesting question whether any of the rotifers possess *true-jointed limbs*. Mr. Gosse says of *Dinocharis*—"This genus is remarkable for possessing true joints in the foot; not merely telescopic inversions of the skin, but permanent articulations with swollen condyles resembling those of the antennæ of a beetle. This fact helps to indicate that this class of animals has its proper affinities with the Articulata, which has been denied by most naturalists."

Should, which seems probable, the rotifers retain the place assigned to them by Siebold and Huxley, their relations with other groups as pointed out by Mr. Gosse are nevertheless very likely to be strengthened by further investigation.

DESCRIPTION OF PLATE.

1. Side view of *Asplanchna Brightwelli*, showing stomach with two egg-shaped glands, the ovary and large resting-egg, magnified 80.
2. The jaws, magnified 240.
3. Portion of ovary, magnified 100.
4. Stomach currents, magnified 1000.
5. Portion of water-vascular system with tags: the dark lines down the tags represent internal ciliary action, magnified about 1000.

STANDARDS OF WEIGHTS, MEASURES, AND COINAGE.

BY JOSEPH NEWTON.

Last year saw carried into effect certain recommendations in reference to the above-named subject, which had been earnestly made and frequently reiterated many years previously. By virtue of an Act of Parliament, which received the Royal assent, on the 6th of August, 1866, the custody of the Imperial standards of length and of weight, together with all secondary standards of weights and measures, all balances, apparatus, books, documents, and things relating thereto, and of the Trial-plates for testing the purity of the coin of the realm, was transferred from the office of the Exchequer to the Board of Trade. The change of arrangement thus ordered to be made was in all respects a remarkable one, for it disturbed a system which had existed from the days of William the Conqueror, when the Exchequer Court formed part of the well-known Aula Regia.

The actual transfer of the custody of the standards, etc., and the determination of his powers and duties connected with them were reported by the Comptroller-General of the Exchequer on the 31st August, 1866, to the Treasury. The same communication made reference, also, to the speedy transfer of the coinage trial-plates to the Board of Trade. Thus the Exchequer was quietly denuded of important duties associated with it from a remote period of English history, whilst a great amount of extra responsibility was imposed upon its more modern and, it must be added, more active successor, the Board of Trade. It would be interesting to trace the annals of the Court of Exchequer from its origin to its partial demise, but it is no part of our present purpose to do so.* We have no intention either to say one word in disparagement of the venerable institution, or of those who filled offices in it. It is, nevertheless true that for many years past the Court of Exchequer, which had charge and care of the national standards of length, weights, and measures, paid no attention whatever to their exactitude. The legislature, and not the Exchequer, must be held accountable for the neglect, for in reality there existed, up to last year, no legal authority whatever for verifying the standards. They had remained, therefore, exactly

* Those who wish to obtain authentic and quaint information of the early history of the Exchequer are referred to the "Dialogus Scaccrario," written by Richard Fitz-Nigel, Treasurer to King Henry II., and printed at the end of Madox's "History of the Exchequer."

as they were constructed in 1824, plus certain alterations made in them by climatic influences, and the hand of time. Oxidation and other deteriorating powers were, of course, not idle, and the standards suffered accordingly. It was nobody's business to attend to their periodical verification, and nobody did attend to it. Hence, the fountains of justice, as it were, became tainted at the source, the so-called standards were no standards at all, and the primary instruments upon which depended (by comparison) the accuracy of all subsidiary weights and measures of the United Kingdom were false guides—blind leaders of the blind. Even in 1853, when new theoretical standards of weights and of length were legalized and promulgated, no comparisons of the old material standards were instituted.* It may seem passing strange that such an omission should have been permitted, but it is for us at present simply to record it as a fact, without further comment.

From these premises it will be readily conceded that the reformatory movement of last year was not made one moment too soon, and, doubtlessly, the interests of the public will be largely promoted by it. There now exists in connection with the Board of Trade, and, of course, subordinate to it, a distinct branch, known as the Standards Department, with an efficient staff of officers, and all necessary appliances, for the express purpose of verifying and maintaining in exact order the imperial standards, primary and secondary, of Great Britain and Ireland. To ensure and facilitate the comparison and verification of provincial, colonial, and local, with and by aid of the master standards, the abolition of all fees and of the stamp-duty payable hitherto for the operations, has been decreed. At the head of the new department, the office of which is in Old Palace Yard, Westminster, is Mr. H. W. Chisholm, whose title—a very appropriate one—is that of Warden of the Standards. Under his energetic and practical guidance it is tolerably certain that the important duties of the whole department will be zealously and efficiently performed, and that the standards will shortly be in as perfect a condition as such arbiters should be in the first commercial nation of the world.

In fact, the Warden has, during his first year of office, just closed, evinced a considerable amount of activity, and caused thereby many valuable improvements as compared with the compulsory "let-it-alone" system of the Exchequer. His

* A perfect standard is only found in nature, and is, therefore, immutable; but a *measure* is variable at the will and pleasure of man. In France, a standard of length is found in the 400,000,000th part of the earth's circumference, which is equal to 39,370 English inches, and is known as a metre. In England, the philosophical standard of length is a pendulum, vibrating seconds in the latitude of Greenwich, and this is, by a law of nature, invariable. From this standard comes the yard and all other measures of length.

searching inquiries have led to the elicitation of some rather startling revelations. For example, it has been discovered that out of three hundred and one cities and towns in Great Britain, which have in times past been furnished with so-called authoritative and judicial standards, one hundred and twenty have now only illegal ones. This amounts to thirty-six per cent. of the whole number. Out of fifty-seven manors or liberties similarly supplied with official arbiters of weights and measures, not less than forty-four, or seventy-seven per cent. (of said standards) have been condemned as quite unreliable. It is feared that further examinations will lead to the elimination of further discrepancies; and in Ireland it is known that the proportion of defective standards is very large. The consequences of these circumstances to the community at large, are very serious. The conviction of dishonest traders in any locality where illegal standards exist, is an impossibility. The Weights and Measures' laws are in such cases "dead letters," for they distinctly specify that the standards shall be legal by which comparisons are to be made.

The significance of these statements is augmented in presence of the known increase of the species of fraud just indicated, namely, the giving of short weights and measures among shopkeepers and others. It is of the highest moment that local standards should be periodically adjusted and reverified, so that thereby the majesty of the laws of England shall be upheld.

From a consideration of the foregoing statements, it is hoped that a clear conception of the importance of the task of the verification of the standards of length, weight, and capacity,* will be gained. Of the value or otherwise of the standard trial-plates for testing the purity of coins, a word or two shall be said hereafter.

In view of the momentous issues involved in the re-adjustment of the standards, the Government has nominated a commission to assist the warden in the performance of the work. That commission is composed of the following gentlemen—the Earl of Rosse, Lord Wriothesly, Sir John Shaw Lefevre, Lieutenant-General Sabine, the Astronomer-Royal, the Master of the Mint, and Professor W. H. Miller. The labours of this eminently scientific body are to be confined mainly to an inquiry into the condition of the old Exchequer Standards, and to ascertain in how far these agree with the Imperial Stand-

* It may be stated that the standards of weight and capacity are based upon principles coincident with those which govern the standard of length, namely, the laws of Nature, while their corresponding measures are mere artificial arrangements. The thermometer illustrates these distinctions very well. The boiling and freezing points of water constitute standards of heat; the intermediate gradations are measures of it.

ards, and with each other. They are also to report from time to time the results of their examinations and experiments, and to recommend such further changes, modifications, and renewals of standards as they may see fit. In short, the Commissioners have undertaken an exhaustive inquiry into the whole subject, of a most minutely scientific character. Up to the present time, we believe, the preliminary official comparisons of the Standards of Avoirdupois and Troy weights only have been effected. The errors in regard to the Avoirdupois Standards, are found to be the greater of the two, and this arises from the fact of their having been much more frequently used. It is only by innumerable weighings, testings, calculations, and comparisons, that anything like absolute truth can be arrived at. The changes of temperature in our variable climate affect not only the dimensions, but the weight of all metallic bodies. A sovereign, for example, held for a minute between the finger and thumb, expands in size and increases in weight. It imbibes heat and has moisture imparted to its surface. Hence the changes. The same principle affects, more or less, all simple or compound metallic substances. It is a point, therefore, in the construction of standards, to employ such admixtures of metal as are least influenced by atmospheric variations.

The Standard Commission, it is understood, are about to institute comparisons of the remaining official standards of "bullion-weight, capacity, length, and gas measures of volume," as well as to the re-verification of the standard of length—the yard. This latter will be effected by a new micrometrical comparing apparatus of great delicacy. The apparatus is to be adapted for longer measures than the yard, as well as to its subdivisions. A totally new standard bar of greater length than the yard, is indeed, in course of preparation, and this will answer a double purpose. Upon it will be indicated not only the yard, with its subdivisions into feet and inches, and the minute subdivisions of the latter, but the French metre with its subdivisions also. This is the more essential, since in very many of the mechanical and engineering establishments of the kingdom, the metrical system of measurement is constantly employed; and the probability being that in time the plan will be widely extended.

In reference to the verification of measures of capacity, the authorities of the Standards' Department have adopted an elaborate mode originally suggested by Captain Kater. Its main feature consists in weighing the exact contents of each measure —those contents being distilled water. In order to accomplish this effectually, accurate observations of the pressure and the temperature of the atmosphere have simultaneously to be taken. The furnishing of the department with the most perfect apparatus and scientific appliances which it is possible to obtain is very properly insisted upon by the warden, for without these and their most scrupulously careful use errors would be generated and multiplied.

It has been suggested as points of importance for the consideration of the Standards' Commission:—1st. The proposed addition to the present number of official standards, and, consequently, to the number of weights and measures in common use, and which may involve the serious question of the establishment or the continued prohibition of metric standards, and weights, and measures in this country.* 2nd. The question of extending the powers and functions of the Standards' Department in relation to the duties performed by the numerous local inspectors of weights and measures throughout the kingdom.

As regards the first of these points, it is to be desired that the commission *will* give it consideration, and should their deliberations result in a recommendation in favour of the establishment of metric standards and weights throughout Great Britain and Ireland, so much the better. Less importance attaches itself to the custody of the standard trial-pieces of gold and silver, used for determining the justness of the gold and silver coins of the realm issued from the Royal Mint, than to that of the imperial standards of length, weight, and capacity. The INTELLECTUAL OBSERVER† has demonstrated the utter inutility of such a mode of determining the purity of gold and silver coins as the standard trial-pieces furnish. When these latter were transferred from the custody of the Exchequer Court, their proper destination was the Royal Mint, and its crucibles. Perhaps they may yet reach that destination.

* As an instance of the confusion which now obtains as to the legality or otherwise of metric weights and measures, the following is adduced. One of the inspectors of weights and measures for the county of Surrey seized some metric weights in a tradesman's shop in Southwark last year. On his bringing the matter before the magistrates, the defendants alleged that the Metric Act, 1864, 27 and 28 Vict. c. 117, permitted the use of metric weights, but gave no power to the inspector to examine them. The magistrate dismissed the summons, observing that the Act was loosely drawn, and that the defendants were justified in using metric weights. The Board of Trade consulted the law officers on this case, and they decided that, notwithstanding the provisions of the Metric Act, a person *using* metric weights or measures is liable to have them seized and forfeited under the Act 5 and 6 Will. IV. c. 63.

† *Vide* No. lxi., p. 10, February, 1867.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1867.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain- read a 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches
July 1	29·796	71·1	59·2	·68	·753	80·4	53·0	27·4	3, 7, 4	S by W, SE, SW.	0·00
„ 2	30·685	59·7	57·6	·93	·518	68·2	56·7	11·5	10, 9, 6	S, WSW, W by N.	·25
„ 3	29·999	59·8	53·4	·81	·519	71·0	54·9	16·1	10, 10, 8	S, W by S, SW.	·00
„ 4	29·855	61·0	57·8	·90	·541	70·8	54·9	15·9	10, 9, 4	S by W, S, SW by S.	·14
„ 5	30·055	59·2	47·7	·68	·509	67·5	57·5	10·0	7, 8, 8	WNW, WNW, NNW.	·00
„ 6	30·157	59·6	46·7	·65	·516	70·8	45·7	25·1	6, 8, 8	WNW, NW, NW by W.	·00
„ 7	...	...	...	...	...	69·0	49·5	19·5	...	... ...	·00
„ 8	30·267	60·0	48·6	·68	·523	70·1	47·0	23·1	0, 3, 3	—, ENE, NE.	·00
„ 9	30·253	62·4	51·4	·69	·566	70·8	46·1	24·7	3, 8, 10	NE, NE, N.	·00
„ 10	30·189	63·8	51·0	·65	·593	74·4	48·3	26·1	10, 1, 2	N by W, NE by N, SE.	·00
„ 11	30·076	64·5	52·7	·67	·607	73·8	46·4	27·4	2, 2, 4	SE, E, E.	·00
„ 12	29·812	64·0	50·4	·63	·597	73·0	55·1	17·9	7, 10, 7	E, E by N, E by N.	·00
„ 13	29·732	58·9	57·4	·95	·504	69·6	53·6	16·0	10, 10, 10	SW by S, S by W, SW by S.	·00
„ 14	...	...	...	...	...	70·1	54·5	15·6	...	... ...	·334
„ 15	29·499	57·0	52·8	·87	·473	64·9	52·7	12·2	10, 9, 8	S by W, S by W, SSW.	·120
„ 16	29·512	55·9	53·0	·90	·456	65·8	55·0	10·8	6, 9, 7	SW, S by W, SW by S.	·241
„ 17	29·708	59·5	45·4	·62	·514	68·6	53·1	15·5	4, 8, 8	WSW, W by S, WNW.	·228
„ 18	29·591	58·3	52·6	·82	·494	68·7	55·6	13·1	10, 7, 8	SW by W, WSW, S by W.	·381
„ 19	29·681	57·6	51·2	·80	·483	64·9	51·6	13·3	7, 9, 10	W, W, NW by W.	·047
„ 20	29·806	57·8	56·3	·94	·486	69·8	52·0	17·8	5, 9, 9	WSW, SW, SW.	·003
„ 21	...	...	...	...	...	70·1	57·6	12·5	...	... ...	·094
„ 22	29·694	61·8	54·0	·77	·555	72·2	54·5	17·7	10, 4, 9	E, SW, SW by S.	·010
„ 23	29·615	61·2	53·3	·77	·544	70·1	55·3	14·8	7, 6, 4	SW by S, SW by S, SW.	·224
„ 24	29·703	58·9	46·0	·64	·504	68·8	51·7	17·1	6, 8, 9	SW by W, W, SW by W.	·020
„ 25	29·771	60·1	50·5	·72	·525	70·7	44·1	26·6	4, 8, 10	SE, ESE, E by S.	·000
„ 26	29·626	50·6	...	...	·381	57·7	51·9	5·8	10, 10, 10	NNE, N, NNE.	1·328
„ 27	30·026	51·4	44·0	·78	·391	59·8	48·8	11·0	10, 10, 10	NW, NNW, N by W.	·158
„ 28	...	...	...	...	...	66·1	45·1	21·0	...	... ...	·000
„ 29	30·042	57·2	44·3	·64	·476	66·2	45·3	20·9	5, 4, 2	N, NW, N.	·000
„ 30	30·020	57·1	45·9	·68	·475	66·8	44·9	21·9	3, 4, 9	NW by N, NW by W, NNW.	·000
„ 31	29·984	60·1	49·0	·69	·525	68·6	47·4	21·2	2, 9, 9	—, E by N, SSE.	·000
Daily Means.	29·894	59·6	51·2	·75	·519	...	...	17·7	...	... ...	3·606

* To obtain the Barometric pressure at the sea-level, these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—July 1867.

Day. / Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
12																																
A.M. 1	5	3	10	10	3	4	1	1	2	1	4	7	4	7	7		15	10	11	7	14	7	15	2	4	12	7	5	4	1	1	6·1
2	4	3	5	12	4	5	4	2	1	0	4	7	4	8	8		15	5	12	9	11	4	7	3	6	10	6	3	2	1	2	5·6
3	1	1	5	12	6	3	5	1	1	1	1	8	3	5	9		17	6	10	6	7	4	1	4	2	13	7	1	4	3	1	4·9
4	3	1	5	11	5	4	2	2	0	0	1	5	2	7	13		17	6	11	5	9	9	5	3	1	15	9	4	4	3	0	5·4
5	6	7	6	10	3	3	4	1	1	2	1	5	3	2	15		15	10	11	10	10	7	5	3	1	17	8	3	3	5	1	5·9
6	1	7	3	10	4	3	4	2	0	1	1	4	2	3	17	281	15	15	11	9	13	11	10	4	0	16	7	5	6	4	3	6·3
7	3	1	5	11	7	4	3	4	1	1	5	8	3	8	20		19	14	15	9	13	13	14	6	3	19	7	3	4	4	2	7·6
8	2	4	3	12	7	6	6	7	1	3	2	10	4	10	9		21	14	17	9	17	15	18	9	5	18	10	5	6	4	3	8·6
9	3	5	3	14	10	8	6	4	4	2	7	9	3	9	19		20	17	19	10	16	15	19	10	5	19	12	10	9	7	4	9·9
10	2	4	2	14	10	13	10	2	3	3	2	11	4	8	19		22	13	19	10	17	17	19	13	7	20	11	9	8	6	6	10·1
11	3	5	2	15	11	13	9	3	4	3	10	13	4	22	18	23	23	16	18	10	20	18	19	13	6	23	11	10	13	9	4	12·0
12	3	7	3	16	15	14	2	7	7	6	10	8	2	10	20	23	23	12	19	10	22	17	21	10	5	22	11	8	10	8	6	11·5
P.M. 1	3	6	3	15	15	14	10	6	6	6	12	10	4	23	22	21	24	17	15	10	18	21	25	13	5	25	13	9	12	6	7	12·8
2	4	6	5	17	12	12	7	8	6	6	12	9	6	12	27	17	22	17	18	12	21	25	25	13	5	22	10	11	10	8	6	12·6
3	7	10	6	13	16	10	9	11	6	5	12	12	7	19	24	13	21	19	17	14	19	27	25	12	7	25	8	10	9	6	10	13·2
4	10	10	16	13	12	10	7	11	7	7	15	12	3	15	29	19	19	20	18	20	20	27	25	11	8	23	9	17	10	6	10	14·1
5	12	10	17	11	14	17	9	12	6	9	17	16	3	18	30	18	23	15	17	14	20	25	23	11	8	24	8	13	10	7	9	14·4
6	15	14	15	8	11	9	5	12	6	9	12	21	4	17	30	16	21	7	15	17	18	20	20	10	8	21	3	9	7	3	1	12·4
7	11	12	13	5	11	7	6	10	10	9	13	20	5	13	30	14	19	11	15	13	13	18	17	8	12	22	3	6	5	2	2	11·4
8	7	9	10	4	6	7	7	10	10	9	14	14	2	13	26	13	16	14	11	11	14	13	12	7	10	20	2	4	3	1	2	9·7
9	4	9	9	6	4	6	7	6	4	9	18	3	3	17	24	11	14	11	9	11	10	8	8	5	10	15	2	3	4	0	5	8·2
10	4	6	7	8	4	5	5	7	3	6	15	12	5	8	25	10	15	7	8	12	12	6	7	5	10	9	3	3	7	1	5	7·7
11	1	8	9	5	1	4	3	5	3	3	14	7	5	5	27	14	13	11	10	15	8	10	6	6	12	10	3	2	3	4	4	7·4
12	7	7	10	3	1	1	1	2	1	1	12	5	8	5	29	14	10	7	6	16	8	15	5	4	11	7	3	3	3	2	2	6·7
Total Daily Movement.	121	155	172	255	192	182	122	136	93	102	214	236	93	264	497	507	439	294	332	269	350	352	351	185	151	427	173	156	156	101	96	9·6

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		
			Calculated.								
Day of Month.	Barometer corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Aug. 1	29·983	52·3	45·7	·80	·404	58·7	49·2	9·5	10, 10, 10	NE, NE by E, NE.	0·000
" 2	30·014	49·3	45·2	·87	·364	58·5	48·9	9·6	10, 10, 10	N by E, NE by E, NNE.	·000
" 3	30·051	57·9	45·6	·66	·487	67·9	42·3	25·6	8, 6, 6	—, N, NE.	·000
" 4	...	...	...	...	...	69·5	51·4	18·1	...	... ...	·000
" 5	29·983	60·7	51·7	·74	·535	70·2	49·6	20·6	4, 9, 9	WSW, W by S, S by W.	·000
" 6	29·753	55·2	54·4	·97	·445	64·4	56·3	8·1	10, 10, 7	SW, SSW, W by S.	—
" 7	29·753	55·8	53·6	·93	·454	64·7	47·9	16·8	10, 9, 10	SW, SW by S, SW by S.	·306
" 8	29·719	63·3	51·7	·68	·583	71·5	54·8	16·7	9, 6, 7	SW by W, WSW, W by S.	·320
" 9	29·846	62·5	51·3	·69	·568	70·0	57·7	12·3	5, 8, 5	WSW, WSW, W.	·060
" 10	30·110	62·7	53·0	·72	·572	72·7	48·8	23·9	4, 5, 5	NW, SW, WSW.	·000
" 11	...	...	...	...	...	76·1	48·4	27·7	...	... ...	·000
" 12	30·075	74·0	59·0	·61	·827	81·0	57·8	23·2	4, 1, 0	S by W, S, SE.	·000
" 13	30·003	75·4	58·6	·58	·865	83·2	57·4	25·8	0, 0, 0	E, ESE, E by S.	·000
" 14	29·915	77·0	66·4	·71	·910	85·9	59·1	26·8	3, 0, 0	S by W, S by E, S by E.	·000
" 15	29·700	58·1	...	...	·491	64·9	61·5	3·4	9, 10, 10	WSW, S by W, S by E.	·180
" 16	29·748	60·7	50·7	·71	·535	69·7	55·3	14·4	7, 7, 7	W by N, W, W by S.	·211
" 17	29·890	61·9	57·0	·85	·557	70·0	53·7	16·3	10, 9, 2	SW by S, SW, SW,	·000
" 18	...	...	...	...	...	73·0	59·9	13·1	...	... ...	·000
" 19	30·010	58·9	...	...	·504	77·3	57·3	20·0	0, 4, 0	—, SW by S, SSE.	·000
" 20	29·878	64·3	55·2	·74	·603	71·2	63·0	8·2	10, 7, 3	SW, S by W, SW by S.	·830
" 21	30·004	61·8	52·0	·72	·555	70·7	53·8	16·9	7, 9, 6	W by S, W, —.	·000
" 22	30·020	63·5	51·7	·67	·587	73·1	49·3	23·8	0, 2, 2	W by S, —, SW.	·000
" 23	30·031	66·2	53·2	·65	·642	74·9	48·0	26·9	2, 1, 2	SW by S, W by N, SSW.	·000
" 24	30·062	65·8	59·8	·82	·633	74·0	49·7	24·3	8, 2, 1	SSW, SW, SW by S	·000
" 25	...	...	...	...	...	75·0	55·5	19·5	...	... ...	·000
" 26	29·965	56·1	55·9	·99	·459	69·3	57·0	12·3	10, 10, 10	SW by S, —, —.	·000
" 27	30·042	59·3	46·8	·65	·511	68·3	48·0	20·3	7, —, 3	SW, W, W by N.	·145
" 28	30·159	58·4	53·8	·86	·496	67·8	45·1	22·7	9, 10, 10	SW, SW by S, SW by S.	·000
" 29	30·165	63·3	61·4	·94	·583	70·9	57·5	13·4	10, 10, 10	SW, SW, SW.	·000
" 30	30·038	62·3	54·6	·78	·564	72·7	55·3	17·4	10, 7, 4	SW by W, SW by W, SSW.	·005
" 31	29·843	68·4	57·3	·69	·690	75·7	55·8	19·9	3, 2, 7	E by S, E by N, E by N.	·000
Daily Means.	29·584	62·0	53·8	·76	·751	...	...	18·0	...	... ...	2·057

* To obtain the Barometric pressure at the sea-level, these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—August, 1867.

Day. Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
12	2	14	1	2	2	11	7	12	12	6	2	1	8	4	1	5	9	14	4	5	9	3	1	1	5	6	4	4	2	8	10	5·7
A.M. 1	5	10	1	3	4	11	6	10	13	4	1	4	8	5	3	5	10	15	3	10	7	3	3	1	9	3	4	3	6	6	6	5·9
2	5	6	1	3	3	10	2	10	13	6	1	2	6	2	4	6	11	15	5	10	7	3	0	0	6	4	3	3	5	4	4	5·1
3	7	12	1	4	3	9	5	12	8	4	1	5	4	2	10	6	11	13	4	10	9	2	1	1	6	2	4	2	7	5	6	5·7
4	9	12	3	2	4	13	4	9	9	4	1	5	3	2	7	6	10	13	3	5	7	2	0	0	4	3	4	3	6	4	5	5·2
5	12	13	2	3	3	11	5	6	10	4	1	5	3	1	6	4	11	13	2	4	5	4	1	2	7	5	2	2	6	3	3	5·1
6	10	14	2	3	5	11	9	10	10	6	0	5	3	1	5	9	14	11	5	4	7	2	1	3	7	5	5	3	8	3	2	5·9
7	11	12	4	3	6	10	9	10	11	5	1	5	5	2	5	10	18	11	5	10	7	2	1	4	9	7	6	5	9	7	2	6·8
8	12	13	4	3	5	11	10	8	12	7	0	7	8	4	6	10	17	11	7	10	7	3	2	3	8	10	5	5	11	8	4	7·4
9	13	14	4	2	8	11	11	11	12	9	2	10	10	2	4	11	19	11	6	11	8	4	3	3	9	10	4	10	11	9	9	8·4
10	17	13	3	4	12	6	10	12	12	8	5	14	13	5	9	12	20	9	11	11	8	7	7	9	8	11	6	12	11	11	13	10·0
11	18	10	6	3	11	7	6	12	10	6	6	14	17	3	7	10	23	8	9	14	8	6	7	10	10	8	6	13	9	11	13	9·9
12	19	12	6	4	14	8	2	16	14	12	7	13	18	5	9	13	22	6	10	20	5	8	6	10	12	9	6	12	7	14	14	10·7
P.M. 1	16	10	6	4	15	9	3	15	11	8	4	13	16	4	5	13	21	10	10	23	10	8	7	11	12	7	5	13	8	13	12	10·4
2	17	8	7	7	13	9	6	17	10	8	4	14	16	6	10	16	24	10	11	22	10	6	6	11	13	4	7	12	10	13	14	11·0
3	17	8	9	4	12	9	11	17	12	8	5	16	15	3	13	13	23	11	10	25	8	6	8	8	8	3	5	14	5	14	14	10·8
4	16	9	9	2	15	4	13	12	12	6	5	13	15	6	12	14	25	14	10	22	7	6	7	9	8	1	7	14	7	12	12	10·4
5	13	7	3	5	13	5	9	15	12	6	2	11	10	9	8	10	22	12	8	20	3	4	6	9	10	3	4	11	5	12	12	9·0
6	17	7	2	5	15	8	3	12	10	2	0	9	8	4	8	12	23	12	3	16	4	6	9	10	6	5	2	12	5	11	12	8·3
7	7	2	1	4	12	9	9	12	10	3	2	9	9	3	9	7	21	10	3	13	3	6	7	6	6	2	4	10	8	14	13	7·5
8	13	2	1	3	8	8	7	10	5	5	4	7	8	3	8	6	18	7	3	12	2	3	4	7	7	5	2	10	8	10	10	6·6
9	14	0	1	7	5	5	9	10	6	0	3	7	8	5	4	6	18	5	4	14	3	2	3	4	7	3	6	9	6	11	16	6·3
10	13	1	4	6	8	6	10	13	6	1	4	8	7	4	6	6	15	5	2	11	2	1	3	4	9	6	5	6	5	15	11	6·7
11	11	0	2	4	9	6	10	14	4	2	0	6	3	2	4	8	13	6	4	10	2	2	3	4	6	5	5	3	5	11	14	5·6
12																																
Total Daily Movement.	294	209	83	90	205	207	176	285	244	130	61	203	221	87	163	218	418	252	142	312	148	99	96	130	192	127	111	191	170	228	227	7·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		Rain— read a 9·30 A.M.
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches
Sep. 1	...	...	...	...	...	75·7	59·4	16·3	...	... ...	0·00
„ 2	30·092	66·8	54·5	.66	·655	75·7	52·3	23·4	2, 3, 2	NE, E, E by S.	·00
„ 3	29·966	64·1	63·5	·98	.599	75·0	60·8	14·2	10, 9, 10	E, E, E.	·39
„ 4	29·820	62·6	56·1	·81	·570	70·0	58·0	12·0	10, 8, 1	SW by S, SW, SSW.	·05
„ 5	29·850	60·0	54·0	·82	·523	68·6	57·6	11·0	10, 4, 3	SW by S, S by W, SSW.	·14
„ 6	29·773	58·3	52·7	·83	·494	67·5	51·1	16·4	8, 7, 4	SW, SW by W, SSW.	·01
„ 7	29.955	60·3	50·7	·72	·528	69·3	54·3	15·0	4, 4, 8	SW by W, WSW, SW.	·00
„ 8	...	...	...	...	...	69·1	47·8	21·3	...	... ...	·00
„ 9	29·860	60·4	52·5	·77	·530	70·1	52·6	17·5	5, 7, 10	WSW, SW, SW.	·00
„ 10	29·885	58·6	48·9	·72	·499	67·0	52·4	14·6	4, 4, 9	WSW, SW by W, W by S.	1·01
„ 11	29·930	57·9	55·4	·92	·487	66·8	47·3	9·5	10, 10, 10	ESE, SSW, —.	·32
„ 12	29·795	62·2	55·3	·79	·563	70·5	58·2	12·3	6, 7, 6	SW by S, SW, SSW.	·00
„ 13	29·936	58·9	49·5	·73	·504	67·1	52·6	14·5	6, 9, 7	—, SW by W, SW.	·00
„ 14	30·011	56·8	50·3	·80	·469	64·5	47·8	16·7	5, 8, —	SW, WSW, —.	·00
„ 15	...	...	...	...	...	64·8	51·1	13·7	...	... ...	·07
„ 16	30·200	53·7	42·4	·68	·423	60·7	45·5	15·2	4, 6, 2	NNW, N by E, NE by N.	·01
„ 17	30·378	50·4	42·2	·75	·378	57·9	43·3	14·6	9, 9, 9	NNW, NNE, N.	·0
„ 18	30·296	56·0	47·9	·76	·457	63·7	49·7	14·0	6, 8, 8	N, NE by N, NNE.	·0
„ 19	30·136	57·0	51·1	·82	·473	65·6	51·0	14·6	8, 7, 3	NE by N, NNE, NE by E.	·0
„ 20	30·156	54·2	46·5	·77	·430	62·6	51·5	11·1	10, 4, 2	N, N, N by E.	·0
„ 21	30·124	52·5	45·3	·78	·406	61·6	45·5	16·1	9, 0, 2	—, SW by W, SW.	·0
„ 22	...	...	...	...	...	64·6	50·5	14·1	...	... ...	·1
„ 23	29·954	56·9	54·4	·92	·471	64·8	45·5	19·3	10, 9, 7	SW, SW, WSW.	·0
„ 24	30·188	51·6	39·1	·65	·394	59·8	47·3	12·5	7, 8, 5	NW by N, N, NNE.	·0
„ 25	30·455	51·1	44·9	·81	·387	59·3	35·5	13·8	4, 6, 4	NW, NNE, NNW.	·0
„ 26	30·435	51·4	47·0	·86	·391	61·9	38·9	23·0	0, 5, 7	— — —	·0
„ 27	30·324	52·8	45·2	·77	·410	60·6	46·6	14·0	9, 3, 8	W by S, SW by W, WSW.	·0
„ 28	30·226	55·6	48·0	·77	·451	62·4	49·3	13·1	3, 9, 7	W by S, SW by W, WSW.	·0
„ 29	...	...	...	...	...	61·7	49·3	12·4	...	... ...	·0
„ 30	30·035	52·5	48·7	·87	·406	63·1	.50·3	12·8	1, 10, 10	W, W by S, WSW.	.0
Daily Means.	30·071	56·9	49·8	·79	·475	...	...	15·0	...	... ...	2·2

* To obtain the Barometric pressure at the sea-level, these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.

SEPTEMBER, 1867.

Hour.	Day 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Hourly Means.
A.M. 12–1	10	1	10	4	18	5	14	7	3	10	2	13	4	6	8	6	6	15	11	8	4	12	7	9	8·0
1–2	5	1	20	2	16	4	15	6	1	15	3	16	4	5	9	5	7	15	12	8	3	12	7	9	8·3
2–3	5	0	14	1	13	8	12	4	1	10	2	15	1	4	9	6	5	18	10	9	5	13	8	10	7·6
3–4	5	1	15	1	9	7	16	1	1	9	1	11	2	5	9	6	7	17	11	10	3	13	4	9	7·2
4–5	5	1	16	2	7	11	18	1	1	6	1	10	1	5	11	5	9	18	8	12	4	14	8	10	7·7
5–6	4	1	10	9	5	11	16	1	1	7	1	12	1	7	11	7	8	18	8	10	3	15	10	10	7·7
6–7	1	1	9	6	8	12	15	1	1	11	2	11	1	4	7	7	9	19	9	10	3	13	15	8	7·6
7–8	2	1	12	11	8	16	22	5	8	10	1	9	3	10	13	8	11	22	9	13	5	14	16	14	10·1
8–9	4	4	12	12	4	20	21	10	11	12	4	15	4	17	14	12	13	27	9	10	4	13	18	19	12·0
9–10	8	5	13	12	7	15	22	11	11	15	4	15	2	17	11	15	13	24	10	10	3	14	19	18	12·2
10–11	13	8	11	13	11	22	20	14	12	15	9	15	6	16	13	15	16	26	13	13	3	10	15	20	13·7
11–12	13	10	10	15	15	24	22	13	11	17	12	19	8	18	11	12	17	28	13	10	4	8	18	17	14·4
P.M. 12–1	14	12	10	15	16	30	19	15	12	14	14	17	8	20	14	15	20	23	10	9	4	12	16	18	14·9
1–2	12	10	12	15	19	22	16	15	12	15	14	16	11	19	15	11	19	25	8	9	6	12	16	18	14·5
2–3	14	12	14	16	20	25	18	18	11	12	11	17	10	20	12	11	19	26	6	9	8	12	19	17	14·9
3–4	13	13	11	20	19	20	13	15	12	13	8	13	6	22	12	9	18	22	7	12	9	11	19	13	13·7
4–5	13	14	9	20	17	19	15	8	8	11	7	15	6	16	10	10	18	22	6	11	7	11	19	11	12·6
5–6	10	14	10	19	15	19	14	8	6	6	9	11	10	19	6	10	15	19	5	5	6	8	16	9	11·2
6–7	7	16	6	16	10	19	11	8	5	7	6	10	10	21	5	10	11	17	2	6	5	7	13	3	9·6
7–8	4	17	4	11	13	17	10	5	4	3	6	7	5	21	4	7	7	17	3	3	11	6	12	5	8·4
8–9	5	18	1	13	2	18	10	2	5	5	7	6	5	19	3	5	9	19	4	4	12	7	15	2	8·2
9–10	4	17	0	13	6	15	6	4	4	6	11	8	6	14	6	3	12	16	9	2	10	4	15	2	8·0
10–11	2	17	2	17	7	20	5	5	4	6	20	3	4	9	6	6	15	15	9	2	11	7	11	5	8·7
11–12	2	17	2	20	3	15	5	5	4	3	17	4	5	8	6	6	14	8	5	3	12	6	9	2	7·5
Total Daily Movement.	175	211	233	283	268	394	355	182	149	238	172	288	123	322	225	207	298	476	197	198	145	254	325	258	10·4

The Anemometer was dismounted on the 25th, for the purpose of erecting a new instrument on the pattern decided upon for the Board of Trade observatories.

NOVEL ACTION OF LIGHT.

BY NIEPCE DE ST. VICTOR.

(Translated from "Comptes Rendus," No. 12, 1867).

I HAVE published, in five preceding memoirs all the experiments which I have made to prove that porous or rough bodies which have been acted upon by light preserve an activity capable of reducing salts of silver in the dark, as though they had been exposed to light. I have shown that this *activity* is persistent; that it is preserved for many days in obscurity or in the free air; that if a body had lost this activity, it could be made to resume it on exposing it again to light; that, supposing a piece of cardboard, was insolated, having been impregnated with nitrate of uranium, or tartaric acid, and shut up in a confined atmosphere, such as a tin case, hermetically sealed, it would have the same activity after several months as it showed on the first day.

This activity acts at a certain distance in the dark, for instance, and is communicated to a similar body in the same way, but the action does not pass through the glass.

M. Arnaudon, a chemist of Turin, has repeated some of my experiments in different gases, and the results have been the same as in free air. It would be very important to make an experiment in a luminous vacuum, but I have not as yet been able to do it. I proved the production of this activity upon the edges of a newly-broken china-plate, as well as upon an unpolished sheet of glass, made perfectly clean with distilled water. It could not be said, therefore, in this case, that there was decomposition of the body acted upon by light. I have shown that the effects of light are not owing to phosphorescence, but I have not said whence this activity comes. Many hypotheses have been put forward. Certain persons have denied the fact altogether, which was more simple; but no one has given a solution to this phenomenon. I said, in my first memoir, that an engraving or a plain sheet of paper having been insolated and afterwards placed on a layer made sensitive to light, such as iodide or chloride of silver, reduces salts of silver in obscurity, as though they had been exposed to light, only much more rapidly. If the sheet is impregnated with nitrate of uranium, or tartaric acid, before being exposed to the light, the reduction of the salts of silver is very quick, especially with the first substance.

This is, then, my experiment. I placed seven strips of red, orange, yellow, green, blue, indigo and violet glass upon a sheet of paper. After insolation, I have applied this sheet of paper to another sheet covered with iodide or chloride of silver, and have then left them in contact, in the dark, for twelve hours. I then saw that the bands of red, orange, yellow and green glass, had not made any impression on the sensitive paper, while the blue, indigo, and violet bands had darkened it. I repeated this experiment upon paper or card-board impregnated with nitrate of uranium, or tartaric acid; the sensitive layer was much more coloured in the parts corresponding to the same rays than I have indicated above. When the sheet of paper containing nitrate of uranium, or tartaric acid, has been insolated, this activity can be easily proved by pouring a solution of nitrate of silver, in form of a train, upon the insolated part. A very strong colouring is immediately seen in the blue, indigo, and violet rays, and not any in the four first, except the exposition to light has been very much prolonged. In this case a slight colouring is seen in the green, yellow, and red rays, but not any in the orange. If bands of glass are placed on a sheet of gummed paper, and it is exposed for about an hour to solar light, on pouring a solution of iodide of potassium on the part covered with the seven bands of glass, the parts of the paper corresponding to the violet, indigo, and blue rays, would be observed to take a brick-red tint, while the green, yellow, orange, and red rays would remain unchanged.

If an iodide of silver is formed by pouring on nitrate of silver before the iodide of potassium, in the dark, the iodide of silver would be coloured in the most refrangible rays. By this means a sheet of paper can be insolated under a press, and a positive proof obtained in the dark, which can be strengthened by means of sulphate of iron. I ought also to mention, that I have made experiments with coloured glasses upon white and coloured stuffs, and the stuffs and the colours were only altered by the light under the violet, indigo, and blue glasses. I should say that light has less action under a violet than a white glass, and less under the latter than in open daylight.

Couclusions.—After these experiments, it can be said that light has only a destructive action in the most refrangible rays. That is known, it will be said; but this *persistent activity* was not known before my experiments, and now I demonstrate that it is owing to chemical rays, and that it has the same effect as direct light in reducing salts of silver.

ARCHÆOLOGIA.

In our July number of the Intellectual Observer, we gave an account of the discovery of what we believe to be the Roman Station of Vindomis, in the neighbourhood of Andover; and we have to add that further discoveries have since been made near the same place. The Rev. E. Kell and Mr. C. Lockhart, to whom we owe these former discoveries, believed that other remains existed in connection with them; and, on Monday, the 16th of September last, they were successful in their search. The foundations of a second Roman building were discovered in the same Castle Field, at the distance of 256 feet to the westward of the one excavated in May last. This new discovery is as yet of small extent; the four labourers employed uncovered the foundations of a wall three feet thick, composed of faced flints, for a distance of fifteen feet only; but there can be no doubt that it extended much further, and that, in fact, it forms part of some considerable building. What relation this may have to the building formerly excavated, it is impossible, with our yet imperfect knowledge, to conjecture. Among the antiquarian relics found in the course of the excavations were a Roman coin, third brass, of one of the Constantine family; numerous fragments of pottery; pieces of stone roof-flags, which showed that it was the wall of a building which had had a roof; iron nails; some oyster-shells; and bones and teeth of the ox, pig, etc. The farmer of the land, Mr. Turner, was unable to allow any complete examination of this new building to be made on the present occasion, as it was necessary to occupy the land immediately for agricultural purposes; but he has promised to allow the exploration to be continued in the autumn of 1868.

The Rev. Canon Greenwell is indefatigable in his researches among the Yorkshire Barrows. He has recently opened a group of seven, in the vicinity of Weaverthorpe, on the range of hills between Malton and Filey, two of which were very remarkable for the objects found in them. They were all of low elevation, from one to three feet; but this was perhaps the mere effect of time. The first of the two alluded to was two feet high by twenty-two in diameter. A skeleton, judged to be that of a female, lay on its left side, doubled up, in the centre, on the natural surface of the ground. On the right wrist was a beautiful bronze armlet, of the snake-head pattern, and a succession of oval swellings lengthwise. Close to the neck was a delicate bronze fibula, of the bow shape, extremely elegant in workmanship. It had originally a tongue of the same metal, which had been broken off, and replaced by an iron tongue. On the chest lay a necklace of extremely beautiful beads, fifty-two of glass and seventeen of amber. The glass beads, with one exception, were blue in colour, and ornamented with a zigzag pattern in white enamel; the exceptional bead being larger and more globular, and ornamented with amulets of white. Much broken pottery was found in the mound, with a few flint-chippings. The other barrow was only one foot high by twenty-seven feet in diameter, and in the centre lay, on the surface of the ground, a female skeleton, also doubled up and laid on her left side. The right wrist, as in the former case, was encircled by a bronze armlet. It is described as being "of the most beautiful description, resembling a delicately-formed cog-wheel, with rounded teeth on both sides, the rim between the teeth being ornamented with three grooved lines. For exquisite preservation, delicacy and beauty of workmanship, high polish, and brilliant patina, this armlet is not to be surpassed." Below the hip were the remains of a plain urn "of a peculiar dark-coloured ware." A hole, or trench, in this tumulus, contained flint-chippings, animal bones, charcoal, and fragments of dark-coloured pottery. The rest of the barrows contained no very remarkable objects; in one only there were the fragments of a highly ornamented drinking-cup. We cannot quite see the evidence on which the writer of the local reports considers these barrows to belong to the late Celtic period, and why they are fixed at a date about one or two centuries before our era. We have given the description of the objects found in the two principal tumuli from the accounts published in the local papers, and it would be necessary to see them before forming any certain opinion; but, from the description, we should ourselves hardly judge them to be pre-Roman. In a cemetery at Seamer, in this same district, opened by Lord Londesborough in 1857, which was undoubtedly of the Anglo-Saxon period, probably of the fifth or sixth century after Christ, the body in one grave lay on its side, doubled up much as described above. An account of it has since been published in the "Journal of the Archæological Association"; and we believe that, in the only other grave opened on that occasion, in which nothing but a skeleton was found, it lay in exactly the same position.

We have just received a new proof of the archæological activity and knowledge of Mr. Ecroyd Smith, in a pamphlet entitled, "Archæology of the Mersey District," 1866, reprinted from the "Transactions of the Historic Society of Lancashire and Cheshire," and containing much interesting matter. Perhaps the most interesting article in it is one which seems to fix the position of a Roman Station which has been hitherto doubtful. It appears, from the second and tenth Iters of Antoninus, that a Roman road from *Deva* (Chester) entered the road which ran from *Mancunium* (Manchester) to *Mediolanum* (supposed now to be Middlewich, in the centre of Cheshire), at a spot where there stood a town or station named Condate. Several localities have been put forward as the site of this place, but with not very satisfactory reasons. It has now, however, been discovered, by very recent diggings for sand, that numerous Roman antiquities are found at a place named Wilderspool, near Warrington, which answers to the Condate of the Itineraries in a very satisfactory manner; and, as we understand, appears, from other circumstances, to occupy the spot where the two roads met. The works, in the course of which the Roman antiquities are brought to light, are carried on in the present year with activity which promises important results. We owe this identification to Dr. Robson, of Warrington; and Dr. Kendrick, who has watched the discoveries at Wilderspool, promises a full account of them for the next volume of Transactions of the "Historic Society."

The latter part of Mr. Ecroyd Smith's pamphlet is occupied by his report of the archæological produce of THE CHESHIRE COAST during the year 1866, in continuation of a former report, of which we have given an account before (INTELLECTUAL OBSERVER for May, 1867). Of the objects thus found, Mr. Smith has given a classed list, descriptive when necessary, with engravings of a few of the more interesting objects found. Under the head of Primeval, he enumerates twenty-one rudely-fashioned implements of flint and limestone, an arrow-head of bone, and a curious skewer, or pin, made of whalebone. To the Roman period belong four Roman coins (the only three which are legible belonging to the Emperors Nero, Antoninus Pius, and Probus); a key; a fibula of the bow shape; an *acus*, or pin, of a brooch; two dress pins, or (as they are usually called, perhaps in this case less correctly) hair-pins; and a piece of hæmatite, which Mr. Smith supposes to have been used as an amulet. The Saxon period is only represented in this list by two glass beads, of a pale straw colour. The objects here classed under the head of Early English, and which would perhaps be better described as Mediæval, are so numerous and so varied in their material and character that we cannot attempt to enumerate them. A few relics of less interest, and dating from the reign of Elizabeth to the eighteenth century, but belonging principally to the seventeenth, are classed under the head of Later English. The total number of objects of archæological interest, irrespective of animal remains, found in or near the sea-beach of Cheshire during the year 1866, amounts to 238.

The new EXCAVATIONS AT WROXETER (Uriconium), though interrupted for a while by the necessity of employing the men in the labours of harvest, have produced some very interesting results, of which we intend to give a more full account on an early occasion. The new room opened, adjoining to what was named the enameller's shop, and, like it, facing the Roman forum, proves to be another shop, of exactly similar dimensions and character. It is singular that two large workshops, evidently for the manufacture of small ornaments in metal, should stand side by side in such a position; and we may almost suspect that Uriconium was a great manufacturing town—a Birmingham of Roman Britain. Future researches will, no doubt, throw more light on this question. Among the numerous relics recently discovered, was a pretty intaglio, engraved in a bright red cornelian, and representing two parrots, seated on what appear to be two vessels, with a large vase between them, into which what bears resemblance to a stream of liquid flows from their mouths. We regret to say that, just as this object was carried to the Museum, some visitors who happened to be there were allowed to take it in their hands to examine, that it quickly disappeared, and that nobody has heard of it since. Fortunately, impressions had been taken in wax; but it cannot but be believed that, whoever has it in his possession, will soon see the propriety of returning it to its right place in the Shrewsbury Museum.

We would call attention to a very ingenious and probably correct suggestion made by Mr. Roach Smith, in his Notes in the last number of the "Gentleman's Magazine." Every one at all acquainted with the Roman antiquities of our island, knows how frequently large HOARDS OF ROMAN COINS are found buried in the ground. The Anglo-Saxons had remarked this circumstance, but they imagined that the Romans, when they left the island altogether, nourished the hope of coming back again, and that they buried their treasures, in the idea they would thus be preserved till their return. It is a remarkable circumstance, that nearly all these hoards contain almost the same proportions of the coins of the different emperors; that the most numerous are those of Tetricus, father and son, and that the least numerous are those of Aurelian, with whom they almost all conclude. Mr. Roach Smith compares two hoards recently discovered, one at Netly in Hampshire, the other in Yorkshire, and therefore in widely distant parts of the island. In the former, consisting in all of 1821 coins, there were 749 of Tetricus the father, 255 of Tetricus the son, and one of Aurelian; in the latter, out of a total of 3095 coins, there were 1097 of Tetricus the father, 434 of Tetricus the son, and four of Aurelian. Mr. Roach Smith conjectures, and we are quite of his opinion, that when, at that eventful period in the history of the Roman empire in the west, the legions in Britain and Gaul, who had supported the usurpation of Tetricus, were called into the latter province to oppose the advance of Aurelian, the soldiers of the legions in Britain, before their departure, buried these hoards, and that the owners never returned to reclaim them, being slaughtered probably in the great battle which restored the western provinces to the empire of Rome. A comparison of these hoards is further interesting to us, as it shows us the proportions of the coinage of the different emperors in circulation at the close of the third century.

T. W.

PROGRESS OF INVENTION.

ARTIFICIAL MEERSCHAUM, ETC.—Chemistry has discovered a new and interesting use for potatoes and other vegetables, illustrations of which are now to be seen at the Paris International Exhibition. If potatoes are peeled, macerated for about thirty-six hours in water, to which eight per cent. sulphuric acid has been added, well washed with water, dried in blotting-paper, and then in hot sand for several days, on plates of chalk or plaster of paris, which are changed daily, being compressed at the same time, an excellent imitation of meerchaum, answering well for the carver, or any purpose not requiring a high temperature, will be obtained. Greater hardness, whiteness, and elasticity will be produced if water containing three per cent. of soda, instead of eight per cent. sulphuric acid is used. And if, after the potatoes have been macerated in the solution of soda, they are boiled in a solution containing nineteen per cent. soda, a substance resembling stags horn, and which may be used for knife handles, etc., will be formed. Turnips may be used instead of potatoes in the production of the artificial horn ; and if carrots are substituted for the potatoes, a very excellent artificial coral will be obtained.

Railway Safety Switch.—It is of the utmost importance that the points on railways should be in the proper position. If they are not, a train may run on the wrong line, and thus destructive collisions ensue. Such has been but too often the cause of serious accidents, and great mischief to both life and property. The pointsman may be neglectful, or over-fatigue may cause him to forget his duty. Hitherto there were no effective means of discovering the circumstance until it was too late. A very ingenious and simple application of electricity now renders it extremely easy. The switch is so arranged that, whenever it is not in a proper position, it completes the electric circuit of a galvanic battery, and the current thus set in motion operates on an electro-magnetic apparatus, which keeps an alarm bell ringing where it cannot but draw the attention of responsible persons to the pointsman's neglect, so that the switch may be put in its proper position before any injury is done.

Manufacture of Starch.—An improvement of considerable importance has recently been made in the manufacture of starch. It is founded on the fact that, although the specific gravities of the starch and of the substances associated with it in the grain, etc., from which it is extracted are very nearly, they are not quite the same; and the improvements, which is due to M. L. Maighe, consists in an ingenious application of centrifugal force. Water is added to the crude starch in the proportion of two parts of the former to one of the latter, and the mixture is introduced into a copper drum which is capable of making some hundreds of revolutions per minute. As soon as the proper velocity has been reached, the starch, having a greater specific gravity than the water, and therefore being more affected by centrifugal force, is driven with such violence against the circumference of the drum that it forms a solid mass of great whiteness and purity, being entirely separated from the other substances, which remain suspended in the water. This method of obtaining pure starch has peculiar advantages: it requires only a few minutes, while the ordinary process takes several weeks ; it is more economical, since with it the yield is twenty per cent. greater, and hence starch may be profitably manufactured from other matters besides wheat, which from its nutritious qualities should be as far as possible kept for food ; and, finally the cellular tissue, gluten, etc., which are very valuable, but by the ordinary modes of manufacture almost entirely go to waste, may be utilized. It is not improbable that a similar application of centrifugal force might be advantageously applied to the separation of other substances differing but little in specific gravity.

A NEW BLASTING POWDER.—Vast quantities of explosive material are now used in the operation of blasting; and hence numerous attempts have been made to discover new and better explosive compounds than gunpowder. The efforts which have been made in this direction have not, as the discovery of nitro-glycerine attests, been without success. The dangerous nature of that substance, however greatly limits its utility. Wilhelm and Ernst Fehleisen have formed a compound which is in several respects superior to any of the explosive materials hitherto used. It cleaves, rather than blows into atoms: an important quality, especially when it is employed in the coal mine. It does not ignite spontaneously, nor is it set on fire by friction or percussion. Its combustion gives rise to no opaque, nor suffocating gases, which makes it very valuable in the operations of tunnelling. It has but one disadvantage: weight for weight, it is twice as bulky as gunpowder; but even this is in a great measure compensated by the fact that it is one-half more powerful. It is formed by thoroughly mixing nine parts by weight saw-dust obtained from a light and non-resinous wood, or wood from which the resin has been extracted, from three to five parts charcoal, and forty-five parts saltpetre, and, if required to be quick, one part ferrocyanide of potassium; the mixture being moistened with one quart of water to every hundred weight. It is granulated by stamping or crushing, and the grains may be polished in the ordinary way; this, however, will merely improve the appearance without increasing the explosive power. This compound has been termed *Haloxylin*.

THE COLOURS OF THE STARS.—The determination of the precise tints of the stars is not only a matter of interest but importance; and an instrument for this purpose has recently been invented. The object proposed by the inventor was to compare the tint of the star to be examined with that of a solution, the colour of which is known. For this purpose, a platinum wire is rendered incandescent by means of two elements of a Smee's battery; and the rays of the artificial star, thus produced, are made to pass through small phials, filled with solutions of known tints, and attached to a drum which has radial openings, and is capable of revolving, after which, they pass into the objective of a small telescope. The artificial and the real star are compared; the drum being turned until the rays from the incandescent platinum appear of the same tint as those from the star. When the tints are the same, it is known that the proper solution has been used, and the tint of this solution being known, the colour of the star is found.

MAGNETISM AND THE METEORITES.—From the fact that meteorites consist invariably and almost exclusively of nickel and iron, it might, at first, be concluded that the small planetary bodies which are now known to circulate in such numbers in orbits intersected by the orbit of our earth, especially in August and November, consist only of these metals. But the conclusion would not be legitimate, if it be true, as there is reason to believe, that gravitation is not the only force which causes meteorites to be precipitated on our earth. It is remarkable that the constituents of meteorites are iron and nickel, two eminently magnetic metals. And it is not improbable that gravity is aided by magnetism, in attracting these bodies to the earth. Only bodies, therefore, containing iron and nickel reach us, because gravity unassisted by magnetic attraction is unable to draw bodies otherwise constituted out of their orbits.

Steam applied to Railway Breaks.—The safety of a train not unfrequently depends on the power of quickly bringing it to a state of rest. This can be effected only by breaks. The more rapidly, therefore, and powerfully these can be brought into action the more they contribute to the safety of the train. Manual power, to be at all effective, must be slow; and hence, independently of its being very limited in amount, an accident may occur before it has had sufficient time to come properly into play. Steam therefore is now being substituted in America for the muscular power of the breaksman, and with most excellent effect. A steam cylinder of small bore, but of considerable stroke is placed in the locomotive, under the driver's foot board. The steam is turned on or off this cylinder, by means of a handle which projects through the foot board. A chain which acts on all the breaks of the train is attached to the extremity of the piston rod. The pressure is never allowed to become so great as to cause the wheels to slide, that in the cylinder being regulated by a safety valve attached to it. The power which may be given to such a break is practically unlimited. That with which the experiments were tried was capable of exerting a force of three thousand five hundred pounds; and of stopping within a space of seven hundred feet, a train moving at the rate of fifty-six miles an hour.

New Preservative Compound.—Many substances have been employed for the preservation of animal matters, and with greater or less success. Most of them are, however, liable to the objection of difficult application or expense. A compound which is cheap and easily applied, and is very effective, especially in the preservation of anatomical specimens, has recently been discovered. It is made by adding to about fourteen parts glycerine, two parts brown sugar, and one part nitre; the addition of the sugar and nitre being discontinued as soon as a slight deposit begins to be formed. Immersion in this fluid for a number of days, dependent on the size of the object to be preserved, effectually preserves organic substances from putrefaction, without, at the same time, altering their appearance. When first lifted out they will indeed, be in the highest degree rigid, but on being placed for a while in a warm dry place they will become as pliant as ever.

New Explosive Compound.—Experiments made on the effects produced by nitrate or chlorate of potash on glue have led to the discovery of a new and extremely cheap explosive compound, which may be employed with special advantage in conjunction with ordinary gunpowder. This compound may be obtained by either of two methods. According to one of them, two parts glue are washed with cold water; then heated moderately with a small quantity of nitric acid, evaporated, again mixed with water, and freed from acid by carbonate of baryta, not in excess: again evaporated to dryness, mixed with one part sulphur, then with water, and next with six parts nitrate of potash. According to the other method, the glue having been melted in warm water, half the nitrate of potash and then the sulphur are added to it. It is then heated until it assumes a uniform appearance, on which the rest of the nitrate is added. The compound obtained by either of these methods is neither deliquescent nor hydroscopic; but being made with nitrate instead of chlorate, unless mixed with ordinary gunpowder it burns slowly and without explosion. If mixed with five parts gunpowder it forms a cheap and powerful explosive agent. It is applicable, advantageously, in the formation of fire-works: and when mixed with the appropriate substances, it affords brilliantly coloured fires.

New Application of Photography.—Photography is now being applied to the registration of the pulsations of the heart and arteries, a purpose eminently useful to the physician. The apparatus employed consists of a glass tube, that at one end is widened out into a cone, the base of which is closed with a thin membrane of vulcanized india-rubber. The upper extremity of the tube is inserted in the slit formed in a division placed in a small camera about its middle and at right angles to its length; the slit being capable of being closed or opened at pleasure, by means of a small moveable screen. The sensitized plate is made to move with a regulated speed by clockwork. When an experiment is to be made, so much mercury is placed in the tube that it will rise to some portion of the slit, within the camera; and the membrane is laid on the heart or the artery the pulsations of which are to be recorded. Every pulsation disturbs the level of the mercury in the upper part of the tube; and as light can pass to the sensitive plate only through the tube, a picture having an undulating lower margin is formed. The sensitized plate moves at the rate of one centimetre per second; but the effect is magnified so that the curve representing it has an extent of fifteen centimetres. The rate and energy of the pulsations of the heart or of any artery is in this way accurately and satisfactorily recorded.

LITERARY NOTICES.

The Theories of Copernicus and Ptolemy. By a Wrangler. *Longmans.*—No proposition, however well established, ought to escape a frequent re-examination, as the development of the human mind is not promoted by the reception of any doctrine, however true, merely upon authority, but rather by a constant search after truth, through the collection of facts, and the operations of reason thereupon. Whatever is taught upon authority only, should be held as a matter for provisional acceptance only, and not advanced higher, until the inquirer has been able to discover or follow the train of reasoning by which it is established. In the absence of any sufficient original investigation into the grounds upon which any proposition that receives the sanction of authority rests, the authority, if supposed trustworthy, affords a convenient resting place, and establishes in the mind of every one who thinks it more likely to be right than wrong, a certain balance of evidence in favour of the proposition it affirms. The evidence is, however, of this character—Smith is an intelligent man—he has studied the subject,—he says so, and he is likely to be right. True, but he is also likely in a greater or less degree to be wrong. A high degree of probability is all that we can expect to attain to; but after the probableness of a statement reaches a certain point, it becomes reasonable to act upon it, and to regard it as true, but faith in the most probable statement should never hinder the perception of the improbability, however small it may be, that remains attached to it, and which cannot be regarded as a constant and ascertained quantity, but must be esteemed as a quantity which further discovery may at any time change the value of, either in the direction of its augmentation or its diminution.

The "Wrangler" who puts forth the pamphlet on the "Theories of Copernicus and Ptolemy," deserves the thanks of those who recognize the truth of the propositions we have thus sketched out. It is no doubt common to assume that the Copernican theory rests upon a more thoroughly complete mass of evidence than can be claimed for it; but its defenders are only bound to show that, as compared with the Ptolemaic theory it is sustained not only by a balance of probability, but by enough probability to be a legitimate basis for thought and action. That the conception of gravitation as an universal force, resident in, or essential to, all matter, and causing all particles to attract each other proportionably to their mass, and in an inverse proportion to their distance, could not be maintained by anything like proof. Astronomers have to recognise repulsive forces as well as attractive ones, and we know of no argument in favour of the supposition that the attraction of gravitation is not correlative with any other mode of force, but always existing without change as an absolute property of each particle of matter, and in eternal antagonism to all repellant forces. Views of this kind have been several times put forward in our pages.

The "Wrangler" contends, not for the truth of Ptolemaic astronomy, but that its major requirements are not improbable, and it is here that most philosophers will disagree with him, and we are not sure that he sufficiently recognises the evidence of improbability that attaches to the best proved systems, or sufficiently admits that some amount of improbability is no ground for disbelief. It is important, however, to bear in mind the doubts and objections of the "Wrangler," which are well put, though not, it strikes us, at all new. Our solar system may be but a portion of a greater system, and the centre of gravity of the whole may be nearer or further than astronomers fancy. This will be generally admitted, so will the analogy between the particles of a small body, and that of sun and the planets regarded as particles of the giant whole. The constitution of nebulæ, the appearance of a repulsive action in the sun on cometary matter, and other facts adduced by the "Wrangler," all point to the conclusion that the laws we are acquainted with do not explain the whole system or cosmos. As the "Wrangler's" paper is only a pamphlet of fifty-six pages, we abstain from extracts, merely recommending it to the notice of those who like to see inquiry stimulated, and the best established beliefs re-examined from time to time.

NOTES AND MEMORANDA.

THE COLOUR OF WATER.—Father Secchi, in a paper on "Star Spectra," in "Comptes Rendus" (1867, No. 14), says: "Having ascertained that the spectrum of sea-water is destitute of red at small depths, and of yellow and green—at least of their greater part—at successively greater depths, at which the water has a blue or violet colour, I wished to see if the same absorptions were exhibited in glaciers. Profiting by the incident of an artificial grotto having been dug in the glacier of Grindelwald, I made some experiments on this subject. The grotto in question is about 100 metres deep, its walls are transparent, and illuminated by sunshine passing through the ice. This light has a fine blue tint, in which the red is extremely weak, so that in the grotto human faces have a frightfully cadaverous aspect. Looking from a certain depth in this grotto back towards the entrance, the light there appears red, owing to the effect of contrast. A spectroscopic examination shows the light in the grotto to be almost deprived of red, and to have the yellow greatly diminished. The thickness of the ice is not sufficient to produce a more complete absorption. It is said to be about fifteen metres thick, but I should say less. The ice is perfectly compact and continuous in its texture. It is limpid as crystal, and contains here and there groups of air bubbles. Its hardness is not great; an iron point easily penetrates it. The result is thus identical with that which is obtained with sea-water at similar depths; and as in the Alpine ice we cannot suppose the presence of extraneous colouring matter that might be presumed to exist in the sea, it follows that the true colour of water is a blue mixed with violet, which grows darker as the thickness traversed by the light increases."

SULPHURIC ACID FORMED BY A MOLLUSK.—M. M. S. de Lucca and P. Panceri state, in "Comptes Rendus" (1867, No. 14), that the salivary organs of the *Dolium galea* secrete a fluid which contains more than three per cent. of sulphuric acid. They examined two specimens caught in the Gulf of Pozzuoles. When filled with liquid, the glands, two in number, are larger than ordinary fowls' eggs, and weigh about seventy grammes. They are formed of two distinct parts—one small and opaque, close to the excretory orifice of the gland; the other large and transparent, the membrane enveloping it being very thin and white. When incisions are made, so that the lower part of the gland comes in contact with the air, gaseous bubbles of pure carbonic acid are disengaged from the *cul de sac* tubes, of which almost all the gland is composed. A gland weighing seventy-five grammes discharged under water 200 cubic centimetres of carbonic acid. The liquid contained in the gland tastes like lemon juice, acts on marble, and changes the colour of litmus. A series of experiments show it to contain sulphuric acid. It was previously known that the *Dolium galea* ejected an acid liquid from its mouth which effervesced with carbonates, and when analysed by M. Bædcker, gave 2·7 per cent. of sulphuric acid. The authors of the paper state that they will continue their researches with a view to discover how the sulphuric acid is produced, and what function it performs in the economy of the animal. They say this *Dolium* "is the first animal which they knew of capable of making sulphuric acid by an unknown process."

THE COLOUR QUESTION AND THE LUNAR ECLIPSE, SEPT. 13TH.—Referring to the accounts of this eclipse we published in our last number, we may say that several observers besides Mr. Browning speak of absence of colour. M. Chacornac states the contrary. He says the greater part of the lunar disk plunged into the shade of the earth was of a red colour, the portion near the limit of the shadow slightly violet. Between these two extremes, yellow, orange, green, and blue exist, resulting from the decomposition of solar light by refraction of the terrestrial atmosphere. Mr. Huggins informs us that excess of light prevents a proper view of colour, and Mr. Knott has found too much light to interfere with a just appreciation of the tints of double stars. M. Chacornac's observations were made at Ville-Urbanne, but he does not say with what aperture. He has the large Foucault reflector there. The "Monthly Notices" contain Mr. Weston's observations made at Endsleigh Observatory, Bath. He describes the prevailing colour as "red-bluish and grey, and grey. The redness increased towards the *darkened edge* of the moon. He did not notice this colour at "the boundary line when the earth's shadow impinges on the moon; but, on the contrary, it was confined to the *opposite* eclipsed region, darkening as it approached the northern parts, and attaining the greatest depth at the moon's periphery. . . . That these effects did not result from any chromatic errors was proved by using different telescopes and powers. The colour and their relative positions differed entirely from those presented in the partial eclipse of Feb., 1858."

TWO NEW PLANETS, (93) and (94).—Mr. Watson, of Ann-Arbor, states in the "Astronomische Nachrichten," that he discovered the first of these bodies on the 24th August, and the second on the 6th Sept. Both are of 11 mag.

MICRO-CRYSTALS OF ALKALOIDS.—At the meeting of the Royal Microscopical Society, on the 9th Oct., Dr. Guy read a long paper on crystallizations and arborescent forms obtained by subliming minute quantities of strychnine and other alkaloids in the manner originally proposed by Helwig. Dr. Guy's process is to place the matter to be sublimed at the bottom of a small flat porcelain vessel, such as a crucible cover. Over it he puts a square of glass, about one-eighth of an inch thick, with a round hole in the middle. Over this hole he places a flat piece of glass. A moderate heat, carefully applied by a spirit lamp, sublimes the alkaloid, and it is condensed on the plate of flat glass, and ready for microscopic examination. Quantities such as the 10,000th part of a grain give satisfactory results. Many photographs of crystallizations, exhibited by Dr. Guy, were of great beauty. Evidence of this kind might be important in medico-legal inquiries, but it could scarcely be regarded as conclusive, though it might form part of a conclusive chain of proof.

THE COMING STAR SHOWERS.—Our readers should refer to the important paper by Mr. Proctor, in our last number, on this subject, before the arrival of the 14th. At a quarter past six on the morning of the 14th may be the maximum, but the meteors should be looked for some hours earlier to prevent disappointment.

A WAISTCOAT-POCKET MICROSCOPE.—The most elegant and convenient portable microscope is one devised by Mr. Highley, on the plan of the class microscopes introduced by Dr. Lionel Beale. Mr. Highley's instrument fits into a German silver case, rather less than four inches long and five-eights of an inch wide. It is furnished with a live-box, draw-tube, eye-piece, and dividing objective. Its power is sufficient to show the nature of urinary deposits and other morbid products; and as a field instrument for the collector of diatoms, desmids, minute algæ, etc., it will be highly esteemed.

INSECT EGGS

THE INTELLECTUAL OBSERVER.

DECEMBER, 1867.

INSECTS' EGGS: THEIR STRUCTURE, VARIETY, AND BEAUTY.

BY JABEZ HOGG, F.L.S., HON. SEC. R.M.S., ETC.

(*With a Coloured Plate.*)

In our country rambles, some among us may have been tempted to examine what appeared to be curled-up leaves, or patches of whitish dots adhering to branch or stem, many so like the bark of the tree itself, that at a first glimpse, even the practised eye might have failed to detect that they were organised bodies. Upon more closely and attentively scrutinizing these little adhesions, they are seen to be collections of insects' eggs, thus skilfully deposited and concealed with maternal care. To such apparently unimportant objects I would direct the reader's attention, and more particularly to their structure, variety, and beauty, as disclosed by the aid of the microscope. My observations will be mainly confined to the eggs of the Lepidopterous insects, which at this period of the year may be secured in large numbers, for the purpose of making a careful comparison of their formation, watching the development of the germinal vesicle into that of the fully-formed embryo, and noting the transformation of the creeping caterpillar to a thing of wondrous life and beauty, taking its flight among the loveliest of nature's handiworks, and sipping honey from every flower "from morn to dewy eve."

Nearly all insects are oviparous; the few instances in which this is believed not to be the case, are not positive deviations from the general law. The eggs of insects, however, do not often fall under notice, for in consequence of their smallness, they escape observation; and from the scrupulous care taken by the parent to conceal them from the depredations of their numerous enemies, they are not easily discoverable. The situation mostly selected by the female moth, is the leaf or bark of such trees and plants as will serve their young for food. Sometimes, with an instrument provided by Nature for the purpose, she bores a hole in the bark in which to deposit them. Not infrequently the interior of fruit or grain, or even a dung-heap is selected, and some few commit their store to water, there to await the heat of the summer sun to hatch the brood.

Their defence against cold, and atmospheric changes consist in coating the inside with a varnish-like substance, while the outside is often covered over with a denser material, as portions of vegetable fibre and the hairs or feathers from the body of the insect, which, together with the leaf on which the eggs are laid, form groups of tiny nests. Others form stronger and more durable receptacles. The female cock-roach constructs a strong horny bag, or purse, in which having deposited her eggs, she carefully carries it about with her. The coccus converts her whole body into a shield or covering for her eggs, so thoughtful does she appear for the future safety of her brood. As a general rule, the female insect having deposited her full number of eggs, leaves them to be hatched by the heat of the sun, which may be accomplished in a few days, or not until the following spring, as is the case with the eggs of the silkworm, and all those laid late in the summer or autumn. The number of eggs produced by different species is very varied, some depositing only two, while others, and by far the largest number, lay them by hundreds. The ant is said to lay from thirty to forty thousand in a year. The queen-bee, fifty thousand; but I believe the ordinary number is much below this. The silkworm moth mostly lays about five hundred eggs. The goat-moth, about a thousand, and the tiger-moth some fifteen hundred, arranged with the most uniform and symmetrical order. Insects' eggs bear great extremes of temperature without losing their vitality; want of air and light appear to be far more speedily detrimental in this respect than the extremes of heat or cold. I have exposed silkworm's eggs to severe frosts, and also plunged them into scalding-water, without in the least affecting them, either for good or evil. Several genera of moths with wonderful instinct, cover their eggs with soft vegetable materials; and some, it is asserted, pluck the hair and feathers from their bodies for the same purpose. A writer states, I think, without sustaining the statement by sufficient evidence, that moths use a pair of pincers, placed at one extremity of the body, for plucking out their hairs to cover their eggs; but this would scarcely seem to be needful, since the eggs are nearly always deposited in groups, and securely fastened up in the leaf on which they have been deposited, so that frequently it requires some force to separate the bundle, and expose them to view.

Some of the Coleopterous insects resort to curious and ingenious methods of concealing their eggs—for example, the burying-beetle deposits hers in the decaying carcasses of such animals as moles and mice, which they bury, if not already beneath the surface. It is stated by an observer of their operations, that in order to effect this object, several beetles unite their labours and remove the earth from beneath the dead body, which gradually sinks; they then proceed to cover it up, and frequently run backwards and forwards, apparently for the purpose of ramming down the earth. According to an eye-witness of the operations of these grave-diggers, four beetles were observed to inter in a very small space of earth, no fewer than twelve carcasses of various small animals. The object of all this care and solicitude, is not alone the security of their eggs, but to ensure an early supply of food for their young. Another example is afforded from among the *Scarabœidœ*, or larger kind of Dung-chaffers. The earth-borer (*Geotrupes stercorarius*), an insect whose "drowsy hum" falls so often on our ear, during a walk in the country in the stillness of an autumnal evening, digs round holes in the earth, often of considerable depth, then conveys a small quantity of dung to the bottom, in which the eggs are deposited. Each of these is placed in the centre of a small ball or pellet carefully prepared for this purpose; when dry enough, the pellet is transported, it may be to some distance from its place of preparation, to be buried in the hole dug for its reception, and what is somewhat remarkable, when it is unable to raise its load from the ground, it rolls it along, or pushes the pellet backwards with its hind legs. When the surface of the ground is irregular, the labour is proportionably increased, and not unfrequently the beetle is obliged to call in the assistance of its help-mate, before it can overcome the obstacles which impede it. According to some writers, the incessant and arduous labour which these beetles were observed to undergo, led the ancient Egyptians to regard them with a sort of sacred awe, and as symbolical of the labours of Osiris.

In form, colour, character, and beauty of design, the eggs of insects are more surprisingly varied than those of the feathered tribes;* but our acquaintance with the composition of either exterior or interior is certainly not so complete as in the case of birds. The eggs of the animal series differ considerably in their external characteristics, nevertheless, all closely resemble each other, while yet a part of the ovarian ovum. At one period of their formation, all eggs consist of three nearly similar parts. First, The internal nucleated cell or germinal

* The elaboration of structure and variety of forms in a large number of eggs, might be turned to a practical account, as many suggest patterns of great beauty and delicacy for art-designs.

vesicle, with its macula. Second, The vitellus or yolk-substance; and Third, The vesicular envelope or vitelline membrane. The germinal vesicle is first produced, and may be regarded as the ovigerm; the yolk-substance next gradually envelopes it, or is deposited around the germinal vesicle, and the vitelline membrane which encloses the whole, is the latest formed.

The chemical constituents of the ovum is albumen, fatty matters, and a large proportion of a substance precipitable by water. "The production of the chorion or shell-membrane does not take place until the ovum has attained to nearly its full size, and it appears to proceed, in part, from the consolidation over the whole surface of one or more layers of an albuminous fluid secreted from the wall of the oviduct. The observations of Herman Meyer have shown that a part of the outer membrane is also derived from a conversion into it, of the inner cellular or epithelial lining membrane of the oviduct, at the place where it is in closest contact with the surface of the ovum. And many of the varieties in the appearance and structure of the external covering, may probably depend on the different modes of development of these cells."*

The embryo cell appears to be so directly connected with the germinal vesicle, that at a certain period it is absorbed and entirely disappears; or rather, "the germinal yolk becomes the nucleus of the future embryo, when a greater degree of compactness is observed to take place in the yolk, and all that remains of the germinal vesicle is one or more highly refracting fat globules." In insects' eggs, as in those of the higher animals, a clear space is seen between the surface of the yolk-substance and the enclosing vitelline membrane.

The shell is furnished with a lid, to facilitate, it is said, the egress of the mature worm; but since we find that the whole integument offers little resistance to the strong and well formed mandible of the creature, an operculum, or lid, seems to be unnecessary for the purpose stated by continental writers. The chorion, in many instances, is so very thin and translucent, that even the changes taking place within can be readily seen; indeed, I have often watched the young silkworm eat its way through the chorion, or egg shell, and this its first trial of a formidable cutting instrument, well supplied with muscular apparatus, it uses with admirable dexterity. The head of the young caterpillar, according to the statement of Meissner, lies towards the dot, or central opening in the lid, and which he has termed the micropyle,† from its resemblance

* Dr. Allen Thomson. "Ovum, Cyclopædia of Anatomy and Physiology."

† The term micropyle (a little gate) has heretofore only been used in connection with the vegetable kingdom; it is used to denote the opening, or foramen, towards which the radicle is always pointed.

to a small gate or opening, through which the worm is seen to emerge forth. From a number of observations made on silkworms' eggs, I have not been able to satisfy myself of the correctness of the particulars described by this observer, nor have I seen the young worm make its way out at this precise spot, but generally at a point much below it. Leuckart states this depression, the micropyle, becomes at a certain period converted into a funnel, which is directly connected with the mouth of the embryo, and serves to convey nourishment from without to it. I see no grounds for such a statement; because in the silkworm's egg, instead of a depression at this point, we have a nipple, and there can be no more necessity for leaving this funnel-shaped opening for the nourishment of the embryo catterpillar, than for that of the chick. There is no opening for such a purpose in the ovum of the bird; indeed the vitelline membrame appears to form a perfectly closed sac to the yolk. In some eggs we appear to have an involuted portion of membrane, indicating simply where either the formative process of the outer membrane terminated, or the spermatozoa passed in to fecundate the yolk mass.*

The germinal vesicle is situated in the yolk mass, it is well marked, and of a very large size, in the egg of the bee, while the egg is yet in the ovasac. By preparing sections, after Dr. Hallifax's method, I find that the germinal vesicle of this insect is not situated immediately near, nor even below, the so-called micropyle, but more to the side of the yolk, represented in Fig. 17, and just in the position which the head of the embryo is found subsequently to occupy towards the end of the period of incubation. The germinal vesicle is well marked; its macula is at first single, then becomes multiple.

The egg membrane, or shell as it is incorrectly called, of the moth and butterfly, is composed of three separate layers; an external slightly raised coat, tough and hard in its character; a middle one of united non-nucleated cells; and an inner one clear, dense, and homogeneous in structure, imparting a fine iridescent glaze to the surface, such as we see and admire in the old glass vessels exhumed from the ruins of Pompeii.

In the silkworm's egg the outer membrane consists of an inner reticulated membrane of non-nucleated cells, and an outer layer, the cells of which are arranged in an irregular circular manner, also non-nucleated, with a number of minute projecting interstitial hairs, or setæ. This layer has probably

* "As to the origin of the micropyle, it does not appear to proceed, as has been supposed by Meissner, from the mere deficiency of the epithelium cells in a certain space, and it is not dependent, either, on its pre-existence in the vitelline membrane, but, according to Leuckart, it is found in the chorion before it appears in the vitelline membrane."—Dr. Allen Thomson.

served, at some time, while the egg was yet a part of the ovarium ovum, as a vascular coat, and being no longer required, has become consolidated to form a part of the dense membranaceous covering.

It is in these several layers of the outer membrane that the micropyle apparatus is situated, and it should be noted that Meissner has described several varieties of the micropyle in the ova of insects belonging to the following genera, viz., *muscæ, tipula, pulex, lampyris, elater, teleophorus, adela, pyralida, tortrix, euprepia, liparis, pieris, panorpa,* and in more than one species of several of these genera. The same author also observed and described in *Musca vomitoria,* a number of spermatic filaments entangled in the micropyle. Leuckart's observations, which are apparently more complete than those of Meissner, differ from his in some particulars; they extend over several hundreds of different kinds of insects' eggs, and he asserts that he succeeded in detecting the existence of the micropyle in not less than 200: he also gives detailed observations on this apparatus, and the structure of the membranes. I willingly admit that such an extended series of observations fully entitles this author to great respect; and when we consider the minuteness of the eggs, and the difficulty of obtaining specimens in a suitable condition for investigations of the kind, we may appreciate the importance of the work, and the amount of labour required to bring such an investigation to a satisfactory conclusion. Leuckart positively asserts that, "in all instances in which the ova were ripe and favourable for examination, he was enabled to assure himself of the presence of the micropyle." This supposed opening will be readily recognised in many of the drawings accompanying this paper, forming, as it does, a prominent spot at the pole of the egg, or in the middle of the circular radiants in the lid.

The outer surface of the egg shell of *Coccus Persicæ* is covered by a series of minute rings, the ends of which somewhat overlap. These rings are believed by Sir John Lubbock to be identical in their character with the whitish substance which exudes through pores on the underside of the body; and it is more than probable that these layers of rings, and their arrangement, account for the beautiful prismatic hues which the egg presents under the microscope, when viewed as opaque objects. This substance, it appears, ultimately becomes a part of the intimate structure of the egg membranes. With regard to the greenish colour of the eggs of *Phryganea,* the same observer states "that it is due to the yolk-globules themselves.* In *Coccus* this is not the case, the yolk-globules are slightly yellow, and the green hue of the egg is owing to

* Phil. Trans. 1859, p. 341.

the green granules, which are only minute oil globules. When, however, the egg arrives at maturity, and the upper chamber has been removed by absorption, these green granules will be found to be replaced by dark green globules, regular in size, and about 1-8000th of an inch in diameter, and which appear to be in no way the same in the yolk of *Phryganea* eggs." Another curious fact has been noticed, which partially bears on the question of colour, the production of parasitic bodies within the eggs of some insects. In the *Coccus*, for instance, parasitic cells of a green colour occur, shaped like a string of sausages, in length about the 1-2000th of an inch, by about the 1-7000th of an inch in breadth. Of the formative process and composition of the colouring matter, not much is known. Valenciennes and Framy, after having bestowed attention on this part of the investigation, selecting the ova of Crustaceans for their purpose, arrived at the conclusion "that it is the same as that existing in the shell; which being green in the moist state, passes into a red colour when solidified." By the aid of alcohol, etc., the colouring matter can be separated and collected in sufficient quantities for spectrum examination. The eggs of moths and butterflies, as I have before stated, present many varying tints of colour, and in speaking of this quality I do not restrict the term solely to the prismatic changes to which allusion has been made, and which are liable to constant mutations, according to the accident of the rays of light thrown upon them, but I more particularly refer to the several natural transitions of colour, the prevailing tints of which are yellow, white, grey, and a light brown. In some eggs the yellow, white, and grey are delicately blended; and these, when viewed with a magnifying power of about fifty diameters, and by the aid of a side-reflector (parabolic reflector), present many beautiful combinations, and the most delicate opalescent, or rather iridescent tints appear on others. The egg of the Mottled-umber moth (*Erannis defoliaria*), Fig. 8, is in every particular very beautiful. It is ovoid, with regular hexagonal reticulations, each corner is studded with a white raised knob or button; the space within the hexagon is finely punctuated, and the play of colours is exquisitely delicate. In this egg I have been unable to make out a micropyle. The Magpie moth (*Abraxas grossularia*), Fig. 1, is another example. The egg is ovoid, and somewhat resembles the former, but does not possess the raised stud or button, at the corner of each hexagon; its colour is very delicate, and silvery in tone. The membrane is so translucent that the movements of the young worm can be very well seen within. The egg of the Thorn moth (*Ennomos erosaria*), Fig. 5, is an elongated square form, one end of which is slightly tapered off, while the other is flattened; in this the lid is placed, surrounded by a beautifully white-beaded border, having in its slightly raised reticulated centre the micropyle. The empty egg-shell gives a fine opalescent play of colours, while that containing the young worm appears of a brownish yellow colour. The egg of the Straw-belle moth (*Aspilates gilvaria*), Fig. 2, is very delicately tinted; it is somewhat long and narrow in form, with sides slightly flattened or rounded off, and is regularly serrated. The top is convex, and the base a little indented; in the latter is seen the lid and micropyle. The young worm, however, usually makes its way through the upper convex side; the indentation represented in the drawing shows the place of exit. One belonging to a very interesting class of moths, the Dingy-shears (*Exarnis ypsilon*), is shown in Fig. 3. A small sub-conical egg, with a flattened base, which admits of its being firmly cemented to either bark or leaf. The egg is beautifully reticulated, the ribs are slightly raised from the membrane, and connected with each other by cross-bars; they run from a marginal ring surrounding the micropyle, in regular order to the base, and a series of fine lines radiates from the central spot to the border.

An example of those eggs possessing a good deal of natural colour is shown in Fig. 10. The Puss moth (*Cerura vinula*), a large spheroidal shaped egg, having, under the microscope, the appearance of a fine ripe orange; the micropyle exactly corresponds to the depression left in this fruit by the removal of the stalk. The surface of the egg is finely reticulated, or rather has the appearance of a piece of netting stretched tightly over it. The colour is a deep orange. The egg of the Swallow-prominent (*Pheosia dictæa*), Fig. 4, is in shape and size nearly the same as the former. It is spheroidal, slightly flattened at the poles, and, with the exception of one spot, that of the micropyle, the surface is a continued series of regular indentations, reminding one of those fine reticulations, or markings, seen on some of the Guiano shells. The colour is a very delicate pink. There are others rather more decided in their colour, as the egg of the Brimstone moth (*Rumia cralagata*), remarkable for its hexagonal reticulations, it is yellow, spotted with red; that of the Lappet moth (*Gastropacha quercifolia*), with its bluish colour, and three circular bands of brown. The Buff-tiger moth (*Diacrisia russula*), Fig. 7, lays an exquisite little globular egg, the external membrane of which is covered by a fine network of irregular hexagons, which terminate at the pole in a micropyle. It has all the appearance of an iridescent minute glass globule, and is so translucent that the young worm can be seen through it. The Browntail moth (*Euproctis chrysorrhæa*), Fig. 12, produces a small spheroidal egg, which, slightly flattened at the poles, is uniformly covered with imbricated scales, and is terminated in the upper pole by a geometrical series, which fold in towards the micropyle. In every instance the worm eats its way out of the side of the egg ; the aperture is shown in the drawing ; this moth appears to cover her eggs with fine hairs, and the empty spherical egg cases are beautifully iridescent. The egg of the small Emerald Volute moth (*Jodis vernaria*), Fig. 16, is remarkable in form, which is somewhat oval, but flattened on the broad side, of silvery whiteness, covered with minute reticulations and dots, peculiarly translucent, so much so that the little yellow-brown worm is seen curled up within, as shown in the egg to the left. At first it appears difficult to detect the presence of either lid or micropyle, and it is not until after the worm has eaten its way out that you clearly see at which end it was placed. The aperture through which it has made its escape is shown in the egg to the right. As to the change of colour (which occurs from physiological causes), connected with the development of the embryo, a remarkable instance is afforded, and one from which the insect partly derives its name, in the Glory of Kent (*Endromus versicolor*). The egg is first bright yellow, then successively green, rose colour, and reddish black. A still more familiar instance is presented in the egg of the Silkworm moth (*Bombyx mori*), Fig. 11, which when first laid is of a delicate pale yellow, this hue it retains for some time, it is subsequently of a reddish brown, and just before the embryo quits the egg it acquires a slate colour, partaking for the time being of the colour of the embryo within ; but so soon as the worm emerges forth, the shell regains its original pale yellow. The micropyle, if that can be so called, which in this egg is a raised nipple, is in the more flattened pole of the egg. The mouth of the young worm lies towards the horn of the crescent of that pole, and it is at this point the first cut is made, just sufficient of the membrane is eaten away to admit of the head and body passing through the aperture. The outer and inner portions of the egg membrane are represented magnified 150 diameters at *a* and *b*, Fig. 11.

The egg of the small Silver-lines moth (*Hylophila prasinana*), Fig 9, is yellow brown, in form a truncated pyramid. The micropyle is enclosed in a regular series of radiating lines. A series of raised ribs are set in regular order around the sides, and the cross bars which connect them. These present a pretty basket-like pattern. The egg is flattened out at the base, apparently for the purpose of securing it more firmly to the leaf. The Meadow-brown butterfly (*Epinephile janira*), Fig. 14, lays a sub-conical egg, considerably flattened towards the apex, the raised ribs which stand away from the sides have a silvery colour, and give to the whole a corrugated appearance.

The lid completely occupies the top, and in a smaller inner circle the micropyle is situated. The latter is better displayed when the lid is separated from the egg, as shown at *a*.

The White butterfly (*Pieris brassicæ*), Fig. 13. The shape of the egg is very like the basket employed in lobster fishing, a rarer form than any of the preceding. It is conical, and of considerable length; the lid forms the base, which is slightly recurved upon the sides, and a regular series of ribs with cross bars run from end to end. The eggs are cemented at the base to the back or leaf of the plant in symmetrical order. In colour they are primrose.

The Brown-hair streak butterfly (*Thecla betulæ*), Fig. 15, presents a perfectly white, exquisitely formed, sub-conical egg; at first sight it might be compared to a beautiful ivory-turned ball in miniature. It is covered by a series of deep indentations, or pits, with regularly projecting spines. The pole of this egg dips inward towards the micropyle, forming the funnel-shaped indent spoken of by Leuckart. It is cemented by its broader base to the leaf.

I may remark that the specimens used for illustration were not specially selected, nor are they intended to be type representatives of the eggs of a class of insects which constitute a very large proportion of the most charming denizens of our gardens, fields, and forests. These eggs are taken from a very limited collection, and in no way do they convey an adequate notion of the variety and beauty of objects, wonderfully and curiously fashioned, no two of the species of which are to be found exactly alike. My thanks are due to my friend, Mrs. Maples, for the accurate and beautiful plate which her skilful pencil has enabled me to place before my readers.

The subscribers to the Intellectual Observer will be glad to know that they can obtain most of these eggs from Mr. J. T. Norman, of City Road.

A LIST OF THE ILLUSTRATIONS.

1.—*Abraxas grossularia*, Magpie moth.
2.—*Aspilates gilvaria*, Straw belle.
3.—*Exarnis ypsilon*, the Dingy shears.
4.—*Pheosia dictæa*, Swallow prominent.
5.—*Ennomos erosaria*, Thorn moth.
6.—*Ourapteryx sambucaria*, Swallow tailed.
7.—*Diacrisia russula*, Buff tiger.
8.—*Erannis defoliaria*, Mottled umber.
9.—*Hylophila prasinana*, Silver lines.

10.—*Cerura vinula,* Puss moth.
11.—*Bombyx mori,* Silkworm moth.
12.—*Euproctis chrysorrhœa,* Brown tail.
13.—*Pieris brassicæ,* White butterfly.
14.—*Epinephile janira,* Meadow brown.
15.—*Thecla betulæ,* Brown-hair streak.
16.—*Jodis vernaria,* Small emerald.
17.—Egg of Honey bee, *showing germinal vesicle.*

RAIN.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

There are, perhaps, few natural phenomena which appear less indicative, at first sight, of the operation of nature's giant forces than the downfall of rain. Even the heaviest showers—at least of those we are familiar with in England—are not phenomena which suggest an impression of power. Yet the forces actually called into action before rain can fall, are among the most gigantic experienced on our earth. Compared with them, *terrestrial* gravitation is more feeble than is the puniest infant compared with an array of giants. Let us look into the matter a little closely, and we shall see that this is so.

It is a common occurrence for rain to fall over an area of 100 square miles to a depth of one inch in twenty-four hours. Now, what is the expenditure of power of which such a phenomenon is the equivalent? The downfall is, so to speak, the loosening of the spring, but how much force was expended in winding up the spring? The evaporation from the sea or from moist soils of the quantity of water precipitated, is not the whole of the work to be estimated, since the vapour has to be raised to the higher regions of the air, and to be wafted by the winds—themselves the representatives of giant forces—to the district over which the moisture is discharged in rain. But let us take this evaporation only, and estimate its real force-equivalent. It may be shown by a calculation founded on M. Joule's experiments, that to evaporate a quantity of water sufficient to cover an area of 100 miles to a depth of one inch, would require as much heat as is produced by the combustion of *half a million tons of coals;* and further, that the amount of force of which such a consumption of heat is the equivalent, corresponds to that which would be required to raise a weight of upwards of one thousand millions of tons to a height of one mile! I will run briefly through the calculation by which this last result is deduced from the well-known result of Joule's experiments that to raise one pound of water one degree Fahrenheit, requires a quantity of heat sufficient to raise one pound to a height of 772 feet; and the further experimental fact, that to raise a pound of water from the liquid to the vaporous state, requires 967 times as much heat as is required to raise the same pound one degree Fahrenheit in heat.

The amount of water required to cover one hundred square miles to a depth of one inch is, in volume—

$$1760 \times 1760 \times 3 \times 3 \times 100 \div 12$$

cubic feet, and as one cubic foot of water weighs 1000 oz., or nearly 63 pounds, we have in weight—

$$1760 \times 1760 \times 3 \times 3 \times 8\tfrac{1}{2} \times 62\tfrac{1}{2} \text{ pounds,}$$

and to raise this weight of water 1° F., would require as much heat as would suffice to raise to a height of *one mile* a weight of

$$1760 \times 3 \times 8\tfrac{1}{2} \times 62\tfrac{1}{2} \times 772 \text{ pounds;}$$

while to vaporize the same weight of water would require 967 times as much heat. Thus we obtain a force sufficient to raise a weight of—

$$1760 \times 3 \times 17 \times 135 \times 193 \times 967 \text{ pounds,}$$

(that is, nearly 1,020,000,000 tons), to the height of one mile.

Such is the amount of force, whose effects are exhibited in a day's steady down-pour over a region of 100 square miles—for instance, over about one-third of Middlesex.

The same amount of water falling in the form of snow, would represent a yet greater expenditure of force. "I have seen," says Tyndall, "the wild stone-avalanches of the Alps, which smoke and thunder down the declivities, with a vehemence almost sufficient to stun the observer. I have also seen snow-flakes descending so softly as not to hurt the fragile spangles of which they were composed; yet to produce, from aqueous vapour, a quantity which a child could carry, of that tender material, demands an exertion of energy competent to gather up the shattered blocks of the largest stone-avalanche I have ever seen, and pitch them to twice the height from which they fell."

But it is when we come to estimate the fall of rain as a terrestrial phenomenon—as a process continually going on over large regions of the earth's surface, as a process in which energies exhibited over one region are expended, frequently, over regions thousands of miles away—that we see the full significance of the drop of rain. We can well understand how it is that "the clouds drop fatness on the earth," when we estimate the powers expended in their genesis. All the coal which could be raised by man from the earth in thousands of years, would not give out heat enough to produce by evaporation the earth's rain-supply for one single year! The sun—whose influence is often contrasted with that of the rain-shower—is the agent in producing that shower as well as in pouring out his direct heat on the soil with such apparently contrasted effect.

The actual process of the production of rain has not yet been completely explained. We are, in fact, doubtful as to the true nature of clouds, fogs, and mist, and, therefore, it is intelligible that some difficulty should surround the explanation of a phenomenon of which these meteors are, so to speak, the parents.

It is generally supposed that clouds consist mainly of hollow *vesicles* of water, and not of minute drops. Yet meteorologists are far from being agreed on this point. On the one hand we have the evidence of De Saussure and Kratzenstein, who actually saw, or supposed they saw, the constituent vesicles of clouds and fogs. De Saussure, indeed, tells us how we may see the vesicles for ourselves. If a cup of coffee, or of water tinctured with Indian ink be placed in the sun, minute vesicles of various thickness will be seen to ascend from the surface of the liquid. He adds that those vesicles which rise differ so much in appearance from those which fall, that it is impossible to doubt that the former are hollow. Kämtz, also, made measurements of the vesicles of fogs in Central Germany and in Switzerland; and in his valuable work on Meteorology, gives a table and a figure, showing the law according to which the dimensions of the vesicles vary in the course of the year.

Despite this evidence, Sir John Herschel holds a contrary opinion. He points out that the observations of De Saussure and Kratzenstein may be readily referred to the effects of optical illusion. The strongest argument put forward by Kratzenstein is founded on the fact that rainbows are never formed on clouds or fogs, as they would be (according to the undulatory theory of light) if these meteors were composed of globules of water. Sir John Herschel, a higher authority on optical questions than either De Saussure or Kratzenstein, is of opinion, on the contrary, that it is possible a re-examination of the very difficult point in question would give a different account than that usually accepted.

Herschel points out the difficulty of understanding in what manner the condensation of true vapour should result in the formation of a hollow vesicle. Tyndall points out, on the other hand, a difficulty depending on the state into which water-particles at high elevations sometimes pass. "It is certain," he says, "that they possess, on or after precipitation, the power of building themselves into crystalline forms; they thus bring forces into play which we have hitherto been accustomed to regard as molecular, and which could not be ascribed to the aggregates necessary to form vesicles."

In whatever state the particles of a cloud really exist, it is certain that the fall of rain depends on a process of increased condensation. The causes producing such condensation have been thus summed up by Professor Nichol:—

(1.) The cooling of clouds through the effect of radiation from them;

(2.) The mingling of vapours at different temperatures—a mingling effected by the agency of the winds;

(3.) The rising of vapours towards colder strata of the atmosphere;

(4.) The increase of atmospheric density or pressure;

And (5.) The accumulation and impinging of masses of vapour against some obstacle.

Singularly enough he omits the most important of all known agencies in the production of rain, viz.:—

(6.) The transfer from the equator towards the poles of large masses of moisture-laden air by means of the upper S.W., or counter trade-winds.

I must note also that cause (4) is more than doubtful. Tyndall has shown that rarefaction is an efficient agent in producing the precipitation of vapour. By increase of pressure a larger quantity of moisture is, indeed, compressed within any given space; but, on the other hand, there is an increase of heat within the space which more than counterbalances the former in effect. "The heat developed," says Tyndall, speaking of an experiment illustrating the effects of increased pressure, "is more than sufficient to preserve it" (the moisture added to a given space) "in the state of vapour."

It will be seen at once from the above imperfect enumeration of causes affecting the production of rain, that the phenomenon is no simple one. When we add the variety of circumstances affecting the action of different causes—as the latitude of the place, the elevation above the sea-level; the proximity of the sea; the laws affecting the seasonal variations at the place; the prevailing winds; and the configuration of the surrounding surface, it will become evident that meteorologists may well be perplexed by the very complex set of agencies acting in the production of rain; and so fail—as they have hitherto done—in interpreting any save the most general laws influencing the phenomenon.

Some of these general laws I now proceed to consider.

In the first place, it may be accepted as generally true that the amount of moisture present in the atmosphere is greatest near the equator, and diminishes towards the poles. With the sun's change of declination the zone of greatest moisture passes to the north or to the south of the equator, *following* the sun. The mean region, it is to be noted, is not absolutely coincident with the equator, but some four or five degrees north of that circle. It is easily intelligible that the hottest regions shouldbe, *cœteris paribus*, those over which the amount of moisture present in the atmosphere is greatest, since the heat vapourises the water over these regions. It may not seem, at first sight, quite so obvious that the same regions of greatest heat should also be those in which the rainfall should be in general heaviest. For it might appear that the same heat which produced the evaporation should maintain the water in the state of vapour. The fact, however, that aqueous vapour is lighter than air, operates to produce ascending currents over the region of evaporation, currents strengthened by the expansive effects of the heat. Accordingly, the vapour rises rapidly, and when it has thus risen, many circumstances operate to produce precipitation. First, the upper regions are rarer; secondly, they are colder; thirdly, radiation of heat takes place rapidly from the upper surface of clouds, brought here, as Tyndall expresses it, into the presence of pure space (*dry air* having scarcely any appreciable effect in checking radiation). The result is, that the uplifting of clouds under the sun's influence is followed regularly over the equatorial regions by the precipitation of heavy rain-showers. And *cœteris paribus*, the fall of rain decreases with distance from the equator of heat, though not so regularly as the amount of moisture decreases.

The next great law which presents itself to our consideration is this, that winds blowing towards the equator are, in general, dry winds, and winds blowing from the equator rainy. This law is the direct consequence of the former, but it is necessary, for several reasons, to present it as a separate law. There is an erroneous method of accounting for this law which is very commonly met with in works on meteorology. It is argued that as winds blowing towards the equator are carrying masses of air from colder to warmer regions, they are necessarily dry winds, since, if the air is saturated, or nearly so, at starting, it cannot be saturated when it has become warmer. And *vice versâ*, winds blowing towards the poles are carrying masses of air to colder regions. The air accordingly grows colder, and if not far from being saturated at starting, cannot fail to become unable to keep its whole burden of moisture in the state of vapour, and must accordingly precipitate a portion as rain. This explanation is insufficient. It would, indeed, be just as reasonable to reverse the argument thus: a wind blowing towards the equator must bring rain; for as it brings cold air into warm regions, if the air in these regions is nearly saturated, the introduction of cold air must lead to the precipitation of a part of the moisture, and *vice versâ*, a wind blowing towards the poles must be a dry, because it is a heat-bearing wind. The simple explanation of the law is, that winds blowing towards the equator are dry, because they are blowing from regions over which moisture is less, to regions over which moisture is more abundant, and *vice versâ*. Of course we must superadd to this the facts mentioned above, because a moist wind blowing towards a heated region would not bring rain with it, and a comparatively dry wind, blowing towards a cold region, might bring rain. But it must not be forgotten that the main question to be considered is the relative moistness of the transported masses of air.

We meet with corresponding laws affecting the rain-producing powers of winds travelling over continents and oceans. A wind blowing over an ocean towards a continent brings rain to the continent, unless the heat over the latter exceeds slightly, or at the least, does not fall short of the heat over the neighbouring ocean. Such a wind is certain to bring rain to an elevated continental region not protected by a mountain barrier yet more elevated. On the other hand, a wind blowing over a continent towards the ocean in general brings no rain.

Lakes, marshes, and rivers, act in a small way a similar part towards the adjoining lands as oceans towards neighbouring continents.

There are circumstances also to be considered as affecting the rainfall in a different manner, viz., not by supplying a greater or less amount of moisture to the atmosphere, but by affecting the power of the atmosphere to keep the moisture it supports in the vaporous state. Such are the *contour* and *elevation* of a country, the nature of its soil, the quantity of forest land, or, wanting this, the relative abundance or paucity of trees, and so on.

A moist and warm current of air impinging on a mountain range, or even on any well-defined rising slope, so as to be carried with sufficient suddenness to colder and rarer regions, is compelled to part with a large portion of its moisture in the form of rain; and conversely a wind which has passed over a mountain range or an elevated plateau, and descends to a lower region, appears as a dry wind, unless that region is one over which a continual process of evaporation sufficient to maintain the air nearly in a state of saturation is going on. In this latter case the effects of the descending wind will vary with circumstances. It will in general appear as a dry wind, but may produce local showers, since it may act, through the sudden addition of cold air, the part of a condenser.

Forests are great generators of rain. This is mainly due to the peculiar radiative power of trees and vegetables. The soil, where it is covered with vegetation, receives no heat directly from the sun, and but little through contact with the heated air. It may seem like a confusion of cause and effect to speak of vegetation-covered countries as rain-generators, since abundant rain is so important a requisite for the abundant growth of vegetables. This is, however, a case in which cause and effect are interchangeable. Rain encourages vegetation, and vegetation in turn aids in producing a state of the superincumbent atmosphere, which encourages the precipitation of rain. The result is that, apart from external agencies, regions covered with abundant vegetation, and especially with high trees, present year after year, and century after century, a ranker and yet ranker luxuriance of vegetable growth.

On the contrary, arid regions prevent, by their very aridity, and consequently by the intense heat of the soil and superincumbent air, the downfall of the showers which would nourish vegetation. The result is, that even when the soil itself is favourable, it is exceedingly difficult to convert an arid into a vegetation-covered district, the want of moisture being destructive to trees planted in such soils with the object of encouraging rain-falls. The process of change must be a gradual one. On the other hand, the improvement of a region over which rain falls too heavily through overabundant vegetation is a comparatively simple process, a judicious system of clearing invariably leading to the desired result.

The influence of the seasons remains yet to be mentioned among the circumstances affecting the distribution of rain over the earth's surface. The influence of the seasons is different in different zones of the earth's surface. Under the tropics the laws affecting the fall of rain are much more regular than elsewhere. On the ocean we have clear skies where the trade-winds are blowing steadily, and heavy rain falls by day over the intermediate zone of calms; but on the land we have regular dry and wet seasons within the tropics. There is, properly speaking, no winter or summer; but applying these terms to the periods at which winter or summer prevails in the temperate zones of either hemisphere, we may say that the sky is serene in the winter, becomes moist in spring, and the rainy season sets in when the sun is near the zenith. Where there is a considerable interval between the sun's passages of the zenith, as in places not very far from the equator, there are two wet seasons, both occurring in summer. In countries in which monsoons prevail, however, the alternation of dry and wet seasons depends on the winds. When the south-west monsoon is blowing over India, for instance, there is no rain on the east coast, but abundant rain on the west coast. During the north-east monsoon these conditions are reversed. A little consideration will show that all the above-mentioned seasonal variations within the tropics depend on general laws already stated.

Beyond the tropics there is less regularity. The fall of rain depends on the prevalence of certain winds which bring moisture with them, and these winds not blowing with any regularity, the rainfall is similarly irregular. In countries close to the tropics, there is a noteworthy dryness in summer; for this reason clearly, that in summer the trades blow over these regions, and bring with them "trade-wind weather." Further north, however, though there may be a tendency to the prevalence of north-easterly winds in summer, this tendency is not so marked as to produce a considerable defect of rain in the summer as compared with the winter months.*

In England we have one cause affecting the rainfall which is worthy of special notice. I refer to the Gulf-stream. The air above this warm stream is not only warmer than the surrounding air, but is heavily laden with moisture. When the western and south-western winds loaded with the vapour of water begin to blow over England, they precipitate their moisture in rain as they encounter the colder air over the land; but the manner in which this happens is variable with the seasons, for in the winter months the moisture-laden winds blow lower, and therefore precipitate their vapour earlier; whereas in summer the clouds range higher, and therefore travel farther inland before they fall in rain. The same effects are observable in the Scandinavian peninsula, Norway receiving more rain in winter than in summer; while Sweden, on the eastern side of the Dovrefields, receives more rain in summer than in winter.

Such are some of the general laws which affect the downfall of rain in various countries and at different seasons. There is one circumstance involving the action of a yet grander law—about which, however, considerable uncertainty still exists. I refer to the difference observable between the northern and the southern hemispheres. It has been already noted that the mean position of the medial zone of calms and heavy diurnal rainfalls lies some 4° or 5° to the north of the equator. The total annual downfall of rain north of this medial line is

* So far as my own observations extend, I should say that the two features of our climate which may be most certainly depended on—which, be it noted, is not saying much—are, heavy rains in July, generally in the last fortnight, and serene weather during the second week of November.

slightly greater (so far as our present information extends), than the downfall south of the medial line. And, therefore, since the area of the northern region is less than the area of the southern, it is clear that the annual downfall over any northern zone is, in general, considerably heavier than the downfall over the corresponding southern zone. Now, if we remember that the amount of aqueous vapour raised by evaporation over the southern or watery hemisphere must necessarily be much greater than the amount raised over the northern hemisphere, this result will appear a remarkable one. One would expect to find a difference—and a very marked difference—between the two hemispheres; but instead of the excess of rainfall being in favour of the northern hemisphere, one would expect it to have been in favour of the southern.

If we assume with Maury that the north-easterly and south-easterly trade-winds which meet near the equator merge, respectively, into the north-westerly and south-westerly counter-trades; that is, that they cross over to the opposite hemisphere to that in which they were generated, the difficulty seems to vanish. For in this case, the downfall over the northern hemisphere is due to evaporation over the southern hemisphere, and *vice versâ*. Maury adduces other arguments in favour of his theory of an intercrossing of this sort. Sir John Herschel, however, will not listen to Maury's views. He "declines adopting the doctrine recently propounded of a systematic crossing of the south-east and north-east trades at the medial line. In so doing," he is "in no way disturbed by the phenomenon of infusorial dust of South American origin which occasionally falls on the north-east of Africa," and so on. I must confess that the balance of evidence seems to me to lie on Maury's side in this instance.

It may be asked, however, whether there is any occasion to adopt either view as a systematic account of the laws affecting the trades and counter-trades. May not Maury and Herschel be like the two knights who saw opposite sides of the same shield, and who—both right and both wrong—were persuaded, one that the shield was silvern, the other that it was golden.

If we remember that the medial line marks a zone of calm towards which, from either hemisphere, immense masses of moisture-laden air are continually being swept in, why should we arbitrarily assign to the masses of air passing away above from this calm zone, such a law of motion that every particle of air which has originally come from the northern hemisphere shall take one course, and every particle which has come from the southern shall take an opposite one. It appears to me, on the contrary, that an intermingling (in masses, it may be, but still complete), must take place above, and result in an almost indifferent diffusion of the vapour-laden air northwards and southwards with the returning counter-trades. The fact that the northern trades have a southerly motion as they enter the calm zone (passing here upwards), and *vice versâ*, may lead to a slight preponderance of air (originally) from the northern hemisphere in the north-westerly counter-trade, and *vice versâ*, but by no means (I should think), to anything approaching the systematic intercrossing imagined by Maury. On the other hand, the preponderance might lie the other way, owing to the effects of collision between the northern and southern trades—but without leading to the systematic return of northern air to the northern temperate zone, and of southern air to the southern temperate zone, conceived to take place by Sir J. Herschel.

One of the most remarkable results of observations made upon rain, has been the discovery that the amount of fall at any place diminishes largely as the rain-gauge is raised above the level of the ground. It is not very easy to explain this remarkable fact. The explanation offered by Kämtz is, that a falling drop carries with it the temperature of the upper regions of air, and condenses on its surface the aqueous vapour present throughout the lower strata of the atmosphere, as a decanter of cold water does when brought into a room. And of this explanation Professor Nichol remarks, that "it is not an hypothesis but a rigorous deduction, giving an account of all the facts as yet ascertained in connection with this subject." But unfortunately, the explanation, though it undoubtedly presents a *vera causa*, will not bear the test of "quantitative analysis." Sir John Herschel has gone through the simple calculation required to overthrow the theory, and points out, that if we allow to the cause the full value it can possibly have (a value far exceeding that which can *probably* be attributed to it) we obtain an effect only one-seventeenth part of what is wanted to account for the phenomenon. Sir John points out also that obliquity of fall cannot possibly affect the observed amount of rainfall, and he offers no hypothesis in explanation of the phenomenon, and remarks in conclusion, that "visible cloud rests on the soil at low altitudes above the sea-level but rarely; and from such clouds alone would it seem possible that so large an accession of rain could arise." He refers, however, in a note, to a paper read by Mr. Baxendell to the Literary and Philosophical Society of Manchester on this subject, in which it is inferred that the only way of accounting for the phenomenon lies in the admission of the existence of water "not in the state of true vapour," but already deprived of its latent caloric, though not affecting the transparency of the air, so that "a shallow stratum of the lower and comparatively clear atmosphere" may "supply as much rain as a densely-clouded and much deeper stratum in the higher regions." Baxendell mentions also the interesting fact, that the drops of water which drip from the upper part of the shaft increase to an extraordinary size in the descent to the bottom.

It appears to me that the well-known phenomenon of rain falling from a clear sky—a rain termed by the French *serein*—has a suggestive bearing on the peculiarity we have been considering. It proves that water may exist, even in drops, in the atmosphere, without appreciably affecting its transparency. And though it may be an uncommon thing for rain to fall without appearing first in the upper regions of air—in the form of cloud, yet it by no means follows that *during a shower* rain might not be falling from the lower as well as from the upper air-strata, without the transparency of the lower strata being much or at all affected. I have noticed, always, that if the eye be directed steadily at the drops of heavily-falling rain, there will be seen flitting, as it were, among them minute specks, which are seen on a closer observation to be small particles of water. Now, it does not appear to me likely that these, or most of them, are produced by the collision of the falling drops—for the paths of two neighbouring drops must be parallel, since the drops are subjected to precisely the same set of influences.

I believe the phenomenon to be one worthy of more careful notice than it has received—in fact, I am not aware that it has been noticed at all. The motions of the particles are themselves interesting—seeming almost as independent of gravitation, wind-currents, or the like, as the motion of a flight of insects would be. It is hardly necessary to observe that if these particles show that rain is being generated in the lower as well as the upper strata of the air, all difficulty in explaining the results of Professor Phillips's observations, vanishes at once.

THE GRAVE-MOUNDS OF DERBYSHIRE, AND THEIR CONTENTS.

BY LLEWELLYNN JEWITT, F.S.A., ETC., ETC.

(*Continued from page* 266.)

THE ROMANO-BRITISH PERIOD.

As I have said earlier on, the greater part of the Grave-mounds of Derbyshire belong to the Celtic period; the intermediate number to the Anglo-Saxon, and by far the least of all to that now under notice, the Romano-British. There is, both in the lowlands of the county, and in the higher or mountainous districts of the Peak, abundant evidence of Roman occupation, and of the arts practised by that people, but very little knowledge indeed is to be gained there as to their funeral customs or their modes of sepulture. Of the *living* Roman and of his avocations, indications are not unfrequently brought to light by the burrowing miner, or by the surface-working agriculturist, but of the *dead* it is rarely indeed that any remains are exhumed.

In Derbyshire the Roman was, it would seem, more of a "bird of passage" (as well as, to some extent, a "bird of prey") than a settler, and the consequence is that no remains —or next to no remains—of villas or of settlements are found, and that where burial has taken place it has not unusually been in the same mound with those of an earlier period. The Ancient Briton raised the mounds over the remains of his own people, and his Roman subjugator, as occasion required, took possession of them, and therein laid his own dead. Thus the same barrow is sometimes found to contain, besides its primary Celtic interment, and others belonging to the same race, later deposits (nearer to the surface or to the side) of the Romano-British or of the Anglo-Saxon periods.

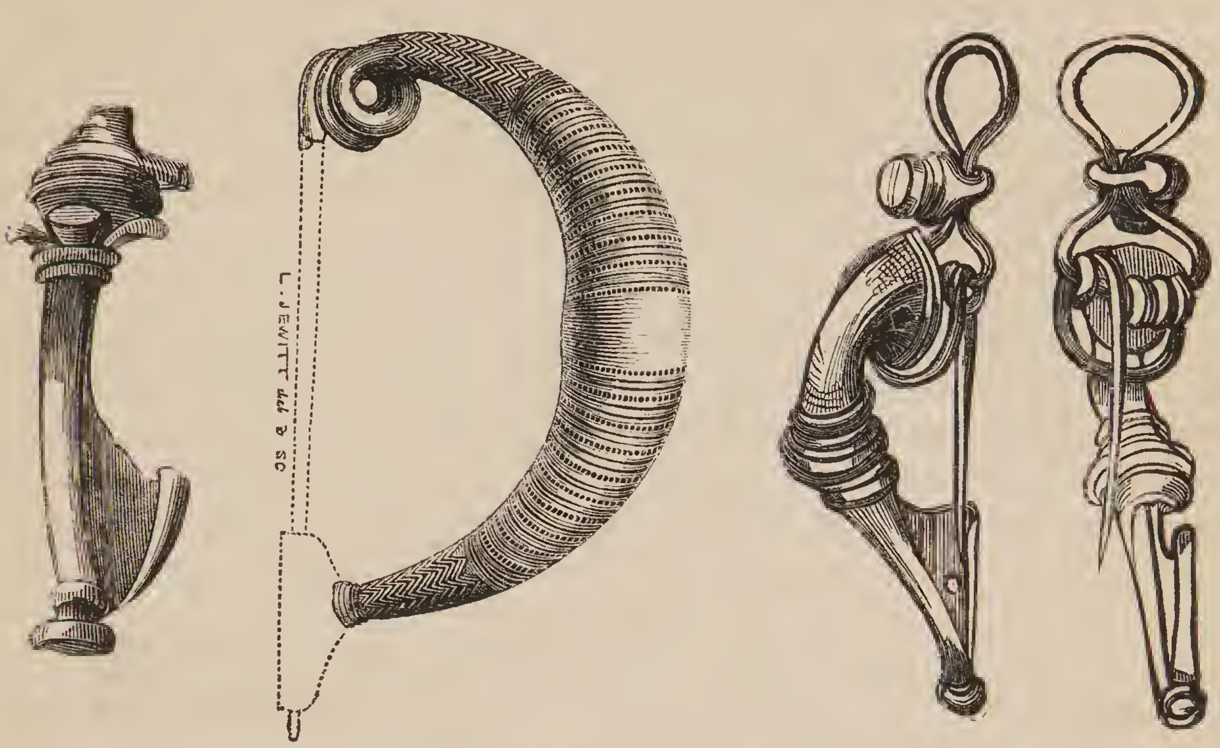
The Roman roads of Derbyshire were many in number, and some of them are of considerable importance. The principal line (as well, most probably, as some of the others) was formed on an old British way; while other roads were constructed by them for the convenience of working, and for greater facility in transporting the produce of, the mines, in which a profitable trade was carried on. The principal road, the Rykneld Street, entered the county from Staffordshire, and passed over Egginton Heath to *Derventio* (Little Chester, now an outskirt of Derby); from thence to Pentrich (which is believed to have been a station), and so on to *Lutudarum* (Chesterfield), and forward into Yorkshire. From Little Chester several of the roads diverged, and other lines again traversed the Peak district, both in the neighbourhood of Buxton (supposed *Aquæ*) and in other directions; whilst others again from the lead-producing districts centred in Chesterfield. The stations, and supposed stations, in Derbyshire, were at Little Chester, where a vast number of remains have been found; Chesterfield, where also coins, etc., have been discovered; Buxton, where Roman baths have been traced; Brough near Castleton; Melandra Castle, Parwich, and Pentrich. At each of these places remains of the period have been found. Roman coins, fibulæ, pottery, etc., have also been found in various parts of the county, and show that it must have been pretty fully traversed, and indeed occupied, by that people.

In the mining districts of the High Peak, Roman antiquities of one kind or another are being frequently turned up, and some of the lead mines, which exist and are worked at the present day, are proved to have been known to, and worked by, the Romans. This is, perhaps, more particularly the case in the neighbourhoods of Elton, Winster, Youlgreave, Matlock, etc., where even the names of some of the mines—such as the "Portway Mine," for instance—give evidence of their early origin. Pigs of lead of Roman manufacture have at different times been found in Derbyshire, some of which bear inscriptions referring to the station of *Lutudarum* (Chesterfield), to which I have already alluded. One of these inscriptions is:— T. CL. TR. LVT. BR. EX. ARG., and another, IMP. CAES. HADRIANI. AVG. MET. LVT. The finding of these inscribed and other pigs of lead, the number of Roman roads which traversed the mining districts, and the number of coins and other articles which have from time to time been found about the mines, and in their neighbourhood, show that lead must have been produced to some considerable extent, and that a large number of people must have been engaged in the getting of the ore, and in smelting it.

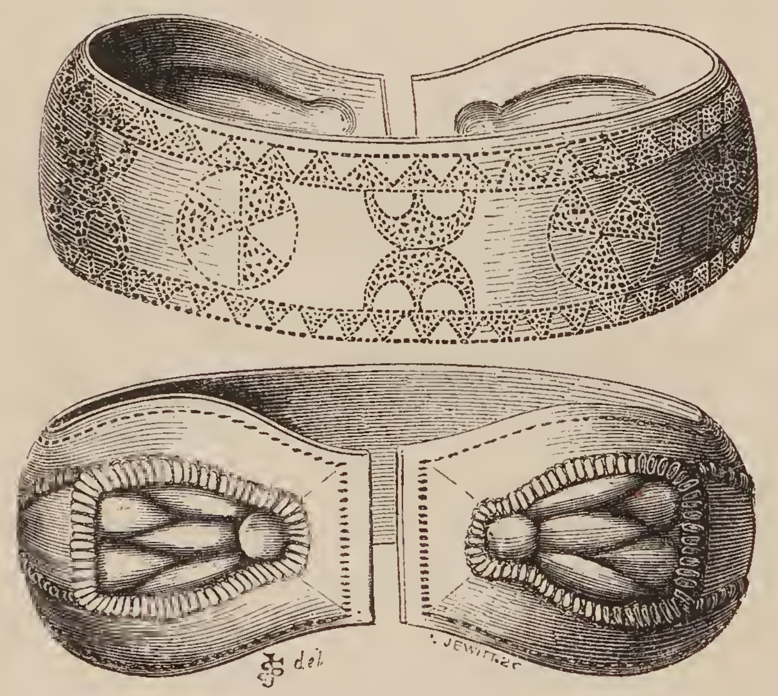
When, in addition to the fact I have stated, that the Roman people did not make regular settlements in Derbyshire, we recal to mind the other fact, that they but seldom raised tumuli over their dead, or, in this country, placed any ostentatious monuments over their remains, the reason is obvious why so few of their sepulchral urns should have been found here, though, doubtless, many urns etc., still lie buried and will yet from time to time be unearthed. It is also necessary to remember that the finding of a Roman coin in a barrow is no evidence of that barrow being raised by the Romans, or even of the person interred being of that race. "The Britons, looking upon these tumuli as a kind of sacred ground, continued, in many instances, to bury in the same barrow for ages after its first construction, and deposited with their dead in later times the coins of their Roman masters, on the same principle as that which prompted them in earlier times to inter the rude weapons or ornaments of flint or bone."

The interments which have been discovered exhibit both burial by inhumation and by cremation. Of the former, examples have been brought to light at Little Chester in the course of excavations both for building purposes, and in the formation of the railway works. A skeleton of a man found there some years ago, lay full length on its back, the arms straight down by the sides. Iron rivets, which were found much corroded, lay near various parts of the body, and a thin stratum of ferruginous matter encased the skeleton at a little distance from the body and limbs. From these circumstances it is to be inferred that the deceased was interred in his armour. Other interments by inhumation have recently been discovered in the same neighbourhood, but without, in some instances, the ferruginous appearances. The remains of horses were found along with them. Interments by inhumation have also been found at Brough and at other stations, and, as later deposits, in Celtic barrows. Those where the bones have been found *in situ*, appear, like the one I have spoken of at Little Chester, to have been laid at full length on the back, the arms straight down by the sides. They appear in most instances to have been simply laid in a very shallow grave, but little below the surface of the already formed mound, and to have been then covered to no great thickness with earth. Where interment has been by cremation, the urn, sometimes covered with a small flat stone, containing the burnt bones, has been placed in a small hole dug in the earth, or in a Celtic barrow, and covered over. Not unfrequently domestic vessels have been placed with the cinerary urn, as will be hereafter described.

As the interments of the Romano-British period in Derbyshire are, as I have said, but few, so, naturally, the articles found with them are far from numerous. They embrace, however, pottery and glass, coins, fibulæ, armillæ, and other ornaments of bronze and iron, knives, spear-heads, combs, etc., etc. Of fibulæ, the three examples here engraved will convey a very tolerable idea. The first was found with a Roman interment in a Celtic barrow near Monsal Dale; the centre one was dug up with a quantity of human bones at Little Chester; and the third one was found at Elton. It is somewhat peculiar in the twisting of the wire at the top. Circular fibulæ have also been



found in the county. Of *armillæ* a very fine pair, here shown, have recently been found at Stony Middleton, about eight feet



below the surface.* They are of base silver and appear to have been much worn. They will be seen to be very similar in pattern to a pair found some few years ago at Castlethorpe, along with a number of Roman coins and other remains, which have been described in the "Archælogical Journal."

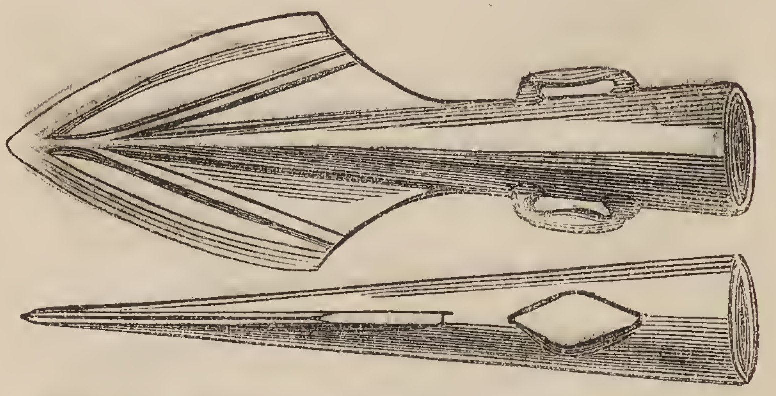
Iron knives have occasionally been found along with human

* Described in the "Reliquary, Quarterly Archæological Journal and Review," for October, 1867.

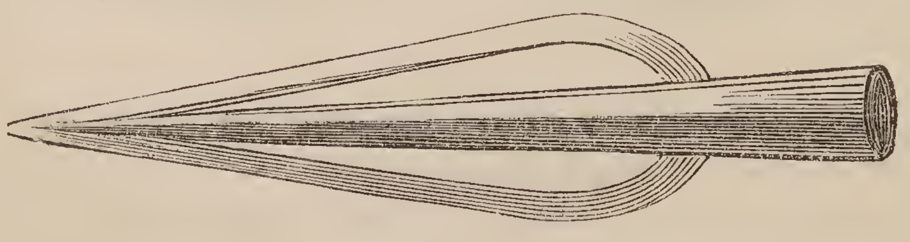
remains of this period. Instances of this have occurred at Middleton-by-Youlgreave and at Hartington, as well as in other

localities. They appear to have had wooden handles, which, of course, are, except small traces of texture, entirely decayed away. Spear and lance-heads, which have also been interred with the dead, have also been found. Of these, for purposes of comparison with those of other localities, I give two examples.

The first, which is of iron, is from Little Chester, where it was found along with human remains, and the second, which is of



bronze, was found at Hartshay. It is, as will be seen, of somewhat unusual form, and has a loop on either side. Another form, from Wardlow, is also here given. It is of bronze and is 3½ inches long.



Combs and bone pins have been found occasionally with interments of this period.

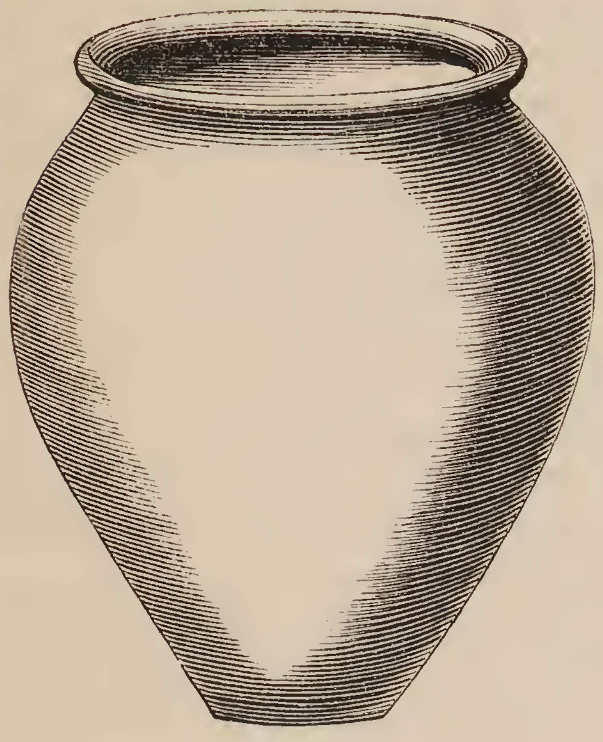
Coins are, as a matter of course, very generally found with interments of the Roman period both in England and in other countries, and Derbyshire is no exception to the rule. Coins were buried with the dead in conformity with a superstitious belief that they would expediate the passage of the soul across the lake in Hades. The magic power of money in all connections with human life, originated this custom. In all worldly matters money then was, as it unfortunately now still is, the main, if not the only sure passport to place and honour; and thus it was believed that the soul of the man who had not received the usual rites of burial, and in whose mouth no fee for the ferry-man of the Stygian lake had been placed,* would wander hopelessly on its banks, while decent interment and a small brass coin would obviate any disagreeable enquiries that Charon might else be inclined to make as to the merits or claims of the applicant. Thus in the cinerary urns of the period of which I am speaking, coins are very commonly found, and also in interments by inhumation a small coin has in more than one instance in Derbyshire been found within the skull in such a manner as to leave no doubt of its having been placed inside the mouth of the deceased. In some instances a considerable number of coins have been found deposited together, or scattered about in a barrow along with the human remains. In Haddon Field a large number of coins, principally consisting of third brass of Constantine, Constans, Constantius II., Valentinian, Valens, and Gratian, were found along with bones, fragments of pottery, traces of decayed wood, and a portion of a glass vessel. At Minning-Low (the fine chambered tumulus described on page 188, *ante*), where several interments of the Romano-British period have undoubtedly been made in the earlier Celtic mound, many Roman coins along with portions of sepulchral urns, etc., have from time to time been found. These are principally of Claudius Gothicus, Constantine the Great, Constantine junior, Valentinian, and Constantius II. In a barrow near Parwich upwards of eighty coins of the later emperors were found. At Little Chester, some in connection with human remains, and others scattered about in different parts of the station, some hundreds of Roman coins have at various times been found. In my own possession are considerably more than a hundred examples from that locality, ranging from Vespasian to Arcadius, and including Vespasian, Titus, Nerva, Trajan, Hadrian, Antoninus Pius, Faustina senior, Marcus Aurelius, Faustina junior, Commodus, Gordianus III., Philippus senior, Volusian, Gallienus, Salonina, Postumus senior, Victorinus senior, Tetricus senior and junior, Claudius Gothicus, Carausius, Allectus, Constantius Chlorus, Helena, Licinius senior, Constantinus Maximus, Constantinus II., Constans, Constantius II., Family of Constantine, Magnentius, Valens, Arcadius, etc., etc.

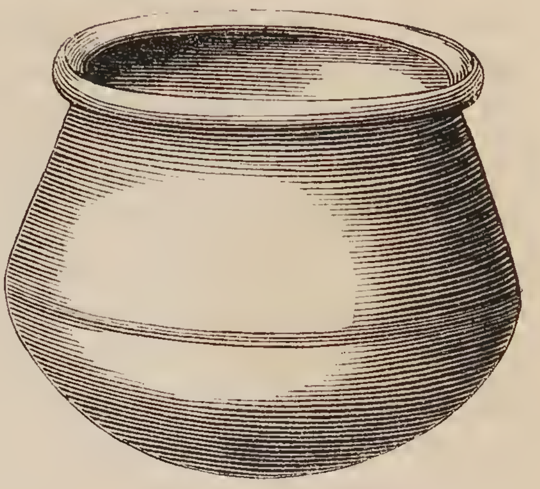
* "Nec habet quem porrigat ore trientem."—Juvenal.

In other parts of Derbyshire coins have been found in considerable numbers, sometimes in connection with interments, but more commonly without. Beads have also occasionally been found. The one here engraved was found near to a deposit of burnt bones in a barrow at Harley or Harlow Hill. It is of blue glass, and is of the most usual form of Roman beads.

Of the pottery alone of the Romano-British period, sufficient interesting matter to fill a couple of goodly volumes might easily be written. It will, therefore, be easily understood that in a paper like the one I am now drawing up, which is simply intended to be a descriptive sketch of the contents of Derbyshire grave-mounds, any account of the different kinds of ware made by that people, and of the modes of manufacture which they adopted, would be not only unnecessary, but, to some extent, out of place. Those who desire general information upon the Samian ware, the Durobrivian pottery, and the pottery of the Upchurch marshes, cannot do better than refer to, and study, the three excellent articles on those wares which have already appeared in the pages of THE INTELLECTUAL OBSERVER from the pen of my friend Mr. Thomas Wright, which will be found to give them all the information they can desire. The Roman cinerary urns found in Derbyshire are mostly of the usual globular form, and of a dark bluish-grey colour in fracture. They are somewhat coarse in texture, and are thrown on the wheel. Other varieties, both in form, in colour, and in material, however, occur, as will be seen from the following examples and descriptions. The first engraving exhibits one of the hard bluish-grey vessels I have just now spoken of. When found, it was like the others I am about to notice, filled with burnt bones. The next engravings show two urns containing human remains, the smaller one of which was found at Little Chester. It is formed of a black clay, mixed with small pieces of broken shells—a kind of pottery much used for sepulchral purposes. The larger urn, from my own collection, is of a hard and compact clay, and is beautifully "thrown" on the wheel. These examples are entirely devoid of ornament. The next

example, also from Little Chester, is of a totally different





character. It is of a fine reddish-brown clay, and is ornamented with "slip" in an unusual manner. It measures 3½ inches only in height, and the same in diameter at the mouth. When found, it was filled with burnt bones, among which were some small fragments of

bronze ornaments, which had evidently been burned along with the body. Along with this engraving I give, for the purpose of comparison representations of two other urns from different localities, which will be seen to be of the same general form as the one I have described, although differing from it in ornamentation and in colour of clay.

In the regular cemeteries of the Romano-British period, the cinerary urns were usually surrounded by a group of vessels of various forms, sizes, and uses, which probably had orginally contained wine, unguents, aromatics, etc. Among these, vessels of various makes are found, and occasionally a Samian-ware cup, a patera, or a bowl. Although in Derbyshire no such regular cemetery has as yet been uncovered, vessels, and fragments of vessels have been found at Little Chester, and other places, along with cinerary urns, which leave no doubt that the usual arrangement obtained in that county, as well as elsewhere. Some of the pottery found appears to be of what is properly described as Romano-Salopian ware—a ware made in Shropshire from its native clays from the valley of the Severn. Examples of Samian ware, too, have been found, but this very seldom, and then only in fragments.

In, at all events, one or two instances of Derbyshire interments, examples of what used to be absurdly called Kimmeridge coal money, but which are, in fact, nothing more or less than the refuse pieces of shale from the lathe of the Roman turner, have been found. Fragments of personal ornaments of the same material have also been discovered.

Enough has now, perhaps, been said to give a general insight into the sepulchral remains of the Romano-British period, as found in Derbyshire. My next chapter will, therefore, be devoted to those of the Anglo-Saxon era.

(To be continued.)

SIR ISAAC NEWTON.

(With a Fac-simile of his Writing.)

BY JOSEPH NEWTON, H.M. MINT.

In introducing the name of the eminent man whose discoveries and deductions in reference to the law of gravitation have recently formed the theme of an exceedingly interesting, and warmly waged controversy, it is not intended to re-open the questions which were at issue between the several controversialists. The reputation, and the merits of Sir Isaac Newton have been ably and successfully defended from the assaults made upon them, and have emerged from the wordy conflict not only untarnished and undiminished, but heightened and enhanced. Were the results, indeed, otherwise, the writer of the present paper would still hesitate before taking part in a discussion which others are so much better qualified than he to sustain. Since, however, the claims of Sir Isaac, as a scientific discoverer have been conclusively established, it may be of interest to inquire into some of his actual works, to demonstrate the practical character of his mind, and to reproduce, as it were, his handwriting and signature, whilst occupying an important post in the State.

For a long series of years the elucidator of the law of gravitation held high office in the Royal Mint of Great Britain, and it is matter of tradition that the establishment in question never had a more assiduous or energetic officer. He was appointed Warden of the money manufactory then existing within the Tower of London, in the year 1695, and in the reign of King William III. This happened to be a remarkable period in the annals of that establishment, for the whole of the monies current in England were then called in and re-coined. In order to defray the expense of the operations, and to cover the loss arising from an immense quantity of counterfeit coin being at the same time taken out of circulation, the device of a window-tax was first employed in this country. Mr. Newton was so successful in his conduct of the important task of remodelling the coinage, that the work was completely effected in the course of four years, and it was admitted that he had, by the introduction of improved mechanical appliances, and of other economical arrangements, saved the country, during that period, no less a sum than £80,000.

His services were duly recognized by the government, and in 1699 Mr. Isaac Newton was gazetted as Master and Worker of the Royal Mint. In the post of Warden his salary and fees amounted to £600 per annum, but as Master they were augmented to about £1,500. From this period forward to the year 1727, when his death took place, Newton continued to fulfil the duties of this latter office. Those duties were complicated to a very considerable extent by the existence of a body of men within the mint, known as the Corporation of Moneyers, and who assumed to themselves, and actually exercised the power, of controlling the executive department of the Mint, independently of the Master. This kind of *imperium in imperio,* as may be imagined, gave great trouble to the supreme governing authority of the establishment. It constituted a state within a state, and it made laws which frequently clashed with those framed by the Master. The Moneyers claimed to be descendants of the oldest officers on record in the Mint, namely, those of Ethelbert, first King of Kent, and who flourished A.D. 561. They stated that the first coin on which the name of a Moneyer appeared was that known as the *sceatta* of Egbert. They traced their pedigree, or their succession, through the Moneyers of the kings of the West Saxons, those of the monarchs of the East Angles, of the kingdom of Mercia, and so on, to the time of William the Conqueror. It was asserted by them that their progenitors were the sole persons mentioned as connected with the Mint, either in the Doomsday-book, or in any of the laws of the Anglo-Saxons. Further, they adduced evidence that the custom of placing the name of the monarch on the one side of the coin, and that of the chief moneyer on the other, was continued up to the time of Edward I.

Without tracing at greater length the history of this remarkable company,* it may be stated that in Newton's time it consisted of eight members, governed by a senior officer, dignified with the title of Provost, and sundry apprentices. These latter were, up to the year 1827, nominated by the Moneyers themselves, and were usually selected from their own family connexions.†

Mr. Newton was a jealous protector of his own privileges, and gave his orders as to the management of the Mint with great decision and perspicuity. In order to convey an exact idea of the mode in which his wishes were forwarded to the Moneyers, and at the same time to furnish a veritable example of his caligraphy, a fac simile of an instruction given to the Provost of the period, Mr. John Braint, is annexed. The original is endorsed, by the hand of Mr. Braint, as an "Order for Alterin ye edging ye money—1700."

It will be observed that the Master of the Mint has written his order in the most explicit manner, and in that bold but peculiar hand which once seen is not likely to be mistaken. There is no doubt whatever of the genuineness of the document, of which the plate is a most truthful transcript. The original was carefully preserved by the Corporation of Moneyers, until 1851, when their tenure of power, and their supposed prescriptive right to coin the monies of this realm ceased. It was then handed to the writer of the present notice, and in his possession it has remained until now.

It has been stated that Newton was promoted to the post of Master and Worker of the Mint, in 1699; and those who are curious about minute points in connection with such matters will note that the newly-made officer was very nearly

* The pages of "Ruding's Annals of the British Coinage" are full of information on the point. The Company ceased to exist in 1851.

† Sir Isaac Newton, in the year 1713, attempted to alter this arrangement, and to obtain the power of nominating apprentices himself. He failed, however, in accomplishing that object, and was not even permitted by the then autocratic Corporation to interfere in their selection of apprentices in any way. An entry in the journal of the Company throws a light upon the subject, and illustrates the position of the Moneyers at this time. It runs as follows :—"Some conversation having taken place between Sir Isaac Newton (the Master of the Mint) and the Company of Moneyers, respecting their taking apprentices according to their usual and ancient custom, the following question was put at a full meeting held in their hall on the 4th November, 1713, 'Whether the Master and Worker be asked for permitting the Provost and Company of Moneyers to take apprentices?' Resolved, nem. con., that the Master never had any authority as to the permitting the Provost and Fellows to take apprentices, and that it is not reasonable to ask the Master his consent in the affair, which course might be of ill consequence in the future." Mr. Tierney, Master of the Mint in 1827, first broke this rule, and nominated in that year an apprentice.

M^r Provost

You are to take care that the five pound pieces &
forty shillings pieces of Gold & the Crowns & half
crowns be made with ANNO REGNI DVODECIMO
on the edges till further order

Is. Newton

To M^r John Braint
Provost of the Moniers

Mint Office May 6^t
1700.

Fac-simile of Autograph of SIR ISAAC NEWTON,
A Copy of a letter in the possession of M^R JOS: NEWTON.

falling into the error of appending that date, instead of 1700, to the official instruction. Evidently the Master passed his finger over the two figures, 1 and 6, ere the ink with which they were written was dry.

Perhaps Monsieur Chasles may be enabled to institute a comparison between the document now transcribed and those which were said to have been written by the same hand to Pascal ?*

It may not be improper to state that the order itself refers to a process of imprinting letters on the edges of coins, which first came into use in the time of the Commonwealth. The impression was given by passing the coin between two plates, one of which was fixed, and the other moveable, by means of a pinion and rack. The half of the legend was engraved on each of these plates, so that when the coin was carried by the moveable plate to the end of the fixed one, it became lettered as desired. The machine used in Newton's time was of this description, and had been invented by a Frenchman, Mons. Caistang.

Newton, who was born on the 25th of December, 1642 (O. S.), at Colsterworth, in Lincolnshire, lived in the reigns of six monarchs and of one Lord Protector. He held the office of Master of the Mint from 1699 to 1727, and therefore under four sovereigns, viz.: William III., Anne, George I., and George II. This statement is sufficient to demonstrate that the posts of Warden, and Master of the Mint, successively held by Newton, were no sinecures. On the accession of each monarch it became necessary to produce new coins of every denomination, and bearing his or her royal image and superscription. Those only who are intimately acquainted with the process of die-engraving, and minting generally, are cognizant of the anxiety and mental and physical labour involved in such changes. They add much to the cares of the responsible officers of the Mint, and demand extreme attention to minute details and minor points of manipulation on the part of subordinates, which is not required when such alterations are completed. For every reason, let us hope that a very long period may

* The French Academy of Sciences is now fully convinced, and freely admits that the Pascal and Newton letters are forgeries, whilst Sir David Brewster has furnished very strong evidence as to the perpetrator of them. From that evidence it seems clear that M. Pierre Desmaizeaux, who resided in England between the years 1692 and 1745, the year of his death, was the author of the whole of the fictitious correspondence. It is known that at Desmaizeaux's death, 120 letters, said to be those of Newton, and 88 letters and notes of Leibnitz, were in the house in which he died. It is highly probable, says Sir David, that Desmaizeaux "spent the last five years of his life in the difficult work of composing the Pascal and Newton correspondence." His family subsequently obtained £500 for the MSS.

elapse before any such transformation is needed in regard to the coinage of these realms!

Previously to Newton's appointment as Warden of the Mint, his sole income is stated to have been derived from his Lucasian professorship, and from the produce of the manor of Woolsthorpe, the combined amount of which, though aided by habits remarkably temperate and abstemious, ill accorded with his natural generosity of disposition, and prevented his relieving the wants of his poor relations.

In proof of Newton's straitened circumstances before receiving the wardenship of the Mint, it may be adduced that there now exists an entry in the "Journal of the Royal Society," dated January 28, 1674—5, whereby he is excused from making the customary payment of one shilling a week, "on account of his low circumstances, as he represented."

Newton received his knighthood in 1705, at the hands of Queen Anne; and at his decease, which took place at Kensington on the 20th March, 1727, he had a personal estate valued at £32,000. At the time of his death Sir Isaac had attained the age of eighty-five. To him may justly be applie the words of the ancient poet:—

> "Qui genus humanum ingenio superavit, et omnes,
> Restinxit; stellas exortus uti ætherius sol."

FUR-BEARING FOXES.

BY JOHN KEAST LORD, F.Z.S.

About seventy-five thousand fox skins of various kinds are sold at auction annually in London, by the different fur companies. As we contemplate these figures, we may well feel astonished, and fail to understand from whence so many skins are procured, or how it happens that the entire race of foxes escape being utterly exterminated. Nevertheless, wonder as we may, the fact stands before us, that this wholesale destruction of animal life has been continued year after year—we may almost say—since the fur trade commenced in North America, and yet the demand remains at a steady average rate, and the needful supply as constantly arrives to meet it.

Eight varieties of the sub-family *Vulpinæ* are trapped or otherwise destroyed, that their jackets may supply the fur-market—the black or silver fox, the cross, red, white, blue, grey, kitt, and corsac-fox.

It may be as well, perhaps, to state for the benefit of my non-scientific readers, that the family Canidæ includes animals which are characterized by having the jaws somewhat produced, the legs of equal length, the anterior pair being furnished with five toes, and the posterior with four. The claws are non-retractile, and from a remarkable habit all the members of the group have of walking, as it were, on tip-toe, the term *digitigrada* is applied to them. Each fore-foot has a rudimentary toe, to which a claw is generally, although not invariably, affixed. There are two well-marked types of this sub-family *Vulpinæ* inhabiting North America. In the one type represented by the red fox (*Vulpes fulvus*), the tail is uniformly bushy, and is made up of long hairs, which are irregularly mixed in amongst and distributed through a short and rather compact fur. The skull is very wolf-like in character; the temporal crests strongly developed, approach each other, and extend rather beyond the parieto-frontal suture; the muzzle is elongated and particularly sharp. The other type is well exemplified by the grey fox (*V. Virginianus*). An examination of the skull shows us that, in this animal, the temporal crests never approach each other; a space of quite an inch on the parieto-frontal suture separates them. Another marked difference is observable in the shape of the muzzle, which is very short and sharp pointed in this type of fox; and the tail instead of being full and bushy, exhibits, when carefully examined, a regular ridge or mane of bristle-like hairs which extend along its upper line from end to end. These hairs have no short fur intermixed with them, and the longer hair, uniformly clothing the tail, hangs down loosely on each side.

"The following diagnosis clearly describes the points of contrast:—*

"A. Tail with soft fur and long hair, uniformly mixed; muzzle long; temporal crests coming nearly in contact. *Vulpes.*

"B. Tail with a concealed mane of stiff hairs, without any soft fur intermixed; muzzle short; temporal crests always widely separated. A supplementary tubercle on the lower sectorial. The under jaw with an angular emargination below. *Urocyon.*"

Before we proceed to play the spy upon reynard at home in the wilderness, it will not be time mis-spent to consider very briefly the distinguishing characters which separate the wolves (*Lupinæ*) from the true foxes.

If you think it worth the trouble, courteous reader, when you next visit the Zoological Gardens in the Regent's Park, direct your steps towards the cages wherein the wolves are

* Baird, "N. Am. Mam.," p. 121.

confined. Look well at the beast's eyes, the pupils, you observe, are circular; now change the "venu," to employ a legal phrase, and walk into the rodents' house, or visit the den of Arctic foxes, it will do quite as well, and mark the form of the pupillary opening in the eye of the fox; it is elliptical instead of being circular. Here then is one great mark of distinction by which you may easily know a wolf from a fox. The other generic characters may be thus summed up: The wolves have tails somewhat short and inclined to be bristly, and the middle upper incisor teeth are curiously lobed on either side. The foxes' tails are large and bushy, the hairs covering them long and silky; the mane-tailed group form no exception, as the stiff hairs do not in any way detract from the bushy appearance of the tail. The general form of the fox is much more lissome and slender than that of the wolf. In all true wolves the post-orbital process of the frontal bone is markedly convex on its upper surface, rounding off outwards and downwards, and having a well-developed point below the plane of the inter-orbital space; in the fox this bony process scarcely projects at all, and in a few exceptional cases it is even slightly concave; the bony point hardly dips at all, a deep indentation marking the process at the place where it springs from the frontal bone.

It is as well to remark that all the animals of a fox-like type found in South America, occupy a sort of intermediate position betwixt the wolves and foxes proper; indeed they are more nearly allied to the former than to the latter group, as the pupillary opening is circular, and the general form very wolf-like. Burmeister proposes a division of the South American fox-like wolves into two groups, *lycalopex* and *pseudalopex.*

The silver fox, or as it is often styled, the black fox (*Vulpes argentatus*), stands first in our list of fur-bearing foxes as supplying the most valuable fur. An idea may be formed of the money value of the finer skins procured from the silver foxes, when we learn that a single skin has been sold in London for the sum of £100. At the Hudson's Bay Company's London sale, held in March, 1866, silver fox skins, in number 646, realized for the best skins £30 per skin, for inferior qualities, 32s. per skin, which gives an average of £7 9s. 3d. per skin; 646 skins at £7 9s. 3d. per skin = £4820 18s. 6d. I have not been able to find out the prices that silver fox skins realized at the other fur company's sales, which were held about the same time, but I shall be pretty near the truth if I assume that the amounts were equal to those of the Hudson's Bay Company's. The Messrs. Lampson generally offer for sale quite as many silver fox skins as the Hudson's Bay Company, and often a larger number, and Messrs. Culverwell and Co. would in all likelihood tread very closely upon the heels of the others.

I may mention incidentally, that the Hudson's Bay Company sell their stock of furs by auction in the month of March. These sales are always attended by fur dealers from foreign markets, who purchase such furs as best suit them, and consign them to Leipsig, at which city these furs are again disposed of during the great fair, and thence are distributed to all parts of the world. The other fur companies hold their sales immediately after the Hudson's Bay Company.

Granting I am right in these assumptions, I may safely say that over £14,000 is returned each year at the March fur sales for skins of the silver fox. But it must not be forgotten that this sum only represents the wholesale price; if we take into consideration that these skins are subsequently dressed and made into garments of different kinds by the furriers, and in that condition are retailed at an enormously increased tariff, we shall find that the skins of the silver fox really constitute a most important branch of commerce.

Most of the fox skins purchased at the annual sales are for the supply of the Russian market. Silver fox skins of the finest quality, when dressed, and made into cloaks or other descriptions of wearing apparel for the Russian grandees, sell for sums of money which seem to us almost incredible. A pelisse which belonged to the late Emperor of Russia, was made entirely from the black necks of silver foxes; it may be remembered that this costly garment was displayed at the Exhibition of 1851; its actual money value was three thousand five hundred pounds sterling. Russian taste generally inclines towards dark coloured furs, hence furs which are nearly or quite black, and at the same time of a lustrous, soft, and silky texture, always command the highest prices for the supply of that particular market.

Beautiful silver fox skins are brought from the cold arid districts of North and North West America, nevertheless they will not bear comparison with those obtained from some parts of Russia. There is a popular saying, that these black fox skins of Russian production are worth their weight in gold, an assertion by the way not so far from a truism, when we read that first-rate skins have fetched four hundred roubles each.

As regards the commercial value of its fur, the cross fox (*Vulpes decussatus*) comes next for our consideration. The name cross fox has been bestowed upon this animal because it is distinguished by having a dark coloured cross on its shoulders. This curious mark is formed by two stripes, one of which extends along the back; in some skins it is quite black, whilst in others it shades off through every gradation of tint, from brown to dingy yellow; the other stripe of a similar tint crosses the back stripe at the shoulders. Skins of the cross fox, when they are very conspicuously marked with either a black or a particularly dark coloured cross, are employed by some religious communities to adorn the vestments of their priests, and extravagantly high prices are frequently paid for skins so coloured, although the market value of cross fox skins is immensely below that of silver. About 3500 cross fox skins are annually disposed of at auction by the London fur companies. I may safely take as a general standard of value for cross fox skins,—a standard quite accurate enough for all practical purposes,—the price paid for these skins at the March sale of 1866, on which occasion the Hudson's Bay Company disposed of 2064 cross foxes at an average rate of £1 14s. 8d. per skin, the highest price being £4, the lowest 14s.; 2064 skins at £1 14s. 8d. per skin = £3577 12s.

The red fox (*Vulpes fulvus*) comes third upon our list of foxes. About thirty-six thousand skins of the red fox are sold each year at the London fur sales, and I shall take the prices red fox skins made, at the March sale of the Hudson's Bay Company for the year 1866, as a fair standard of their average value. The number of red fox skins sold was 13,746, the highest price per skin was 18s. 9d., and 4s. 9d. the lowest; this gives an average for each skin of 10s. 0½d. 13,746 at 10s. 0½d. per skin = £6901 12s.; but we must bear in mind this only represents the sale of one company's furs. To the above number of red fox skins, viz., 13,746, must be added 22,205, as quoted on Messrs. Lampson's catalogue, and 1265 for those of Messrs. Culverwell, Brooks, and Co.—in all 37,214 skins.

Turks are the great consumers of red fox fur, because it is generally employed to line the long cloaks which are so universally worn in Turkey. A very large number of red fox skins are likewise sent to Russia, as well as to the colder parts of Europe, where they are employed for making rugs for carriages and sledges, and as linings for winter garments.

In the trade these three foxes—viz., the silver, cross, and red foxes—are held to be distinct species, but there can be very little, if any, doubt that they are simply varieties of one common type. If a specimen of the black or silver fox is placed beside a red fox, the difference of colour is so marked that one is disposed to say at once that the two animals must be specifically distinct from each other; but when I go to the fur stores and arrange a hundred or more skins side by side, I find every gradation of colour, placing the cross fox in the centre of the line, from the black at one end to the red at the other, and I defy the keenest and most experienced fur trader to say, in very many instances, to which of the three varieties of fox a skin actually belongs. The red fox, if we admit this opinion to be correct, may be said to have three distinct types of colouration—No. 1, very bright yellowish-red; No. 2, having a dark cross on the shoulders, the prevailing colour of the sides being a yellow-brown; No. 3, sometimes nearly black, at others grey and silvery. The Indians positively assert that it is by no means unusual to see these three varieties of colour exhibited in different cubs of the same litter; and that the black and red varieties constantly interbreed I know to be a fact. I state this from my own actual observation of the animals when I was trapping and hunting on the eastern and western sides of the Rocky Mountains.

Of shy and crafty habits, few fur-bearing animals are more difficult to trap than foxes. The red men in North and North-West America employ a fall-trap for the capture of foxes, a trap requiring the greatest care both to bait and to set it. Each foot-print must be brushed over in order to destroy every trace of scent, and this obliteration is accomplished by the trapper as he walks backwards from the trap, using for the purpose a large broom, made of cedar boughs.

The bait, which is usually a skinned ruffed grouse or a rabbit, must not be touched with the fingers. Great care, therefore, is needed during the process of stripping off the skin. The "dead-fall," so called, is a heavy tree adjusted to tumble upon the animal's back just behind the shoulders, so soon as it unsets the trap. The "red trappers" have an idea that if a fur-bearing animal be not instantly killed the fur looses all its gloss. The same sort of idea is entertained by the metropolitan "white savages," who brutally skin unfortunate cats whilst they are alive. The inhuman monsters' pitiful excuse is, "if the cat was killed prior to its being flayed the fur would possess no gloss," hence the skin would lose much of its value. For reasons similar to the above North American savages seldom set steel traps for the capture of foxes, martens, or indeed any of the fur-bearers, the value of whose fur in great measure depends upon its silky and lustrous surface. The skins are stripped off in a peculiar manner, a small incision only being made betwixt the hind legs; the skins are turned with the fur-side inwards during the act of flaying, and they are then dried in the sun, stretched upon a piece of board carefully shaped for the purpose.

To my mind, the prettiest and sharpest fox caught for the sake of its fur is the kitt-fox, or swift fox (*Vulpes velox*), which is a very much more appropriate name. The vast prairies, not unlike grassy oceans, over which the bisons roam in countless herds, east of the Rocky Mountains, are the favourite haunts of the kitt-fox. The little fellow can outrun the fleetest horse or dog, and even the long-legged and swift-footed greyhound-wolves fail to overtake it in a fair race across the rolling plain. As the trappers aptly say, "The kitt-fox goes like a ball from a rifle." As far as my own observations have been able to settle the question, I think I may safely say that the kitt-fox is entirely confined to the eastern side of the Rocky Mountains. There is not even any tradition, so far as I know, existing amongst the Red Indians concerning the existence of the kitt-fox west of the Rocky Mountain range; and, moreover, they do not even know the animal by name. I sought information from the Hudson's Bay Company's traders and the white trappers I from time to time met with, relative to their knowledge of the kitt-fox being known anywhere in our possessions westward of the Rocky Mountains; but in no case could I discover that the animal had either been seen or trapped. The number of kitt-fox skins sold in London annually, when compared with either red or grey fox skins, seems to be a very diminutive quantity, nevertheless, 8657 skins of the kitt-fox is about the yearly supply sent to our markets.

This quaint little fox differs entirely from all the other fur-bearing foxes. Firstly, we are amazed at its diminutive size when contrasted with its brethren. The extreme length of the kitt fox, measured from the tip of the nose to the root of the tail, does not exceed twenty-four inches; the tail is likewise remarkably short for a fox, being only from nine to ten inches from its junction with the body to the very extremity of its brush-like termination. The limbs are short, but strongly formed, which gives to the animal an appearance of being disproportionately long for its height. The toes are each armed with a claw, very much curved and always sharp, and during the winter months the soles of the feet are clothed with a perfect mat of hair—a good coating of hair invariably covers the lower part of the feet during the summer, but it is not nearly so thick and so dense as it is in the winter.

We can easily see the utility of this hairy kind of shoe or mocassin—it affords perfect protection to the fleshy "pads" whilst the animal is going at full speed over angular stones and rocks, or over that still sharper material, the "crust" upon the frozen snow.

The fur of the kitt-fox is close, soft, velvety, and very like dressed seal-fur to the touch. The head is remarkably short, and very broad between the ears, and the skull exhibits a very close analogy to that of the red fox, except that it is considerably smaller. Professor Baird thus describes the skull of the kitt-fox :—"The upper outline is almost precisely the same as the red foxes, but perhaps more convex about the meatus. The temporal crests in seven skulls before me do not approach each other so much as in the red fox; the shape (lyre-form) and distance of the ridges more like what is seen in the grey fox, although otherwise this is a very different animal. The post-orbital processes of the frontal bone are rather short, and are more obtuse than in the red fox. The temporal fossæ are considerably larger in proportion, and the distance between the zygomata wider. The sides of the skull at the temples are considerably more convex. The forehead is rather flatter. The orbital process is further back. The lower jaw is very similar in shape to that of the red fox, although its lower outline is more curved."*

The dental formulæ differs very little from that of the red fox. The tail looks as if some person had shorn it, so short, and dense is the covering of fur; it is as round as a ruler, and terminates in a blunt tip, as if the end of it had been chopped off with an axe.

If different religious sects prevail among the foxes, the kitt-fox should assuredly belong to the "Society of Friends," always supposing we were to guess its creed from the style of its dress. No showy colours bedeck this tiny dweller upon the prairies, but clad from head to foot, in a suit of the soberest grey, it is in nothing conspicuous; neither has it anything to be proud of, save it be the quiet neatness of its exterior. The colour of the entire upper surface, together with the fore and hind legs, is a grizzly kind of grey, but this is overcast with a faint shade of brownish yellow; if the very thick fur be drawn apart with the fingers, or puffed open by blowing into it, it will be seen that the lower portion of the hairs are pale lead colour, whereas the tips are yellowish brown; whilst the longer hairs, interspersed amongst the fur, are of one uniform shade of brown to near the tip, which is reddish yellow, the shade usually designated "carroty" will best express my meaning. The under fur is pale yellow, but in old animals it becomes nearly white; a faint tinge of reddish brown overspreads the cheeks and lips, and extends nearly to the crown of the head. The colour of the tail, viewed from above, is precisely the same as that of the back, its inferior surface, however, is nearly white. The whisker hairs are unusually long and quite black. The kitt-fox more closely resembles the corsac fox (*Canis corsac*) than it does any of the North American foxes, the structural resemblance betwixt the skulls is very striking, and it is very difficult to discover

* "North Am. Mam.," p. 135.

any characters sufficiently defined to justify our making a separation specifically between the kitt-fox common to North America and the "corsac-fox," a native of Tartary.

The food of this singular fox is of the most varied character; sometimes it devours prairie-mice, and the smaller kinds of spermophiles; when luck befriends its efforts, a grouse is nabbed, and then the hunter feasts royally; but when times become disagreeably hard, and the larder is badly stocked or altogether empty, then in these straits grasshoppers and field crickets (*Acheta nigra*) are greedily devoured, and even old leather, or the hide of an animal, hair and all, comes not amiss, in the absence of more toothsome viands. The kitt-fox is a thief by nature and profession; hence anything, or I may say everything stealable, is most unscrupulously appropriated. Should you in an unguarded moment tether your horse with a lasso or hide "lariat," and a kitt-fox discovers your imprudence, you will most certainly find only the remnants of the tether; the horse which you expected to find safely fastened has gone you know not where. The robber, having gnawed the tether line in two parts, feasts himself upon that portion attached to the picket, or tree stump, to which you so carefully tied it.

If a hunter quits his camp in the morning, heedlessly leaving his mocassins or saddle, or food of any sort, within the reach of quadruped thieves, the first to discover it is pretty sure to be a prowling kitt-fox. Far from being content to dine respectably off tough mocassin or indigestible saddle, the glutton must needs taste everything he can find, with a reckless disregard to future consequences. A trapper is safe to pay dearly for thus carelessly leaving his camp, and returns to find his saddle with pieces bitten from out different parts of it, his mocassins minus toes, his bridle-reins nibbled into sundry pieces, the leather "possible sack" torn open, and its contents bestrewing the grass, and, to pile up the agony still higher, a dainty piece of buffalo meat that the hunter has probably been mentally grilling and eating during the homeward route, is borne off by the rascally kitt-fox. It is of little or no use to hide anything eatable, the kitt-foxes are sure to find it; the only safe plan is to place whatever you are desirous to keep upon a stage lashed securely to upright poles, and the stage must be at least six feet above the ground. I have often known kitt-foxes steal the bait from out a badly set fall-trap; and, moreover, they travel so swiftly and traverse such long distances when searching for food, that it is never safe to leave any articles within their reach, though you may feel quite confident that there is not a kitt-fox anywhere in the neighbourhood.

The female usually has young in the month of April, at the bottom of a deep hole, which she either excavates for herself, or she appropriates the abandoned residence of a badger or a marmot. The locality mostly chosen for the nursery is a steep earth-bank, beetling over a stream. The hole is dug in an oblique direction into the ground often to a depth of six feet. The number of cubs brought forth at a litter ranges from four to six, although the red men informed me that it was no unusual occurrence to find as many as eight. By exercising extreme caution, the woolly little family may occasionally be watched gambolling like so many kittens at the mouth of the hole, the slightest noise, even a stick snapping beneath your tread, sends them helter-skelter into the gloomy confines of their subterranean abode.

The grey fox (*Vulpes* (*urocyon*) *Virginianus*), so far as I know, is never found in Canada, but is extremely plentiful in the Northern and Southern States; it has been also found in Texas and Oregon. Some idea of the abundance of this fox may be learned by referring to the Catalogue of the March fur sales of 1866; 17,212 skins of the grey fox were then disposed of. The extreme length of the grey fox, exclusive of the tail, is about twenty-six inches, the tail measures about fourteen inches. I have previously described the curious mane-like arrangement of stiff hairs which grows along the upper surface of the tail. The grey fox is very distinct from the red fox, but it would not prove of any interest to the general reader were I to point out in detail the osteological differences, which undeniably prove that the red and grey foxes are specifically different. It is rather difficult to define the colour of the grey fox's fur, black, white, red, and brown, are so jumbled together, that it is next to impossible to convey by words what the shade actually is. Dark grey decidedly predominates along the line of the back, but at the nape of the neck it shades off into cinnamon yellow, which colour likewise tints the head, legs, and under parts. The tail is grey like the back, its inferior surface being a rusty kind of yellow. The hairs growing upon the back are about two inches in length, and some of them are quite black, whilst others are ringed with white from base to tip; the mane hairs extending along the tail are about three and a quarter inches long, and are generally of one uniform shade of colour, although annulated hairs are frequently observable. The short under fur is mostly of a yellowish brown colour.

I do not know a more wary animal than the grey fox; ever on the watch and sly to a proverb, it is by no means an easy beast to trap. Its fur is principally consumed in the manufacture of sleigh rugs, and for lining overcoats, cloaks, and other descriptions of apparel usually worn by Continentalists during the winter months.

There yet remain two foxes that demand a passing notice, as being of some considerable importance to the furrier: the arctic fox (*Canis lagopus*), known commercially as the white fox, and the "blue" arctic fox.

It is very difficult to discover the actual number of white fox skins annually imported into this country from the arctic regions, but if we assume nine thousand as being somewhere about the average number, we shall not be very wide of the mark. I find, on referring to the catalogue of the collection of animal products in the South Kensington Museum, that the number of undressed fox skins imported in the year 1856 was as follows:—

From Hanse Towns	1,588
United States	44,126
British North America	35,598
Other parts	175
	81,487

From out of this heavy supply, 79,063 fox skins are re-exported to various cold countries. The chief demand for furs of this description is among the nations of Tartar and Slavonian extraction. I may instance the Russians, Poles, Chinese, Turks, and Persians. Then, again, we have another market amongst the people of Gothic origin, who occupy portions of the middle and western parts of Europe.

White fox skins are deservedly celebrated for their beauty, and the extreme fineness of their fur; neither have they the pungent, disagreeable odour that characterizes the skins of the other species of foxes. The price for white fox ranged, at the March sales of last year (1866), from 4s. the lowest price, up to 19s. 6d. the highest, which gives an average of 11s. 6d. per skin. As there were 7591 skins sold, the sum returned for white fox-skins would equal £4364 16s. 6d.

The arctic fox is principally found in the countries bordering the Frozen Ocean in both continents. It hardly needs any detailed description, because there are a great many specimens of this curious little animal in the Zoological Gardens in the Regent's Park, where five minutes' observation will do more to familiarize any person with its peculiarities than whole pages of description. As the cold and snows of winter approach, the coat of the arctic fox becomes exceedingly thick and ragged, and changes from blackish-brown, which is the summer colouration, to pure white. The winter jacket is therefore a most admirable protection; in the first place its thickness defies the extreme cold which prevails in high northern latitudes, and, secondly, its whiteness helps to conceal the animal when traversing the snow.

In nearly every book on arctic travel the white fox is referred to, and its habits described. Pennant tells us "that in Spitzbergen and Greenland, where the ground is entirely frozen, they live in the clefts of rocks, two or three inhabiting the same hole. They swim well, and often cross from island to island in search of prey." The Greenlanders trap them either in pitfalls dug in the snow and baited with fish, or in an ingenious kind of spring trap constructed of "whalebone."

Sir John Richardson informs us that the arctic fox appears to be wanting in that extreme cunning for which reynard in general is so celebrated; "they will stand by whilst the trap is being prepared for them, and walk straight into it as soon as the hunter has left it."

It is an open question whether or not the "blue fox" is a species distinct from the white, or only a different condition of age; and as I am not prepared with any facts likely to settle the matter one way or the other, I shall not attempt to enter upon any discussion concerning it. There were only about ninety-two skins offered at the March sales, for the year 1866.

THE STRUCTURE OF THE ANNELIDS, WITH A CRITICISM ON QUATREFAGES.

By Edouard Claparede.

(*Continued from page* 273.)

Respiratory Apparatus.—"M. Quatrefages has actually made science retrograde in respect to the structure of the organs of respiration of Annelids. This is the weakest part of his book, alike in the introduction and in the generalizations concerning each family. The branchiæ have, according to the opinion of the honourable academician, a special structure, which permits them always to be distinguished. "These organs," he says, "are characterized by a single canal, to and from which the afferent and efferent vessels run. This canal, of which the walls are sometimes visible, and at others indistinct, is surrounded by a diahhanous substance, which appears to result from a thickening of the dermis. In this substance ampulla-shaped lacunæ are hollowed out, more or less developed, and always destitute of proper walls. The whole is surrounded by an epidermis extremely fine, and not presenting any appreciable structure. . . . . . At the close of a variable time the branchiæ contract, although no muscular fibres can be distinguished. The ampullæ empty themselves, and sometimes completely disappear. The blood runs by the central canal of the branchiæ, and arriving at the base of that organ, passes into the efferent vessel. In this return movement it necessarily meets with the venous blood, and must mix with a certain quantity of blood which has not been subjected to the action of air." Bearing in mind this radically false description, let us see how the normal circulation takes place in the branchiæ of an Annelid. There cannot ordinarily be any mixture of arterial and venous blood. In fact, the artery goes to the extremity of the branchia, where it turns upon itself to return as a vein. Vein and artery are exactly parallel to each other. Throughout the whole length of the branchia these two vessels are placed in communication by a double series of vascular loops, which pass into the subcuticular layer, and which offers the greatest facility for the action of water charged with oxygen, through the very thin cuticle. As for the contractility of the pretended ampullæ, there is nothing of the sort. Certain genera, like the Terebellians and Telethusians, for example, exhibit many rythmical contractions all through the branchia, but not of the vessels themselves. Moreover, this fact is exceptional. In the family of the Serpulæ only do the branchiæ exhibit even a remote resemblance to the description of M. de Quatrefages. In fact, in these Annelids the artery is continued directly into the vein at the base of the branchiæ, and from this point of reunion a single vessel proceeds, which penetrates the branchiæ, and sends a cæcum into each branchial branch. But M. Quatrefages describes in the secondary branches of the branchiæ of the Serpulians an apparatus of ampullæ, of which no trace exists. The blind-vessel exhibits no ramification, it is simply cylindrical and contractile, as described by Grübe and Kölliker. In their branchiæ, the blood exhibits an alternating movement, which is exceptional. In all the other families the branchial circulation is continuous in one direction. Blind vessels with alternating circulation, are found in the tentacles of Spiodians, Amphictenians, and Pherusians; in one part of the so-called branchial threads of Cirratulians, but these organs are not respiratory (unless, perhaps, lymphatic). [M. Claparède then remarks on the way in which M. Quatrefages was misled, and observes that the point was cleared up thirty years ago by Grube.]

"*Reproductive Apparatus.*—The reproductive apparatus of Annelids remains very imperfectly known. It is true numerous works have thrown fresh light upon the educatory organs known, since Dr. Williams described them, under the name of segmentary organs; but our knowledge of the sexual glands has made little progress for the last thirty or forty years. This memoir will, I hope, make these organs, in a great number of species, sufficiently known."

M. Claparède then remarks on the very inexact description of M. Quatrefages, and continues:

"The distribution and conformation of the sexual glands of Annelids is subject to numerous variations, which will be illustrated by numerous examples in this memoir. The following may, however, be regarded as the most widely diffused. The sexual glands form more or less complex clusters or interlacements of cords, of which the axes are occupied by sanguiferous branches, often contractile. The sexual elements, when growing, form ruffs round the vascular axes, and develop at the expense of a layer of nuclei close to the vessel. With certain vesselless Annelids this form of sexual gland is preserved, but the axis is occupied by a solid cord, instead of a vessel. Among the females, the ovules are often in close juxtaposition in the ovary; sometimes, however (*Owenia*, Della Chiaje, and certain Polynoe), each one is inclosed in a special ovisac. In either case the eggs, on arriving at maturity, detach themselves from the ovary, either directly or indirectly, through rupture of the ovisac. The zoosperms detach themselves from the testicle to float freely in the perivisceral cavity. Doubtless this fundamental form is sometimes subjected to important modifications, to constitute, for example, the peculiar sexual tissue of the Nereidians, or the floating testicles of the Dasybranchians, which will be specially described. The egg-formation of the Terebellians and Serpulians is still more divergent, but we always find a cellular tissue, fixed, or composed of floating materials, in the midst of which the sexual elements are developed. . . .

"The sexual glands have long been recognized in many Annelids, but these old observations have been partly forgotten. Thus, while Pallas erroneously supposed the eggs of the Aproditians to originate in the liquid of the perivisceral cavity, Gott, R. Treviranus and Della Chiaje recognized the true ovaries at the base of the feet of these worms. . . . Even the existence of a sanguiferous vessel in the axis of the sexual glands was not unknown."

M. Claparède points out the errors of various authors, and adds:—

"It is indubitable that Annelids exist which are destitute of segmentary organs, or in which they are reduced to simple openings in the back of the body.

"*Nervous System.*—It is, without doubt, to M. Quatrefages and M. Leydig that we owe the best researches into the nervous system of Annelids. The first chiefly directing his attention to the external form of this system, and the second to its histology. . . . M. Quatrefages has been so fortunate as to find a stomato-gastric system of nerves, similar to that of the Hirudinea. I have not been able to recognize it, but I am sure that a negative result is not of great importance in these difficult investigations. I am, however, astonished that the combined efforts of other observers have been equally unsuccessful. . . . The structure of the nervous system varies astonishingly in the series of Annelids; the distribution of nerve-cells particularly being subject to a host of variations, which will be explained hereafter. In the ventral chain the cells belong chiefly to the surface and the sides, as Leydig has already noticed. The existence of large tubular fibres on the dorsal surface of the nervous chain, so general among the Oligochæta, is confined among the Polychæta to a small number of families (Capitellians, Aricians, Spiodians, Syllidians, Eunicians), and even appear in some representatives only of these families.

The nerve terminations amongst the Annelids have only been studied hitherto by myself, and by MM. Keferstein and Kölliker. All these terminations appear related to the functions of touch. The nervous expansions of the organs of sight and hearing are little known, even in Alciope, notwithstanding the researches of Leydig. In reference to this subject, I may recal an opinion of Joh. Müller, which has fallen into oblivion. We owe to this great physiologist an excellent figure of the central nervous system, and of the eyes of the Nereids—a figure to which his successors have not added anything important. He does not consider the organ called a crystalline lens as a dioptric medium. He denies its transparency, and regards it only as a terminal enlargement of the optic nerve. Although the transparency of the crystalline body is in many cases incontestible, the opinion of Müller on the functional value of this organ should not be rejected. The eyes of Nereids and of most other Annelids appear destitute of all apparatus for accommodation. Admitting that the percipient elements are lodged between the granules of pigment, it could be only objects at a determinate distance that could project their images upon this choroid pigment, and the sight of the creature must be very limited. This difficulty disappears if we seek in the crystalline body at once a refractory medium and a percipient organ, as we are almost obliged to do in the crystalline cones of the Archropoda. . . .

Restoration of Mutilated Parts.—The observations of Bonnet on the restoration of mutilated parts among the earth-worms, confirmed by Lyonnet, Réaumur, Dugés, etc., were timidly questioned by Vandelius, and by Bosc, and more recently and positively by Williams, Vogt, and others. We must, therefore, be thankful to those who called attention to early observations, like Baird, or made fresh experiments, like Quatrefages.

The restoration of mutilated parts of Annelids is incontestible. Many of them can reproduce even the anterior region with the head. Amongst recent authors, M. de Quatrefages has demonstrated this fact over again in Eunice, and Dalyell followed step by step the reproduction of the head and branchiæ by the posterior extremity of a Sabella. I have also met several times with marine worms (Eteone, Nepthys, etc.) which have undoubtedly reproduced their anterior region, the restored portions being distinguished by lighter colour and smaller diameter. The aspect of these worms resembles that of the Heteronereids; so great is the difference in the two regions, one would think they were two portions of different worms stuck together. One interesting remark occurs with reference to this subject: If a worm is severed transversely, does the posterior part always reproduce exactly the number of segments in the suppressed anterior portion? It is probable. At least I met with an Eteone which reproduced an anterior portion of nearly fifty segments. The head is undoubtedly the first to be formed, and then fresh segments are successively produced at the junction of the old part and the new. This, however, requires to be supported by positive observations.

Geographical Distribution of Annelids.—In this section M. Claparède disputes the accuracy of M. Quatrefages in limiting the locality of species. M. Quatrefages does not admit, for example, that the Mediterranean and the ocean can be inhabited by the same species, and sometimes makes specific distinctions out of the fact of locality only. He also maintains that littoral species cannot live under such changes as the presence or absence of tides. At Naples, however, M. Claparède kept littoral Annelids for months in captivity, and found the best mode of making them prosper was to deprive them of water for some hours each day, in order that the vessel might be oxygenated.

Classification.—On this subject M. Claparède remarks that we are approaching a natural classification, and that the families now established are for the most part well founded. He does not propose any new families.

LUNAR DETAILS.—DOUBLE STARS.—CLUSTER AND NEBULÆ.—TRANSITS OF SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

Much of the story of *Copernicus* remained untold when we broke off last month, and what we have already heard may well give us an interest in the remainder. It will be matter of familiar observation how striking is its aspect under very varied angles of illumination—how the magnificence of its broad and massive wall, and the extraordinary roughness of its *glacis*, as it rises upon the terminator, give place to a relief in higher sunlight which exhibits the serpentine terraces, the central elevations, and the whole arrangement of the structure in a more intelligible manner; and how this aspect is again gradually replaced under increased illumination by one of more delicate but still very expressive relief, and of considerable permanency; I have seen a little true shadow cast from the great peak in the W. wall, and from a steep terrace on that side, as late as 3d. 1½h. before Full Moon. The beauty of these very dissimilar, yet intimately related aspects must be seen, and studied, to be fully appreciated. Mention ought to be made of a very striking engraving proceeding from the Collegio Romano,* as exhibiting the latter of these positions on a large scale, and with much cleverness of effect as well as fullness of detail, but, we are obliged to add, some degree of inattention also. We shall, however, proceed at present with an abstract of the remarks of B. and M. on its immediate vicinity. It is enclosed by a great mass of closely crowded mountain chains, arranged in lines partly radiating, partly parallel to the ring, especially on E. Here many of them are of very slight elevation (250 to 650 ft.), but on the opposite side they reach nearly 3000 ft. "Craters are first found at some distance, and but few in the mountains themselves, though those very obvious;" a great contrast, by the way, to the aspect of many other large cavities and their rings, as though the eruptive action had here more completely exhausted itself at one wide and unimpeded aperture. One is a small twin-crater (*Copernicus* A) on the S. slope, already seen by Schr., the larger orifice lying N., so deep that it holds its shadow longer than the great crater itself; its ring, of 6° light, is much more distinct from its interior of 3° than is usual in such little cavities; the small crater B, equidistant from the grand ring S.E., appears of similar depth. Towards the foot of the N.E. glacis, a larger opening, *Gay Lussac*, has broken through; this with its smaller

* Memoirs Roy. Astron. Society, XXXII. pl. viii.

companion, 4800 ft. deep according to Schr., was discovered by him, as well as a curious cleft running E.S.E. from it for some distance, which he compared to the great valley in the *Alps*, from the way in which its sloping sides are studded with small irregular hills, as though an upheaved and hollow ridge had fallen in, leaving the firmer portions hanging on its declivities. In the Roman drawing, the end next the crater is feathered out into oblique lateral fissures.

But the more remarkable features here are the great light-streaks which diverge from it in every direction. They form a less regular system of radiation than is to be found issuing from other centres, but still their relation to *Copernicus* as a departure point cannot be mistaken. Several of them connect this great crater with others in the neighbourhood which repeat the phænomenon, though on a smaller scale; in fact, but few large rings between the equator and 30° N. Lat. are wholly without them, and some exhibit them even beyond that limit. Near *Copernicus* they are merged in a bright but confused "nimbus," or glory, interrupted here and there by streaks and insulated patches of darkness, of which one is even found close to the wall. Further out they expand, and direct themselves partly in divergent, partly in parallel lines, to the neighbouring craters. Those pointing S. towards *Reinhold* (31) and *Gambart* (a crater between *Reinhold* and *Sömmering*—Int. Obs., xii. 218) are more feeble and ill-defined; they seem to indicate a fresh focus at *Reinhold*, but do not diverge from it again: those directed towards *Schröter* are more considerable, but do not reach the hill country; and here the aspect of the surface is rather that of dark streaks traversing brightness than the reverse. One such large dark streak passes from *Copernicus* A to *Stadius*, the S. quarter of which it includes, and then is lost. The darkest of these begin at a grey mountain marked ζ, and extend S.W. for 40 miles: the inquiry of B. and M. whether one or other of the unascertained spots of Riccioli is to be recognized here, must appear singular after a slight comparison of the old maps, which leave no doubt of identification as to his *Rhæticus*, though some regret at its not having been more accurately delineated in their great map. Towards *Eratosthenes* almost all the light is united in one mass, of which the brightness of the *Sinus Æstuum* may be considered a continuation. Further N. begin some very prominent streaks, few less than five miles broad, one leading to *Lambert* (35), 14 miles; some, which seem to start in the plain itself, are crossed obliquely by others coming from *Eratosthenes* the reverse way. Towards N. they are narrower and much interrupted; they are larger and more intense N.E. A great divided streak passes from *Mayer* (32)—a large crater N.E. of

Copernicus, with a smaller one on its W. edge—to *Euler* (36); others pass through the *Oceanus Procellarum* to meet the narrow and not easily distinguishable streaks of *Aristarchus* (43), and run into a great spot of light between both. Others, shorter and less distinct in appearance and direction, are found S. of *Mayer*. On the side of *Kepler* (41) they are more clear and decided: several, nearly parallel, run E. to that crater, and enter its "nimbus," thus uniting the two main streak-systems of the N. hemisphere. These details are so far worthy of record, as the suspicion of change in the reflective power of portions of the lunar surface, if not yet warranted, is not unreasonable. The streaks are of course best seen in Full Moon, very little of them being visible if the terminator has not passed *Mayer* in the increase, or reached *Eratosthenes* in the wane, and that little being masked by the opposite direction of the mountain ridges.

Copernicus and its nimbus can be clearly made out on the night-side before the First, not so readily after the Last Quarter.

We now come to a very singular region, more than once adverted to in our previous paper, and certainly in its own way one of the most remarkable in the Moon;—the *Crater-chains*, as we may term them, between *Copernicus* and *Eratosthenes*. Here we find the greatest and strangest contrast to the neighbouring *Sinus Æstuum*. There, craters are all but invisible, even after the strictest search: here they exist in such profusion that it is doubtful whether any really level surface intervenes. The sixty-one shown in the map, of which the greater part lie in a line between *Pytheas* (a moderate-sized crater two-thirds of the way from *Copernicus* to *Lambert*) and *Stadius*, are probably not the half that are perceptible, but past delineation. They are not scattered at random through the plain, but lie behind one another in rows, in some places closely compressed, in others wider apart at nearly equal distances, and but few seem entirely insulated. Though the majority are very minute, and only a few exceed 1″ in diameter, B. and M. cannot give them, like Gruithuisen, a width of only 500 (French) feet, but would estimate most of them at as many toises (3200 feet). The closely compressed rows, they observe, assume easily the aspect of a connected cleft; and, in fact, the two forms are nearly interchangeable; we only need imagine the absence of a common and usually very low partition, to convert the one into the other. At the N. end of the landscape, for the length of a lunar degree, there is such a cleft, with a distinct embankment on either side, and four of the smallest craters in its depth, with which the next three craters S. of it often seem to form a whole. At a distance of

20° at furthest from the terminator this crater-swarm becomes invisible, and the surface is then almost exactly similar in aspect to the *Sinus Æstuum* itself.

The discovery of this very singular region is due to Gruithuisen, 1815. He has well described its aspect, and speaks of the rows of craters as forming in places hollow ways, or being connected by a large longitudinal furrow, while the separate craters had outlets E. and W., which, however, are not visible if the illumination is precisely in that direction. And then he goes on, in his own way, to refer to the especial fertility indicated by the darkness of the soil; and considers them, if not volcanos, the artificial dwellings of living beings; in another place indicating his own choice between the alternatives by asserting that there is not a trace of a volcano, ancient or modern, upon the Moon! all its cavities having been formed by the impact of masses falling from space—of which portions still protrude as central hills! They are mentioned again by Kunowsky, 1821, who says that he often distinctly recognized, in clefts, rows of crater-like eruptions. Lohrmann's Sections and letterpress unfortunately do not include this region: his General Map indicates broad, low ridges, pierced with a moderate number of craters; but, though the first impression is not that of similarity to the Map of B. & M., a closer inspection shows that the objects represented must have been nearly the same. A corresponding view with that of Kunowsky is taken by Schmidt, who remarks that "everywhere a keen and unprejudiced course of observation will indicate that rills (clefts) are only crater-rows in a particular modification, as the innumerable transition-forms prove, and as Mädler first (?) pointed out." Little craters, he tells us, often lie in long lines, as if they had broken out of a crack, and he enumerates about 300 visible in the region now under discussion, many of which are contiguous, and frequently so confluent as to form ravines like regular clefts: their external height being, he thinks, very insignificant—somewhere between 150 and 600 feet.

Why these crater-chains were unnoticed by Schr. is a question which, though it seems to have been never asked, is deserving of an attempt at a reply. It so happens, indeed, that *Eratosthenes* and *Copernicus* were examined by him at different times, and represented in separate views; and that these miniature volcanos soon disappear after sunrise; and it may be admitted that he overlooked many small objects in various places. But, on the other hand, it must be borne in mind that his attention was evidently frequently directed to *Copernicus*; that the object, though fugitive, is in a very remarkable and conspicuous place, and is by no means collectively minute, and that it would be distinctly visible in instruments having not more than a tenth or twentieth part of the power of those employed by him. If, therefore, we were to infer that this manifold outburst had taken place some time at the beginning of the present century, our argument would not want plausibility. It can, however, be only advanced with hesitation, especially in the face of such an authority as Schmidt, who asserted (previous to the much controverted discovery as to *Linné*) that no single region of the Moon had been sufficiently investigated, even with only a 5-ft. refractor, to admit of a satisfactory solution of the inquiry, whether eruptive action is still in progress. This, he then thought—a few years may probably show how far correctly—would require a special delineation and measurement of small areas little affected by libration, carried on for years with the most powerful instruments, and, if possible, under a sky such as the North of Europe does not afford.

It may, at any rate, be admitted that Selenography is not as yet sufficiently advanced to admit of our rejecting as wholly unserviceable any observations made with ordinary care and knowledge of the subject; and selection can only be practised among an accumulation of materials such as we do not hitherto possess. It is on this ground that I venture to bring forward a few extracts from my own note-books, which may be of some use for the purpose of comparison, or as awakening the curiosity or directing the attention of those who may be commencing lunar inquiries. We shall include the *Mare Vaporum* and *Eratosthenes* with our present position, in a very desultory and incomplete study of some of the aspects of this region.

"1831. April 20. Near *Eratosthenes*. The level plains and singular dusky tracts S. and S.W. of this crater, when carefully viewed, exhibited a peculiar stripy appearance, extremely like that of a cloudy sky; and the effect was quite that of local colour, not unequal surface, since the streaks made only an angle of 10° or 15° with the line of the cusps." The instrument employed was an ill-corrected fluid achromatic, on Barlow's principle, with an aperture of three inches, and power about 100.

1855, Oct. 18. The terminator passing through the *Sinus Æstuum*, this curious effect was again observed with a good $3\frac{7}{10}$-inch object-glass, as though a brushfull of dark but not evenly-mixed grey colour had been swept over the surface towards E. by S.—The following night, when $\frac{1}{4}$ of the ring of *Copernicus* was enlightened beyond the terminator, it was very evident and more extensive—"a vaporous or smoky appearance, drawn in stripes or thin parallel bands over most of the surface included between *Manilius* and *Copernicus*; its N. limit being bounded by a line joining the centres of *Manilius* and *Eratosthenes*, its S. extending as far as *Schröter* (of B. and M.). The direction is about E. by S., and the streaks are parallel, and show no tendency to converge to *Copernicus*."—Oct. 20. The dark streakiness was "more intermixed with light stripes, which seem to be the streaks of *Copernicus;* in fact, the appearance, judging from to-night, may be due to the gradually-increasing visibility of those streaks coming up into sight with the higher illumination, through a smoky, brownish-grey surface. As observed last night, these streaks in the S. part of the surface in question do not point to the centre of *Copernicus*." Oct. 22, 4d. 2h. after First Quarter. "Dark streakiness seems now, in a very changed aspect, with great preponderance of light, to show an admixture in its S. portion of the streams of *Kepler* with those of *Copernicus;* the former seeming to pass by the S. side of the ring of *Copernicus*, and, of course, to be subsequently parallel to its streams. There is an evident crossing and interference of the two systems, as if they had not been contemporaneous, but the one had burst through the other." 1855, Dec. 29, 2d. 4h. before Last Quarter. *Mare Vaporum:* "the streakiness not remarkable, as in the increasing Moon."

1855, Oct. 19 (as before). Dark tracts near *Sinus Æstuum*. The equatorial region is "strikingly marked by three undefined spots of a brownish-grey of considerable extent, having a smoky aspect. The first is the slope of the *Apennines* S. of *Huygens*, especially where it borders the *Sinus Æstuum* by a gentle and slightly-elevated circular sweep; the second is apparently a rough surface of no great height, extending from Γ (B. and M.) N. of *Schröter* to the E. side of that crater; the third is a mass of low hillocks beneath the S.W. foot of *Copernicus*. Besides these, and divided from the second by a lighter surface, is a small dark tract, consisting, I believe, of two portions, and so represented by B. and M., N. of Γ (above)." These spots are all fairly traceable in the great map. 1867, Nov. 7. $9\frac{1}{3}$-inch silvered reflector; terminator a little beyond *Gassendi* (64). The three dark spots of 1855, Oct. 19, very fairly made out, though illumination very much more advanced: the third seems to be the *Rhœticus* of Riccioli, very distinct and dark; but if the dark spot divided by a light streak S.W. of *Copernicus* in B. and M. is meant for this, as it appears, it is not well laid down; too small, and too far N. The "small dark tract of two portions" appears of a more complex form: the W., which is a pretty regular ellipse in B. and M. is now divided in half by a narrow brighter streak pointing S.W.—the E. is deeply indented from N.E. in the same direction by a broader and more obvious stream.

A continuation of these rough sketches must be deferred to another occasion.

DOUBLE STARS.

Before the constellation *Lyra* sinks too far towards the setting sun, we may point out some objects in it deserving of a search. The search itself, in a transparent sky, will sufficiently repay our trouble, for truly beautiful are the fields which, even with a small aperture, pass under review in sweeping over this district. We have long ago (INT. OBS. ii., 299, *et seqq.*) specified the principal double stars; we shall now add—

162. (Σ 2372). If we draw a line from γ through β, bend it slightly—about 25°—to the N, and carry it on fully 2°, it will strike upon this fine open pair. Σ makes them 6·7 and 8·2; white and bluish—I thought the latter pale purple. His other data are, 25″·147, 84°·23 (1829). Dawes's recent measures, 24″·75, 83°·57, very obligingly communicated to me, prove that the vicinity is merely optical. His acute vision detects a most minute point (12 mag. of Σ's scale) at a short distance.

A line carried the reverse way from β through γ, and similarly bent a little N, if carried a shorter distance than that between those stars, will fall upon—

163. 17 *Lyræ* (Σ 2461). 3″·6. 329°·9. 6 and 11. Light yellow and cerulean blue. This is called by Smyth very beautiful and delicate; and will be found a trying object for a small aperture. The companion is a minute point even with 5½ inches.

If we make the line joining *Wega* and γ one side of an equilateral triangle, the opposite angle will fall near two 5 mag. stars, η, *n*, and θ, *s*. Something more than 1° *p* the latter, a little *s*, is a 6 mag. star, 19 *Lyræ*; closely *p* which, a little *n*, lies a little quadruple group, of which the leading star is—

164. P. XIX. 13 *Lyræ* (Σ 2472, 2473.) 18″·5, 74″·8; the two nearest 5″. 337°, 350°; the same two 294°. 8, 11, 9½, 12. Bright yellow, pale grey, greenish, and dusky. The object is a singular and beautiful one, but its chief interest is the probability of variation in one of the two closer stars, which Sm. has recorded as very unequal, 1835·73, but which have been noticed by several modern observers as much less so, if at all. I remarked no difference, 1865·72. There is also a very minute star between the pairs not mentioned by him, though quite within reach of his instrument. The *lucida* seemed white to me.

If we make the line from β to γ the hypotenuse of a right-angled triangle, of which another side is directed from γ towards *Wega*, the right angle will fall nearly on a little star, just visible with the naked eye. This will be our—

165. *Lyræ* 91 Bode. The telescope shows it as a wide but very beautiful pair, measured by Dawes at 45″·47. 350°·45, and Knott with almost an identical result. Argelander has given the magnitudes 7, 8·7, but has entered them collectively as 6 in his "Uranometria Nova."* I perceived, with 5½ inches, two minute attendants, of which one is very small, perhaps Sm.'s 15 mag. The tints are in charming contrast; with 9⅓ inches of silvered glass I thought them straw-colour and purple.

A similar object is to be found thus. If, instead of taking *β Cygni*, as usual, for the foot of the cross formed by the leading stars in that constellation, we make all the four arms equal, we shall be guided to a star to which the map of S.D.U.K. gives but 6 mag., but Argelander, 4.5. This is *η*. About 2° *of arc* (more, of course, of R.A.) *p* this, or more than 1° *n* of *χ*, a beautiful pair, our No. 59 (Int. Obs., ii. 304), we come upon—

166. P. xix. 278 *Cygni*, 39″.28°·8. 6 and 8 (Argelander, however, has not included it among naked-eye stars). Straw-colour and smalt-blue. H, with his usual predilection for ruddy hues, called it garnet and red. This and the last object are of the class of which *β Cygni* may be considered the type; either of them, however, appears to me, though far less brilliant, to surpass that celebrated pair in beauty of contrast, in consequence of the absence of any green tinge in the smaller star.

While referring to *β Cygni*, we may add another double star to our list from its neighbourhood. If we look for the only (telescopically) considerable star lying *n f* from it, we shall find the following delicate and beautiful object—

167. P. xix. 169 *Cygni*. 5″·8. 5°·2. 9 and 11. White and pale blue.

More directly *n* of *β* is a coarser pair, in a pretty "sprinkle" of stars. We may also mention that about ½° *s*, a little *f* from *α Cygni*, is a fine open pair, 8 and 8½, white, followed by three stars of about the same magnitude, in a field finely dotted with minute points in the light of a 9⅓-inch silvered mirror.

Observers who delight in star-colours will find it worth while to turn to λ *Lyræ*, 5.6 mag. (Argelander) closely *s f γ*. I have recorded it of a very fine yellow. A similar star (Y^2, that is, of the second degree of yellow in Smyth's notation)

* It is greatly to be regretted that the catalogue accompanying this accurate work which has received the high approval of so eminent an authority as Dawes, should be rendered extremely inconvenient in use by the want alike of an Index to the names of the constellations (under which it is arranged), and a corresponding heading to the pages.

will be found about 1° *p* γ *Cygni*, a little *n*. I noted it 7 mag. 1865, Sept. 22, but subsequently ascertained that, in the Larger Star Maps of the S.D.U.K., there is a 5 mag. star not far from its position, though rather more *n*. Argelander places a 6 mag. (166 Bode) much nearer my place. Is there room for a suspicion of variable light? There is also a 7 mag. star, solitary as regards rivals, though with a delicate 11 mag. attendant, pointed at by a line drawn from the 9½ mag. star in the group of ε *Lyræ*, through the southern of these two pairs, which shows a pale but evident carmine hue. It is registered as Bessel (Weisse) xviii. 1169.

An object of more signification than these is o^1 *Cygni*, the outlying member of the group o^2, described as No. 58 of our list (INT. OBS., ii. 304). The second and third stars of this fine combination were each described as *cærulea* by Struve, as far back as 1835; with the addition that all the colours were *insignes*, remarkable. He then expressly states that the blue stars maintained their tint whether the strong yellow *lucida* was in the field or not, so as to exclude the idea of contrast. In 1838 Smyth gave the same hues, and noted the same proof of independent colour. But in 1850 I entered the colours, with a 3 7/10-inch achromatic, deep yellow, white, and blue; and in 1865 I found, with 5½ inches, the 5½ mag. star, "white, or very pale yellow, with a sort of eye of blue, but certainly not at all like 7½" (the closer star) "which I found kept its colour when 4 was put out of the field. I had not at this time identified this as o^2 *Cygni*, and was quite ignorant of my former observation upon it." June 27, 1867, my 9⅓ inch "With" mirror showed them as strong orange, fine blue, and very pale yellow, or in Smyth's chromatic notation, $O^{2.5}$, B^3, Y^4, "the latter with a cast of blue, a strange but accurate description." The slight yellow tinge associated with reflection from these silver films would account for the deeper hue here ascribed to the great star; but not for the yellowish cast of the one in question, as fortunately it had been previously noticed with a very fine object-glass. It requires, however, to be noted by the way that those who possess these powerful instruments should look occasionally to the condition of the mirrors, especially the plane, or "flat," in such observations, as a slight degree of tarnish or cloudiness, such as may be expected to form from time to time, and may be readily and safely removed by gentle friction on a suitable rubber, would have a material influence on stellar hues. Were it not for the direct comparison with the unquestioned blue star at so short a distance, this might have been more lightly dismissed as a case of "chromatic personal equation;" but, under the circumstances, it seems to deserve more attention, as inferring the probability of actual change; and those who are interested in this curious subject will find this group well worthy of study. My own impression has the strong confirmation of Knott, who, in July, 1865, noted D (the star in question) "white, with pale dash of blue. D is certainly not so *blue* as C."

While speaking of coloured light, it may not be uninteresting to note the comparative absence of any decided hue in the larger stars of the Pleiades, as contrasted with many other parts of the sky, for instance, the galaxy region of *Sagitta*, where most of the leading stars show yellow, or ruddy light.

This opportunity should be taken for a careful study of the colours of the beautiful double star *α* Piscium (Int. Obs., iii., 55), as to which there is a remarkable discrepancy among astronomers. I have never been able to satisfy myself as to their real character.

The possession of the beautifully-figured 9⅓-inch "With" speculum, already alluded to, leads to the addition of the two following objects as tests for those who may be equally fortunate in optical means.

168. *δ Cygni* (Σ 2579), at the end of the *p* arm of the cross represented by the principal stars of that asterism. 1″·8. 25°·6. 3½ and 9. Pale yellow and sea-green. Such were Smyth's data for this celebrated but very difficult binary, 1842·56, which H saw 2″·5 apart, 1783·72, but single 1802, 1804, as did H. and South 1823, and South 1825. Σ, however, found it 1″·91, 1826·55; Smyth 1″·5, 1837·78; Dawes 1″·67, 1865·38; Knott 1″·7, 1866·68; while its orbital revolution has carried it through zero from the *nf* into the *np* quadrant, from H's 71°·39, 1783·72, by a regular gradation to Knott's 348°·31, 1866·68:—the "periastron" being considered to have occurred in 1860. This extremely difficult test I have seen so fairly with 450 in only a moderately favourable state of air, and at a comparatively low elevation, that it may be inferred to be easy under really advantageous circumstances; on the majority of nights it would, of course, be waste of time to look for it. The other object is

169. *μ Andromedæ*; the 4th mag. star next *np β*, in the line pointing upwards to the Great Nebula. This has a companion at 45″ and 115°, 16 mag., which is consequently as severe a test of light as the previous pair is of definition. It is so minute that Smyth saw it but once with his 5·9-inch object-glass, and when the larger star was hidden by a bar in the field.

This most delicate point I have caught up without much trouble, and that while, from a mistake as to the angle, I had so little expectation of seeing it where I found it, that I had been diligently gazing at a spot 90° distant. It was but just steadily visible, but showed itself in the full presence of its blazing companion, so that it may be fairly inferred that this telescope reaches 17, at any rate, of the 20 magnitudes grasped by the 18-inch front view of H.'s metallic mirror. It may be mentioned that this speculum, which, however fine, can at any time be equalled, if not surpassed, by its truly successful maker, shows a black division, with 450, between the components of γ^2 *Andromedæ*, and, with a low power, traces for a long distance both of the remarkable "canals," or rifts, in the Great Nebula in the same constellation (INT. OBS., iv. 347).

While in this neighbourhood, we may look with a low power about $\frac{3}{4}$° *f* μ, where we shall find a deep orange single star, and a pretty open pair *s* of it, all of about 7 magnitude.

CLUSTER AND NEBULÆ.

46.—4575 Gen. Cat. (H̥ viii. 56) is a charming group of stars of various sizes, to be found $\frac{1}{2}$° *n* of γ *Cygni*, a little *f*. H. saw it 5′ long, 3′ broad, and counted forty stars, two 7.8 mag., the rest 11 mag. In another observation he speaks of stragglers 10-16 mag.

47.—218 Gen. Cat. This curiously-placed and readily found nebula is in the field with β *Andromedæ*, a very strong yellow (Y^2) star; it lies at a short distance *np*, and is very easily seen in my reflector. H. calls it pretty bright, considerably large, gradually brighter in the middle.

A more singular object awaits us at no great distance, which we shall point out by the intersection of two straight lines, one drawn from γ *Andromedæ*, to γ (the central star) in *Cassiopea*, the other from β *Androm.*, to the glorious cluster in the Sword Hand of *Perseus:* near the point of their crossing are two 4 mag. stars, 2° apart; the further *n* of these is ϕ *Persei*, and 1° *n* of this is the nebula we are going to describe.

48.—385, 386 Gen. Cat. (M. 76). This is not a very conspicuous object with ordinary instruments, though it was "very bright" in H̥'s reflectors; but its most remarkable feature is its double character, consisting evidently of two closely-connected lobes, and resembling a good deal the "Dumb-bell" in miniature, at least as that object was commonly figured before it came under more careful review. It has been examined by Huggins, with the following truly curious result:—"Both parts of this double nebula give a gaseous spectrum" (as is the case with the Dumb-bell nebula).

"The brightest only of the three lines usually present was *certainly* seen. The second line is probably also present. I suspected a faint continuous spectrum at the preceding edge of No. 386" (the *f* nebula).

TRANSITS OF JUPITER'S SATELLITES.

Dec. 4th. II. shadow in transit, 6h. 2m. to 8h. 51m. II. egress, 6h. 15m.—7th. I. ingress, 7h. 54m.—9th. I. shadow egress, 6h.—11th. II. ingress, 6h. 4m., shadow ditto, 8h. 39m. —16th. I. shadow in transit, 5h. 37m. to 7h. 56m. I. egress, 6h. 42m. IV. will be in transit while the planet is visible.—21st. III. shadow egress, 7h. 45m.—23rd. I. ingress, 6h. 21m., shadow, 7h. 33m.—28th. III. egress, 7h. 16m.—29th. II. shadow egress, 6h. 1m.

OCCULTATIONS.

Dec. 8th. B.A.C. 830, 6 mag. 8h. 2m. to 8h. 10m.—9th. *f* Tauri, 4 mag. 3h. 18m. to 3h. 43m.—11th. 130 Tauri. 6 mag. 8h. 49m. to 9h. 24m.—13th. 5 Cancri, 6 mag. 11h, 29m. to 12h. 31m.—28th. B.A.C. 7097, 6 mag. 3h. 49m. to 4h. 49m.

TERMITES, OR WHITE ANTS, IN INDIA.

BY CAPT. R. C. BEAVAN, C.M.Z.S.

In a tropical climate like that of India, it is well known what numbers of destructive creatures, of all sorts and kinds, are rapidly generated in the warmth, and prove, more especially to the naturalist, a source of the greatest trouble and annoyance. Amongst the worst of these may perhaps be classed the Termites, or White Ants; and I propose to give a short account of what seems to be a beneficent provision of nature in the process by which at times they are nearly annihilated. Working in the dark as they do, and always hidden under cover, for they invariably form an exterior tunnel of mud under which to operate when they find it necessary to cross some hard substance that they cannot penetrate (such as iron, or the brick walls of one's house), it is not easy to imagine how they can possibly be got at or destroyed by their natural enemies; nor, indeed, could they, were it not for the fact that, at a certain stage of existence, the majority of them are obliged to leave their secure underground retreats, and to take to the winged state. It is generally of a dry, calm evening,* frequently after rain, that from various crevices in the walls or stone flooring of the verandah myriads of unwinged white ants are seen to issue, as if forming both the escort and advanced guard of the grand army which, provided with wings, are about to follow. The toads, *Bufo melanostictus*, and frogs (*Sp. incog. nobis*) are on the look out for the former, and immediately congregate near the spot. Again and again is the tongue darted out, at every sweep clearing off several; and there they will stay and continue to feed, until their bloated appearance proclaims that they are full to repletion; when, suddenly, out come the winged host, which, rising with fluttering wings into the air, are met by birds and bats innumerable, and few escape. On the occasion referred to, we noticed the following birds of some twelve different species making sad havoc amongst the winged white ants which were rising from our verandah. Usually rather wild, on this occasion they were perfectly fearless and tame; and the perpetual snap-snap of their beaks whilst hovering in mid-air, and the sudden disappearance of every white ant that rose beyond a certain height from the ground, was a curious sight to see. The birds observed on this occasion were:—1st, the black-headed oriole, *Oriolus melanocephalus;* 2nd, the common king crow, *Dicrurus macrocercus;* 3rd, the tree-pie, *Dendrocita rufa;* 4th, the magpie robin, *Copsicus santaris;* 5th, actually a small owl not usually diurnal in its habits, *Athene Brahma;* 6th, the common babbler (or "seven brothers" of the natives, because they generally associate in that number), the *Malacocircus terricolor* of naturalists; 7th, the scarlet-vented bulbul, *Pycnonotus pygæus;* 8th, the common grey-necked crow, or jackdaw of India, *Corvus splendens;* and we think we also observed the green bee-eater, *Merops viridis;* whilst higher up in the air might be seen the common pariah kite, *Milvus govinda*, and the Brahmin kite, *Haliastur Indus*, swooping down on those unfortunates which escaped the birds at lower elevations. In addition to these may be mentioned the common Indian swift, *Cypselus affinis*, and, in fact, all birds which feed on insects would, we imagine, readily do the same. As it gets dark, the ants increase in number, and the birds, already filled to repletion, gradually go off to their roosting-places, and it seems as if they (the ants) were going to escape after all. But just at this moment another more terrible enemy makes

* The following notes were made at Barrackpore, on the 8th November, 1864.

its appearance. The air is suddenly filled with bats of all sizes; backwards and forwards they shoot without any intermission, and so eager are they in pursuit of their prey that we have frequently caught them in a butterfly net by simply holding it out from the top of the house. As may be imagined, these foes grant but little quarter, until the whole winged cloud of white ants is totally annihilated. Scarcely one has escaped to found a new colony; and, as night closes over the scene, they seem to be aware that wings are after all of little use.

Another note regarding them. We have frequently, of an evening, observed what seemed to be water-beetles in our tank and others in the neighbourhood. They kept spinning round and round like a Catherine-wheel, disturbing the water within a radius of fourteen inches. Occasionally one was taken down by a fish, or the species of skipping-frog, so ably described by Dr. Adams in his "Naturalist in India," page 16, would suddenly rush out from the bank, seize one, and devour it. Determined to secure one of these beetles, one evening, for our English correspondents, and being, moreover, rather puzzled as to why we only saw them spinning round of an *evening*, we made a capture, and, to our no small disgust, discovered that they were only winged white ants which had fallen into the water. The reason they are only seen of an evening is of course explained by the fact that white ants only come out in the winged state during that time.

LITERARY NOTICES.

The Darwinian Theory of the Transmutation of Species, examined by a Graduate of the University of Cambridge. (Nisbet and Co).—Cambridge has not been successful with her "Graduate" who wrote this silly and impudent book. He has learnt nothing of the art of thinking, though he has made some progress in the trick of logic chopping, and in no part of his volume do we trace any symptom of his understanding the theory he undertakes to confute, and if, as we believe, he deserves to escape from the charge of wilful misrepresentation, his acquittal will be founded upon the evidence that he does not know enough of scientific facts and arguments to be competent to give an intelligible and accurate account of any important scientific work. His book begins with a statement purely and obviously erroneous, that "in Mr. Darwin's theory the idea of design in every form of organic life is steadfastly denied, and it is asserted that all existing plants and animals have been produced by slow changes, without any plan or intention, from some antecedent forms." This wrongheaded passage may perhaps be considered as tantamount to the assertion that there can be no plan or design in the creation of plants and animals subject to modification under fixed laws, for that is all that Darwinism implies. The "Graduate" is not original in this illogical notion, he has simply followed the practice of a class of persons who continue to find heresy in all science they do not understand, and who appeal—as the Graduate does—to what they term "common sense," as a convenient substitute for the accurate knowledge they have not the inclination or the capacity to acquire. Darwin's view on this subject is plain from the concluding remarks of his well-known work, in which, alluding to his theory, he says "there is a grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or one, and that while this planet has gone cycling on, according to the fixed law of gravity, from so simple a beginning, endless forms, most beautiful, and most wonderful, have been, and are being evolved." The theory of Darwin rests upon probabilities, which may be strengthened or overthrown, but whatever its ultimate fate in the belief of mankind, it does not touch the question of design or no design, in the manner supposed by the "Graduate," because no amount of action through secondary causation can render less probable the existence of a primary cause. On the contrary, if the operation of those forces, which are called secondary causes, can be shown to have led to harmonious and admirable results through long cycles of ages, the *quantity* of evidence in favour of plan and design is largely increased. An atheistic philosophy, no doubt, requires some physical theory of the production of organized beings, and it may, though not necessarily, adopt a scheme of development and hereditary succession with variation. If an animal sprang suddenly out of the earth, or were formed by a rapid concourse of atoms before our eyes, the spectacle, though contrary to experience, would not, in reality, be more wonderful than the methods of production we are accustomed to by the development of a minute germ, nor could its appearance be a greater proof of design.

A good deal of the "Graduate's" logic chopping is devoted to an attempt at showing that Mr. Darwin admits the existence of species as *permanent* entities, while he is arguing against them. Quoting a plain passage, in which Mr. Darwin speaks of the more permanent varieties leading to sub-species, and species, he exclaims, "Well, then, *permanency* is, by Mr. Darwin's own showing, the attribute of species," although the passage in question contains no word to that effect, and the whole tenor of Mr. Darwin's book is to show that what are called species are subject to change. This shallow, flippant mode of treating a grave subject would have justified our taking no notice whatever of the "Graduate's" book, but although thoughtful arguments against Darwinism would be valuable contributions to a very difficult discussion, and would be welcomed by thinkers on both sides, it is time to put a stop to mere impertinence on such important themes.

In page 57 the "Graduate" gives a conspicuous instance of his habitual, though we have no doubt unintentional misrepresentation. Speaking of a well-developed tail—an organ he might possess with advantage, if it were prehensile enough to grasp an argument, or an idea—he exclaims "How formed? By natural selection, of course, for the theory allows no other *formative* power." Had he looked at, and been capable of understanding, a sentence in the "Origin of Species," 8th edit., p. 91, he would not have made this blunder, and probably would not have written his book.

At the place cited, Darwin says:—"Several writers have misapprehended, or objected to the term natural selection. Some have even imagined that natural selection *induces* variability, *whereas it implies only the preservation* of such variations as occur and are beneficial to the being under its condition of life." In page 115 the "Graduate" exclaims with that amusing self-confidence which crass ignorance permits to grow in egotistical minds, "Let, then, Mr. Darwin say what he likes, when animals cannot anywhere be discovered before a certain point in the geological series, it will be believed that their non-appearance is owing to their non-existence, and it will also be believed that when we first find them in a certain geological formation, that they then first began to exist. This is the opinion of a crowd of other geologists, and is the deduction of common sense"! These things will no doubt be "believed" by those who have been erroneously led to suppose that geologists have been able to examine a complete series of strata, corresponding with the successive groups of organized beings which have existed upon the earth. Students, however, who have had any opportunity of acquiring scientific knowledge on this subject, will be aware that the geological record, as at present known, consists only of imperfect fragments of a gigantic work, of which the missing chapters appear to have been much longer than those which have been recovered, and they will, instead of falling into the errors of the "Graduate," perceive that his "common sense" differs little from common ignorance, puffed up by uncommon conceit.

We could adduce many similar instances of the way in which the "Graduate" has attempted to fulfil his self-appointed task, but these will suffice, and if it should be our fortune to meet him again in print, we hope we shall find him in possession of a subject more adapted to his powers. Great workers in science, like Mr. Darwin, whether right or wrong in any particular hypothesis, are entitled to respectful treatment, and it is the duty of the press to protect them against unmannerly assault.

THE CABINET OF THE EARTH UNLOCKED. By Edward Steane Jackson, M.A., F.G.S., Second Master in the Tattenhall Preparatory School. (Jackson, Walford, and Co.)—This is a remarkably elegant little book; the very thing to coax young readers into a knowledge of elementary geology. The illustrations are unusually good; the landscape vignettes especially possessing great merit. We recommend this work to those who wish to make a pretty and useful present at a small cost; but in another edition we should advise Mr. Jackson not to dip his young folks in that sea of troubled waters, the reconcilement of Genesis and geology, and not to call the coral polyp an *insect*.

PHOTOGRAPHS OF EMINENT MEDICAL MEN OF ALL COUNTRIES, with brief Analytical Notices of their Works. Edited by Wm. Tindal Robertson, M.D., M.R.C.P., Physician to the General Hospital, Nottingham. The photographic portraits from life by Ernest Edwards, B.A., Cantab. No. 6, Vol. II. (Churchill).—The present number of this interesting series contains portraits and notices of the late Dr. Hodgkin, Dr. Cobbold, and Mr. Holmes Coote. This work merits the support of the scientific world.

HANDBOOK OF THE HISTORY OF PHILOSOPHY. By Dr. Albert Schwegler. Translated and Annotated by James Hutchinson Stirling, LL.D., author of the "Secret of Hegel," etc. (Edmonston and Douglas.)—Schwegler's work has been very popular in Germany. Its plan is to give brief notices of the various schools of philosophy, from the early Greeks down to Hegel. Dr. Stirling is anxious to counteract the positive school—Comte, Mill, Buckle, etc. In this he is not very happy, but his book will be very useful to students, and would have been more so if it had been printed in larger type. It is a mistake to put abstruse matter into very small print. Dr. Stirling coincides with Schwegler in making the history of philosophy terminate with Hegel, in which many will not agree. The merit of the book consists in the general clearness of its descriptions of various methods of thought.

RELIQUIÆ AQUITANICÆ. Being Contributions to the Archæology and Palæontology of Périgord and the adjoining provinces of Southern France. By Edmund Lartet and Henry Christy. Edited by Thomas Rupert Jones, Professor of Geology, etc., Royal Military College, Sandhurst. Part IV. (Baillière.)—The fourth part of this splendid work contains very interesting matter, both in the text and in the elaborate illustrations. Two specimens of what are supposed, with probability, to have been stone mortars are figured. Objects of this kind are found of various sizes; some large enough to grind small quantities of grain, while others of less dimensions may have been used for triturating articles on a smaller scale. They seem to have been made by hollowing out a depression in water-worn stones or pebbles. They are mostly of granite, but three or four of quartzite have been discovered, and one or two of sandstone. They are from two to eight inches in breadth, and are not polished. Numerous illustrations are also given of prehistoric art, in the shape of carved and sculptured bone, chiefly reindeer horn. The attempts to execute floral patterns are very roughly carried out, but much greater success attended the endeavours of the old Aquitainians to depict animals, as, even when the outlines are clumsy and incorrect, there is often a striking appreciation of the true character of the object. Thus in Plate VII. and VII. two awkwardly delineated horses are remarkable for a rude power of expressing motion, and the same may be observed in the two adjacent reindeer. Two fragments of dart heads are ornamented with very badly executed human arms and hands. Angular marks are sculptured on the arms, but it is impossible to say whether they represented tattooing or dress, or were merely fanciful lines of ornament. In another dart head we notice what the text calls a "bar-like ornament." It looks something like a leather strap or belt, with four holes at one end and three at the other. Most of the attempts at art are imitations of natural objects, but the slightly curved implement in B Plate X., with its row of oval figures touching each other, each oval having three furrows cut at one end, looks like an effort to make a conventional design, and cannot be complimented for its success. None of the ornamentation possesses a trace of humour, the grotesque probably being of much later date. In one case the stretched-out skin of some long-tailed animal has furnished the design.

Organic Philosophy. Vol. II. Outlines of Ontology, Eternal Forces, Laws and Principles. By Hugh Doherty, M.D. (Trübner and Co.)—When thoughtful works are written by men of considerable ability and attainments, they deserve a respectful treatment, and if a reviewer does not take the trouble to follow the author's lines of argument, and understand his results, he should abstain from hostile criticism. Now with regard to Dr. Doherty's ontology, we are in the condition supposed. We do not feel disposed to make a study of the work, because, from a cursory view of it, we do not think it would repay us for the labour. We cannot, therefore, pretend to do more than just glance at his philosophy. He classifies the sciences as methodological, cosmological, and ontological, and subdivides these into lesser groups. At the top of his methodological group stands biologics, comprehending physical biology, instinctual biology, mental biology, and spiritual biology; and at the bottom of this group we find physics, subdivided into photological physics and chemics, electrological physics and chemics, thermological physics and chemics, and barological physics and chemics. Below biologics he places sociologics, and between sociologics and mechanics stands "dialegmatics," comprehending musical sciences, linguistic sciences, dramatic sciences, and methodic sciences, the three first being called "impartative" and the last "investigative" We may not be able to apprehend the ideas which are intended to be conveyed by these arrangements, but they do not seem founded on positive knowledge or fact, but rather to represent an arbitrary scheme in the author's mind. Perhaps our readers will derive some information from the following illustration of "transcendental philosophy." "An individual being is a miniature human world within a family, the family is a tiny world within a city, the city is a complex world within a nation, and a nation is a larger world within the limits of terrestrial humanity. Beyond the natural world of humanity we have the lymbic, beyond the lymbic the supernatural, and beyond all human worlds the superhuman."

GERMINAL MATTER AND THE CONTACT THEORY. An Essay on the Morbid Poisons, their Nature, Sources, Effects, Migrations, and the means of Limiting their Noxious Agency. By James Morris, M.D., Lond. Second Edition. (Churchill.)—A well-written and interesting little book, applying Lionel Beale's theory of germinal matter to the explanation of contagious disease. It is certainly exceedingly probable that such matter, in a minute state of division, brought into contact with appropriate materials in living bodies, is a common cause of disease; but the author throws little light on the question, as to the extent and circumstances under which physical or other conditions may occasion disease, without the actual importation into the system of an extraneous and living morbid particle. Nor does he afford fresh information as to the circumstances which enable some persons to resist contagious or infectious influences while others succumb to them. In spite of the best sanitary arrangements, particles of germinal matter, capable of inducing disease, are probably so widely diffused in large towns and their vicinity, that no one could expect to escape, unless the conditions under which they can operate mischievously were happily comparatively rare. The cattle plague doctors and the Privy Council recommended killing and burying every patient afflicted with the disease. Dr. Morris does not advise such treatment of bipeds, and does not enter into the question of its propriety with respect to quadrupeds. We cannot do wrong in following his advice to destroy germs of disease as far as possible; and the promulgation of the theory he espouses will be beneficial in suggesting useful action, and also in stimulating further research. With regard to the philosophy of the book, we may remark that a portion of "germinal matter" capable of independent existence, does not seem distinguishable from a "germ," and the diffusion of germs has long been recognized as a cause of disease.

THE MICROSCOPE, ITS HISTORY, CONSTRUCTION, AND APPLICATION; being a familiar introduction to the use of the Instrument and the study of Microscopic Science. By Jabez Hogg, F.L.S., F.R.M.S., Secretary Royal Microscopical Society, Member of the Royal College of Surgeons of England, author of "Elements of Natural Philosophy," a "Manual of Ophthalmic Surgery," etc. With upwards of five hundred engravings and coloured illustrations, by Tuffen West. Sixth Edition. (Routledge).—Without disparaging the excellent works of other distinguished authors, to Mr. Jabez Hogg belongs the credit of having done the most for the popularization of microscopical science. In the preface to the present and sixth edition of his work, he justly observes that "a sale of fifty thousand is an unprecedented event for a work of this kind." Since the publication of his fifth edition, much light has been thrown upon various subjects then imperfectly understood, and some changes have taken place in power and apparatus. It was, therefore, necessary that a considerable portion of the matter in that edition should be modified or rewritten, and that entirely new subjects, such as the application of the spectroscope to the microscope, should be described. The present (sixth edition) will be found to contain a good deal more matter than the last, and it is enriched by eight beautifully coloured plates, which will add greatly to its popularity and value. It makes indeed so handsome and attractive a volume that it may well take its place amongst the gift-books of the season, and if accompanied by one of the numerous forms of microscope which it describes, it will supply intelligent families with a fund of instructive enjoyment. The average and deplorable ignorance of the upper and middle classes in this country on scientific matters, and the tendency to resort to frivolous amusements by way of killing time, is a painful fact against which our social reformers must struggle manfully, and although we do not wish to imitate the professors in the *Bourgeois Gentilhomme* in exaggerating the value of any particular pursuit, we feel amply justified in recommending the microscope as one of the most effective instruments for general instruction. To purchase a microscope with a few slides, and then to make unsuccessful efforts at the examining of common objects, is a process which has been tried hundreds of times with inevitable disappointment. To enjoy or appreciate the performance of a microscope, a considerable amount of scientific knowledge must be obtained. To manage the instrument well is impossible without some knowledge of optics: objects cannot be prepared, so as to be seen properly, without an acquaintance with their structure, and the acquisition of manipulative power. Vegetables and animals, either whole or in part, will afford little amusement without some acquaintance with, at least, the elements of physiology, natural history, botany, chemistry, etc. Thus the employment of the microscope may be made a constant stimulant to various studies, and any knowledge gained immediately repays the student by giving greater interest to old objects, or suggesting important points to be ascertained with regard to new ones. The task which Mr. Hogg has proposed to himself, and carried out with well-known skill, is to smooth over the difficulties which beset beginners, and he has achieved a high degree of success in the difficult art of combining the popular with the scientific. Many writers who undertake to be popular only twaddle about science, and their productions should be avoided as likely to mislead. Mr. Hogg adopts a strictly scientific method, but by avoiding the needless use of hard words, and by a good logical arrangement, he brings complicated subjects within the reach of ordinary intelligence and reasonable attention. The first chapter of his work in its present state relates to the history of the invention and improvements of the microscope, and we may notice parenthetically that the publisher has unwisely placed the words "History of the Microscope" as the external title shown on the binding, thus misleading those who see no more as to the character of the book. The second and third chapters describe at length various instruments and apparatus, modes of preparing objects, etc.

The second part of the volume consists of six chapters, the first devoted to the vegetable kingdom, the second to the protozoa, and other forms up to the echinodermata, the third begins with the polyzoa, and ends with the annelida, the fourth relates to insects and spiders, the fifth deals with the microscopic structure of the vertebrata, and the sixth refers to crystals, polarization, spectrum analysis, etc., etc.

Although we recommend this work to intelligent *beginners*, it must not be supposed that it will not prove of service to more advanced students. It is indeed adapted to both—to the former from its simplicity and clearness, and to the latter from the care taken to bring each subject down to date. Thus the physiologist will find Mr. Whitney's elaborate and interesting researches into the respiratory apparatus of the tadpole fully explained and illustrated by a fine series of coloured drawings.

We feel bound to pronounce Mr. Hogg's sixth edition an honour to English microscopy, and we have no doubt we shall soon congratulate him on the appearance of a seventh, in which we recommend him to reconsider his reprint of the statement so commonly made about the highly composite character of the spider's thread. We pointed out last year that by placing an earwig in the web of the handsome garden spider, *Epeira diadema*, the use of the multiplicity of spinnets may be easily observed. The spider shoots out a sheaf of her silken threads, the ends of which stick to the earwig, which she then *pats* round and round, as if she were roasting him on a spit, until he is swathed like a mummy in the silken winding-sheet which the numerous spinnets enable her to form in a few seconds.

We must, however, while amply recognizing the merits of Mr. Hogg's book, protest against the injustice done to one of our great firms—Messrs. R. and J. Beck—whose numerous excellent forms of microscope are most unaccountably and unfairly omitted.

Introductory Text-Book of Geology. By David Page, LL.D., F.R.S.E., F.G.S. Seventh and Enlarged Edition. (Blackwood and Sons.) Advanced Text-Book of Geology, Descriptive and Industrial. By David Page, F.R.S.E., F.G.S., etc. Fourth Edition, revised and enlarged. (Blackwood and Sons.)—The second edition of Mr. Page's excellent "Introductory Text-Book" was published in 1855; the third in 1857; the fourth in 1860; the fifth in 1861; and the sixth in 1864, and now come the seventh in 1867. These simple facts testify to the great merit of the work as a simple intelligible introduction to a comprehensive and difficult science. We need only repeat the favourable opinion we have before expressed of Mr. Page's labours, and add that his volume is well illustrated, and so low in price as to be within the reach of students of very small means—a fact which we consider important. Mr. Page's larger work made its first appearance in 1856, and the demand for a fourth edition, so soon as 1867, shows the well-deserved repute in which it is held. The present edition appears to notice all recent facts of importance. It is well printed and well illustrated.

PROGRESS OF INVENTION.

A New Hydraulic Cement.—Many excellent hydraulic cements are already known. A very simple and effective one has recently been added to the number by M. Lorel. It is merely a basic hydrated oxy-chloride of magnesium, and it is formed by adding a more or less concentrated solution of chloride of magnesium to magnesia. The magnesia may be very conveniently obtained by adding quick-lime to the mother liquor, that is the residue in salt works, which contains chiefly chloride of magnesium; magnesia will precipitate, and is to be calcined. Double chloride of calcium, and magnesium will remain in the liquid; and if chalk or lime are added, an excellent material for hardening common plaster on walls, etc., will be obtained; or the liquid itself may be used for moistening the materials in making the cement. Magnesiam cement is extremely plastic, and forms a substance like marble. It takes colour well, and it has such agglutinative power, that one part of it is capable of uniting twenty parts sand. It is, therefore, expected to constitute a means of rendering building easy, where building materials do not exist.

New Tubulated Syphon.—The common syphon, though made of glass, cannot it is obvious, be used with corrosive fluids without great inconvenience. A partial remedy, which consists of an accessory tube containing a bulb, has been long employed. The air is drawn by means of this tube from the lower end of the longer leg of the syphon: the necessary vacuum being thus made, the liquid ascends, and soon begins to flow. The bulb in the accessory tube with moderate care, almost prevents the danger of any of the liquid being drawn into the mouth. M. Zaliwski-Mikorski has, however, invented a syphon which is perfectly safe, and very simple; and in which blowing is substituted for suction. In his instrument, the accessory tube is attached to the lower extremity of the shorter leg of the syphon, and, on blowing into it, the liquid will be drawn up, and the syphon filled, provided the place of attachment is not too far from the liquid.

Printing on Glass.—Very cheap and beautiful products are now obtained by printing on glass; a large amount of the fine effect of stained glass being had for a very small portion of its cost. The inventor, M. De Mothay, uses for colouring matter pigments mixed with a solution of silicate, or silico-borate of potash and lead, and a solution of resin in turpentine. The printing is effected with rollers, and the colours are vitrified by heat, no distortion taking place.

A New Anemometer.—This self-registering instrument, the invention of M. Radan, consists of a pencil moving uniformly down a vertical cylinder, or from the centre to the circumference of a disc, on each of which paper has been placed. If the cylinder, or disc, is stationary, the line drawn on the paper placed on the cylinder will be perpendicular to the circumference of its base; and that on the paper placed on the disc will correspond with one of the radii of the disc. The pencil is connected with a Robinson anemometer in such a way that, when the cups have made a certain number of revolutions, it is lifted from the paper, an interruption being thus produced in the line drawn upon it. And the cylinder, or disc is made moveable on an axis, at the upper end of which is fixed an ordinary weathercock. The paper on the cylinder, or disc, is divided by lines into spaces which correspond with equal portions of time. The interruption, therefore, in the line made by the pencil, corresponding to a given time, will show the velocity of the wind during that time. And the deviations of the pencil-line from a round line will show its direction during any given time.

A New Cannon.—It is a matter of great importance that the force produced by the explosion shall be gradually communicated to the projectile. The inertia of the latter renders this necessary; since, though motion may be communicated very rapidly, it still requires a certain time for transmission. A powder may explode with such velocity, as that instead of the projectile being driven forward, the gun shall be burst; such would be the case were any fulminating compound substituted for gunpowder. Among the means used for securing a gradual communication of the explosive force to the ball is a cannon recently invented in America, and which is said to afford excellent results. Instead of the powder being accumulated in one chamber behind the ball, only a portion of it is placed there, the remainder being introduced into lateral chambers in front of the ball, and communicating by openings with the interior of the gun; when the powder has been placed in any one of these chambers, the opening which forms the communication between it and the exterior is closed by a screw. As soon as all have been charged, the piece is ready to be fired; and the instant the ball has passed the opening leading to one of these chambers the intensely heated gases following the ball, enter it, and exploding the powder which it contains, a new impulse is given to the projectile. This takes place after the latter passes each of the chambers; the explosive force of the powder being separated into successive portions and therefore rendered more effective. The explosion being divided there is less danger of the gun bursting; but the complication, and the time required for loading will be found more or less objectionable.

A Self-Registering Mariner's Compass.—A mariner's compass which is capable of registering the ship's course, and is by no means complicated, has been invented by the Baron Webel-Jarlsberg, a Norwegian nobleman, connected with the marine. A time-piece, is placed in the upper part of the binnacle, and is so constructed, that every two minutes it lets fall a very small leaden shot. This shot, falling on the moveable card of the compass, is conveyed by a channel to an aperture in the card, in which is fixed a small glass tube, and passing through this tube, it falls into some one of thirty-two radial compartments, into which a small box, which has been placed under the compass, is divided. As the box is immoveable, and the card is moveable, it depends on the course the ship is following, which compartment a given shot shall fall into; and the number of shots found in a given compartment, will show the length of time during which the vessel was steered in the direction corresponding to that division, since each shot answers to a space of two minutes. The contrivance is very ingenious, but, as at present arranged, it has certain defects: it does not tell exactly the length of time during which the vessel was steered in any direction: and at the end of a given period, only the sum of the times during which a given course was held, and not those times themselves can be ascertained. This, however, is not so inconvenient as might at first be supposed.

Simplification of the Galvanic Battery.—It has been found by M. Manuelli Giacomo, that sulphate of zinc may be substituted for the sulphate of copper in a Daniel's battery, without lessening the power of the battery. The effects of such a substitution is a considerable saving of expense, since the cost is merely that of the zinc consumed. He found also that a very good galvanic current will be produced, if zinc is substituted for the copper of the battery. In this case, the zinc constitutes both the electro positive and electro negative metal.

New Application of Gelatine.—The addition of glycerine to gelatine imparts to it new and valuable properties: the mixture solidifies on cooling, without ceasing to be ductile. Common glue mixed with one-fourth glycerine, becomes very similar in properties to caoutchouc, thus it will remove pencil marks from paper: it may, also be used as a varnish.

A New Photometer.—The transparency of the air on the approach of rains, so that distant mountains become more distinctly visible, has long been recognized as an almost certain prognostic of approaching rain. This transparency is usually considered to arise from the presence of watery vapour; but is said to be partially due to the rendering transparent, or precipitation of, organic matter. This is inferred from the fact that the air coming across arid deserts is transparent in dry weather, but the contrary in moist weather, when it has traversed tracts in which the heat rapidly and abundantly developes animal and vegetable life. In a moist atmosphere, the distant mountain is seen more clearly, because the watery vapour contained in the air either renders the germs of vegetables, etc., transparent, or makes them so heavy that they fall to the ground. And as the sanitary condition of the atmosphere is intimately connected with the presence of organic matters in it, an instrument capable of measuring the transparency of the air, and, therefore, of indirectly indicating the amount of organic matters which it contains, becomes of some importance. M. De La Rive has recently constructed an instrument of this description. It is founded on the fact that the images of two objects, the rays from which traverse portions of air having different degrees of transparency, will be of different brightness; and that, if their brightness is equalized, the amount of adjustment necessary for the purpose will be a measure of the difference of the transparency of the two portions of air through which the rays from them respectively have passed. To secure accuracy of result, the two objects must be seen with the same eye, in the same general direction, and in the same conditions; and the light from other objects must be excluded. M. De La Rive's instrument consists of two tubes, having each an objective at one end, and their other ends attached to a common eye-glass, of which each objective takes up half the field. The optical axes of the two objectives form an angle which may vary from 0° to 29°, at the will of the observer. The rays passing along the principal axis of each objective are made parallel with the axis of the eye-glass by two rotal and successive reflections—the first from a moveable and the second from a fixed prism. The movement of the moveable prism is so connected with that of the moveable tube, that the angle described by the prism is half that described by the tube. Whatever the points towards which the tubes are directed, the images of these points are in juxtaposition in the focus of the eye-glass. The instrument is proved to be properly adjusted by turning it round through 180°, so that the objects are seen the first and second times through different tubes. The images obtained are equalized by the means used with ordinary photometers. This instrument will measure the comparative brightness of two stars, or of different portions of the heavens.

New Gauge for Steam Boilers.—One of the most frequent causes of steam-boiler explosions, is an insufficient water supply. This arises in some instances from neglect on the part of those in charge, but more usually from the difficulty of ascertaining the water level within the boiler. Many modes of automatic indication of a deficiency of water have been employed, and to a greater or less extent with advantage, but none are sufficiently effective to remove any possibility of accident. An American has, however, devised an apparatus for the purpose which is very simple, and appears to be very reliable. It consists in a tube fixed into the boiler a little below the proper water level, and projecting for some distance outwards, the internal extremity being open, and the outward closed. Around this tube is a casing, and the annular space between it and the tube is filled with water. As long as a proper water level is maintained in the boiler, the tube remains full of the fluid, but as soon as the water in the boiler falls below the opening of the tube, the latter becomes filled with steam or foam, and the water in the annular space around it boiling, steam is generated, and passes into a space prepared for it, where it blows a whistle, and even, if desirable, acts on a lever that opens the safety valve of the boiler and allows the escape of steam. Thus, not only is there notice of danger, but it is considerably diminished, until the proper measures are taken.

Undulating Railways.—The idea of an undulating railway is not a new one: it has long since been proposed to utilise the force generated by descent down one incline for ascent up the next: so that some of the motive power required for propulsion of a train, should be obtained from gravity. An ingenious means of storing up the force of gravity so as to prevent the great variations of velocity which constitute one of the most serious objections to an undulating railway, is being experimented upon in Paris. The engine by which the motive power used for propulsion of the train is furnished, is provided with two heavy fly-wheels, capable of being made to work with or in opposition to the driving wheels. During descent, these fly-wheels, being made to revolve by the driving wheels, cause great retardation, and at the same time store up the power they have thus absorbed. Continuing to revolve with great velocity when it is necessary to ascend, they are so connected with the driving wheels that they cause them to revolve. The train is thus propelled, and at a practically uniform velocity, since from the large amount of matter the fly-wheels contain, they can lose a considerable amount of motion, without their velocity being greatly affected. Some motive power, independent of that obtained from gravity, would, of course, be required to supply the loss of that destroyed by friction, and the resistance of the air; but the amount must be inconsiderable.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*Nov.* 6.

Warrington Smyth, Esq., President, in the chair.

A. Tylor, Esq., F.L.S., etc., read a paper on the Amiens Gravel.

The author referred first to the prevalent views respecting the gravels of the Valley of the Somme, namely, (1) That there are two deposits of distinct age—the upper and the lower valley gravels; (2) That the former of these is the older; (3) That the Valley of the Somme has been excavated to the depth of forty or fifty feet since its deposition; (4) That both gravels contain bones of extinct, animals, and implements of human manufacture, the lower gravels, however, containing the greater number of species of Mollusca, and the upper the greater number of flint implements; and (5) That the height (seventy feet) of the gravels of St. Acheul above the present level of the Somme is much beyond the limit of floods, and that, therefore, they could only have been deposited before the river channel was cut down to its present level. He then pointed out that the general effect of these views is to refer back the remains of man found at St. Acheul to an indefinite date separated from the historical period by an interval during which the valley was excavated.

In former papers Mr. Tylor stated his belief that the upper and lower valley-gravels of the Somme are continuous, and of the same age, which he considered to be close to the historical period. In this paper he stated facts which appeared to him to demonstrate the truth of his views, and described a number of sections near Amiens, in which the levels were laid down from an exhaustive survey by M. Guillom, Chief Engineer of the Northern Railway of France.

The conclusions he had thus been able to arrive at are the following: (1) That the surface of the chalk in the Valley of the Somme had assumed its present form prior to the deposition of any of the gravel or loess now to be seen there; (2) That the whole of the Amiens valley-gravel is of one formation, of similar mineral character, contains nearly similar organic remains, and belongs to a date not much antecedent to the historical period; (3) That the gravel in the Valley of the Somme at Amiens is partly composed of débris brought down by the river Somme, and by the two rivers the Celle and the Arve, and partly of material from the higher grounds washed in by land floods; (4) That the Quaternary gravels of the Somme are not separated into two divisions by an escarpment of chalk parallel to the river, as has been stated; (5) That the evidence of river-floods extending to a height of at least eighty feet above the present level of the Somme is perfectly proved by the gradual slope and continuity of the gravels deposited by them; and (6) That many of the Quaternary deposits in all countries, clearly posterior to the formation of the valleys in which they lie, are of such great dimensions and elevation that they indicate a pluvial period just as clearly as the Northern Drift indicates a glacial. This pluvial period must have immediately preceded the true historical period.

ROYAL GEOGRAPHICAL SOCIETY.—*Nov.* 25.

Sir R. Murchison, President, in the Chair.

The following important letter relating to Dr. Livingstone was read, and it strongly encourages the hope that he is yet living, and may be continuing his journey with success. We present the letter entire, because our readers may have occasion to refer to it on future occasions, when fresh information arrives. In the course of the discussion which took place after the letter was read, additional reasons were suggested for accepting its evidence. If true, many months may elapse before the esteemed traveller, whose fate is an object of such profound interest, can make his way to any locality from which information can be transmitted.

" *Zanzibar, Sept.* 28, 1867.

" My dear Sir Roderick,—You know that a rumour has been current on the coast to the effect that a white man has been seen near Ujyl. Such a story came to us at a time when it was quite impossible that Livingstone could be the man. Now, however, another narrative has reached us, which, if we believe, it is, I think, difficult to avoid the conclusion that our distinguished traveller may even yet succeed, and disprove the story given us of his death by the Johanna men.

"A Banian trader at Bagamayo told me three days ago that he had heard a rumour that some white man had been seen at Uemba; of this he seemed to have no doubt. To-day he brought a native whom he introduced and left alone with me. I entered into a conversation with him, and led him in an irregular way to give a general account of his journey, without guiding his imagination by any leading questions, determining to meet him again and fill in the details. When I had dismissed him, after my first conversation, it appeared that a ship would sail for Bombay immediately, and, not to lose a chance, Mr. Churchill, the consul, to whom I gave the notes, at once sent all to Bombay, and a request that the substance might be telegraphed to the Foreign Office—viz., that we had now some grounds for believing that a white man resembling Livingstone has been seen to the south of Ujyl.

"This native, with the rest of the caravan, left Bagamayo, and passed along the usual trade route to Uemba and Marunga, where they remained trading for some time, and again returned to the coast, where, in one of the villages under Marunga, which is a region governed by several chiefs, more or less dependent on one paramount, a white man arrived with a party of thirteen blacks, who spoke Supeli. All had firearms, and six carried double-barrelled guns. The white man was of moderate height, not stout, dressed in white, and wore a cloth wrapped round the head. He gave the chief a looking-glass, and was offered ivory, which he declined, stating that he was not a trader. He then went northwards. I do not know that this man can tell much more; he is a simple carrier who formed part of a caravan, but if we can find the head man of the party, it will be possible, no doubt, then to identify this stranger, who seems to our hopeful imagination so like our long lost friend; and then only think of the revelation he will have to make to us.

"It is decided that we go to Bagamayo in two days to make inquiries, but we must do so quietly. The story of a white man having been seen at Ilruwa, to the west of the lake, is a distinct thing from the more definite narrative we now have. But the one adds confirmation to the other, and shows that if it be Livingstone, in whose track we now are, that he has more than half finished his work, and is about to go to the Albert Nyanza. I may mention that there is now no doubt that the white man of whom I wrote formerly, long ago, as having been seen on one of the lakes by an Arab, and who remained on the coast, was a Turk, one of the traders who remained on the coast at Gondokoro, who have been met with in Uganda by Zanzibar merchants. The description fully satisfied me of this, and nothing is more probable. Thus the traders of Egypt and Zanzibar have now met in the interior of Africa. Speke's route has been quickly followed; how far this has been for the immediate benefit of Africa others may judge. In the end Africa will be overrun with traders in all directions, and then the vast resources of the continent will be shown.

"P.S.—Since writing the above I have again seen my informant, and placed before him my books of photographic portraits. In the first book he did not recognize the likeness of the man he saw in the interior, although it contained a very fine side view of Dr. Livingstone. In the second he at once pointed out a staring likeness of Livingstone, which I kept as a caricature, and said, 'That is the man. But,' he added, 'come to Bagamayo and see my master and the other men; they have seen him also, and will tell you all they know.'

"Suspend your opinion for a little, Mr. Churchill, and I go in two days to Bagamayo to make inquiries. Please communicate this view to Mr. Webb, Miss Livingstone, and other friends, but until my next maintain some caution.

"JOHN KIRK."

ROYAL MICROSCOPICAL SOCIETY.—*Nov.* 13.

James Glaisher, Esq., President, in the chair.

J. Gorham, Esq., read an interesting paper on a peculiar venation chiefly traceable in the leaves of certain compositæ, of which the marginal veins found in Eryngo offered an interesting specimen.

At the close of the regular business the meeting was made special to alter the bye-laws. In future, the entrance-fee will be £2 2s., and the annual subscription £2 2s. The composition fee for new fellows, £21.

NOTES AND MEMORANDA.

ROSS'S NEW FOUR-INCH OBJECTIVE.—Mr. Ross has very judiciously decided on meeting the demand of microscopists for a low-power object-glass, adapted to viewing large live objects, polyzoa, etc., and has produced a four-inch combination of great merit and utility. Many highly interesting objects—including anatomical preparations, entire insects, small star-fishes, sponges, corals, etc.—can be shown better with this glass than with any other we have seen. With the A eye-piece of Mr. Ross' series it takes in an object 7—16″ in diameter, and the field is beautifully clear and flat. With deeper eye-pieces a higher magnification may be obtained, accompanied by much greater penetration than deeper objectives and lower eye-pieces will give, which is an immense advantage in many investigations. Mr. Ross has not hitherto, like Messrs. Beck, given his instruments enough rack-room for such low powers. He can, however, by a simple arrangement, accommodate the new glass in a perfectly satisfactory way. Every microscopist who sees the working of this four-inch glass will infallibly desire to be its possessor.

CHEAP COMPRESSORIUM AND SLIDE-CELLS.—At the suggestion of the Editor, Mr. Curteis (Mr. Baker's) has turned his attention to the manufacture of Compressoriums, which, while not pretending to all the convenience and accuracy of the most expensive kinds, will meet the average requirements of students at a small price, and replace the clumsy and objectionable "live-box." In size and shape the Cheap Compressorium resembles two ordinary glass slides, one overlying the other. It is made of two pieces of brass—one carrying the cover, and the other the glass bed. It is raised by springs, and depressed by two screws easily worked. We have tried it with various objects, and can recommend it. As soon as an approximation to contact is obtained, the screws must be worked alternately, and very gently. Mr. Curteis' slide-cells are modifications of a plan introduced by Mr. Richard Beck. The cell is formed in an ordinary slide, with or without a back, according to its depth. The cover turns upon a pivot. They work well, provided the cover is quite free from grease; and this condition is easily obtained by washing it with a little caustic soda.

Day View of Venus with Small Telescope.—Mr. Levander, of Canonbury, writes to us, that on the 20th of October, 2h. 50m., he saw Venus when only about 25m. 56s. east of the sun, and 9″·6 in diameter, with an inch and a half telescope, mounted equatorially by himself, and a power of about 90. A cloud obscured the sun at the time.

Test for Ozone.—During a recent discussion at the French Academy on the difficulties of Ozonoscopy, M. Le Verrier stated that, when the subject was discussed last May at Metz, M. Schönbein pointed out that a colourless solution of the protoxide of thallium became yellow under the influence of ozone, and was not, like the iodine test, affected by nitrous compounds; but, unfortunately, the subject was not yet brought to a practical state.

Free Sulphuric Acid in Mollusks.—In addition to the *Dolium galea*, MM. St. Lucca and Panceri inform the French Academy that they have discovered free sulphuric acid in the glands of *Tritonium corrugatum*, *T. cutaceum*, and *T. hirsutum*, *Cassis sulcosa*, *Cassidaria echinophora*, *Murex trunculus*, *M. brandaris*, *Aplysia cornatus*, and others (not named). They observe—"Free sulphuric acid is thus found to be an element necessary to the organic functions of a numerous class of mollusks, living in stony localities, and carrying a shell formed almost exclusively of carbonate of lime, accompanied by traces of carbonate of magnesia. The strong acid is found in company with a weak acid—carbonic."

Electricity and Vegetation.—M. Ch. Blondeau states ("Comptes Rendus," Nov. 4, 1867), that subjecting fruits—apples, pears, and peaches—to the action of an induced electric current hastens their maturity. Having rendered seeds good conductors by moistening them, he affirms that electrizing them by induced currents causes them to germinate earlier than similar seeds not subjected to such action. He says, "Some haricot beans which were electrized exhibited a singular peculiarity. They germinated head downwards, and root upwards, in the air. That is to say, the gemmule, surrounded by its cotyledons, remained in the ground, while the root, separated by a little stem from the gemmule, erected itself in the air. This fact appears important, as explaining the reason why plants push their roots into the earth, and their stems into the air. This tendency is so strong, that efforts to cause them to act otherwise are fruitless; but it may be overcome by the electric shock, in the same way as the poles of a magnet may be reversed. We are tempted to liken the embryo to a small magnet with opposite poles."

Hybrid Cotton.—M. J. E. Balsamo states ("Comptes Rendus") that, by artificial fecundation, he succeeded in obtaining hybrids between the Nankin cotton-plant and the *Gossypium barbadense*, and *vice versâ*. In both cases the cotton obtained was of a character intermediate between the two types.

Light and Vegetation.—The same observer planted cotton-seeds in a glass vessel at various depths of garden mould, and in contact with the glass side. Some were protected by yellow paper gummed to the glass, and others left exposed to the light. The former began to grow in nine days, while the latter were found to be slightly decayed at the end of ten days.

New Mud-fish from New Zealand.—In "Annals Nat. Hist." for November Dr. Günther describes a new mud-fish sent to the British Museum by direction of Sir G. Grey. It is about 5½ inches long, possesses the general characters of Galaxias—scaleless fresh-water fishes, of which five out of twelve known species belong to New Zealand, New South Wales having three, and Van Dieman's Land two. "Eastwards the same genus is met again in the southernmost parts of America (Falkland Islands, Patagonia, Terra del Fuego), and a minute form occurs in Chili." Dr. Günther names the new fish *Neochana apoda.* It has a broad, obtusely-rounded snout, mouth-cleft moderately wide, the maxillary extending below the eye, which is very small. Anterior nostril prolonged into a minute tube; several wide pores at the upper part of the head. A rather deep groove from the head along the middle of the back and abdomen. Dorsal and anal fins about as high as the tail between them, and both continuous at the base with the rudimentary rays of caudal fin. Caudal fin rounded, as long as head without snout; pectoral somewhat shorter. Brown, with irregular, blackish, transverse spots. Dr. Hector states that it was found four feet from the surface, in a stiff clay, embedding roots of trees, in a locality thirty-seven feet above the Hokitika River, three miles from the sea, which was at one time a backwater of the river during floods. Two years ago it was a swamp, but the miners pierced through the clay to a bed of gravel, and drained it. Dr. Hector adds, "Mr. Schaw, the Warden of the District, has examined seven or eight specimens of this fish, and assures me they occur in hollows of the clay, and that although when first extracted they moved freely, if placed in water they get sluggish, and soon die." He further states that the early settlers in Zealand were frequently astonished at digging up fish as well as potatoes. All these fish are very fat, and Dr. Günther found this one quite greasy.

The Newton Forgeries.—There seems now every reason to believe that the extraordinary mass of forged correspondence in the possession of M. Chasles, and which he has defended with such remarkable and ill-judged pertinacity, was fabricated by Desmaiseau between the years 1732 and 1745. He was a collector and dealer in autographs. Sir. D. Brewster says that the "celebrated deist, Anthony Collins, the friend of Locke, left him his MSS. to be published after his death; but he sold them for fifty pounds to Mrs. Collins, by whom it appears they were destroyed." Internal evidence at once showed that Sir Isaac Newton could not have written the letters ascribed to him; and the more the correspondence has been examined, the stronger has been the proof that the whole collection was fictitious.

Electro-capillary Currents in Plants.—M. Becquerel eleucidates this subject in "Comptes Rendus." He says that he makes a transverse section of the stem of a young poplar, oak, or maple in full sap, and introduces two non-polarized platina needles, in connection with a very sensitive galvanometer—one in contact with the central pith, and the other with one of the ligneous layers. An electric current is immediately manifest, and by its direction indicates that the pith is always positive, relative to the other parts. The maximum of effect is produced when the second needle is placed between the woody layer and the bark. The positive condition of the layers augments towards the pith. From this state of things it follows that the liquid which moistens the pith, and the cellular tissue in general, is more oxygenated than what is found in other parts of the plant. In leaves the cellular tissue is positive, with relation to other parts. The earth is found positive in relation to the roots of plants, and their stem and leaves; that is to say, in relation to the liquids which moisten them.

The Walrus at the Zoological Gardens.—We recommend all our readers who have not already done so to go and see the young walrus at the Zoological Gardens. He answers to the name of "Jemmy," and seems both tame and good-natured. He has improved much in appearance since his arrival, and thrives upon a diet of fish and porridge. A few days ago Mr. F. Buckland tried to tempt him with some shrimps, as "Land and Water" tells us, but he did not condescend to eat them, though fond of whelks and mussels. He does not walk as well as the sea-bear, nor manifest as much agility; but he is only a youngster, and has not had much pains taken with his education. He is now in the large pond with the seals.

THE INTELLECTUAL OBSERVER.

JANUARY, 1868.

THE INTELLECTUAL OBSERVER AND "THE STUDENT."

NOTICE TO OUR READERS.

WITH the issue of this number of the INTELLECTUAL OBSERVER the Twelfth Volume of that WORK is completed. We advisedly say *Work*, because it was our intention from the beginning not to produce an ephemeral serial, but a publication of permanent value, consisting of articles on a variety of topics of enduring interest, bringing to a focus many scattered rays of knowledge, and offering to the educated classes, wherever the English language is read or spoken, a record of research and discovery in various departments of human inquiry, which we hoped would not be found unworthy of their enlightened support.

From our first issue to the present time, the public have appreciated our labours, and awarded to the INTELLECTUAL OBSERVER an amount of favour never before bestowed upon any scientific publication taking the same high ground. In addition to a sale in monthly numbers extending to many thousands, there has been a continued demand for volumes and for sets. The public have thus recognized in the INTELLECTUAL OBSERVER the character we desire to claim for it—that of a permanent WORK.

This success has necessitated the course we now beg to announce—that of bringing our labours to a definite conclusion, with a view to their immediate resumption in another form. With this number the INTELLECTUAL OBSERVER completes and closes its career, and, on the 1st of *next month* (February, 1868), "THE STUDENT" will appear as the successor of the INTELLECTUAL OBSERVER, continuing the plans carried out in the former publication, with such improvements and additions as the wants of the public and our experience may suggest.

By this arrangement new subscribers will have the advantage of coming in at the beginning of a New Magazine of

Science, Literature, and Art, which will combine all the advantages of our previous publication, with a wider range of topics, a greater variety of illustration, and especial adaptation to the requirements of young men and women standing on the threshold of Intellectual Culture, and needing a friendly hand to guide them through its gates.

For further details of the new arrangements, we respectfully refer our readers to the Prospectuses now issued of "The Student."

Let not the name offend—the wisest are students from their earliest perceptions to their latest thoughts. Nor must it be supposed that this study and contemplation is without its recreative delight. "The Student's Bower" is no dull abode. To peruse what others have deciphered, or to

"Read what is still unread
In the manuscripts of God:"

to hear the music of "Nature, the dear old nurse," when she sings

"To Him night and day
The rhymes of the universe;"

these are the privileges of the Student, and, promising that those who best interpret her language shall make its meaning familiar to our readers, whenever she—

"Sings a more wonderful song,
Or tells a more marvellous tale,"

we look with hope and confidence to the future, as we invoke a large and liberal amount of public confidence and support.

ON THE PRE-HISTORIC MAMMALIA FOUND ASSOCIATED WITH MAN, IN GREAT BRITAIN.

BY W. BOYD DAWKINS, M.A., F.R.S., F.G.S.*

At the time man first appeared on the earth, the physical conditions obtaining in Western Europe were altogether different from those under which we now live. Britain formed part of the mainland of Europe, and low fertile plains covered with the vegetation peculiar to a moderately severe climate, stretched far away into the Atlantic from the present western coast line. The Thames also, instead of flowing into the German Ocean, joined the Elbe and the Rhine in an estuary opening on the North Sea about the latitude of Berwick. The climate also was very severe, and strongly resembled that of Siberia and North America. One would naturally expect that the animals living on that vast pleistocene continent, under such conditions of life would differ materially from those now living on what are the mere relics of that submerged land. Some of them have utterly disappeared from the face of the earth, such as the sabre-toothed lion, the cave-bear, the Irish elk, the mammoth, *Elephas antiquus*, the hippopotamus, and the woolly rhinoceros and the *Rhinoceros Leptorhinus* of Owen. Others again have departed to northern regions, such as the glutton, the reindeer, the true elk, the musk-sheep, the pouched marmot, and the lemming, while others, such as the cave-lion and cave-hyæna have retired southwards, and taken refuge, the one in Africa, the other in that continent and in Asia. The history of all these animals, and of the race of men associated with them, is, to a certain extent, familiar to most of you. The subject that I have now to bring before you relates to the animals which lived from the disappearance of the post-glacial mammals down to the times of history—a period of uncertain length, to be reckoned certainly by centuries, and probably by tens of thousands of years. The human remains found in Britain, and belonging to the stone and bronze folk, have been diligently looked after by the archæologists and craniologists, but the remains of the animals, carefully sought after in Switzerland and Denmark, have for the most part either been overlooked in this country or confounded with the animals of the preceding epoch. They have been derived from villages and tumuli of unknown antiquity, from refuse heaps and from caverns, which were at once the abodes and burial-places of some early race of man. For this group of animals, and those from alluvia and peat-bogs, I

* "Sur les Mammifères Pre-historiques trouvès avec l'homme dans Grande Bretagne," read at the Congrès Internationale d'Anthropologie et d'Archéologie Pre-historiques in Paris, 1867.

have proposed the term Pre-historic,* because they came into being at a time far beyond the ken of the historian, some of them also long after the close of the post-glacial era. Unfortunately I cannot separate those belonging to the stone folk from those living in the bronze age in Britain. The remains found in tumuli and villages will be first considered.

In 1862 I had the opportunity of examining the remains at Stanlake,† a small hamlet in Berkshire. They were found in and around the circular depressions and trenches which mark the site of a village probably of Keltic age. They consisted of large quantities of the bones, teeth, and skulls of animals that had been used for food, such as *Bos longifrons* in great abundance, the sheep or goat, the horse, red-deer, pig; and there were also the dog, cat, and martin. The metacarpal of a roe-deer had been polished, and exhibited the marks of friction by a string. Along with them were large quantities of flint flakes, rudely chipped lumps of flint and coarse pottery and ashes. There was nothing found to stamp the absolute date of the village, but it probably may have been inhabited at the time of the Roman invasion. In the tumuli of Wiltshire the same group of animals has been met with by Dr. Thurnam, with the exception of the cat and martin. In the same county also the skull of urus has been found underneath a tumulus near Calne,‡ associated with remains of the deer and wild boar, and fragments of pottery ornamented with right lines. It is remarkable as the only authenticated instance of the recurrence of the animal with the remains of man in pre-historic times in Britain.

A vast number of bones have been dredged out of the Thames near Kew Bridge, along with polished stone axes and bronze swords. Their condition proves them to have belonged to animals that were eaten for food, the horse, *Bos longifrons*, pig, sheep, goat, red-deer, and roe-deer. There were dredged up also with them several human skulls that had been gashed and partially cleft, and Roman horse trappings. The river at Kew is shallow, and when we take the number of bronze swords into consideration, some of them even with the metallic end of the scabbard still on the blade, the human skulls and the Roman phaleræ, it is very probable that it was the site of a battle between the Kelts and the Roman legions. All that can be said with reference to the date of the accumulation of bones, is that it was probably anterior to the time of the Romans. A little higher up the river, near the new water-

* "Introd. Pleistocene Mammalia." Part I., 1866. Paleontographical Society.

† "Archæologia," vol. xxxvii. p. 363. "Proceedings of the Society of Antiquaries," vol. iv. p. 93.

‡ "Fossil Skull of Ox." By Henry Woods, A.L.S. 4to. London, 1839.

works, a similar deposit of bones was discovered in the beginning of the year 1867. I found on examination that large oaken piles had been driven into the gravel which anciently formed the bottom of the Thames, and that a quantity of brushwood, principally of willow, had been pressed in between them. On the top was a large quantity of bones, broken more or less for food, and belonging principally to *Bos longifrons*. The whole was covered with alluvium from four to five feet in thickness. It is very probable in this case that the piles are the remains of dwellings somewhat similar to those in the Swiss lakes. There were, however, no fragments of pottery and no implements, the only human remains being some of the long bones.

We will now pass on to the consideration of the pre-historic caverns in Britain which have afforded traces of the abode of man. In 1859 I explored a small cave at the head of Cheddar pass in Somersetshire. The mammalia found in it consisted of the wolf, fox, badger, wild boar, goat, roebuck, *Bos longifrons*, and horse. A human skull, also from this cave, is preserved in the Oxford Museum, which is very well developed, and may have belonged to a person of considerable capacity. During the exploration of caverns in Somersetshire by Mr. Sanford and myself, in 1863,* a second cavern of pre-historic age came before our notice, also in the mountain limestone of the Mendip range in Burrington Combe, about twelve miles from Bristol. It was situated high up in the ravine, and was very nearly blocked up with earth mingled with charcoal. It contained a large quantity of the remains of *Bos longifrons*, red-deer, goat, wolf, fox, badger, rabbit, and hare. In the lower portion of the cave we disinterred fragments of a rude urn of the coarsest black ware, devoid of ornament, and with the rim turned at right angles, together with a piece of bent iron, which more closely resembles those found strengthening the angles of wooden chests in Roman graves on the banks of the Somme than anything else we have seen. The accumulation of bones and charcoal prove that the cave was inhabited by man for some considerable time. The interment is clearly of a later date than the occupation, because it is made in the mass of earth, bones, and charcoal which resulted from the latter. The interval between the two is of doubtful length. In the same year we explored another cavern in the same ravine, which consisted of two large chambers connected together by two passages not more than a few inches high. The natural entrance, but a little larger than a fox-hole, was in the roof of the first chamber, and through this we had to let ourselves

* "Proceedings of the Somersetshire Archæological and Natural History Society." 1864.

down into the cave. Subsequently we blasted a second entrance. The first chamber was at least half full of broken rocks, covered with a mortar-like mass of decomposing stalagmite. Underneath them was a group of four skulls, one of which belonged to the *Bos longifrons*, two others were those of a species of the goat tribe, approaching more closely to the *Aegoceros Caucasica* of Asia, than any other recent species in the oval section of the horncores, in their parallelism to one another, and their slight backward curvature. We have met with a similar form in a refuse heap in Richmond in Yorkshire,* and in the disturbed soil on which London stands, and M. Lartét writes me that he has detected it in a cave in the Pyrenees. In the absence, however, of the necessary materials for comparison from the museums of London, Oxford, and Paris, I do not feel justified in proposing a new specific name. The fourth skull belonged to the pig, and had a round hole in the frontals rather larger than a florin, which had the appearance of being made by human hands.

The presence of the lower jaws with the skulls indicates that they were deposited in the cavern while the ligaments still bound them together. They were all more or less covered with decaying stalagmite. The outer chamber was remarkable for the absence of earth of any kind, except underneath the hole in the roof, where there was a very little; while the inner one, running in the same slope, has its lower end entirely blocked up by a fine red earth, deposited by a stream which flows during heavy rains. Between the stones on the floor were numerous bones and teeth of wolf, fox, mole, arvicola, badger, bat, along with a metacarpal of red-deer and the remains of birds. How the animal remains were introduced, for they exhibit no marks of gnawing, and there are no fragments of charcoal in the cave, or any other traces of man, is altogether a matter of conjecture: but the fact of finding the skulls in one group, coupled with the presence of the hole in the frontal of the pig, leads us to believe that they have been introduced by the hand of man. The entrance was far too small to admit of an ox falling into the cave by accident, and scarcely large enough for a goat or deer to squeeze themselves through; had they been brought in by wolf or fox they would have exhibited marks of teeth.

In 1863 Mr. James Parker explored a cave in the limestone cliffs at Uphill, near Weston-super-Mare, and obtained human skulls and bones, along with rude pottery and charcoal. I have determined the presence of the following animals:—the wild cat, wolf, fox, badger, *Bos longifrons*, pig, red-deer, dog, and water-rat. Most of the remains belong to young

* "Quarterly Geological Journal." November, 1865.

animals, and some are gnawed by dogs, wolves, or foxes. The Heatheryburn cave, in Yorkshire, explored by Mr. John Elliot in 1862,* yielded, besides the remains of man, those of the otter, badger, goat, roe-deer, hog, and water-rat.

In the following table I have arranged the animals found associated with man with those found in the most modern of all the stratified deposits, the peat and alluvium, classing with the latter all those animals now living in Britain which have been found in pleistocene deposits, and which also must have lived, therefore, in the pre-historic period. I have also added a list of the animals living in Britain while it was a Roman colony and those alive now.

TABLE OF BRITISH PRE-HISTORIC MAMMALIA.

	Animals found with man in caves and river deposits.	Animals in peat-bogs & alluvium.	Animals of the Roman period.	Animals now living.
Homo. L.	*	*	*	*
Rhinolophus ferrum equinum. Leach	*		*	*
Vespertillio noctula. Schret		*	*	*
Talpa Europea. L.	*		*	*
Sorex vulgaris. L.		*	*	*
Felis catus ferus. L.	*	*	*	*
Canis familiaris. L.	*	*	*	*
Canis vulpes. L.	*	*	*	*
Canis lupus. L.	*	*	*	
Mustela ernimea. L.				*
Mustela martes. L.	*			*
Mustela putorius. L.				*
Lutra vulgaris. Erxl.	*	*		*
Meles taxus. L.	*	*		*
Ursus arctos. L.		*	*	
Mus musculus. L.			*	*
Castor fiber. L.		*		
Arvicola amphibia. Desm.	*	*	*	*
Arvicola pratensis. Bell.				*
Arvicola agrestis. Flem.				*
Lepus timidus. Erxl.	*	*	*	*
Lepus cuniculus. Pall.	*	*	*	*
Equus caballus. L.	*	*	*	*
Alces malchis. Gray		*		
Megaceros Hibernicus. Owen.		*		
Cervus tarandus. L.		*		
Cervus elaphus. L.	*	*	*	*
Cervus capreolus. L.	*	*	*	*
Ovis aries. L.		*	*	*
Capra aegagrus. L.	*	*	*	*
Capra hircus. L.	*	*	*	*
Bos longifrons. L.	*	*	*	*
Bos urus. Plin.	*	*		
Sus scrofa. L.	*	*	*	

* "Geologist's Magazine." 1862.

I have chosen these caverns as representing the pre-historic fauna of Great Britain. I might have quoted others, such as Kent's Hole, which, having been open during pleistocene and pre-historic times, contains the animals that were then alive, the former at a lower level than the latter; or the Paviland Cave, described by Dr. Buckland, in which the remains of both periods were mixed. I have, however, given a sufficient number of examples to prove how far the pre-historic differed from the post-glacial fauna. These pre-historic mammalia, associated with the remains of man, are also found along with others in the peat-bogs, so that by putting the two groups together we can form an adequate idea of the entire group of animals that inhabited Britain from the disappearance of the post-glacial mammals down to the time of the Roman invasion.

The correspondence of the animals found with man with those taken from the peat-bog and alluvium, and from certain of the more modern caverns, proves that geologically they belong to the same pre-historic epoch. The cave-bear, cave-lion, and cave-hyæna had vanished away, along with the whole group of pachyderms, and of all the extinct animals, but one, the Irish elk, was still surviving. This animal, indeed, is much rarer in England than in Ireland, in which latter country it seems to have lingered after its extinction in the former. According to some of the Irish *savants* it was destroyed by the hand of man. The reindeer still lived on; and its presence proves that the pre-historic climate was more severe in Britain than that under which we now live. As the pre-historic is remarkable for the absence of many of the animals of the preceding period, so is it characterized by the presence of others of a totally distinct character. The sheep, the goat, and the *Bos longifrons* appear for the first time; they are widely spread through and highly characteristic of all the deposits. With reference to the latter of these animals I am obliged to differ from the views of Professor Owen, who considers that it is also of post-glacial age. An analysis, however, of all the evidence that there is upon the subject, compels me to believe that the animal has not yet been found in any deposit of that age in Britain.* Before the invasion of the Romans it was kept in great herds by the pre-historic folk, and is found universally in their tumuli and places of habitation. During the Roman occupation it was not supplanted by any other breed of oxen, as Professor Owen suggests, for its broken bones, teeth, and horncores in the refuse heaps of every Roman town and station in Britian, prove that it alone of the oxen, was the food of the provincials. On the landing of the Saxons it disappeared

* "Quart. Geol. Journal." 1867. Brit. Foss. Oxen, Part. ii.

from the portion of the country conquered by them, and now lives in the smaller breeds of Wales and Scotland, where the Romanised Kelts took refuge.

About that time also it was supplanted by a larger breed probably brought over from Friesland, the home of the Saxon invader. Whence the sheep and goat and *Bos longifrons* came is a question I will not dare to enter upon; but all of them appear simultaneously in Britain, and all are associated with man. It seems to be highly probable that they were introduced by him into our island. The true elk was very rare, and has left its remains only in one place—in Newcastle in a subturbary deposit. The red-deer had vastly increased in numbers since the post-glacial epoch, and very nearly replaced the rein-deer. Its remains, however, show the effect that a more limited range had on the development of the antlers. In post-glacial times, while England formed part of the mainland of Europe, they were very large; in pre-historic times after Britain became insulated they were smaller. A decrease of size is also noticeable in those used for food in the time of the Romans, while a minimum is reached in those which are now living in certain restricted parts of England and Scotland. The wolf and fox were very abundant, but the brown bear was by no means common.

We will now pass on to the comparison of the pre-historic animals with those living in Britain at the time it was subject to the Roman power, and with those which are living at the present day. The Irish and the true elk had disappeared from Britain before the landing of the Roman legions; with these exceptions all the animals still lived on. To the Romans we are probably indebted for a new species of deer, the fallow-deer; for it has never been found in any post-glacial or pre-historic deposit, while in refuse heaps of Roman age it is by no means uncommon. At all events its presence in Britain dates from the arrival of the Romans. After this time in proportion as civilization increased on the haunts of the wild animals, they disappeared one by one from before the face of man. The last historical notice we have of the beaver is that afforded by Geraldus Cambrensis in the year 1188, when he met with it in the river Teivy, in Cardiganshire, on his tour through Wales to collect volunteers for the first Crusade. The brown bear became extinct in the year 1057, if there be any truth in a legend of the Gordon family in Scotland. The wolf, which was sufficiently abundant in Sussex to eat up the corpses of the Saxons left on the field of Hastings by Duke William

> "Vermibus atque lupis avibus canibusque voranda
> Deserit Anglorum corpora strata solo,"

lingered on in England until 1306, in Scotland until 1680, and in Ireland, protected by the uncultivated wilds and the misrule of the country until the year 1710.

In this outline of the pre-historic animals associated with man, I have attempted to prove that the animals of the neolithic and bronze ages in Britain are identical with those found in peat-bogs and alluvia, and that the whole group so constituted differs totally from the post-glacial group of animals. And I have striven to show their relation to the animals now living in Britain. Their comparison with the pre-historic fauna of the Swiss lakes, or that of Scandinavia, Germany, France, and Italy, I must leave to the *savants* of those countries. The modification of that fauna I have shown to be the result of man's influence, and I cannot help believing that the disappearance of the larger animals associated with man in post-glacial times, is in a measure owing to the same cause, as well as to climatal or geographical change. With the larger carnivores man must have waged a war of extermination; while the larger ruminants on which he fed must have found the difficulty of concealment increase in proportion to their size. There is a great gulf fixed, so to speak, representing an inconceivable length of time between the post-glacial and pre-historic periods; and the fauna of Europe, as we have it now, dates from the latter epoch. In Britain, of course, insulated from the mainland of Europe, several animals probably introduced into Europe after that insulation, have not been found, such as the chamois and bouquetin. Had Britain been united to France during the rein-deer epoch, we might have expected to find the remains of those animals.

ELECTRICAL COUNTRIES.

BY M. J. FOURNET.*

(*Continued from our September Number.*)

In a preceding article upon electrical countries, I especially directed my investigations to remote regions. It now remains, therefore, to concentrate the field of these researches, and to remark that in the mountains of the basin of the Rhone, and those in connection with them, there are some places which are distinguished by electrical discharges of a very remarkable intensity, whilst up to the present time the most absolute silence reigns in others, notwithstanding the apparent identity of surfaces. I hope that the details which follow may excite some attention in observers so that at last some meteorological law may be established. Leaving, therefore, for the present, the details already mentioned by M. Arago, I shall first consider that which concerns the Alpine and Jurassic group, and afterwards return to the most western parts of our country.

Alpine Electricity.

1. *Illumination of the rocks of Mont Blanc.*

A. During the night of the 11th of August, 1854, Mr. Blackwell being stationed on the Grands Mulets (altitude 3455 mètres), the guide, F. Le Couttet, went out of the cabin about 11 o'clock at night, and saw the crests of these mountains all on fire. He made this circumstance immediately known to his companions, they all wished to be assured as to the fact, and they saw that by an effect of electricity produced by the tempest, each one of the adjacent rocky projections appeared illuminated. Their clothes were literally covered with sparks, and when they raised their arms their fingers became phosphorescent.

At the same hour we had at Lyons rather a violent shower with thunder, from the south-west, and the whole of the day had been very stormy.

According to information, for which I am indebted to M. V. Payot, a naturalist universally known, the guide, Couttet, of Chamounix, at the time of his ascent of Mont Blanc the 25th of August, 1841, with M. Chénal, was surprised by a storm on the Grands Mulets which placed them in actual danger on account of the thunder and lightning which surrounded them without intermission. All the stones around them had

* Translated from the "Comptes Rendus."

their electrical sparks, and yet the summit of Mont Blanc as well as the sky were perfectly serene.

2. *Electricity on the Breven.*—In 1767, during very stormy weather, De Saussure, Jalabert, and Pictet were on the Breven (altitude 2500 mètres). There they had only to raise a hand and to extend a finger to feel a kind of pricking at the extremity. This remark, first made by Pictet, was soon followed by another, that as the sensation became more apparent it was accompanied with a kind of whistling. Jalabert, whose hat was trimmed with gold lace, heard a fearful buzzing round his head. They drew the sparks from the button of his hat as well as from the ferrule of his cane. At last the storm was so violent in the cloud which was in the same plane with their heads, that they were obliged to descend from the summit to 20 or 24 mètres lower, where they no longer felt the electrical influences.

3. *Electricity of the snow lying on the soil of the Jungfrau.*—Snow lying on the ground, does not prevent these manifestations; this fact results from the following details. On the 10th of July, 1863, Mr. Watson, accompanied by several other tourists and guides visited the summit of the Jungfrau. The morning was very fine, but on approaching the summit they perceived large clouds piled upon it, and when they had almost reached it, they were assailed by a tremendous puff of wind accompanied with hail. After some minutes they were obliged to make a retreat, and during their descent the snow continued to fall in such a quantity that the little troop, mistaking the direction, travelled for some time in the Latoch-Sittel. They had scarcely perceived their error when they heard a violent clap of thunder, and soon afterwards Mr. Watson heard a kind of whistling which proceeded from his stick. This noise resembled that which a kettle makes when the water boils briskly. They halted and remarked that their sticks, as well as the hatchets with which each was provided, produced a similar sound. These objects did not discontinue their singular whistling even when one end was placed in the snow. Presently one of the guides took off his hat, exclaiming that his head was burning. His hair literally stood on end like that of a person who had been electrified under the influence of a very powerful machine, and all experienced a sensation of pricking and heat in their faces and other parts of the body. Mr. Watson's hair was straight and stiff, a veil which was round another traveller's hat was lifted vertically, and they heard the electrical whistling at the end of their fingers when moved in the air. Even the snow emitted a sound analagous to that which is produced by a sharp hail-storm. There was not, however, any appearance of light, which must have been the case

had it been night. Other claps of thunder suddenly stopped these phenomena, which recommenced, however, before even the grumbling of the clap had been echoed through the mountains. They all experienced an electrical shock, more or less violent, in several parts; Mr. Watson's right arm was paralysed for several minutes till one of the guides pinched it violently with his hand; but he felt a pain in his shoulder for several hours. At last, about half-past twelve o'clock, the clouds dispersed and these effects disappeared, after having been felt for about twenty-five minutes. At Lyons a brisk north wind completely neutralized these stormy manifestations.

4. *Electricity of the Piz Surley.*—A little more to the east are the Grisons which touch Italy, concerning which M. H. de Saussure, whose observations made in Mexico I have already mentioned, has just forwarded to me the following note :—

"The 22nd of June 1865, setting out from Saint Moritz (Grisons) I ascended the Piz Surley, a granitic mountain whose summit, more or less conical, rises to the height of 2300 mètres. During the preceding days the north wind had persistently prevailed; it became variable on the 22nd, and the sky was covered with wandering clouds. Towards noon, these vapours increased, reuniting above the highest, and in other directions keeping high enough not to hide the greater part of the summits of the Engadine, upon which local showers soon fell.

"Their appearance of *dusty vapours* half transparent caused us to think that it was only a shower of hail and snow or sleet.

"About one o'clock at night we were overtaken by a fine sleet, thinly scattered, while similar showers of hail enveloped the greater number of the rocky peaks, such as the Pic Ot, Pic Julier, Pic Languard, and the snowy summits of the Bernina: whilst a violent shower of rain fell in the valley of Saint Moritz.

"The cold increased, and at half past one o'clock P.M., having arrived at the summit of the Piz Surley, the fall of sleet becoming heavier, we prepared to take our repast, near a pyramid of dry stones, which crown the summit. Whilst resting my cane against this construction, I experienced a violent pain in my back, at the left shoulder, which resembled that which would be produced by slowly thrusting a pin into the flesh, and in taking away my hand without finding anything, I felt a similar prick in my right shoulder. Then supposing that my linen overcoat contained some pins, I threw it of; but instead of finding any alleviation, my pains increased, stretching across my back from one shoulder to the other, accompanied by a sensation of tickling, and painful stinging, like that which might be produced by a wasp or some other insect in my clothes riddling me with pricks.

Taking off a second coat I did not discover anything which could have wounded me, while the pain assumed the character of a burn. Without reflecting, I fancied my woollen shirt had taken fire and was going to undress myself completely when our attention was drawn to a noise which reminded us of the humming of wasps. It was produced by our sticks which sang loudly and resembled the noise of a kettle when the water is on the point of boiling; this lasted, perhaps, about twenty minutes. . . . Some moments after, I felt my hair and my beard stand on end, which produced upon me a similar sensation to that which results from a dry razor being passed over stiff hair. A young man, who accompanied me, exclaimed that he felt all the hairs of his moustache growing, and that from the top of his ears there were strong currents. . . . A clap of distant thunder towards the west warned us that it was time to quit the summit, and we descended rapidly for about a hundred mètres. Our sticks vibrated less and less as we descended, and we stopped when the sound had become sufficiently weak, only to be heard by putting our ears close to them. The pain in my back had ceased with the few first steps of descent, but I still retained a slight sensation of it. A second clap of thunder, ten minutes after the first was heard in the west over a considerable distance, and this was the last. There was not any lightning, and half an hour after we left the summit the sleet had ceased and the clouds dispersed. At half-past 2 o'clock P.M. we again reached the culminating point of the Piz de Surley to look for the sun. The same day there was a violent storm in the Bernese Alps, where an English lady was struck by lightning.

"After all, we considered that these phenomena must have extended to all the high rocky points of the Grisons, even to the horizon where there were several stony summits, like that on which we were, enveloped by whirlwinds of sleet, while the high snowy points of the Bernina seemed to have been exempt, notwithstanding the scattered clouds which surrounded them. . . . . On a previous occasion at Nevado de Toluca I had been present at scenes of the same kind, but much more severe, on account of its tropical situation and its height of 4548 mètres.

"However, in bringing together different observations, many points in common can be distinguished amongst them, viz., 1st. The flow of electricity from the culminating rocks is produced under a stormy sky covered with low clouds, enveloping the summits or passing at a very little distance above them, but without there being any electrical discharges in the neighbourhood of the place where the continual flow is manifested.

"2nd. In each of the cases observed the summit of the mountain was enveloped in a shower of sleet, from which it might be inferred that the continual flow of electricity from the ground towards the clouds helped in a great degree to their formation. Thus, during the observation of the 22nd of June, 1865, in particular, all the rocky points were under the same meteorological conditions, while the valleys situated between the points received violent showers of rain.

"However we must take into account the higher temperature of the hollows, where sleet about to fall turns into rain. M. de Charpentier long ago pointed out the importance of this fact, and with sleet or snow, the results must be the same.

"ELECTRICITY OF THE JURA.

"5. *Electricity of meadows near Courtavon.*

"An instance of *meadow lightning* has been observed in the neighbourhood of Porentury, at the foot of the Jura and near Courtavon. About 100 mètres above the valley, stands the ancient castle of Morimont, the restoration of which has been entrusted to the Engineer of the mines, Quiquerez de Délémont, a man well-known by his splendid mining and archæological works. Being engaged with directing his workmen, on the 26th of August, 1865, he was overtaken by two successive storms between nine and twelve o'clock. At three o'clock in the afternoon there was a third, when the clouds were very low down. Electricity was then exhibited in a frightful manner over the whole extent of the adjacent meadows; sparks succeeded each other in rapid luminous trains passing over the grass instead of through the air. The general noise was such that the individual cracklings were not distinguished. It did not rain; but the observers were almost in the clouds and were all drenched with the morning showers.

"During this journey, three or four leagues east of Morimont and on the continuation of the Jura chain, but a few minutes later, lightning was remarked which ran over the fields and meadows, as if the earth was all on fire. Thus M. Quiquerez was not the only one who observed this phenomenon, and I may add that the storms extended to Lyons.

"6. *Electricity of the lakes near Neufchâtel.*

"Discharges of the same kind are manifested on lakes, and M. Arago has already noticed the fact in a pond at Parthenay (Vendée) in his *Notice sur le tonnere*, page 371.

"The Swiss Société d'Histoire saw an example, on the 2nd of August, 1850, while sailing on the lake of Moret about eight or nine o'clock at night. They then heard thunder at Montbéliard, Châlon, and Bourg.

"Also on the lake of Bienne, the boatmen of Nidau thought on one occasion that they were crossing a sheet of fire."

NOTES ON THE CRUSTACEAN FAUNA OF THE ENGLISH LAKES.

BY GEORGE STEWARDSON BRADY, M.R.C.S., C.M.Z.S.

(With a Plate.)

Having, during several short rambles amongst the mountains of Cumberland and Westmoreland, paid considerable attention to the microscopic Crustacea which inhabit the numerous lakes and tarns of that district, I propose, in the following pages, to offer a few remarks relative chiefly to the distribution and habitat of the various species, and also to describe briefly two or three new or little-known forms. And though I take the group known as *the* English lakes, *par excellence*, for the groundwork of my remarks, I shall also include therein to some extent the lakes of Northumberland, Dumfriesshire, Selkirkshire, and Kirkcudbrightshire, amongst which I have spent many pleasant days with net and collecting bottles. The lakes included in this programme may indeed be looked upon as forming in themselves a pretty well-defined group intermediate between those of the Scottish Highlands on the one hand, and of the Southern English Lowlands on the other. Whether the Crustacea of the more northern Scottish waters differ materially from those of the south cannot now be stated, as they have yet received scarcely any attention; but from all that we know of the lacustrine Crustacea of the English Lowlands, it may confidently be asserted that the difference is here very great indeed.

And it may be interesting to tourists with a love for natural history (but who begin to find the geology, botany, and mineralogy of our islands worn somewhat threadbare, so far as the discovery of new things is concerned) to know that the microscopic Crustacea of our ponds and lakes, and especially of *mountain* lakes, are sure to afford novelties to the diligent observer for many a year to come. Not that the discovery of new species ought to be the chief ambition of the naturalist, nor that even this may not yet be done by the hard-working botanist or geologist; but there is, nevertheless, a legitimate pleasure in discovering and describing forms of life which have been hitherto unknown; and in no branch of investigation are we, perhaps, more likely to find it, than in that of which we are here treating.

The higher groups of Crustacea (Amphipoda and Isopoda), which are abundantly represented in lowland ponds and streams by such creatures as *Gammarus pulex* and *Asellus aquaticus*—animals of the sandhopper and woodlouse type—are scarcely to be found in mountain lakes, though we occasionally meet with them in very small bog-pools on the hill-

British Lacustrine Entomostraca.

sides, where there is a rank vegetation of Sphagnum and water-grasses. Very probably, however, in the more sheltered and weedy portions of the larger lakes they would be found; but be this as it may, the microscopist will be disposed to think that their "room is better than their company," as they have neither rarity nor beauty to recommend them. G. O. Sars and other naturalists have, in some of the large lakes of Sweden, obtained some curious *marine* Amphipoda by dredging, thus affording an interesting confirmation of the fact, that the Scandinavian peninsula is slowly rising from the sea; and though similar discoveries might not reward the naturalist in our English lakes, it would still be worth while to try the fortune of the dredge in some of them.

The Crustacean inhabitants of our lakes belong, then, almost exclusively, to the order Entomostraca; and of the three divisions of that order which constitute the great bulk of the British fresh-water species (Cladocera, Ostracoda, and Copepoda) the Ostracoda are, on the whole, very poorly represented. One very common species, *Cypris ovum* (Jurine), exists in almost every collection of water, from the lowest to the most elevated; and in company with it, very often, a closely allied species, *C. lævis*, Müller. *Cypris compressa*, Baird, is of rather rarer occurrence; while in Loughrigg Tarn, and some of the small lakes of south Northumberland, I have found a very fine species (*C. obliqua*, Brady), which is closely related to, if not identical with, *C. elliptica*, Baird. *Notodromas monachus* (Müller) occurs abundantly in many of the lochs of Selkirkshire and Dumfriesshire, as also a little member of the family Cytheridæ, *Limnocythere inopinata*, Baird, which is probably much more common than it appears to be, but may very readily be overlooked, owing to its minuteness, and to its living almost entirely amongst mud.

The group Copepoda includes several lacustrine genera—Diaptomus, Cyclops, and Canthocamptus—but the various species have not as yet been adequately investigated.

The third great division, Cladocera, is much more numerously represented, and, so far as mountain districts are concerned, forms much the most interesting section. It is not needful or desirable to occupy the pages of this magazine with technical descriptions of these species, especially as a monograph of the more important families, comprising descriptions of all the species, has recently been published, and is easily accessible to all who are interested in the subject.* My

* "A Monograph of the British Entomostraca, belonging to the families Bosminidæ, Macrothricidæ, and Lynceidæ." By the Rev. A. M. Norman, M.A., and George S. Brady, M.R.C.S., C.M.Z.S. With six plates. London: Williams and Norgate. 1867.

purpose here extends only to the description of certain forms found since the publication of the monograph referred to, and to the presentation of a few observations relative chiefly to distribution. And before proceeding to notice the various species seriatim, a few general remarks will not be out of place.

In considering the question of altitudinal distribution, it is quite possible that we might arrive at erroneous conclusions, owing to the mixing up of other accidental circumstances not connected solely with elevation. We find that Entomostraca are usually most abundant where there is a profusion of vegetation; in little sheltered bays, margined with sedge and rushes, and bearing luxuriant beds of Myriophyllum, Potamogeton, or other water-plants—lovely little inlets, which we may find plentifully on the shores of Windermere and Derwentwater. And when we notice that in elevated tarns the number, both of species and individuals, is comparatively small, it is well to remember that this may partly depend upon the fact that these sheets of water are mostly, owing to their exposure and want of shelter, almost entirely destitute of vegetation, except of a very stunted kind; so that the poverty of the fauna is doubtless dependent partly on these causes, and only indirectly through them on elevation and temperature. For it is not unusual to find in pools close to the margin of some lake a Crustacean fauna totally different from that inhabiting the lake itself. Thus, in some pools on the shores of Ennerdale Water, which had formed, apparently, in the hollows left by turf-cutters, and were filled with Myriophyllum, Utriculariæ, and Potamogetons, I took an astonishing number of various Daphniæ, Lyncei, etc.—seventeen species in all; while along the whole length of Ennerdale Lake itself I could not succeed in capturing a single specimen of any kind. But the margins of this lake are excessively barren and stony; so much so, that in walking along its northern shore I could not detect a single patch of weed, and the net, when put into the clear water, collected nothing but little masses of spawn—of what animal I do not know. Still, I have no doubt that a prolonged search might have revealed spots more favourable to microscopic life, and that, even where no vegetation existed, Entomostraca might perhaps have been found—if not then, under other conditions of water or atmosphere. For vegetation does not appear to be absolutely essential to the lower forms of animal life. I have taken various Entomostraca in water where no vegetation, at any rate, higher than Diatoms or Desmids, existed; but in such situations they are always scanty, if existent at all, and the number of species capable of living under such conditions seems to be very limited.

In Ennerdale Water, however, this paucity of animal life would appear to be distinctly the result of lack of vegetation: it cannot be dependent on elevation, for the level of the lake is only 369 feet above the sea, and, as has been noticed, the pools close to it swarmed with life. It may be noted also that the members of the family Daphniadæ scarcely ever occur, except where there is abundance of vegetation, while the Lynceidæ seem to thrive well on a stunted cover of *Lobelia Dortmanna* or *Isoetes lacustris*.

It may be interesting here to place side by side (as types of the very wide difference existing between the Crustacean faunas of weedy pools of low elevation, and exposed mountain tarns of great elevation) lists of the Entomostraca obtained in two such localities.

Pools in Ennerdale: height above the sea, 370 feet.—*Daphnia reticulata, D. pulex, D. mucronata, Acantholeberis curvirostris, Ilyocryptus sordidus, Sida crystallina, Bosmina longispina, Lynceus harpæ, L. quadrangularis, L. elongatus, L. truncatus, L. globosus, L. barbatus, Eurycercus lamellatus, Diaptomus castor, Cypris lævis, C. ovum.*

Angle Tarn, under Bowfell: height, 1553 feet.—*Bosmina longispina, Lynceus elongatus, L. guttatus, L. exiguus, L. testudinarius, L. sphæricus.*

Daphnia Jardinii, Baird (Figs. 9, 10).—This curious species has, I believe, not been previously figured; and, indeed, I am not aware that it has been noticed by any observer, except Dr. Baird (Edinburgh, New Philosophical Journal, vol. vi., 1857, p. 24). I took three or four specimens in Rydal Water in 1864, and from one of these the drawing given in the accompanying plate was made. Its claim to specific rank may, however, be reasonably doubted. The produced vertex, by which it is chiefly distinguished from *Daphnia pulex*, is known in the case of *D. mucronata* to be a variable character, and the form known as *D. cornuta* is acknowledged to be merely a variety of the latter species. *D. Jardinii* is indeed smaller and more slenderly formed than is usually the case with *D. pulex*, but I am not able to discover from my specimens any specific character more valid than that already referred to, nor does Dr. Baird's description indicate any such. On the other hand, it should be stated that the three specimens preserved in my collection all have the cephalic cornua, though of variable size and shape, and I do not remember that any specimens of the normal *D. pulex* occurred in company with them. The length of my largest specimen is one-sixteenth of an inch, exclusive of the posterior spine.

Daphnia pulex (Lin.) and *D. vetula* (Müll.) occur commonly in lowland pools; and in the peaty hollows in Ennerdale, already referred to, I found also *D. mucronata* and *D. reticulata*, the latter in very great abundance. But in pools of this kind occurring at a greater elevation, the Daphniæ seem to give place to another member of the same family—*Acantholeberis curvirostris*—which will presently be noticed.

Sida crystallina (Müll.) occurs plentifully amongst reeds and rushes round the margin of lakes, but does not, apparently, reach any great elevation.

Acantholeberis curvirostris (Müll.).—This species is not uncommon throughout the British islands in pools of peaty water, ranging from near the sea-level to considerable elevations. It does not so often occur in clear lakes and tarns. Sprinkling Tarn, and Crag Lake, Northumberland, are the only such localities in which I have any record of its occurrence.

Ilyocryptus sordidus (Liévin).—A rare and curious species, of which I found two specimens in my gathering from the peaty pools in Ennerdale. It had previously been found, though very sparingly, in two situations in Northumberland and Durham.

Drepanothrix hamata, G. O. Sars, is of not unfrequent occurrence in the upland districts of the north of England and south of Scotland, frequenting lakes and clear water. In the Lake district, I have found it in Rydal Water, Blea Tarn (Langdale), Little Langdale Tarn, and Easdale Tarn.

Polyphemus pediculus, Müll., though common in the moorland lochs of Northumberland and southern Scotland, is not so in the Cumberland district, the only lake in which I have found it being Derwentwater.

Bosmina longirostris (Müll.) and B. longispina, Leydig, occur, one or both of them, in almost all pieces of water in the Lake district. The males of these animals differ remarkably from the females in having the anterior antennæ connected with the body by a sort of ball-and-socket joint, and in the tapered form of the abdomen. This sex is, however, rarely met with; the only place in which I have found it being a small rushy tarn on some hills, called the Humbles, on the north-western border of Northumberland. This pool contained abundance of the Bosmina, but scarcely any other species; and I found this to be the case also in a somewhat similar situation on the northern slope of Mickle Fell, in Yorkshire; but in this latter case my gathering contained no males.

Lynceus harpæ (Baird), a very common species in almost all clear pieces of water throughout the kingdom, and on the continent of Europe, seems little affected by elevation, being met with in almost all the pools, lakes, and tarns of the Lake district.

Lynceus macrourus, Müll., is much rarer than the preceding species, to which it bears a striking general resemblance. Buttermere, Derwentwater, and Blea Tarn (Langdale) are the only localities in the Lake district where I have met with it. It seems to be a lowland rather than an alpine species.

Lynceus quadrangularis, Müll., is still more decidedly of lowland proclivities, being quite one of the rarer species in mountainous districts, but almost the commonest of British Lyncei in the plains. I have taken it, however, sparingly in Grasmere, Easdale Tarn, Derwentwater, Blea Tarn (Langdale), and in pools in Ennerdale. Its place in the waters of the lowlands seems in mountain regions to be usurped by the following species :—

Lynceus elongatus (G. O. Sars)—Fig. 8—which may be looked upon as the form most characteristic of mountain lakes, its strongholds being bleak, elevated sheets of water, such as Stickle, Angle, and Sprinkling Tarns, while at low elevations, and especially in small pools, it is much scarcer. In the lowland and southern districts of England it is not at all met with. When living in high, bleak tarns, it is often of a very deep, opaque brown colour, verging on blackness, and sometimes appears to be almost the only animal inhabitant of the water; but in lower and more sheltered situations it to a great extent loses its deep colouring. A very remarkable peculiarity of *L. elongatus* is that the carapace, though normally consisting of two valves, like all the rest of the genus, is very often found to be made up of two or three pairs of valves superimposed one on another. This condition is seen in the specimen represented at Fig. 8 of our plate, the six layers of carapace being plainly indicated by the minute tooth at the lower posterior angle of each. In this condition the edges of the several valves occupy very various positions. Sometimes all three (and I have never seen *more* than three) are pretty close together, as in the figure; at other times the edge of the uppermost comes nearly in the middle of the animal. It is remarkable, too, that the several coats do not separate in the process of exuviation, for the sloughs, which are often taken in great numbers along with the living animals, constantly show the several valves in union just as when alive. I cannot yet say whether the young are born in the multivalvular state, or whether it is a result of growth, but in every copious gathering of *L. elongatus* many specimens in this condition are sure to occur, and in some they form almost the greater part of the whole. This is the more interesting when considered in relation to a very curious species of the same family, *Monospilus tenuirostris*, one striking character of which consists in a somewhat similar but much more pronounced multiplication of valves; and the question suggests itself—do we, in the case of *L. elongatus*, see a species which is undergoing a gradual transformation in the same direction?

L. elongatus occurs in all the gatherings which I have made in the Lake district, and is frequent also in similar situations throughout the north of England and Scotland.

Lynceus costatus (G. O. Sars), seems to be a tolerably common inhabitant of lakes and clear water in moderate altitudes, but is seldom found in more elevated and exposed situations. Buttermere and Derwentwater are the only two localities in our Lake district where I have met with it.

Lynceus gutattus (G. O. Sars).—Well marked forms of this species are undoubtedly very distinct from the foregoing, but I am disposed to doubt whether the differences ought not to be regarded as varietal rather than specific. It is not uncommon in similar situations, ascending, however, to greater altitudes, and ranging from the sea-level to a height of 1553 feet (Angle Tarn). The following are the lakes in which I have met with it: Buttermere, Thirlmere, Easdale, Langdale, Angle and Sty Head Tarns.

Lynceus testudinarius, Fischer, is a widely distributed and very well marked species, and appears to haunt indifferently water of all degrees of exposure and elevation. It occurs in my gatherings from Buttermere, Langdale, Angle and Sty Head Tarns, and from pools on Eskhause, at an elevation of about 2000 feet.

Lynceus exiguus (Lilljeborg).—A very small, but well marked species, occurring in almost all the waters of the lake districts, but more commonly in those of considerable altitude. I find it in Buttermere, Thirlmere, Derwentwater, Easdale, Langdale, Sprinkling, Sty Head, Stickle, Angle and Floutern Tarns, and in the river Brathay, below Skelwith Bridge.

Lynceus truncatus, Müller, is a common species in the low country, and at moderate degrees of elevation in the lake district, but is not so frequent in the higher mountain tarns, the greatest height at which I have found it being 915 feet (Easdale Tarn). It occurs also in Windermere, Grasmere, Rydalwater, Derwentwater, Langdale, and Blea Tarns; in pools in Ennerdale, and in the River Brathay.

Lynceus uncinatus (Baird).—This species is at once known by the upturned extremity of the rostrum and strongly toothed infero-posteal angle. Buttermere is the only one of the lakes in which I have found it.

Lynceus nanus (Baird), the smallest of the British Lyncei, occurs at all altitudes. I have noticed it in Buttermere, in Floutern, Blea, Sprinkling, and Sty Head Tarns, and in pools on Eskhause and Honister Pass.

LYNCEUS GLOBOSUS (Baird). (Fig 7.)—One of the finest, and by no means one of the commonest of the British species, living always in clear water, where there is abundance of vegetation, and mostly in situations of no great altitude. In the lake district it inhabits Windermere, Grasmere, and pools in Ennerdale. From a specimen taken in the latter place our figure has been drawn. The shell, when closely examined, after the internal parts of the animal have been removed, is seen to be regularly reticulated throughout, but on the ventral margin the reticulations partially coalesce, so as to form concentric furrows. In the living state these markings are a good deal obscured, and give rise to an appearance of dotting or scaliness which does not really exist.

LYNCEUS BARBATUS, nov. sp. (Figs. 1, 2).—Carapace subsemicircular; dorsal margin boldly arched from the postero-superior angle to the extremity of the rostrum, which is long, slender, and acutely pointed, and projects beyond the ventral margin; ventral margin gently convex, fringed with spiniform hairs which commence about the middle, and gradually increase in length to the posterior extremity, where they end abruptly; posterior margin slightly angular above, rounded off below; anterior antennæ slender, about half the length of the rostrum; abdomen broad and short, superior margin deeply excavated, superior posteal angle produced and obtusely rounded, armed with about nine long and nearly equal spines, terminal claws slender and bearing a single small spine at the base; eye-spot situated nearer to the eye than to the extremity of the rostrum, and about half its size; shell devoid of reticulation or striation, but slightly waved round the margin, especially on the dorsum. Length one fifty-fifth of an inch.

This is a very distinct, and apparently a rare species. I have seen only four specimens, three of which were taken in Buttermere, and one in a pool in Ennerdale.

LYNCEUS SPHÆRICUS, Müller—(Fig. 6)—is found everywhere, from the smallest road-side pool to the most elevated mountain tarns, but is most abundant in somewhat foul and stagnant water.

Var. FAVOSA (Figs. 3—5).—Closely allied to the last, and almost exactly similar in shape, except that the rostrum is perhaps somewhat longer and more slender. The markings of the carapace are, however, entirely different, consisting of very deep and conspicuous irregularly angular excavations, which are restricted to the head and the inferior and posterior portions of the carapace. The margins of the valves are always entirely free from these markings, but their distribution over the other portions is somewhat variable, and the parts not thus marked are quite devoid of reticulation, or any perceptible structure, as represented in Fig. 5. In the typical form of *L. sphæricus*, on the other hand, the surface is regularly, but faintly reticulated, as shown in Fig. 6. This is most plainly seen in young specimens, but in older examples is often visible on the margins only, while the margins of the valves in the variety *favosus* are always, as has been said, quite destitute of sculpture. Length one fifty-eighth of an inch.

This form occurred plentifully in some small peaty pools on Eskhause, at an elevation of about 2000 feet. The peculiarities of shell sculpture lead me to suspect that it may be a distinct species, though it must be confessed that in other respects there is little or nothing to distinguish it from *L. sphæricus*.

Eurycercus lamellatus (Müller) is common in all the low-lying lakes, but does not apparently inhabit those of great altitude. The only tarns in which I have found it being Langdale (340 feet) and Easdale (915 feet).

EXPLANATION OF PLATE.

Fig. 1.—*Lynceus barbatus*, nov. sp., female, x 84.
Fig. 2.—Abdomen of the same, x 210.
Fig. 3.—*Lynceus sphæricus*, *var. favosa*, female, x 84.
Fig. 4.—Abdomen of the same, x 300.
Fig. 5.—Exuvium of left valve, showing sculpture, x 84.
Fig. 6.—Marginal reticulations of *Lynceus sphæricus*, x 210.
Fig. 7.—*Lynceus globosus*, female, x 50.
Fig. 8.—*Lynceus elongatus*, female, multivalvular form, x 50.
Fig. 9.—*Daphnia Jardinii*, female, x 25.
Fig. 10.—Abdomen of the same, x 40.

THE PHILOSOPHICAL INSTRUMENTS IN THE PARIS EXHIBITION.

BY C. R. WELD.

AMIDST the vast gathering of products of human industry and invention, which attracted millions of visitors from all countries to the French metropolis this year, the objects classed under the head of Philosophical Instruments hold very high rank. For it is, to a great extent, by the agency of these instruments that the present generation enjoys comforts and luxuries wholly unknown to the early inhabitants of our globe.

While contemplating with feelings of wonder and awe the pyramids of Egypt, we cannot but remember that though they are stupendous monuments of the former rulers of that country, they are also monuments of slavery and drudgery, for by brute force were they heaped up, thousands of toilers and long years being required to do that which now, by the aid of machinery, could be effected in a few months. When the inhabitants of a country are condemned to unceasing labour, progress for the race is impossible. "How," remarks Solomon, thinking probably of the slavery of the nations around him, "shall he that toileth all day long have knowledge," and assuredly the more that we can make machinery perform offices of manual labour, the more will man be raised in the scale of civilization, provided always, that with the leisure thus afforded him, suitable education is provided. For, just in proportion as the exertions of those who toil are aided and systematized by the employment of force-evolving machines, will there result surplus wealth, more and more leisure for all, an educated class spreading wider and lower; in a word, all that is man's proper destiny—progression in happiness.

How greatly machinery is indebted for its perfection to philosophical instruments is well known. Mr. Fairbairn, the eminent engineer, says that when he first went to Manchester, the whole of the machinery required for the mills in Lancashire was made by hand. Now tools, which may be almost regarded as philosophical instruments, so exquisitely accurate and highly scientific is their construction, are employed for this work. The high character of modern British machinery is due to the great pains bestowed on the tools used for its fabrication, a large proportion of which are made by Mr. Whitworth. With the wonderful measuring machine invented by this gentleman, demonstrating the one-millionth of an inch,* and his true plane,

* Mr. Whitworth has presented one of these really marvellous machines, and three of his true planes to the South Kensington Museum.

he is enabled to produce tools of an accuracy hitherto unknown, while these in their turn create machinery which has contributed largely to make our country famous and wealthy.

But philosophical instruments embrace a wide range of utility. By their aid we are enabled to explore with safety deep mines pregnant with the fierce fire blast, the astronomer guages the heavens, and guides the mariner over the pathless ocean, and the wonderful phenomena of light, heat, and sound, are examined and made to minister to the wants and comforts of mankind.

The Official Catalogue of the Paris Exhibition enumerates 490 exhibitors of philosophical instruments. At the Exhibition of 1862, the number was 351. Looking at the countries of the former exhibitors, we cannot help being struck by the spread of philosophical science over the globe. For, while the exhibitors of scientific instruments at the International Exhibition of 1862 came, with few exceptions, from well-known countries, several at the Paris Exhibition represented nations which we have hitherto regarded as but semi-civilized.

As astronomical instruments show mechanical progress and invention in their most refined development, we shall commence with them. The instruments of this description by no means represented the high perfection to which their makers have attained. This, however, is not surprising. Astronomical instruments are, as a rule, far too valuable to be sent to an Exhibition. There were, nevertheless, some fine equatorials exhibited.

The largest of these instruments was constructed by Brunner, of Paris, for the Boulik Observatory in Egypt. The object-glass is 8·4 inches in diameter, and it is provided with a very perfect clock movement.

Mr. Dallmeyer also exhibited an excellent six foot equatorial with a 5 inch object-glass. A notable feature of this fine instrument is that the same clock sets two circles in motion, one of which shows sidereal time, while the other moves the telescope. M. Evrard, of Paris, exhibited a large astronomical telescope with a 9·2 inch object-glass, but the performance of this instrument was not equal to that of Mr. Dallmeyer, which on competitive trial was found to be the best refracting telescope in the Exhibition. The superiority of this, and other English astronomical instruments, is partly due to the excellence of the optical glass made by Messrs. Chance, of Birmingham. These gentlemen, and M. C. Feil, of Paris, manufacture the best optical glass.

Reflecting telescopes, which have been highly instrumental in enlarging our acquaintance with the heavenly bodies, and especially with the nebulæ, were very poorly represented. One, however, exhibited by Secretan, of Paris, was in all respects a most excellent instrument. The chief interest consisted in the speculum, which was one of Foucault's.

Instruments made upon this principle by English artists are so well known to readers of THE INTELLECTUAL OBSERVER, that I need not dilate upon their merits, or explain their construction.

The display of mounted and hand telescopes for military, naval, and travelling purposes, was extremely large and excellent. The most important novelty in these instruments was to be seen in those exhibited by T. Ross and Dallmeyer. Their focal length is only from nine to ten times the diameter of the clear aperture; notwithstanding which, they combine excellent definition with great portability. Messrs. Beck exhibited new and very ingeniously constructed binocular telescopes with which some extremely interesting features connected with binocular vision can be examined. A vast variety of binocular opera-glasses were exhibited by various makers. The low prices of M. Bardou's small telescopes and opera-glasses considered in connection with their excellence, is astonishing. He manufactures enormous quantities of these instruments for England, where they obtain a ready sale.

France and Prussia made an extremely fine display of alt-azimuth, meridian circles, and transit instruments. Those exhibited by Brunner of Paris were highly remarkable for combining the great desiderata of lightness and rigidity, and for being applicable either to astronomical or geodisical purposes, both circles being read off by means of micrometer microscopes. The graduation of these instruments was excellent; instead of the figures being cut on brass or silver, they are white on a black ground, and can be read with very great ease.

To no new discovery are philosophical instrument makers more indebted than to aluminium. This light and beautiful metal is peculiarly suited for astronomical instruments. Besides its great lightness, it is extremely rigid, and but little liable to tarnish. Many instruments in the Exhibition were made of this metal, and particularly of bronze aluminium. This is composed of ten parts of ordinary aluminium, and five of copper, and it possesses a strength both vertical and transverse far exceeding that of wrought iron. This metal is especially valuable in the manufacture of sextants, which require to be held in the hand, and often for a long time. Bearing in mind how highly important a part the sextant plays in navigation, it is lamentable how worthless a large proportion of those instruments are. Happily, however, great pains have been lately taken by philosophical instrument makers to improve them, and with considerable success. The show of sextants at the late

Exhibition was excellent. The great desideratum of attaching an effective artificial horizon when the sea-line is obscured, may be said to have been attained. Eminent makers of optical instruments will always supply a good and reliable sextant; but we may observe that no English mariner need now go to sea in doubt respecting the performance of his sextant, as the British Association for the Advancement of Science have organized measures by means of which sextants can be efficiently tested at the Kew Observatory.

The surveying instruments exhibited were greatly superior to those at the Exhibition of 1862. With the theodolite, which is certainly the fittest instrument for measuring terrestrial angles with precision, and which has displaced the separating circle on the continent, very great pains have been taken to obtain precision with compactness. The theodolites exhibited by London, Paris, Berlin, and Vienna makers were admirable, as also were those shown by J. Kern of Aarau in Switzerland, who employs many hundred hands in making these and other instruments. The Industrial Institution of Lisbon also exhibited several well-made theodolites. A very ingenious stenographic and orthographic machine was exhibited by Cavaliere Rossi of Rome, with which he has made a very trustworthy survey of the catacombs under and around that city. A very good display of telemeters and planimeters was made by France and Prussia, both of which nations have used these instruments extensively in field operations during war.

A very large display by various countries was made of mathematical and drawing instruments. Those exhibited by Elliott Brothers, maintain in all respects the high character of their house. Excellent instruments of this description were also exhibited by Gravet-Tavernier of Paris, J. Kern of Aarau, and Haff of Munich. The extremely low price of the instruments by these makers, as compared with those made in England is very remarkable. The Swiss and Bavarian makers sell a magazine case of excellent instruments containing a beam compass, proportional compass, six pairs of ordinary compasses of various dimensions, several excellent drawing pens, graduated rulers, sectors and protractors, all in electrum metal, for £3 18*s.* The United States of America, which formerly imported nearly all their dividing-engines and mathematical instruments, now manufacture largely and well. The instruments exhibited by Darling, Browne, and Sharpe, of the above country, are admirable. The accuracy of their steel straight-edges is very great, and the divisions on all their scales, which are effected by machinery, are extremely clear and accurate. These articles are manufactured very largely for the engineering establishments of the United States, and also for the English market.

Several excellent cathetometers were exhibited. The most delicate were those made by Bauer, of St. Petersburg, under the direction of Professor Jacobi, and by Perreaux and Guillemot of Paris. These instruments show with great accuracy the distance between two points in a vertical line to the 0·0002 of an inch. A pantograph contrived by M. Gavard of Paris, who has long been engaged in perfecting this instrument, was highly deserving of notice for the new application that it involves. By its means duplicate figures can be engraved on several copper cylinders, and impressions taken from them. The invention is likely to be introduced in the calico printing trade.

The great attention devoted during recent years to meteorology has led to considerable improvements in instruments for registering meteorological phenomena. The exhibition of these in Paris was very complete, comprising a great variety of barometers, thermometers, anemometers, rain-gauges, etc. By far the most important exhibition in this department was that by Padre Secchi, Director of the Observatory in the Collegio Romano, who showed his automatic meteorological apparatus, invented, and almost entirely constructed, by himself. This, which is by far the best apparatus of the kind in existence, registers, by means of curves traced on paper, the temperature, pressure of the atmosphere, direction and force of the wind, amount of rain, and humidity. The apparatus, which is acted on by clockwork and voltaic currents, performs admirably, and its registrations are worthy of the greatest confidence. The construction of this elaborate and highly ingenious apparatus is most creditable to Padre Secchi; and the more so, as he derives very little assistance from Government funds. A new barometer was exhibited by the inventor, Mr. Clum, of the United States. He has called it the Aëlloscope Barometer, from *αἔλλα*, storm, and *σκοπε*, to view; its object being to indicate the powerful atmospheric vibrations which precede storms. It is certainly extremely sensitive, but so complicated and costly, that it is not at all likely to come into general use. The lowest price of this instrument is 1000 dollars. A new mercurial barometer, of a very sensitive nature, and extremely portable, was exhibited by Messrs. Beck. It has been tested to a height of 14,000 feet, and found to be extremely accurate.

The Aneroid Barometer,* which has become a very trust-

* This instrument was invented by Conté (known for the drawing-chalks which bear his name), when he was director of the Aerostatic Establishment at Meudon, founded by the first Napoleon for campaigning purposes. Conté was desirous to make a barometer that should be smaller and less liable to injury, than the usual mercurial instrument; but though he constructed that now known as the Aneroid, he was not able to make it sufficiently precise to be depended upon, and thus left it for Vidi and others to perfect it.

worthy instrument, has, in the hands principally of Naudet, of Paris, been still further improved, and especially those intended for pocket use. Bourdon's metallic barometers, composed of coiled tubes exhausted of air, and hermetically sealed, have also been considerably improved, principally by Richard, of Paris, who states that they now require no correction.

A great variety of excellent thermometers were exhibited, principally by foreign makers. No important improvement was, however, apparent. Those made by Reverend, of Paris, are remarkable for their clear and well-cut graduations. Mr. Bache, of the United States, exhibited a deep-sea thermometer of novel construction, for registering the temperature by the action of metal bars. M. Bréguet's metallic thermometer has been further improved, so as to render it more sensitive. This instrument has been lately used by Mr. Wheatstone, in connection with his invention for ascertaining the temperature at distant places by telegraphy. By means of magnets and connecting wires, a Bréguet thermometer, placed on the summit of Mont Blanc, can be read off at Chamouni, or the temperature at great depths in the earth or ocean ascertained in the same manner at any moment.

Electricity, and especially electro-magnetism, was largely illustrated. The apparently inexhaustible applications of this mysterious force are continually taxing the inventive power of man. The grand desideratum, however, of obtaining a motive force which shall supersede that of steam has not yet been discovered, the few machines of this nature in the Exhibition being at once weak and costly. The great mechanical difficulty which prevents the application of electro-magnetism as motive power in prime movers is the short distance through which the action of magnetism extends. This has been sought to be overcome by calling into action, *seriatim*, a number of electro-magnets. It is possible by this means to work a crank of one or two inches in length with sufficient power to turn a small lathe; but it admits of easy demonstration that an electrical machine, with zinc for its fuel and acid to burn it, cannot be made to rival steam-engines.

Mr. W. Ladd exhibited a very ingenious and energetic electro-magnetic machine, embracing the new principle of augmenting indefinitely the power of an electro-magnet by currents produced by itself. The apparatus can be employed for lighthouses, or other purposes. It is driven by a one-horse power steam-engine, by which force effects are produced quite equal to a fifty Grove's battery.*

Very beautiful illustrations were exhibited of the application

* Mr. Saxby has lately discovered that by passing electro-magnetic currents through masses of iron, internal flaws in the iron can be unfailingly detected.

of the laws of electro-magnetism to astronomical purposes. The Americans were among the first to apply them to determine the difference of longitude at various places. The most interesting object in this department of electricity was Professor Bond's astronomical clock and chronograph, which were used for ascertaining, in connection with the Atlantic Telegraph Cable, the difference of longitude between Newfoundland and Valentia. The apparatus of this clock and chronograph are so contrived, that the precise epoch of an observation can be registered to the one-fiftieth part of a second. Such is the wonderful accuracy of observation to which modern science has attained. As appertaining to this apparatus, Sir W. Thomson's ingenious electro-dynamometer may be noticed, which was exhibited by Messrs. Elliott. Sir W. Thomson has been long engaged in perfecting this instrument, which was of signal use in laying the Atlantic Telegraph Cable; and he has lately constructed one of such delicacy, as to be capable of measuring differences of *potential*, ranging from one-four-hundredth of a Daniell's cell up to 100,000 cells.

The best chronoscopes and chronographs were exhibited by France. The principal use of these instruments is to determine the velocity of projectiles by electricity, and to register the precise time at which an astronomical observation is made. Those constructed by E. Hardy for the French Government are admirable specimens of mechanical ingenuity.

A very clever contrivance for engraving by electricity was exhibited in the machinery department. A metal plate, having the design which is to be engraved drawn on it with a particular kind of ink, is slowly rotated, while several other plates, on which the design is to be engraved, are also slowly rotated. The engraving is then effected by applying a diamond cutting-point to the face of each plate, which is pressed against it, through the agency of an electrical current, whenever a blunt point presented to the first plate encounters the ink, but is withdrawn at other times. The point presented to the first plate is a feeler which determines by electrical agency whether there is ink beneath it or not. If there is, the diamond points opposite to all the other plates are pressed in; if there is not, they are withdrawn, and do not act.

A new and powerful electrical machine was exhibited by P. Töpler, of Riga. It acts on the principle of multiplying induction resulting from a series of glass parallel discs rotating rapidly. The sparks produced by this machine are very numerous and powerful. France exhibited a great variety of magnificent magneto-electric apparatus, constructed for the Ecole Polytechnique by Nollett and Ruhmkorff. The best application of electricity for the production of electric light was exhibited by M. Serrin, whose electric lamps for lighthouses are now in general use in France. This light is so intense, that it has been used with great success to obtain photographs of the catacombs under Paris. The applications of electricity to telegraphy and horology were well represented, but they were not included in the department of philosophical instruments. A whimsical application of magneto-electricity was exhibited by Trouvé, of Paris, in the form of various quaint figures, mounted as pins, etc., which are set in motion by miniature electro-magnetic apparatus.

The beautiful and interesting phenomena of diffraction and polarization have caused many ingenious contrivances to be invented for their display and examination. By far the best and most complete polarising apparatus was that exhibited by Duboscq and Bertaud, of Paris.

One of the most interesting novelties in philosophical instruments is the spectroscope, which has made us acquainted with several new metals, and to a great extent with the solar photosphere. The startling success that has attended these philosophical investigations has led to the spectroscope being greatly improved. Extremely fine instruments of this description were exhibited by France. The most remarkable in all respects was that shown by Duboscq. The beam in this instrument is successively transmitted through six prisms of sixty degrees, by which means the separation of the bands of the spectrum is greatly increased. By an ingenious contrivance these prisms can be easily moved in combination.

The recent exhibition, like that of 1862, has been very complete in its display of microscopes, accessory apparatus, and objects. It is gratifying to be able to record that our country maintaimed its pre-eminence in these valuable instruments. The microscopes of Messrs. Beck, T. Ross, and Dallmeyer were found, on trial, to be the best exhibited. As was to be expected, the binocular microscope is gaining rapidly in estimation. The principle generally adopted is that of Mr. Wenham's, admirable specimens of which were exhibited by several makers. While willingly testifying to the great excellence of our English microscopes, it is very satisfactory to be able to add that the microscopes exhibited by continental makers were in all respects superior to those exhibited by the same makers in 1862. The microscopes of M. Hartnack, of Paris, were especially good.

It is remarkable that the continent, and especially France, should not have shone in the late Exhibition in calculating machines. Pascal, with whose name unwarrantable use has lately been made with respect to the forged letters attributed to him, invented an arithmetical machine; and Leibnitz invented another, of a more complicated kind. But although several extremely ingenious calculating machines have been constructed since that period, the only machine of the kind in Paris was that exhibited by C. Thomas, of Colmar, which multiplies 8 figures by 8 in eighteen seconds; divides 16 figures by 8 in twenty-four seconds; and extracts the square root of 16 figures in ninety seconds. The price of this machine was £20. It is to be regretted that a specimen of the extremely beautiful calculating machine invented by the Messrs. Scheutz, of Stockholm, was not exhibited. One of these machines is employed in calculating a new life table in the Registrar General's office in London, and simultaneously prints the results.

It would greatly exceed our limits to even briefly notice the numerous objects falling under the head of miscellaneous philosophical instruments. A few, however, are too important to be omitted. Among them may be classed Lissajous' and Desain's apparatus for representing acoustic vibrations optically and graphically, exhibited by the maker, M. Kœnig. This apparatus is the most perfect that has been devised for demonstrating the various combinations of rapid vibratory movements. Many other beautiful and novel acoustical instruments were exhibited by M. Kœnig, who has been for many years engaged with great success in investigating the laws of sound.

The collection of spectacles by continental makers was extremely large; but as the eminent British makers of these useful articles did not exhibit, no comparison can be instituted between them and the former. How much machinery has done to reduce the price of spectacles is apparent by the fact that the house of Morey, Baillet, and Co. manufacture excellent spectacles, in good steel frames, which are sold at 2*s.* 6*d.* the dozen pair. In nearly all the spectacles exhibited provision has been made to enable the axis of each eye to coincide with the central spot of the lens, without which arrangement spectacles must be always defective.

In the department of philosophical instruments, the Paris Exhibition contained a great variety of models of machines, drawings for teaching the physical, natural, and musical sciences, anatomical preparations, etc. With scarcely an exception, all these were contributed by continental countries, the governments of which are far more disposed to afford facilities for technological instruction than that of our own. The objects of this nature exhibited by France, Belgium, Prussia, Italy, and Russia, were admirably adapted for the above purpose. There was a very interesting exhibition in the department of anatomy, by Dr. Brunetti, of Padua, who has discovered a process by which, in thirty hours, he can preserve the human and other bodies. The preparations are life-size, and so little changed by the process, that they can be used for anatomical purposes, nor are they affected by time or insects. A committee of the Paris Academy of Sciences has been appointed to examine and report on Dr. Brunetti's invention, with the view of purchasing the secret of his process, should it be found to be valuable.

In conclusion, we may remark, that although no just comparison can be made between the merits of foreign philosophical instrument makers and those of our own country, in consequence of the absence from the Exhibition of many of our most eminent makers, there is no doubt that in this department, as well as in many others, continental nations show great progress. We have, indeed, only to examine the foreign mechanical products to be made aware that the excellent and comprehensive practical education afforded throughout the greater part of the continent, and especially in Prussia, has already borne valuable fruit; and if we desire to keep up in the race of progress, we must be at more pains to disseminate technological education among skilled artisans.

The philosophical instruments lately exhibited in Paris were not, it is true, remarkable for any great novelty, but they were highly remarkable for their general excellence; and this was often to be found in instruments made in countries which a few years ago did not produce an ordinary barometer. It was also a very noticeable feature that the foreign instruments are much more moderate in price than the English, which is principally due to the lower rate of wages paid to continental workmen.

To the philanthropist who desires to see the advance of mankind, this progress is extremely gratifying. "The introduction of noble inventions," says Lord Bacon, "seems to hold by far the most exalted place among all human actions. This," he adds, "was the judgment of the ancients, who accorded divine honours to inventors." And by the improvement of existing, and construction of new philosophical instruments, we have every reason to believe that the prosperity and happiness of the great family of mankind is largely advanced.

LUNAR SKETCHES.—TRANSITS OF JUPITER'S SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

In our last number we gave the commencement of a few original rough sketches of the lunar surface in the neighbourhood of *Eratosthenes* and *Copernicus,* as a small contribution to the materials which in great measure yet remain to be collected for future comparison and study. We now propose to continue our remarks upon the same interesting region.

Eratosthenes.—The following notices may be referred to, concerning this crater.

1856. Jan. 15. 3$\frac{7}{10}$-inch achrom. "One-third of ring faintly enlightened beyond terminator, and just connected with it by a dimly lighted ascent," showing that the ground in the neighbourhood of this great eruption had been upheaved like that round *Copernicus,* though in a much less conspicuous degree.—1861. April 18. 5½-in. achrom. Terminator through *Tycho* (48) and *Fontenelle* (N. of *Plato,* 38). "The wall a grand sight in itself. Its N.W., W., and S. slopes to a considerable distance are most curiously roughened with small hillocks and ridges, whose general direction is concentric with the wall, and whose appearance bespeaks a former semi-fluid condition," as, perhaps it might have been added, their arrangement would rather suggest the ejection of blocks than the flow of lava. Such ideas, however, can only acquire weight from extended observation.—That the surface hues in and around it are of a decided character appears from the following notices. 1864. Aug. 13. 5½-in. achr. "The wall still casts a penumbra on each side, yet the interior begins to show local colour." Aug. 15. (1d. 16h. before Full.) "Penumbra gone; a strange mixture of light and duskiness on its site." How these shadowings are arranged will appear, to some slight degree, from the two following entries, which I quote just as they stand, having given no further attention to the region, and being at present unable to examine how far they admit of being reconciled. 1864. July 22. (3d. 17h. *after* Full.) 5½-in. achr. "*Eratosthenes* has its E. side filled with a dark lake, or rather, two such spots joined by a narrower neck: a small dusky spot lies also at the W. foot of the central hill." 1867. Nov. 8. (3d. *before* Full.) 9⅓-in. silvered "With" mirror. "*Eratosthenes* now all in local colour; from point of junction of *Apennines* round the E. semicircle, the outside glacis of wall shows a curious dark grey border. This is penetrated in two places by the streaks of *Copernicus*, which extend perhaps (but qu?) across *Eratosthenes* itself. Curious as to chronological sequence." It is just possible, however, that some process affecting the reflective power of the surface may at this time be working here; for B. and M. say that this crater is "in Full Moon not very distinct: we only see a very undefined faint light spot in a vicinity almost equally luminous." No mention is made of any darker portions, or of their being so situated as to indicate the position of the ring, and the description certainly does not tally well with present appearances. This is a peculiarly suitable spot for examining the question whether the Full Moon markings are unchangeable. Fixity, of course, if established by a long course of observation here, or anywhere else, would be no argument for its universal prevalence, since a state of quiescence in this respect might be attained at very different epochs in different regions; but should the reverse be clearly ascertained in a single well-marked, even though minute, case, it need not be mentioned that one distinct, incontrovertible affirmative weighs down any number of negative instances, and merely throws back the date of their changes to a pre-historic period. Sketches at the telescope, in lamp-black, Indian ink, or sepia, if really careful and trustworthy, would be very valuable, and in some hands made with much facility. There is this great convenience attending them—that the ground-markings they represent are much less fugitive than the actual shadows indicating the relief of the surface, and that many more opportunities are afforded in each succeeding lunation for the production of such designs, than of delineations containing ordinary effects of light and shade. And hence, by the way, as regards that great desideratum, a good map of the Full Moon, much more might be effected in a corresponding time than in the case of the details of actual relief. Even a single observer, possessed at once of accuracy of eye and artistic training of hand, might make a great advance in the right direction. To such an one (but more than one, we trust, may be found) the experience of the Astronomer Royal for Scotland (Piazzi Smyth), himself eminent alike as astronomer and artist, may be acceptable. In sketching the *Mare Crisium*, at the request of the former Lunar Committee of the British Association, he found oil colours much preferable to water for producing a likeness under the required conditions. It need scarcely be added that a large scale would be required to follow his example with success. But to return to our immediate subject:

Sinus Æstuum.—1864. Dec. 6. $5\frac{1}{2}$-in. achr. "The entrance of this dark plain is magnificent, and the curved banks lying obliquely over one another, but with a general parallelism to the mountain boundary, look like the rolling waves of some viscous material, agitated just before consolidation." The remarkable appearance here referred to is not confined to this region. I have traced it in others of the so-called lunar seas: in the *M. Nubium* (M), the *M. Humorum* (N), the *M. Nectaris* (O), and near the E. shores of the *M. Serenitatis* (E); further search will probably detect it in other situations; and it is probably one of those significant features which deserve peculiar attention in any speculation as to the probable origin of existing configurations. Very imperfect at present such speculations must necessarily be; and whether they may ever assume the proportion of a consistent theory will depend first on diligence of examination, and next on the care and impartiality exercised in dealing with the materials of thought. At present they are but guesses and inquiries, worthy of being recorded only so long as they make no further pretension.

Stadius.—The curious discovery of a number of minute craters within this slight enclosure was made by Dr. Dobie, of Chester, with a 5½-in. object-glass in the summer of 1863. His obliging communication of it to myself led me to wish for an examination of the region, which I was unable to accomplish for a considerable time; the illumination suitable for such minutiæ being always transient, and the air not frequently sufficiently steady. However, 1865, Jan. 6, when the terminator was passing through the E. side of *Reinhold* (31) and *Bullialdus* (60), and definition, with haze and a cold N.W. breeze, was fine, but rippled over, and very unsteady, my 5½-in. achr. enabled me to make out 10 or 12 minute pits, similar to those in the crater-chains of *Copernicus*, but smaller, and without distinct rings; they were chiefly in S. and W., and none, I thought, in the centre. I detected them again 1866, Feb. 23, the terminator having passed beyond *Plato* (38) and *Tycho* (48) by the amount of their own diameters; and I have since seen them with my beautifully defining 9⅓-in. silvered mirror, but not under the favourable circumstances which they require. May we imagine that these are of modern date? The large maps of B. and M. and Lohrmann contain only one small crater in the S.W. part of the floor of *Stadius*, a crater which I think I have seen pre-eminent among the rest; but the others might easily have escaped the small aperture of B. and M., and Lohrmann's Sections and letterpress unfortunately do not extend so far: we must, therefore, suspend our opinion, and allow the probability to be decided by less ambiguous evidence elsewhere. In one respect this region is worthy of attention on the part of those who have a clear optical command of it: its circumscribed nature enables the little included cones to be counted and drawn with greater certainty than might be the case in a less definite area. We proceed now to the

Crater-chains of Copernicus.—To the details previously given, the following may be added.—1855, April 2. $3\frac{7}{10}$-inch achromatic; $\frac{1}{3}$ of ring of *Copernicus* enlightened. The row of craters casts a considerable external shadow (so 1866, April 23. $5\frac{1}{2}$-inch).—1861, April 18. $5\frac{1}{2}$-inch achromatic. "The W. portion which joins the ring of *Stadius* is on the terminator. It is evidently a low ridge, blown through in many places by a succession of little bowls, whose summits caught the sun in a wild, strange, confused manner, and exhibited two interrupted parallel lines of little, bright, irregularly-disposed specks."—1862, Feb. 8. $5\frac{1}{2}$-inch achromatic. *Copernicus* its own breadth within the terminator. The region "wonderfully seen, and in much fuller detail than in B. and M. I seem to see through and beyond all their work. The N. extremity of the crater-chain dies out in a faint narrow rill [cleft], otherwise than in B. and M. The S. and S.W. slope of *Copernicus* are thickly studded with very minute craters, omitted by them, but really forming an unbroken dotted continuation of the Crater-Region, as far as their *Copernicus* C [at the N.E. end of Riccioli's *Rhæticus*], and as far as (? if not beyond) their double crater *Copernicus* A, towards *Reinhold*. Thus it is evident to sense that the whole crater-region is posterior to *Copernicus*."—1862, April 8. $5\frac{1}{2}$-inch achromatic. *Copernicus* entered half its own breadth. "Very fine definition, tranquilly undulating, which would have defied photography, with cool but not severe N.E. gentle breeze—*Copernicus* a glorious sight; continuation of crater-chain most distinct all along S.W. slope." —1864, Dec. 8. $5\frac{1}{2}$-inch achromatic. Terminator through *Heraclides* (E. cape of *Sinus Iridum*, K). The row of minute craters ending with *Stadius* C (B. and M.) is confluent for a short distance, otherwise than they have figured it.—1865, Jan. 6 (see *Stadius*). The crater-chains "are very wonderful; they seem much more inosculating and rill-like than as given in B. and M., or than as I used to see them. Three or four craters N. of B. and M.'s C are evidently blown into one long trough."—1866, Feb. 23 (see *Stadius*). The crater-chain is "exceedingly rough and irregular, but casting some shadow; enough to show that the rings of the little pits are of a fair proportional elevation. It is much like a mole-run, with holes in it. It leads straight on to the E. side of *Stadius*." The simile here employed would be naturally suggested by a residence in the country, where such objects frequently meet the eye. In the course of the following autumn I came across a "run" of this nature in a meadow, fifty-four or fifty-five yards in length, ending by inclosing an oval space. Without including two small side branches, I counted upwards of ninety larger or smaller mole-hills on this ridge, nowhere more than two yards, and often but a few inches, apart. To anyone familiar with lunar features, the resemblance in these cases is so striking, that it seems hardly possible at first to believe that it is a mere coincidence; but a little reflection will show that it can be nothing more. There can be no analogy between the operations of an intelligent and self-directing creature, burrowing intentionally just below the surface, and the mechanical working of a force which, obeying involuntarily the law of creation, is compelled of necessity to burst through and expend itself at once wherever the least resistance is offered. Schr., indeed, and B. and M. have spoken of the lateral working of elastic subterranean forces; but it is very difficult to conceive the *modus operandi*, especially in a case like the present, where the tunnelling is so superficial, and the vertical resistance can have been so slight; unfortunately, it seems equally difficult to suggest a less objectionable explanation. We are here, however, struck with at least one analogy, which is exemplified in innumerable situations and upon very varied scales in the Moon;—the great tendency pointed out by Sir C. Lyell in terrestrial volcanos "to shift their principal points of discharge."*—1866, April 25. $5\frac{1}{2}$-inch achromatic. Terminator through E. wall of *Gassendi* (64). "Have not some of these pits become larger and deeper?"—an idea, however, which might arise from closer acquaintance. ♅ pointed out a similar illusion in the case of double stars, which seem to widen as we are familiarized with them, and among such minute details every precaution must be taken against involuntary deception. —1867, Nov. 18. $9\frac{1}{3}$-inch mirror. Terminator (in *wane*) close to *Linné*. "Crater-chains so evident at this distance from Terminator, that it is inconceivable how they should have been missed by Schr."

Copernicus.—Of this glorious object I have, of course, many notices.—1862, April 8. $5\frac{1}{2}$-inch; *Copernicus* entered something more than half its breadth. "The outer E. slope of the ring showed a number of furrows radiating outwards, as though the interstices of lava-streams." These, as we have remarked on a former occasion, were discovered by Schr. (It may be added that, considering that these furrowings, of which he says he found scarcely any on the W. side, extend down to the immediate neighbourhood of the crater-chain; that the instrument employed was a powerful speculum of about 9 inches diameter; that the illumination must have been favourable; and that the observation bears every mark of care; it is very difficult to conceive how so curious an object could have escaped his earnest and careful gaze, had it been as fully developed, 1796, March 18, as it is now. A similar

* Memoir on Etna, "Philosophical Transactions," 1858.

remark applies to his observation of 1797, Feb. 6, when he discovered, with a power of 288, the cleft already described on the N.E. side of the glacis, and when he says the terraces of the ring were so sharply defined that he felt as though he could climb them. Contrast this with the fact that, without any previous knowledge of its existence, and without any special attention to its site, I detected this object, 1832, April 9, with an aperture of 3-inches of an ill-corrected fluid achromatic, bearing a power somewhere about 100.)—1864, March 17. 5½-inch; *Copernicus* entered more than its own breadth. "There are wonderful radiating streams, as of a continuous succession of blocks, or of lava cracked and roughened in cooling, extending to a long distance on every side. They are most visible in the present illumination through the E. semicircle—least distinct S.W. Through the W. semicircumference these streams seem to cover all the glacis even from the top of the wall; on the opposite shadowy side the terraces are so strongly marked that the radiations do not appear across them, though they cover the slope beneath. The S. half of the interior (or rather the S.E. quadrant, the S.W. being in shade) is all strewed with blocks—especially with 212 [a very keenly defining microscopic eye-piece]; the N. part is much smoother."—1864, March 18. 5½-inch. Terminator just beyond *Sin. Iridum*, and touching W. wall of *Gassendi*. "The interior terraces are shown by their shadow to have a convex outline, from the foot of the highest wall to the floor, indicating, perhaps, that in settling down the upper part was the most fluid."

1864, Dec. 8, 5½-in. Terminator through *Heraclides*. "A strange observation—definition marvellously sharp—I have very rarely seen it matched; but low clouds hanging around, and dissolving into rain so close over our heads, that when one of them was passing as a haze across the Moon, I found, by lengthening the focus, that a profusion of the minutest dark globules were streaming over the disc from the W. (somewhat like Messier's observation of the Sun), notwithstanding which the details, though pale from haze and a considerable amount of dew and rain on the object-glass, continued sharp, and the limb was fairly defined even when I tried a power (461 and Barlow lens reversed) which must have approached 700 or 800. *Copernicus* glorious, full of details, almost like Secchi [the engraving]. The S. half of the floor is very irregular; the unevennesses have more the aspect of streams flowing from the central cones than of single blocks. There is some, but a less degree of roughness in the N.W. quarter; I trace none in the N.E." [The particulars of this observation are given in full, as being instructive in their own way. They show under what unexpected circumstances the greatest distinctness may be found; and that, therefore, no night should be condemned untried; and that it is extremely difficult for an inexperienced person to form, from a brief trial on celestial objects, an accurate opinion of the quality of any *large* instrument: *small* apertures are far less affected by atmospheric disturbance.]—1865, Mar. 6, 5½-in. Central hill beginning to appear. "*Copernicus* very magnificent, covered with hillocks and roughnesses, which, under the present illumination, so extend over the terraces of the ring that the summit of the latter does not appear as though it rose clear above the external lava-streams, but as though they had flowed over it."—1866, Feb. 23, 5½-in. "W. ring just beginning to come on terminator: marvellously rough glacis, but no distinct radiation.—1867, Dec. 5, 9⅓-in. mirror. "It is very interesting to mark the contrast between the bright white illumination of the interior of the wall and its terraces on the E. and the colossal heaps of grey scoriæ, which look as if they had been rolled over the summit of the ring on every side, and remained piled one above another even to its summit; it being quite evident in this illumination that the wall has nowhere a distinct existence above them. The radiations, which are very clear, do not begin till a long way below." 2h. later, when the ring was distant a diameter from term., it is noted that the E. side, "at some little distance from its summit, casts a black shadow for a considerable length, giving the mistaken impression of a perpendicular cliff, or even overhanging edge, so that there must be a sudden increase of declivity at this part; the radiations are all below, and the upper part of the ring looks exactly as though it had been rolled over the lip of the crater, or forced by pressure out of the interior, subsequent to the formation of the radiated surface; the lava-currents, if they are such, and not streams of blocks or scoriæ, must have been in a more fluid condition than the wall, both as extending further, and over a more gentle slope. The internal terraces look as though they had resulted from the slipping back into the interior of matter which had failed to be projected over the lip." 1¾h. afterwards, "the black shadow is passing off, and there is a distinct impression that the ring proper is convex on the outside in a vertical section," as the terraces, at least W., had been found to be in the interior. "Above this there is a low, narrow, irregularly bent central crest or lip, of considerable steepness, which seems to divide the ring proper—*i.e.*, the convex part without, and the terraces within, into nearly equal parts in point of horizontal extent." My powerful reflector exhibits with ease the curious vertical gullies which cut down for a short distance the inner slope just above its junction with the floor; they are readily seen N. and S., but are most evident on the former side: land-slips from above may probably explain them.—As to Full Moon markings, I find only the following: 1855, Aug. 27, "The appearance of the ring is encroached upon by a grey bay on S.S.W. side."—1855, Oct. 24 (a little before total eclipse), "While none of *Tycho's* streaks reach the foot of his wall, it is remarkable that *Copernicus* is penetrated even to the centre by several of his; two distinctly on the W. side, and one or two, not so well made out, on the N. The former look almost like a prolongation of the system of *Kepler*, as if *Copernicus* had pierced through, or been pierced through by it." (From some such observations, of which he has given no detail, Nichol assigned the chronological sequence, *Copernicus*, *Aristarchus*, *Kepler*. However this may be, it is not easy to interpret the development of a different shading, frequently taking the appearance of a definite patch or stain, among matter not only forced from beneath, but subjected to the most violent dislocation. If not due to original difference of material, it points to subsequent modification either from within or without. There seem reasons for doubting the former cause, as well-defined dark spots are occasionally met with where, as we suppose, the materials have been so dislocated that any original distinction could not have been so clearly maintained.)

The bare results of these rough studies might have been given in a briefer compass, but, in the original form, there may be some interest and some advantage to the inexperienced student. He may thus perceive what apparent variations may be produced by a slight difference in illumination, how unsafe are inferences from single observations, and how discrepancies are to be reconciled, if at all, by repeated examination. With a little more of the advantges of leisure, these memoranda might have been presented in a less fragmentary form, especially since the mirror now in my possession gives results far in advance of almost any hitherto published (and indeed the same might be said of smaller apertures of the same accurate workmanship). But even these may answer a good end by stimulating curiosity, and showing in what direction it may be suitably exercised.

Before finally quitting the neighbourhood of *Copernicus*, it may be well to make some addition from the observations of B. and M. The next crater of any size S.S.W. of the mighty monarch of the district, is *Gambart*, a circle, 16 miles across, but neither high nor deep. In this direction lies a large insulated accumulation of short ridges, trending the same way, the highest lying in a line from *Copernicus* to that crater. They are more connected, but less elevated, on the W. of the centre of that line, where they form a nearly equilateral triangle, with one angle N. The N.W. side of this area is bordered by a long dark valley, extending S.W. 37 miles, and dividing it from a system of small parallel chains, whose highest summit, ζ, attains about 2600 feet. This mountain, already mentioned in p. 371 of our last number, must be looked for just S.S.W. of the little but conspicuous crater c, the only one at once S.W. of *Copernicus* and S.E. of *Stadius*; it must also stand very near the N.E. end of the bright streak which divides *Rhæticus* in the Full Moon (p. 216, *antea*). Of the parallel ridges they say, " these mountains are very dark, and here, in the Full Moon, a large blackish spot shows itself," in which they are unconsciously describing the W. part of their vainly-sought *Rhæticus* of Riccioli, the other portion seeming to be the " long dark valley " just described. There appears little doubt that in this parallelism may be found the " rampart-work " of Gruithuisen, the regular arrangement of which would probably repay a search; at the other end of the streak dividing *Rhæticus*, and consequently near the S.W. angle of their hill-triangle to the E. of it, they place a little summit ε. They remark that while the dark mountains continue so in full illumination, the triangle is brighter, 3° to 3½° of light, and ε has " exclusively a brilliancy of 7°, which it does not lose even in the neighbourhood of the terminator, an anomaly which is so much the more remarkable because it otherwise is not distinguished, either through form or elevation, from the rest, several of which overtop it." I regret that I did not notice this curious passage in time to compare it with the existing state of reflective power, but I have no recollection of such a spot when I was identifying *Rhæticus*, the notices of which are strangely scattered about in B. & M., and it must be left as an interesting subject of research for some of our readers.

E. of *Gambart* is a bright (8°) and conspicuous little crater A.

Reinhold (our 31) is a crater 31 miles in diameter, with strong terraces and a central hill at the N. end of a little ridge. The W. side of the ring is 9400ft., the E. 7000ft. above the interior. Schr. gives the former measure 8700ft., and makes the external height of the E. wall 1900ft. A mountain-ridge connects it with *Copernicus*, bending, as it were, round both the rings.

N.E. of *Copernicus*, we find a lofty tract which B. and M. call *Mt. Carpathus*, extending with its dependencies from E. to W. 280 miles. It includes *Gay Lussac*, a double crater already described in our p. 370: the smaller basin A is deeper, steeper, and brighter than its broader, and apparently more ancient neighbour; a relation frequently obtaining in these configurations. Close S.E. of it our guides notice a dark spot in the Full Moon; an exemplification of our recent remarks. The ring of *Gay Lussac* is interrupted by a minute crater close to the companion-crater A; and they point out a curious arrangement here: three pairs of objects—A and this little pit—two summits (α) close together on the N.W. slope of the ring—and two others (β) on the E., make up respectively two equilateral triangles, with sides parallel and very close together, whose common centre coincides with that of *Gay Lussac* itself. The cleft proceeding from it has already passed under our review. The mountains E. are confused in arrangement, with no central axis; and are penetrated by valleys usually as luminous as the heights. Measurement is difficult from the way in which the shadows fall. One high promontory reaches 6300ft. Towards the E. extremity lies a considerable crater, *Tobias Mayer,* 22 miles in diameter. A summit of its W. ring rises 9700ft. above the cavity. Schr. pointed out that in consequence of its position on the mountain's flank, its E. side was much lower—he gave it but 2700ft. (short measure). It has a central hill, which from local colour appears large in Full Moon. S.E. of this the map shows a very minute crater in the depth; rather an unusual position. W. of the ring lies a conspicuous *sub-crater,* as it might perhaps be termed, *Mayer* a. The extremity of the mountains N.E. of *Mayer* rises to 4000ft.—*Milichius,* a small bright (8°) crater lies in a curiously-shaded region of the *M. Imbrium* (I), nearly S. of *Mayer* and E. of *Copernicus.* S.S.E. of this is another similar crater, *Hortensius,* very remarkable for its isolation, and the luminosity surrounding it, almost like a miniature streak-system. In a position forming a right-angled triangle with the two last objects—the right angle being towards *Copernicus*—is a spot containing within the compass of less than 30 miles eight parallel ridges running nearly N. and S., and all pretty nearly of similar length and elevation.

Another step S.W. brings us from *Hortensius* to *Reinhold* again, and completes the circuit of a region where so much is seen, and so little is understood, of the wonderful works of God.

TRANSITS OF JUPITER'S SATELLITES.

Jan. 1st. I. egress, 5h. 11m.—Ditto shadow, 6h. 16m.—5th. II. shadow ingress, 5h. 50m. II. egress, 6h. 34m.—8th. I. shadow ingress, 5h. 53m. I. egress, 7h. 12m.—12th. II. ingress, 6h. 29m.—15th. I. ingress, 6h. 54m.—24th. I. egress, 5h. 45m.—Ditto shadow, 6h. 31m.—30th. II. shadow egress, 5h. 45m.—31st. I. shadow ingress, 6h. 8m.

FRESH-WATER PLANARIÆ.

OCCULTATIONS.

Jan. 6th. 48 Tauri, 6 mag. 9h. 20m. to 10h. 24m. γ Tauri, 4 mag. 11h. 28m. to 12h. 33m.—30th. *f* Piscium, 6 mag. 9h. 56m. to 10h. 26m.

OUR FRESH-WATER PLANARIÆ.

BY W. HOUGHTON, M.A., F.L.S.

(*With a Plate.*)

Anybody who has occasionally gathered water-cress, or searched amongst aquatic weeds for objects for the aquarium, must be acquainted with certain small black or brown creatures, of an oblong form when at rest, soft, smooth, and flat, and about five lines in length and one and a half broad. These are two species, or, it may be, two varieties only, of Planarian worms. Probably the collector of objects for the aquarium sees in these animated black blotches very little to attract his attention, and he throws them aside; or if curiosity tempts him to bottle a few specimens for examination, he finds that he is able to make out very little of their structure, and sees scarcely anything to interest him in their habits; and certainly when we compare these fresh-water *Planariæ* with other rare and exquisite forms of animal life, such a *Cristatella, Fredericella* or *Plumatella* amongst our fresh-water Polyzoa, or a *Melicerta* or a *Stephanoceros* amongst the *Rotatoria,* these little black dabs have small claims to beauty; nevertheless the large white species, *Planaria lactea,* with the pink arborescent ramifications of its digestive system, is by no means devoid of beauty, whilst the commoner black or brown kinds present many points of interest to the naturalist, both in their habits and anatomy. The *Planariæ,* as their name imports, are of a flattened form; the under surface of some of the species bears some resemblance to the foot of a gastropodous mollusc. In many parts of their organization the *Planariæ* resemble the Flukes which inhabit the liver and other viscera of various animals, especially ruminants; but none of the *Planariæ* are internal parasites, nor do they, like the Flukes, undergo a metamorphosis. They inhabit fresh and salt water, and are to be found on the leaves and stems of aquatic plants, and amongst the roots of the *Laminariæ,* between tide marks. On the present occasion I shall confine my remarks to the fresh-water species, of which a great number have been described as occurring in France by Dugès who has published two very interesting memoirs on these animals.* In this country also,

* See "Annales des Sciences Naturelles," Tom. xv. and Tom. xxi.

several kinds are found, of which *Planaria lactea*, *P. torva*, *Polycelis nigra*, *P. brunnea* are common everywhere in ponds, streams, and ditches. A favourite place of resort of these creatures is within the stems of *Sparganium*, whence they may be readily picked or scraped off with the point of a knife and placed in a bottle of water. Difficulties of dissection long prevented naturalists assigning to the *Planariæ* their true place in the animal kingdom; Cuvier, following Müller, Linnæus, Pallas, and Lamark, placed them amongst the parenchymatous *Intestinalia*, or *Trematode Entozoa* (as the Flukes *Distoma*), acknowledging at the same time their resemblance to certain species of the *Hirudinidæ* or leech family. The *Planariæ* have affinities with both these families, and lead from one to the other. Let us suppose we have under examination the largest of the British fresh-water *Planariæ*, viz: *P. lactea*; this species varies a little in colour, which is either cream, roseate, or quite white; it is from six to ten lines in length, and about two lines in breadth; we first notice the delicate arborescent form of the digestive system; we place the creature on a glass slide and hold it up to the light, in its middle part we see a milk white spot which extends linearly towards the posterior extremity; by allowing the water gradually to evaporate, the animal shows signs of discomfort, and we observe a long cylindrical tube to be pushed out from a pore slightly posterior to the middle of the body: this pore is the mouth, and the tube is the proboscis, a formidable instrument of attack in these creatures; we notice two black oculiform spots, parallel, and placed on the anterior part of the back; a little below the oral aperture we see, but very indistinctly in *P. lactea*, another pore which belongs to the generative system; we find the body to be slimy, very soft, and readily breaking up if not handled with great care. Let us take another specimen of the same species, and with the aid of a camel's hair pencil, place it gently in a vessel of water, and observe its locomotive powers; we see it gliding in an even and regular manner, like a *limax*, or slug; if we touch it, the animal twists itself in various folds, or it fixes its head portion to the vessel, and, by contracting, brings the other parts of the body along, then the posterior part is attached, and the head portion elongates and advances. In the species *Polycelis nigra*, *P. brunnea*, *Planaria torva*, we observe the gliding locomotion to be frequently exercised on the surface of the water, the ventral side of the animals being uppermost; none of the true fresh-water *Planariæ* can be said to swim; but an allied marine species, *Leptoplana tremellaris*, progresses by flapping its sides as a Ray its fins.* When we consider how varied and energetic are the movements of the

*Dugès "Annal. des Sciences, Nat." xv. 151.

Planarian worms, for they can contract and elongate their bodies, fold themselves together in various forms, and unfold themselves, we naturally expect to find the presence of muscular fibres; how can such movements be explained except by the admission of the existence of a muscular system? And yet there are some animals of low organization, such as the small species of the *Trematoda*, which are endowed with active contractility, in whose bodies, notwithstanding, no muscular fibres have been detected. With respect to the *Planariæ* many observers, as de Blainville, Dugès and others, entirely deny the existence of a muscular system, except in the proboscis, and genital organs; M. Quatrefages, on the other hand, describes a sub-cutaneous plane of muscular fibre, as being recognisable in some species, and Professor Owen remarks that in the *Planariæ*, in which as in the *Tœniæ*, according to his observations, the muscular system is indicated only by the striæ on the superfices of the apparently homogeneous parenchyma, the phenomena of muscularity are strikingly displayed in the varied and energetic actions of the living animal.* My own investigations have satisfied me of the existence of a sub-cutaneous plane of loose muscular fibre in the fresh-water genera, *Planaria* and *Polycelis*. A nervous system in some species has been recognised by de Quatrefages, who describes it as "consisting of two ganglions, more or less intimately united, which are situated in the mesial line, near the anterior part of the body. This double ganglion, which may be called the brain, and which is sometimes visible to the naked eye, is lodged in a special lacuna or cavity, recognisable from its transparent outline, and is seen to give off nervous filaments in various directions to different parts of the body."† In vain have I laboured in search of the faintest indications of a nervous system in the species I have examined. The relation of the *Planariæ* to the Flukes, as already noticed, might lead us to expect the existence of a rudimentary nervous system in them as in those Entozoa, nevertheless, I think that we must still consider its presence in the fresh-water species as a subject requiring verification. Professor Rolleston, who, at my request, kindly repeated his examination of many specimens of *Planaria lactea*, says, "With reference to the nervous system of this species, I have never been quite satisfied that it was a real existent thing. Leydig says he has failed to see it sometimes in the fresh-water *Planariæ;* but that the analogy of the marine *Planariæ*, where a nerve-system is undoubtedly present, has forced him to look for it, and that he believes that a couple of pear-shaped ganglia underlying the two eyes, and

* Todd's "Cyl. of Anat." ii., p. 128.
† Rymer Jones, "General Structure," p. 146.

figured by him, really exist, and are the nerve-system. At page 139 of his Handbook, he says he has not been able to see any commissure connecting these two ganglia in *P. lactea.* I looked into the matter in the summer, and have since my return to Oxford, on the receipt of your note, looked into it again. I had written as follows for my book in the summer: speaking of the 'anterior cœcal end of the intestine passing up between the two eyes, and underlaid in the marine genera allied to this by a nervous band, passing from the ganglia in relation with the eyes. According to Schmidt and Schultze ("Zeitschr. Wiss. Zool., x. Taf. iii. fig. 1), the same is the case in the fresh-water *Planariæ.* Of this, however, it is difficult to convince one's self, with the semi-transparent species, *Dendrocœlum lacteum,* which is very closely allied to this.' On further investigation I see no reason to alter this." In a subsequent letter the Professor writes that "between the cœcal ends of the intestinal tree-branches and the eyes, I saw a number of large cells with hyaline contents and a centrally-placed granular nucleus. These cells, I take it, are the nerve ganglia, loosely apposed cells making up the nerve ganglia in some of the anneloids, at least if we rank Echinodermata under this head. But I saw no commissure connecting these aggregations of cells." But whatever may be the truth with respect to a nerve-system, the *Planariæ* are certainly sensitive, the *P. lactea* particularly so; they are fidgetty under condensed light, especially when applied to the head; when touched with the point of a needle, or when pierced by the proboscis of one of its own kin, as by *Polycelis brunnea,* the large *Planaria lactea,* evinces by its contortions, an undoubted sensibility. Living almost exclusively in shaded habitations, the *Planariæ* cannot be expected to possess visual organs of much complexity, but there seems no reason to doubt that the oculiform spots, which vary from two to fifty, according to the species, do in some degree perform the function of eyes.

Let us now examine the digestive system of a Planarian worm.—The mouth in the true *Planariæ,* as has been already stated, lies on the ventral surface, a little below the centre of the body; it is a circular aperture, through which the muscular contractile œsophagus, or tube, is protuded, whether for the purpose of feeding or for defecation. In form this proboscis is chiefly cylindrical, as in all the fresh-water species. In the marine *Leptoplana tremellaris,* it is infundibuliform, and gracefully waved. The proboscis can be protruded to a considerable length; according to Dugès, it consists of two tunics, the external one being formed of longitudinal, the inner one of circular fibres, and it is to the peristaltic constrictions of this inner tunic that the mechanism of suction is due, and the passage of nutritious particles into the ramifications of the stomach and digestive apparatus. It is most curious to watch the movements of a planarian proboscis when forcibly detached from the body of the worm; it almost seems to enjoy a separate existence for a time; it may be seen to open the orifice and swallow the pulpous particles of its own body, then by contracting, to eject them through the other end. This tube is in contact with the stomach and digestive system, and opens out into it; its basilar portion being apparently connected with the stomachal walls by a very thin transparent membrane, very easily ruptured. The digesive apparatus in the true *Planariæ* consists of a number of arborescent ramifications; there are three principal trunks, which unite about the centre of the body and receive the particles of food supplied them by the proboscis; one of these trunks proceeds in a direct line upwards towards the head, along the mesial line of the body, and from it on either side there are numerous branched cœcal appendages; the other branches immediately diverge and pass down the sides of the body, again converging towards the posterior extremity. This arrangement is very apparent in *Planaria lactea*, in which the cœcal appendages are most numerous; in the other species, owing to the opacity of the body, it is not so readily seen; slight pressure with the compressorium, however, reveals a similar structure. The food of the *Planariæ* consists of infusorial animalcules, small naïd worms, the blood of which they suck, sometimes, according to Dugès, without perceptibly piercing their skins. The same observer states that animalcules of the family *Cyclidina* are sometimes found alive in their digestive organs. That they have, however, cannibal propensities and devour each other, I have myself frequently witnessed; this character, according to my own observations, belongs more especially to the species *Polycelis nigra*, and *P. brunnea*; it is curious to see the rapidity with which one of these fellows bores a hole into the body of one of the large *Planaria lactea*, and crumbles him into his component particles. The attacking enemy throws his body in a fold over some portion of its victim, and immediately begins to bore into him with his proboscis; this boring very soon reduces a part of the body of the victim into minute particles which are sucked up by the proboscis, as it makes its way along. The *Planariæ*, like the parasite *Trematoda*, are destitute of an anus, the undigested portion of their food being regurgitated through the suctorius tube.

The circulation in these animals is described as consisting of a mesial and dorsal canal and two lateral vessels, from which proceed in all directions, a fine cutaneous network of minute nutrient vessels, which issue from the extremities of the intestinal cœca. Dugès says the circulation is best seen in *Polycelis nigra,* and *P. brunnea,* and in the marine *Leptoplana tremellaris*. I confess that notwithstanding the most patient observations, I have not yet been able to make out completely the circulation in these worms ; young specimens, from their comparative transparency, I thought would readily show it, but I have been disappointed in my examinations.* The circulation is readily enough seen in the equally small species of snail-leeches (*Glossophonidæ*) ; why it should be so difficult to make out in the *Planariæ* I cannot tell, but Dugès is so trustworthy an authority, that one is not inclined to dispute his statements. The mesial dorsal trunk in *P. nigra* and *P. brunnea* is described by him as being tortuous and narrow, sometimes more difficult than at other times to make out, on account, no doubt, he adds, of its dilating and contracting ; the same systole and diastole may also be noticed in the lateral vessels. This arrangement of the circulation in the *Planariæ* reminds one of that of the leeches.

Of the respiration little need be said. The circulating fluid is oxygenated by the air contained in the water over the whole surface of the body, the numerous minute cilia which clothe the margin of the body, helping to bring fresh currents. *Planariæ* require a constant renewal of water, if kept many together in a vessel, or they soon die.†

The *Planariæ* exhibit the phenomena of reproducing lost parts, almost emulating, in this respect, the *Hydræ*. Sir John Dalyell says of the black *Planaria* (*Polycelis nigra*), that "it is privileged to multiply its species in proportion to the violence offered to its otherwise delicate frame. It may be almost called immortal under the edge of the knife. Innumerable sections of the body all become complete and perfect animals. If the head be cut off, a new head replaces it ; if the tail be severed, a new tail is acquired." Dugès experimented considerably, and with the same result as Dalyell. An individual cut into eight or ten parts produced the same number of complete animals. The time required to reproduce a lost part depends on the time of year—fourteen or fifteen days being required in winter, four or five in summer. The species also differ in this respect. This reproduction by division appears to take place sometimes

* The only point of the circulation I have distinctly seen, occurred in a specimen of *P. lactea*. I noticed various ramifications of the water-vascular system in the regions of the eyes, under $\frac{1}{4}''$ objective, but could see no dorsal or lateral channels.

† They can, however, bear extreme cold without being killed. I have some specimens of *P. torva* and *Polycelis nigra* which have been frozen in a tumbler of water during the last frost. They are now as active as ever. Some of these specimens were not more than two lines long, and about six weeks old.

naturally, as in the *Vorticellæ* and other *Infusoria*. Müller noticed it in *P. ciliata,* Dugès in *Derostoma leucopta,* Otto Fabricius in *P. vulgaris*. Draparnaud and Dugès saw it several times in *P. tentaculata*. I have frequently experimented myself in this way, and have seen these creatures reproduce lost halves, or segments; but on chopping them into eight or ten parts, I have always found they died, doubtless from some causes not favourable to reproduction. An individual divided in a longitudinal fissure at the head will often exhibit the phenomena of two heads. *Planariæ* propagate by mutual contact, as in other animals; they are androgynous; and no doubt the presence of two individuals is necessary for the procreative act. Dugès has witnessed the copulation in *P. torva,* and recently I have noticed it in the same species. According to the researches of Dugès, "the male organ consists of two parts, one of which is free, smooth, semi-transparent, contractile, and always divided into two portions by a circular constriction; it is traversed by a central canal, susceptible of being dilated into a vesicle, and is open at its free extremity, which is turned backwards; the second division is thicker, more opaque, vesicular, adherent to the contiguous parenchyma, and receives two flexuous spermatic canals. The free portion of this organ is contained within a cylindrical muscular sheath, which is adherent to the circumference of the base of the intermittent organ, and serves to protrude it externally. This sheath communicates with the terminal sac of the female apparatus near its outlet by a projecting orifice. The oviduct opens into the posterior part of the terminal sac; it is a narrow tube which passes directly backwards, and dividing into two equal branches, again subdivides, and ramifies amongst the branches of the dendritic digestive organ. Besides the ovary, there are two accessory vesicles, communicating together by a narrow duct, and opening into the terminal generative sac." The *Planariæ* lay round or ovoid eggs, with a horny covering, containing three or four young ones. These cases are of a reddish colour, and may be found in numbers deposited singly on the leaves of aquatic plants, especially within the stems of *Sparganium*. I believe the young ones issue from the capsules in eight or nine days after they have been laid; the young ones are minute and drab-coloured, about a line long; they exactly resemble the parents, both in form and manner of life; they grow rapidly where the water is fresh and the food plentiful.*

* Other modes of propagation have been observed to take place in some of the *Turbellariæ,* as by internal budding, or the young are at first larvæ unlike their parents. Professor Agassiz once thought that certain infusoria, as *Paramecium* and *Kolpoda,* were Planarian larvæ; but the researches of Balbiani have

Planariæ soon die when taken out of the water, a drop of spirits of wine or other alcohol, kills them instantaneously and renders their bodies hard; vinegar softens but does not dissolve them.

The *Planariæ* belongs to the order *Turbellaria*, whose characters are thus given by Dr. Johnston: "Worms individual, locomotive, very rarely tubicolous, monœcious, or diœcious, with or without eyes, the surface usually coloured, and sometimes in elegant patterns, transparent or opaque. Body soft, parenchymatous or cavernous, flat or sub-cylindrical, naked and lubricous, covered more or less with vibratile cilia, and sometimes with papillæ, often very contractile, and polymorphous, and sometimes breaking up voluntarily into pieces, head continuing with the body, or rarely, imperfectly defined, either without tentacula, or with two frontal or dorsal ones prolonged from the surface. Mouth either terminal or ventral, and in the latter case situated in the anterior third, or near the centre, or towards the tail; often furnished with a prehensile proboscis. Intestine dendritically branched, or undivided, with or without an anus. Zoophagous, but some appear to feed, occasionally at least, on decaying plants. Oviparous, or viviparous, very rarely multiplying by spontaneous division. There are no suckers or discs, and progression is made by gliding or by natation. They are never internal parasites, but tenant fresh and salt water, and are found sometimes in moist places. The skin is very rarely iridescent, and there is no phosphorescent species."

As Dr. Johnston's book* is probably in the hands of only a few readers it may be well to give here his classification of the British genera. The order *Turbellaria* he divides into two sub-orders, viz: I. *Planariea* and II. *Teretularia*. The first order alone concerns us at present; it is thus defined:—

"The body, parenchymatous, flat, or flattened, usually only a little longer than broad, acephalous, with or without eyes on the dorsum in front. Mouth, a simple pore, often the aperture to a prehensile proboscis. Anus, none. Genital pore, posterior to the oval." This sub-order, *Planariea*, is divided into three families, with their respective genera, as follows:—

negatived that idea. Whether the fresh-water *Dendrocœls* or *Rhabdocœls* ever go through a larval condition I know not. I have hatched scores, and always noticed that the young exactly resembled their parents.

* I am well aware that Dr. Johnston's catalogue of British non-parasitic worms is far from complete; nevertheless, as it is the only English text book on the subject, and the work of a very accomplished naturalist, I have preferred in this paper to retain it. It must be confessed that at present the subject of the Planarian worms and other *Turbellariæ* is involved in obscurity. Identification of species is difficult. Young specimen have, it is probable, been sometimes taken as distinct species.

** Intestine dendritically branched.*

Family I.—PLANOCERIDÆ. Flat: the mouth nearly in the centre of the ventral surface, and furnished with a short proboscis, crenated or lobed at the orifice.

1.—*Leptoplana.* Multocular, the eyes clustered: no tentacula.

2.—*Eurylepta.* Multocular, the eyes clustered: two frontal tentacula.

3.—*Planocera.* Multocular, or eyless: two dorsal tentacula.

Family II.—PLANARIADÆ. Flattish: the mouth inferior, sub-central, with a long cylindrical proboscis, plain at the orifice.

4.—*Polycelis.* Eyes, many, in a marginal series.

5.—*Planaria.* Eyes, two; dorsal and paired.

*** Intestine an undivided tube.*

Family III.—DALYELLIDÆ. Mouth terminal, or sub-central, eproboscidean.

† Eyes, two.

6.—*Dalyellia.* Mouth, terminal.

7.—*Derostoma.* Mouth, ventral, anterior.

8.—*Mesostoma.* Mouth, ventral, sub-central.

‡ *Eyeless.*

9.—*Opistomum.* Body, elongate; mouth terminal.

10.—*Typhloplana.* Body, linear-oblong: mouth ventral, sub-central.

11.—*Convoluta.* Body, involute.

In the PLANOCERIDÆ, the body is thin, flat, and laterally expanded; the eyes when present, are clustered. The oral aperture is usually closed, and becomes almost indistinguishable, but the position of it, and of the proboscis, is marked by an oblong spot, near the middle of the ventral surface. This is always paler than the dorsal, which is commonly beautifully coloured. The motion is slow. The food is soft, either the juices of invertebrate animals, or the parenchyma of decaying algæ. All are marine, and propagate, probably, by naked cilated ova, undergoing no metamorphosis. In decay the body is diffluent, and decomposition has far advanced before life is extinguished. The species *Leptoplana tremellaris* and *Eurylepta vittata,* with its sinuated margin, and dotted, ear-shaped tentacles, are probably familiar to many sea-side explorers, being not uncommon under stones, and within the tangled roots of laminaria, but our business is with the fresh-water, and not the marine species.

The *Planariadæ* contain the species of true *Planariæ*; and, as I have already given my observations upon them, there is no necessity to define the family again. It consists of two genera, *Polycelis* and *Planaria*, the chief characteristic distinctions between them being that *Polycelis* has numerous oculiform spots of a black colour, bordering the anterior margin of the animal; these spots extend to about a third of the length of the animal; whilst *Planaria* has two eyes, nearly parallel, situated on the back of the head.

Of the genus *Polycelis*, Dr. Johnston enumerates three British species, viz: *P. nigra*, *P. brunnea*, and *P. felina*. The two first are considered by some naturalists to be merely varieties; I am rather inclined to regard them as specifically distinct. *P. nigra* is extremely common in ponds and ditches; it is evidently the "limace aquatique noire," portions of which little creature Trembley used sometimes to treat his favourite hydræ with. The body is depressed, even, and very smooth; of a black velvet colour. Of an oval form when at rest: linear-oblong when moving. The head is slightly sinuated with a central projection in front, and two marginal ones: this is seen only when the creature is in motion; the oval proboscis is long, white, and cylindrical, with a plain but dilatable orifice; length, when extended, about five lines, and one and a half broad.

P. brunnea does not differ, perceptibly, from *P. nigra*, except in colour, which is a smoky-brown, with a dark mesial line very distinct; it is as common as the black species. *P. felina* which, like the last named kind, is regarded by Diesing only as a variety of *P. nigra*, is described as being linear-oblong in form, minutely tricuspidate in front, of a uniform dark brown, paler underneath, and eight lines long by one and a half broad. I do not know the species; it appears to be the *Planarian viganensis* of Dugès; and from the decidedly auricular form of the head, to judge from Dugès figure, ought perhaps, to be considered a distinct species. It inhabits stagnant waters, in which aquatic vegetables abound, and rarely is found in springs. Of the genus *Planaria*, Dr. Johnston enumerates four British fresh-water species, viz: *P. lactea*, *P. torva*, *P. Arethusa*, and *P. Edinensis*. The first named species is white or pinkish, and shows most clearly the dendritic cavity of the digestive system. When moving it is of an oblong form, the front truncate, a little auricled on each side; but it assumes various forms, and frequently sinuates its margins in elegant folds. The normal number of eyes is two, but there are occasionally four, in which case the anterior pair is very minute. Dr. Johnston says it inhabits cold springs and lakes, is gregarious, and not common. I find it in the canal near my house, and in pools in the neighbourhood, tolerably abundant, and have never any difficulty in procuring specimens for examination. I do not consider it more gregarious than other species.

P. torva. This is a very quaint looking fellow; its two black eyes, which are of a crescent form, are partly surrounded by a white ring or halo, which gives the creature a squint-like look: suggesting, probably from its sinister appearance, a disposition conveyed by the epithet, "torva." It is described as being cinereous or black, on the dorsal, and greyish on the ventral surface. The front is obtuse, rounded on the angles, and projecting in the centre. It deposits a large oval capsule, and is six or seven lines long, by about two broad.

I have recently met with some very large velvety-black *Planariæ*, which resemble *P. torva*, in having a white halo round the eye-spots; but I have reason for believing that they are individually of a distinct species. The black eye-specks in the surrounding uncoloured halo are not visible under a simple lens in the individuals I am speaking of; but the compound microscope of about twenty diameters reveals them. In *P. torva*, the eye-specks are very apparent under a simple lens: the colour is of a decided black when viewed by reflected light; in size it is almost equal to the large *P. lactea*, and it often crenulates its margins like it, but only very slightly. I do not find any other *Planariæ* like the ordinary *P. torva* in the water whence I obtain these large individuals, and I am inclined to regard them as, if not a distinct species, at any rate a well-marked variety. I have occasionally found a *P. torva* with four eyes, each pair with the characteristic white halo; the anterior ones in this case are small, as in *P. lactea* when possessed of four eyes. I have little doubt that this four-eyed variety of *P. torva* is the *Tetracelis fontana* of Diesing ("Systema Helminthum," i., p. 191), who thus describes it:—"Corpus depressum ellipticum, antice truncatum, fuscum. Ocelli geminati nigri in macula alba, postici reniformes majores. Longit. 6‴, latit. $1\frac{1}{3}$‴."

P. Arethusa is described as being truncate and auriculate in front, leaden or slate grey, paler underneath, having a black eye on a white spot on each side of the medial line in front. Length, six lines; breadth, one line. It is said to be common in pure springs and rivulets. I do not know this species.

P. Edinensis inhabits pure springs, and is rare. It is the smallest of the fresh-water *Planariæ*, being only three lines long and one broad; it is linear oblong, and rather narrowish in front, of a pale carnation, head obtuse, rose colour; eyes nearly marginal in the rose-coloured part. It has been found in the neighbourhood of Edinburgh, as its specific name implies, by Dalyell, Flemming, and Johnston. I have never seen this species.

The family of *Dalyellidæ*,* so called after Sir John Dalyell, who has paid much attention to these creatures, containing six genera, five of which are lacustrine, differs from the foregoing groups, in all its members having the intestine an undivided tube. "They are small animals, of a parenchymatous consistency, in which it is often difficult to trace any distinctly defined viscera, or their openings on the surface. The body is acephalous, and more or less contractile, with an entire margin. They are either marine or lacustrine; and the latter, in general, lay their eggs enclosed in a cocoon or capsule. Of the mode in which the marine genera are propagated, nothing appears to be known." The fresh-water genera are defined severally as follows:—

(1.) *Dalyellia.* Body somewhat compressed vertically, elliptical; the mouth terminal; eyes two, parallel, posterior to the mouth and dorsal; ova capsulated. Lacustrine. Dr. Johnston describes two British species, viz.:—*Dalyellia helluo*, which is narrowed at both ends, most so posteriorly, of a uniform grass-green colour, with a transparent margin, one to one and a half lines long, inhabiting stagnant waters; and *D. exigua*, which in motion resembles a double cone in form, reddish in colour, one-third of a line in length, and an inhabitant of ponds. The first species has been described by several naturalists; the second was first noticed by Sir John Dalyell. I am unacquainted with both.

(2.) *Derostoma.* Body linear-oblong, rounded at both ends, with two eyes or none; mouth pitcher-shaped, concealed, opening by a longitudinal fissure on the venter. Two British species are described, viz., *D. unipunctatum*, which is plump, narrowed towards the anterior extremity, and obtuse behind, dingy yellow, with two yellow eyes, and three lines long, an inhabitant of ponds with a muddy bottom; and *D. vorax*, with round body, obtuse in front, tapering backwards to a point, greenish, and without eyes. It is one and a half lines in length, and is found in fresh-water marshes. The generic name, which signifies "long-mouth," from its longitudinal opening, was proposed by G. Dugès in 1828.

* The Planarian worms have been well divided into the two following sections:—

(1.) DENDROCŒLS, having a digestive apparatus dendritically branched.
(2.) RHABDOCŒLS, having a straight or unbranched digestive apparatus.

(3.) *Mesostoma.* Body somewhat flattened when at rest; the mouth ventral, sub-central, encircled with a broad annular sphincter; eyes two approximate, on the dorsum behind the apex and anterior to the mouth. Lacustrine. The ova capsulated. Dr. Johnston describes one species only, viz., *M. rostratum.* It is elongate, elliptical, acuminate, and alike at both ends, whitish and pellucid, or tinted a yellowish-red; eyes reddish or black, approximate; mouth central; egg capsules dark brown or reddish, length three lines, breadth half a line. This little animal I find quite common within the stems of *Sparganium,* but owing to its small size and pellucid appearance very easily overlooked. The reddish colour, of which Dr. Johnston speaks, is owing to a number of red capsulated ova often seen within the body of the animal; I have occasionally counted as many as twenty-five or thirty. The proboscis, or œsophagus, is bulbous in form, with five or six strong radiating muscles (see Fig. 6). It glides along the surface of submerged bodies and moves rapidly in the water, which appears to have suggested the epithet *Velox* to Dr. Johnston. I believe the animal dies immediately after laying its eggs. Another species (Fig. 10), the *M. personatum* of Dr. Oscar Schmidt, I have found in a reedy pond, near Preston on the Wild Moors, Salop. I have recently added it to the British fauna. See Ann. and Mag. Nat. Hist. for last December.

(4.) *Opistomum.* Body flattish, with an anterior sub-terminal mouth; the œsophagus pitcher shaped, not protrusile; eyes, none. Lacustrine. One British species only has been described, viz., *O. serpentina,* which is tongue-shaped, dilated and rounded in front, lanceolate behind, white or grey, two lines in length, and an inhabitant of fresh-water pools. Sir J. Dalyell found this little animal, and on his authority, it is added to the British fauna. It appears, from the description, to be identical with the *Opistomum pallidum* of Schimdt. It is unknown to me.

(5.) *Typhloplana.* Body oblong, somewhat roundish; head continous with body; mouth sub-central, a little posterior to the middle of the body; eyes, none. Lacustrine. Two British species are enumerated in Dr. Johnston's catalogue, *T. fœcunda* and *T. prasina.* The first is nearly linear, or a little swollen at the middle, with obtusely rounded extremities, white, and half a line in length; it is found in ponds in autumn. The second is grass-green in colour, obtuse in front, tapering to a point behind; it is gregarious, and is found in ponds in autumn. Both are minute species, about half a line in length. I am not acquainted with either of these species. The species belonging to the genus *Convoluta,* being marine, do not come within the scope of our inquiries.

The above descriptions of these *Planarian* worms, partly taken from my own observations and partly from Dr. Johnston's catalogue, will, I hope, be found of use in helping some of my readers to determine the species they may meet with. The works I have consulted on this subject are Dugès two valuable memoirs, Diesing's "Systema Helminthum," O. F. Müller's "Vermium Terrestrium et Fluviatilium," the "Prodromus Zoologiæ Danicæ" of the same author; Oersted's "Entrouof Plattwürmer;" Professor Owen's artice on Entozoa in "Todd's Cyclopædia of Anatomy," and Dr. Johnston's "Catalogue of the British Non-Parasitical Worms in the Collection of the British Museum," published by Taylor and Francis in 1865. The large work of Müller, "Zoologia Danica," contains several figures of the *Planariæ*, as also does Sir John Dalyell's work, "The Powers of the Creator Displayed in the Creation," published by Van Voorst. The former work I have not seen, the figures in the latter are not very good. There is also a treatise by Dalyell, "Observations on the Planarian Worms." Dr. O. Schmidt's Treatise ("Die Rhabdocœlen Strudelwürmer") is the best work on the fresh-water *Rhabdocœls*. It contains numerous figures of these animals. The researches of the same author on the sexual organs of the *Dendrocœl Planaria*, in the "Zeitschrift für Wissenschaftliche Zoologie," Band. x. and xi., must be especially mentioned, but I regret I was unable to consult the volumes at the time I was investigating the anatomy of these worms, neither have I been able to meet with Schultze's "Bertrüge zur Naturgeschchte der Turbellariea."

Description of Plate.

Fig. 1.—*Planaria lactea*, showing dendritic form of digestive system (after Dugès).

Fig. 2.—The same species, drawn from a living specimen.

Fig. 3.—Head of *P. torva*.

Fig. 4.—*Mesostoma rostrata*, as it progresses.

Fig. 5.—The same species when at rest.

Fig. 6.—Full and side view of proboscis of ditto (from specimen).

Fig. 7.—Head of *Polycelis brunnea*.

Fig. 8.—Capsulated ova of *Mesostoma rostrata*.

Fig. 9.—Ditto of *Planaria torva*.

Fig. 10.—*Mesostomum personatum* (from a specimen).

Fig. 11.—*Planaria torva*, with protruded proboscis, swallowing a worm (after Dugês).

Fig. 12.—The same, in another position, attacking a worm (after Dugès).

Fig. 13.—*Polycelis nigra*, progressing.

Fig. 14.—*Polycelis nigra*, at rest.

Fig. 15.—Reproductive organs of *P. lactea*. *a*, Penis and sheathe; *b*, oviduct; *c*, vesicle and reservoir of eggs; *d*, common orifice (after Dugès).

All the figures, except 11, 12, 13, and 14, are magnified.

THE GRAVE-MOUNDS OF DERBYSHIRE, AND THEIR CONTENTS.

BY LLEWELLYNN JEWITT, F.S.A., ETC., ETC.

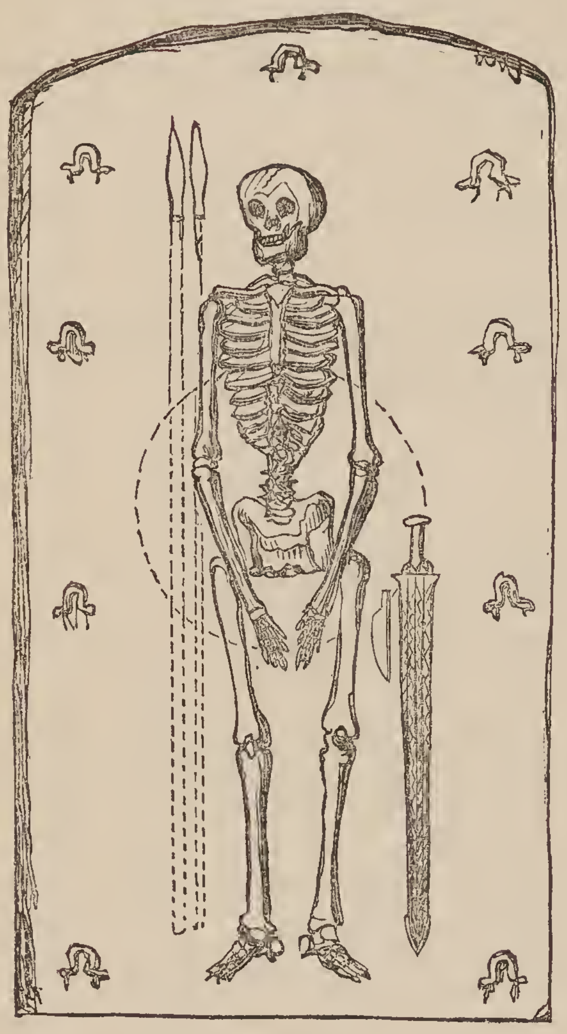
(*Continued from page* 350.)

THE ANGLO-SAXON PERIOD.

The county of Derby fortunately affords abundant and unusually excellent, as well as remarkable, examples of the graves of the Anglo-Saxons, and therefore we need be at no loss in describing the modes of interment, and the objects which are found in the graves and in the barrows of this period. When it is recollected that one of the towns of Derbyshire—Repton (Hrepandune)—was the capital of the kingdom of Mercia and the burial-place of the Mercian kings; that the names of many other places are derived from their Saxon owners; and that one of the main roads used by them—and before their time by the Normans and the ancient Britons—the Rykneld Street, ran through the county, it will easily be seen that in the Saxon times Derbyshire was so well populated and so thriving, that the interments must have been not only numerous but of all kinds. Accordingly we find examples both of burial by cremation and of the unburnt body in cemeteries, as well as instances of interment having been made in the earlier Celtic barrows.

Generally speaking the Anglo-Saxon graves were rectangular cists or pits cut in the ground to the depth of from two or three to seven or eight feet. On the floor of this the body was placed at full length, on its back, in the dress which was worn by deceased when living. The arms were usually extended by the sides, with the hands resting on the pelvis. Around the body were placed articles which had been used, or were valued by, or which it was thought might be useful to, the deceased. The grave was then carefully filled, and a mound of but low altitude raised over it; the earth being generally "puddled" or tempered. This mound or hillock was called a

Hœlw from which the Derbyshire name of *Low* is evidently derived. The accompanying plan of a grave opened by Mr. Bateman on Lapwing Hill, will pretty tolerably illustrate this mode of Anglo-Saxon burial. Beneath the bones of the skeleton were "traces of light-coloured hair, as if from a hide, resting upon a considerable quantity of decayed wood, indicating a plank of some thickness, or the bottom of a coffin. At the left of the body was a long and broad iron sword, enclosed in a sheath made of thin wood covered with ornamental leather. Under or by the hilt of the sword was a short iron knife; and a little way above the right shoulder were two small javelin heads, four-and-a-half inches long, of the same metal, which had lain so near each other as to become united by corrosion. Among the stones which filled the grave, and about a foot from the bottom, were many objects of corroded iron, including nine loops of hoop iron (as shown in the engraving) about an inch broad, which had been fixed to thick wood by long nails; eight staples or eyes which had been driven through a plank and clenched, and one or two other objects of more uncertain application, all which were dispersed at intervals round the corpse throughout the length of the grave, and which may therefore have been attached to a bier or coffin in which the deceased was conveyed to the grave from some distant place." Indicacations existed of the shield having been placed in its usual position over the centre of the body, but no umbone was in this instance found. The mounds are usually very low, frequently not being raised more than a foot above the natural surface of the ground. The earth was, as I have stated, usually "puddled" or tempered with water, and thus the body in the grave became closely imbedded in a compact and tenacious mass. That the tempering, or puddling, was accompanied with some corrosive preparation, there can be little doubt, for it is a fact, though a very remarkable one, that whilst the skeletons of the



Celtic period are found in good condition, and in some instances perfect and sound, those of the Anglo-Saxons have, almost invariably, entirely disappeared. Thus in a Celtic barrow the primary interment of that period may be found in perfect condition, while the secondary interment, that of the Anglo-Saxon, although some centuries later in date, and some three or four feet nearer the surface, will have decayed away and completely disappeared. Thus, in a barrow at Wyaston which had been raised over the body of a Saxon lady every indication of the body had disappeared with the exception of the enamel coating of the teeth, while a splendid necklace of beads, a silver ring, silver earrings, and a silver brooch or fibula, remained *in situ* where the flesh and bones had once been. Another instance (to which I shall have occasion again to allude) which may be named was the barrow at Benty Grange—a mound not more than two feet in elevation, but of considerable dimensions, and surrounded by a small fosse or trench, raised over the remains of a Saxon of high rank. In this mound, although a curious and unique helmet, the silver mountings of a leather drinking cup, some highly interesting and beautiful enamelled ornaments, and other objects, as well as indications of the garments, remained, not a vestige of the body, with the exception of some of the hair, was to be seen. The lovely and delicate form of the female and the form of the stalwart warrior or noble had alike returned to their parent earth, leaving no trace behind, save the enamels of her teeth and traces of his hair alone, while the ornaments they wore and took pride in, and the surroundings of their stations remained to tell their tale at this distant date. In a barrow at Tissington in which the primary (Celtic) interment was perfect, the later Saxon one had entirely disappeared, while the sword and umbone of the shield remained as they had been placed.

The mode of interment with the funeral fire, as well as the raising of the barrow, is curiously illustrated by the opening of two Saxon graves at Winster. A large wood fire had, apparently, been made upon the natural surface of the ground. In this a part of the stones to be used for covering the body, and some of the weapons of the deceased, were burned. After the fire was exhausted the body was laid on the spot where it had been kindled, the spear, sword, or what not, placed about it, and the stones which had been burnt piled over it. The soil was then heaped up to the required height.

The instances I have given (and most others which have been examined) of interment of the entire body, have occurred in the district of the Peak. In the lowlands of the county the interments appear mostly to have been by cremation, and here somewhat extensive cemeteries—either as groups of small low barrows containing interments of burnt bones—or otherwise, have been found. In some of these the body has simply been burned, the calcined bones gathered into a small heap and then the mound raised over them. In others, and more usually, the calcined bones have been carefully collected together, placed in cinerary urns, and buried.

Two of the most extensive and remarkable cemeteries of this kind are those at Kingston and at King's Newton, both near Derby.* At the first of these places an extensive cemetery was discovered in 1844, and resulted in the exhumation of a large number of urns; indeed, so large a number, that, unfortunately, at least two hundred were totally destroyed by the workmen before the fact of the discovery became known. On the surface no indication of burials existed, but as the ground had some sixty years before been under plough cultivation, and as the mounds would originally have been very low, this is not remarkable. The urns had been placed on the ground in shallow pits or trenches. They were filled with burnt bones, and the mouth of each had been covered with a flat stone. They were, when found, close to the surface, so that the mounds could only have been slightly elevated when first formed. Of the form of the urns I shall have to speak later on.

The cemetery at King's Newton, though not so large as the one just named, was an extensive one. It was discovered during the present autumn (1867), and a large number of fragmentary urns were exhumed. The mode of interment was precisely similar to that at Kingston, and the urns were of the same character as those there discovered. There were no traces of mounds having been raised, although most probably, they had originally existed.

Cremation was the predominating practice among the Angles, including Mercia, and the modes of burning the body, and of interment of the calcined bones in ornamental urns, which I have described, in the two cemeteries just spoken of, are characteristic of that kingdom. This mode is curiously illustrated in the Anglo-Saxon poem of "Beowulf," which evidently describes the custom of the Angles. The following extract forcibly illustrates the mode of interment. The funeral pile having been raised, and hung round with shields, helmets, and coats of mail,

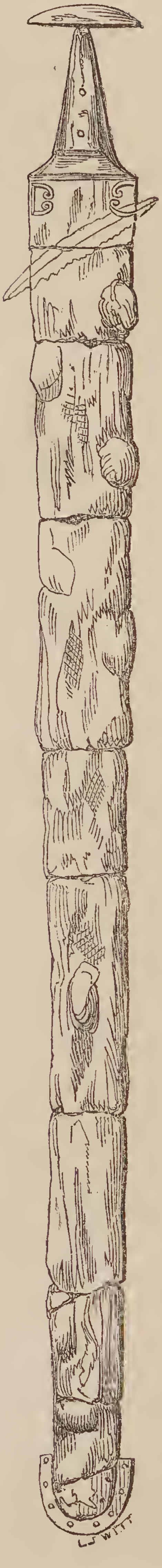
> ". . . the heroes, weeping,
> laid down in the midst
> the famous chieftain,
> their dear lord.

* It is a singular fact, and worthy of note, that the two most extensive Saxon cemeteries—indeed, the only two worthy the name of cemeteries—discovered in Derbyshire, are at Kingston (King's Town) and at King's Newton (King's New Town), and that at each the urns are of remarkably fine character.

Then began on the hill
the mightiest of funeral fires
the warriors to awake;
the wood smoke rose aloft,
dark from the fire;
noisily it went
mingled with weeping."

The body having been burned, and the ashes collected together, the warriors and friends of the deceased raised a mound over the remains "high and broad;"

"and they built up
during ten days
the beacon of the war-renowned.
They surrounded it with a wall
in the most honourable manner
that wise men
could desire.
They put into the mound
rings and bright gems,
all such ornaments
as before from the board
the fierce minded men
had taken."



With interments in urns, but few articles, either of personal ornament or otherwise, are found. With those, where the body has been placed entire in the grave, the objects are numerous, and, in some instances, are elaborate and beautiful in ornamentation. Among the articles which the Saxon grave-mounds of Derbyshire have produced are swords, knives, seaxes, spear-heads, umbones of shields, buckles, helmets, querns, drinking cups, enamels, gold, silver, and bronze articles, baskets, buckets, draughtsmen, combs, beads and necklaces, rings, ear-rings, caskets, armlets, fibulæ, articles for the chatelaine, pottery, etc. Of some of these I will now proceed to speak.

The sword of the Anglo-Saxon period, as evidenced by the Derbyshire barrows, is of the form shown on the accompanying engraving, from a barrow at Tissington. This sword, which is thirty-four inches in length, and two and a half inches in breadth, is, of course, of iron. It had been originally enclosed in a wooden scabbard, or sheath, which had, apparently, been covered with leather, and mounted with elaborately ornamented silver. The chape, which was of silver, was simply rounded, and the rivets which attached it, as also those which attached the leather, remained. Another fine example was found at Brushfield, by the side of the body shown on page 460. It, too, had been enclosed in a sheath of wood, which had been covered with leather, ornamented with lines and lozenges.

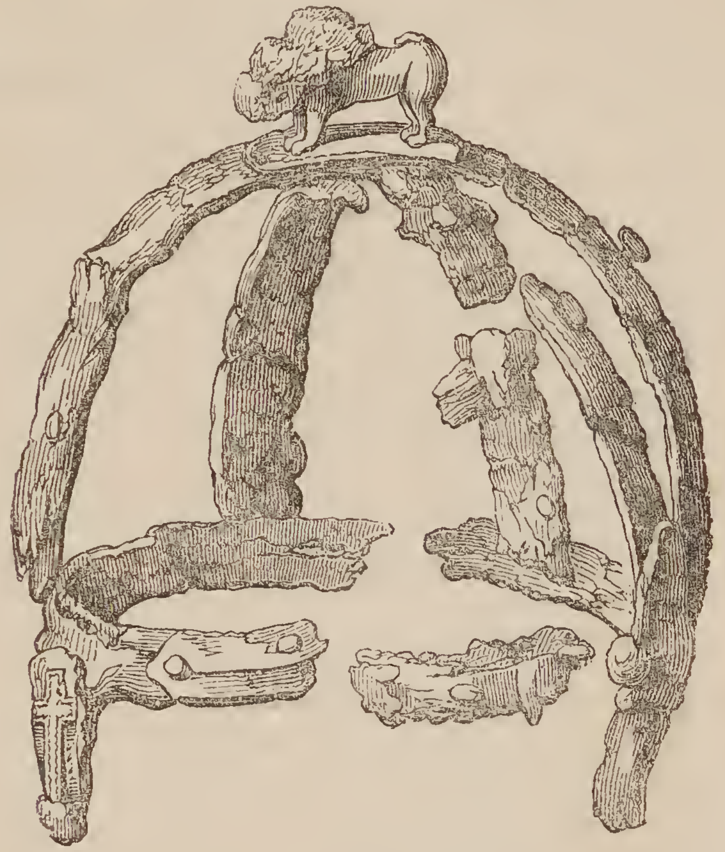
The shield was usually placed in Saxon interments over the middle of the body, as indicated in the plan on page 460; but of this, indications only were in this instance found. In the Tissington barrow before spoken of, a portion of the edge of the shield was found adhering to the sword, as shown in the engraving, and the umbone, or central boss of the shield was also found. This umbone, here engraved is of iron, conical in form, and measures nine inches in height. It is the largest yet found in Derbyshire, and is in form similar to examples found at Sibertswold, and in other localities. When found, the umbone was surrounded with a mass of decayed wood, the remains of the shield, and small fragments of corroded iron, which were, doubtless, a part of its mountings.

The knives found in the Derbyshire barrows are of the general forms. They are usually found, sometimes one and sometimes two, lying by the skeleton on the opposite side from the sword, though, in some instances, the knife and sword have been found lying side by side, as in the interment on page 460.

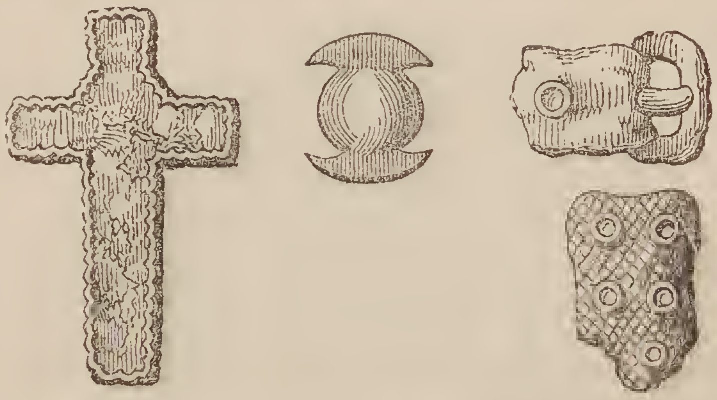
Spear heads also of iron are occasionally found. Two of these, lying on the right side of the head, will be seen in the engraving on page 460. They are short and socketed.

One of the most remarkable objects of the Saxon era which has been exhumed is the helmet already alluded to. This highly-interesting relic was discovered by Mr. Bateman at Benty Grange, in 1848. The barrow was of but slight elevation, and contained the remains of a body which had been laid on the natural surface of the earth, as already named. Among the articles remaining—for the body, with the exception of a portion of the hair, had entirely disappeared—was the remarkable helmet here engraved. This helmet "consists of a skeleton formed of iron bands radiating from the crown of the head, and riveted to a circle of the same metal, which encompassed the brow; from the impression on the metal it is evident that the outside was covered with plates of horn, disposed diagonally, so as to produce a herring-bone pattern.

The ends of these plates were secured beneath with strips of horn corresponding with the iron framework, and attached to it by ornamental rivets of silver, at intervals of about an inch



and a half from each other. On the bottom of the front rib, which projects so as to form a nasal, is a small silver cross (shown in the engraving), slightly ornamented round the edges



by a beaded moulding, and on the crown of the helmet is an elliptical bronze plate, supporting the figure of an animal carved in iron, with bronze eyes, now much corroded, but perfectly distinct, as the representation of a hog. There are, too, many fragments, some more or less ornamented with silver, which have been riveted to some part of the helmet in a manner not to be explained or even understood. There are also some small buckles of iron, which probably served to fasten it upon the head." The boar, which is here borne as a crest on the top of the helmet, was, it appears, according to Tacitus, borne as a charm against the dangers of war, and this custom is curiously illustrated by the poem of "Beowulf," which is thus translated :—

"They seemed a boar's form
to bear over their cheeks;
twisted with gold
variegated and hardened in the fire,
this kept the guard of life."

And again, in other parts of the poem, the following allusions occur:—

"Surrounded with lordly chains,
even as in days of yore
the weapon-smith had wrought it,
had wondrously furnished it
had set it round with the shapes of swine,
that never afterwards
brand or war-knife
might have power to bite it."

"Ah, the pile was
easy to be seen
the mail-shirt coloured with gore,
the hog of gold
the boar hard as iron."

"Then commanded he to bring in
the boar, an ornament to the head,
the helmet lofty in war,
the grey mail-coat,
the ready battle sword."*

It will be noticed in these extracts that the "mail-coat," or "mail-shirt" is twice mentioned, as well as the "helmet lofty in war." Thus the passages fully illustrate the extra-

ordinary discovery in Derbyshire, which embraced a coat of mail along with the helmet and other objects (amongst which was a curious six-pronged instrument of iron). The coat of mail consisted of a mass of chain work, the links of which were attached to each other by small rings. The links were

* *Collectanea Antiqua.*

of two kinds, "one being flat and lozenge-shaped, about an inch and a half long; the others, all of one kind, but of different lengths, varying from four to ten inches. They are simply lengths of square rod iron, with perforated ends, through which pass the rings connecting them with the diamond-shaped links. They all show the impression of cloth over a considerable part of the surface, and it is therefore no improbable conjecture that they would originally constitute a kind of quilted cuirass, by being sewn up within or upon a doublet of strong cloth." Fragments of another helmet of very similar character were found in the following year in another barrow, a few miles from the one just described.

Of fibulæ, besides some small circular examples which have been from time to time found, a magnificent one of gold was discovered some years ago in a barrow on Winster Moor. This remarkably fine fibula (page 466), was formed of gold "filagree" work, which was mounted on a silver plate. It was set with stones or paste on chequered gold foil, and measured two inches in diameter. Along with this fibula were found the following interesting articles: a cross of pure gold, ornamented, like the fibula, with "filagree" work, and having a garnet cut in facets set in its centre; a silver armlet; two glass vessels, and a number of beads. These and some other articles were all found by the sides of two cinerary urns. A remarkably fine penannular brooch of the Irish type,

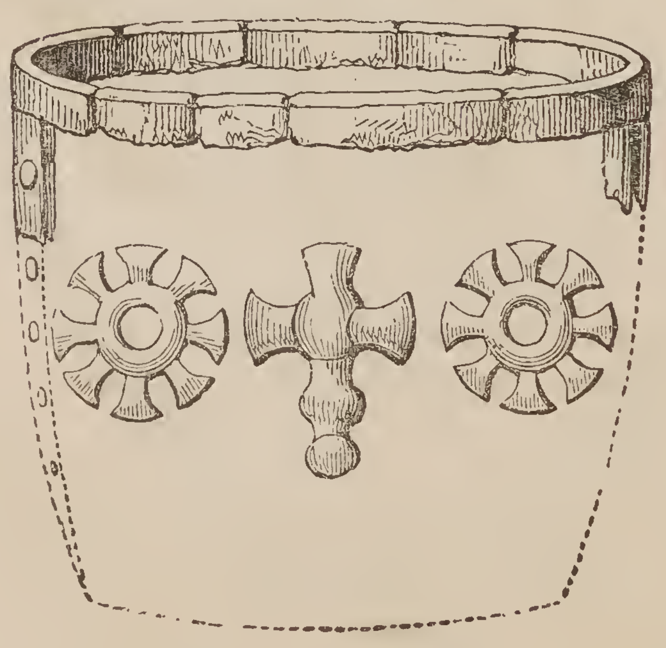
of the period now under notice, was discovered in the same neighbourhood (at Bonsall), of which I may yet take occasion to speak in the pages of The Student.

Of beads and necklaces some extremely beautiful examples have been found; of these, the necklace from the barrow at Wyaston (page 467,) will be sufficient for my present purpose. It consists of twenty-seven beads, five of which are of amber, carefully rounded into a globular shape, the largest an inch in diameter, and the remaining twenty-two are of glass or porcelain, variegated in different colours. Another necklace was formed of garnets, etc., set in gold, and was of extremely elegant pensile form.

Combs, rings, earrings, and armlets have occasionally been found, and have been of the usual forms.

Of enamelled ornaments some choice examples have been

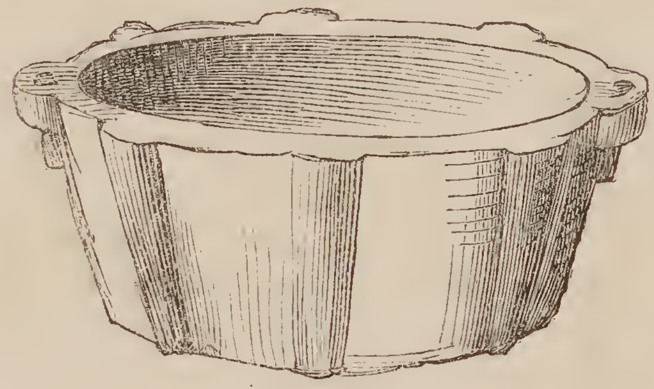
exhumed. One of these, a pendant ornament, was found in a



barrow on Middleton Moor, and others, though fragmentary, which are here engraved, at Benty Grange. In the same barrow were found the silver edging and mountings, and the ornaments, of a small drinking cup of leather. The cup was about three inches in diameter at the top, and had been ornamented by two crosses and four wheel-shaped ornaments of silver, and by a silver rim and upright bands. It is shown page 468. Several other objects, in silver, including earrings, rings, sword mountings, fibulæ, and other personal ornaments, have also been brought to light. In one interment some silver ornaments, and various articles belonging to a lady's chatelainé, along with a thread box of bronze, and some bronze needles or pins, were found in what appeared to be the remains of a wicker basket. Portions of buckets too have been noticed.

In bronze many articles have been found. Among these, perhaps two of the most curious are the bowl and the small

box pierced for suspension, here shown. The bowl measured



seven inches in diameter, and the box two inches. Bosses, highly ornamented, and other bronze objects, have also been found.

One of the most curious set of objects which the Saxon graves of Derbyshire have produced is a set of twenty-eight bone counters, or draughtsmen, some of which are shown on the following engraving, where they are represented of their full size. They were found by Mr. Bateman in a barrow near Cold Eaton, along with an interment of burnt bones, some fragments of iron, and portions of two bone combs. The draughtsmen, as they are supposed to be, and the combs had been burnt with the body. Querns have occasionally been found in Saxon barrows.

Of glass vessels I have already mentioned the finding of some examples, but it is necessary also to note the curious discovery of the glass cup here shown, and

which, from the care which had been taken in inclosing it in a wooden box must have been no little prized by the deceased lady. The cup, of thick green glass, a bone comb, some small instruments of iron, a piece of perforated bone, and a necklace with pendant ornaments, with other articles, were found inclosed in a box or casket, made of ash wood half an inch in thickness, with two hinges, and a small lock, which had, when placed in the grave, been carefully wrapped in woollen cloth. The interment was in many respects a highly interesting one.

The pottery of the Anglo-Saxon grave-mounds and cemeteries consists almost entirely of cinerary urns. These were undoubtedly, like those of the ancient Britons, made near the places where the remains have been discovered, and, as a natural consequence, usually from clays found in the neighbourhood of the place. The form of the cinerary urns is somewhat peculiar. Instead of being wide at the mouth, like the Celtic urns, they are contracted and have a kind of neck instead of the overhanging lip or rim which characterizes so much of the sepulchral pottery of that period. The urns are formed by hand, not on the wheel, like so many of the Romano-British period, and they are, as a rule, perhaps, more firmly fired than the Celtic ones. They are usually of a dark-coloured clay, sometimes nearly black, at other times they are dark brown, and occasionally of a slate or greenish tint produced by surface colouring. The general form of these interesting fictile vessels will be best understood by reference to the accompanying

engraving which exhibits two of the urns from Kingston. One of these will be seen to have projecting knobs or bosses, which have been formed by simply pressing out the pliant clay from the inside with the hand. In other examples these raised bosses take the form of ribs gradually swelling out from the bottom, till, at the top they expand into semi-egg-shaped protuberances. The ornamentation on the urns from these cemeteries usually consist of encircling incised lines in bands or otherwise, and vertical or zig-zag lines arranged in a variety of ways, and not unfrequently the knobs or protuberances of which I have just spoken. Sometimes, also, they present evident attempts at imitation of the Roman egg and tongue ornament. The marked features of the pottery of this period, is the frequency of small punctured or impressed ornaments which are introduced along with the lines or bands with very good effect. These ornaments were evidently produced by the end of a stick cut and notched across in different directions so as to produce crosses and other patterns. In some districts these vessels are ornamented with simple patterns painted upon their surface in white; but so far as my knowledge goes, no examples of this kind have as yet been found in Derbyshire. One or two examples of domestic vessels, though but in fragments, have been found in the cemeteries; but of these just now it will be unnecessary to speak. Those who desire more extended information on the subject of the pottery of the Anglo-Saxons cannot do better than turn to the sixth volume of the INTELLECTUAL OBSERVER, where they will find an admirable paper on the subject from the pen of my friend Thomas Wright, who, along with another valued friend, Charles Roach Smith, was among the first to clear up the mystery which surrounded the remains of the fictile arts of that people.

Having now fulfilled the promise which I made in the opening of this series of papers, that of devoting them to giving a general insight into the modes of construction and the contents of the grave-mounds of Derbyshire, I close my subject with the earnest expression of a hope that the information which I have given, brief though it necessarily is, may be of service to the readers of the INTELLECTUAL OBSERVER, and may enable them to appropriate to their respective ages such remains of the early inhabitants of our country as may come under their notice. In future volumes of THE STUDENT * I hope to give from time to time some short separate papers on matters to which I have so far but passingly alluded.

* See Notice on page 401.

PROGRESS OF INVENTION.

Improvement of Davy's Lamp.—Many improvements of this most valuable apparatus have been invented: one, very recently proposed, consists in the application of an outer cylindrical case, which is made, in part, of glass, and in part, of wire gauze. Both cases have independent fastenings, and therefore are not likely to be opened by any accident, nor, in ordinary circumstances, can they be opened even by design. Experiments made with this lamp have shown that it is much more to be relied upon than the ordinary kind: since it remains perfectly cool, in an atmosphere in which an ordinary Davy's lamp would be very soon heated to redness.

Steam Boiler Incrustations.—These, a prolific source of steam-boiler explosions, consists of earthy substances, that are bad conductors of heat, and therefore they permit the boiler, notwithstanding the proximity of water, to be unduly heated: the consequence of which is, that the metal of which it consists is burned, and greatly deteriorated in strength, or the earthy coating cracks, and allowing the water to come in contact with the highly heated metal, a vast quantity of steam is suddenly formed, or the water is even decomposed. The steam in one case, and the gas in the other, gives rise to such a pressure as the boiler may be unable to bear. The prevention of incrustration, besides removing a serious source of danger, would have the effect of economising fuel, by leaving the capacity of the metal for transmitting heat to the boiler unimpaired. One method of preventing incrustrations, is the removal of the earthy matters from the water before it is introduced in the boiler; this is difficult, and from circumstances often impossible. Another method, is to render the earthy matters harmless, by keeping them in a pulverulent state, and suspended in the water. An improvement on this method consists in arranging a number of small thin plates within the boiler, in such a way as that they over-lap, like the tiles on a roof, and form a thin space between themselves and the walls of the boiler. The heat being imparted directly to the water contained in this space, such a circulation is produced, that any deposit of sediment on the boiler is impossible. The sediment is, however, deposited on the plates; but, not being there exposed to a high temperature, it has no tendency to become a compact mass. This arrangement is attended with another advantage—the uniform and comparatively quiet disengagement of the steam: not in the lower part of boiler, but at, or near the surface of the fluid, on account of the presence of a large amount of solid particles thrown up by the circulation caused by the wall of plates.

Caloric Engines.—Whether steam or heated air is used, it is only the vehicle for transmissions of the heat from the fuel to the working point, to be changed there into motion. Steam has unquestionable advantages: air has, however, persevering and plausible advocates. M. Bourget has recently introduced a modification of the caloric engine which is attracting considerable attention. He heats the air, after it has been condensed, by a system of tubes which are placed in the flue of an ordinary furnace, and after having expanded in the cylinder, and thus actuated the piston, it is transmitted back to the heating tubes, the caloric it still retains being by this means economized. The heating power of the tubes is augmented by filling them with scraps of metal which render them magazines of heat, absorbing it when it would be in excess, on account of connection with the cylinder having being cut off during expansion, and giving it out at other times. A still better engine of this description has been invented by Mr. Wenham. It is remarkable for simplicity, economy, and compactness. The expansion of air driven through a small furnace and a very mild explosion of carbonic oxide, supplies a perfectly safe motive power.

PURIFICATION OF SULPHURIC ACID.—Sulphuric acid, from the mode of its manufacture, is very frequently found to contain nitric acid, which though small in quantity, is difficult of separation, and if unremoved is often very inconvenient. It has been found, that sulphuric acid may be completely freed from nitric, so as to afford no indication of its presence, by means of freshly calcined and pulverized wood charcoal, which may be removed by filtration.

PRODUCTION OF CALORIC BY MAGNETISM.—It has been ascertained that the rapid rotations of a magnet, or what is more effective, of a compound magnet consisting of several magnetized bars, will afford caloric. The effect is due to the prevention of motion which the magnet tends to produce. The experiment may be made, by placing above the poles of a magnet, which is capable of revolving on a vertical axis with its poles upwards at the rate of fifteen or twenty times a second, a small copper plate of a circular form, and about half a millimetre thick, and putting upon this plate a flat bottomed flask of considerable capacity, and having fixed in its neck, by a cork, a tube in the form of an S with a little water in its lower curve which is within the flask; the rapid rotations of the magnet heats the air: and this expanding acts on the surface of the water in the tube and causes it to ascend. When a maximum temperature, depending on the velocity of rotation is attained, the water will remain stationary. M. Louis D'Henry, to whom this experiment is due, believes that with a sufficently powerful system of magnets, and a rapid rotation, water in a copper vessel, placed on the copper plate might be made to boil.

NEW SUBSTITUTE FOR PHOSPHORUS IN THE MANUFACTURE OF LUCIFER MATCHES.—The terrible effects produced by ordinary phosphorus on those who manufacture matches with it, and the obstacles to the introduction generally of amorphorus phosphorus renders a substitute for this pernicious material very desirable. Such a substitute is most probably to be found in a mixture recently discovered by M. Böttger. It consists of eight parts trioxide of thallium, and one part penta-sulphuret of antimony: and may be ignited by friction.

UTILIZATION OF THE RESIDUES OF THE SMELTING FURNACE.—Large quantities of cinders, hitherto incapable of use for any industrial purpose are produced by smelting furnaces. They have been found on examination to consist for the most part of very minute globules of iron. The recovery of this iron will not only be a means of getting rid of very large quantities of very troublesome material, but a source of considerable profit.

New Mode of Manœuvering a Vessel.—Floating batteries are being constructed for the protection of the coasts of Sweden. They are provided with a turret: and as the turret does not revolve, in order to secure the power of aiming the gun it contains in all directions, it is necessary that the vessel itself should rapidly turn round. This is effected with ease and certainty, by means of a paddle wheel fixed at the bow, and turning on an axis which is parallel to the length of the vessel. This wheel is entirely immersed and therefore if constructed in the ordinary way with fixed floats, it would produce no motion, the floats on opposite sides neutralzing each other. It is therefore so arranged that the floats, when in a higher position feather, and move through the water horizontally so as to have no effect in producing motion. The floats which are at the time in a lower position produce a maximum effect. This paddle wheel offered little resistance to the progressive motion of the floating battery as the floats are made of thin sheet iron: and they present their edges to the direction in which the vessel is moved. Such an arrangement would however not be suitable with other than vessels intended to remain constantly at or very near the same place.

Production of Detonating Powder, with the Materials of Ordinary Gunpowder.—It has been found that the rapidity of combustion of gunpowder depends greatly on the nature of the charcoal employed; the development of this fact has been carried so far, by a suitable selection of the charcoal, that the combustion becomes so rapid as to be an explosion of the unconfined powder. This is effected by the use of carbon obtained from rice starch, the albumen of blood, or leather. With nitrate of potash such carbon forms not ordinary gunpowder but a detonating material.

LITERARY NOTICES.

Sun Views of the Earth; or, the Seasons Illustrated. Comprising Forty-eight Views of the Earth as supposed to be seen from the Sun at different Hours and Seasons. With five enlarged Sun Views of England, and a Diagram representing the Earth's daily motion in her orbit. By Richard A. Proctor, B.A., F.R.A.S., late Scholar of St. John's College, Cambridge; and of King's College, London. Author of "Saturn and its System," "The Constellation-Seasons," etc. (Longmans.)—The changes from spring to summer, autumn, and winter, depending on the positions taken up in succession by the earth in its journey round the sun, may be represented by a series of views of the earth as it might be seen from the sun at any point of the journey. The places which the sun looks straight at will receive a full share of light and heat, those which he looks at more slantingly will receive less, and those out of his reach none at all. Mr. Proctor has devised a highly instructive and pleasing set of pictures illustrating these facts, and giving a far better notion of the cause of the seasons than any diagram we have seen. Plate I. gives four coloured views of the earth at the winter solstice (Dec. 21), at 6 a.m., 6 p.m., noon, and midnight; and at a glance it is seen how the northern regions are foreshortened and the polar portions out of the sun's sight. Plate II. has similar views representing the state of things one month later, and so on in succession through spring and summer to a month before the winter solstice, represented in Plate XII. The XIIIth Plate shows on a larger scale the way in which Great Britain, France, Holland, Denmark, etc., are presented to the sun at various periods of the year. We are glad these drawings are published at a very moderate price, because they will, with the help of the explanatory letter-press, be of great use to schools and families, and to teachers who wish to know how these matters may be made most intelligible to their pupils.

We have also received from Messrs. Longman four charts drawn by Mr. Proctor: one of the Zodiac, on which, with the help of an almanack, the paths of the moon and planets may be easily traced; another of Mars representing that planet as seen from the earth at various points of his rotation. Two other charts represent the orbits of Mars, the Earth, Venus, and Mercury; and of Neptune, Uranus, Saturn, and Jupiter. A great deal of astronomical information is compressed in these diagrams, which are well worth attentive study.

How to Use the Barometer, 1868. By the Rev. R. Tyas, M.A. Cantab., F.M.S., Member of the Scottish Meteorological Society. Author of "Favorite Wild Flowers," etc. (Bemrose and Sons.)—The author also calls this little book "A Companion to the Weather-glass." It contains useful information about instruments, and a series of tabular forms to facilitate the registration of meteorological changes. These are very handy, though on a somewhat small scale. The author likewise does a little weather prophecying, founded upon principles which he does not explain, but which, he asserts, have usually led to correct anticipations. He says, "Although we are unable to say positively that there will be rain in any period—say of seven or eight days—yet the probability approximates so nearly to a certainty, that we may reasonably expect rain or fair weather about the times herein stated, and this expectation leads us to watch more carefully the signs of change." Those who buy this little book may amuse themselves by testing the value of these prophecies.

PHOTOGRAPHS OF EMINENT MEDICAL MEN OF ALL COUNTRIES. With brief Analytical Notices of their Works. Edited by Wm. Tindal Robertson, M.D., M.C.P. The Photographic Portraits from Life, by Ernest Edwards, B.A. Cantab. No. 7, Vol. II. (Churchill and Sons.)—The portraits now given of this interesting series are those of Erasmus Wilson, F.R.S., Sir James Bardsley, and Dr. Thomas Hawkes Tanner. They are all good.

CLIMBING THE HILL. A Story for the Household, by the author of "A Trap to Catch a Sunbeam." (Groombridge and Sons.)—A tale by the author of so exquisite a story as "A Trap to Catch a Sunbeam," cannot fail to be welcome. The present story relates to a young couple "climbing the hill." It is gracefully told, and being published in a very handsome form, will make an appropriate new year's gift.

RAIN: HOW, WHEN, WHERE, AND WHY IT IS MEASURED. Being a Popular Account of Rainfall Investigations. With Numerous Illustrations. By G. J. Symons, F.M.S. Editor of "British Rainfall," and "Symons' Monthly Meteorological Magazine." (Stanford: Simpkin.)—This is the best book on the subject to assist in spreading a knowledge of various matters pertaining to rainfall, the methods of measuring it, and the utility of the process. Some of the tabular matter is especially interesting, such as the "Fluctuations in the Fall of Rain from 1726 to 1865," and the "Approximate mean Annual Depth of Rain at 165 Stations," in which we observe Lincoln, Southwell, and Stamford stand lowest at 20 inches, while the Stye, near Southwaite, in Cumberland, is at the head of the wet places, and shows an average of 165 inches. London stands at 24 inches, being the same as Norwich and Edinburgh. In addition to this information, we want to know the average moisture in the air, as places may have a good deal of rain distributed in heavy showers, and yet be on the average much drier than other spots where the rainfall is less, and the quantity of vapour greater. Mr. Symons points out the necessity of using the hygrometer as well as the rain-guage, and we hope that, in a few years, accurate information on the English climatology will be obtained. We agree with Mr. Symons' suggestion that local authorities should undertake the slight expense required for daily observation and records. Wind should be registered as well as rain and moisture, and so should temperature and atmospheric pressure. Magnetic and electric observations need not be so general, but should be established upon a system at public cost.

THE BOY'S OWN BOOK. A Complete Encyclopædia of Sports, and Pastimes, Athletic, Scientific, and Recreative. A New Edition, thoroughly Revised and considerably Enlarged. (Lockwood & Co.)—We are glad to see a new edition of this book; certainly one of the best ever written for boys, and having the advantage of containing matter for boys of all ages. The new edition is a very handsome volume of nearly 700 pages, richly illustrated. It relates to all kinds of sports and pastimes, indoor and out, and mingles with cricket, archery, gymnastics, etc., directions for keeping birds, rabbits, and other domestic pets, and enough scientific recreations of various sorts to stimulate to graver studies in their proper place. It is a book we cordially recommend as a new year's gift.

On the Middle and Upper Lias of the South-West of England. By Charles Moore, F.G.S. Reprinted from the Proceedings of the Somersetshire Archæological and Natural History Society, Vol. XIII. 1865-6. (Taunton: F. May.)—A very useful monogram on the subject of which it treats, illustrated with seven nicely executed plates, containing numerous figures.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*Dec.* 4.

Robert Etheridge, Esq., in the chair.

Henry Alleyne Nicholson, Esq., read a paper on the Graptolites of the Skiddaw series, premising that the slates of that series corresponded with the Quebec group of Canada. He described twenty-four species.

P. Martin Duncan, Esq., M.D., described in a concluding paper the Fossil Corals of the West Indies. Dr. Duncan mentioned several curious facts in the distribution of West Indian corals, both fossil and recent, and especially the circumstance that, whilst Jamaica, San Domingo, and Guadaloupe present solitary species, mixed with those inhabiting shallow water or a reef, Antigua and Trinidad offer for consideration only reef species. In conclusion, the author drew attention to the confirmation by subsequent discoveries of his theory of an Atlantic Archipelago, which he had put forward in his earlier papers.

ROYAL MICROSCOPICAL SOCIETY.—*Dec.* 12.

James Glaisher, Esq., F.R.S., in the chair.

C. Stewart, Esq., read a paper describing the pedicellariæ of the Cidaridæ. In the discussion which ensued, Mr. Jabez Hogg stated that he had seen pedicellariæ in certain star-fish pass fragments of food from one to another towards the mouth. A Fellow remarked that Agassiz had noticed their removal of fæcal matter from the neighbourhood of the anus. Mr. Stewart said that although such actions might have been observed in certain species, many pedicellariæ were so situated as not to be capable of performing these functions, and that their real purpose was still undecided.

H. J. Slack, Esq., Sec. R.M.S., read a paper on a microscopic ferment found in red French wine, and probably being the same as M. Pasteur's mycoderma vini, though larger than that gentleman's measurements as given in "Comptes Rendus." The mycaderm he examined consisted of minute cells, which, when the wine was poured out, rose to the surface like a fine powder. It had not turned the wine sour. He succeeded in growing the *penicillium glaucum* from it in abundance, by simply exposing the wine to the air in a tumbler. Some of the cells placed in moist sugar and water occasioned a butyric fermentation, which seemed to be caused by their decay. After a few weeks the butyric acid and other compounds of nauseous odour disappeared, and the remaining cells then increased in number, and excited a vinegar fermentation. A mixture of the wine containing the cells with treacle and water, kept in a warm place, produced *penicillium glaucum*, and the fluid became only slightly acid.

NOTES AND MEMORANDA.

Comet III., 1867.—M. Hoek, of Utrecht, writes to the "Astronomische Nachrichten" as follows:—"In my researches on cometary systems, I instanced Comets III. and V., of 1859, as probably belonging to the same system. I did not hesitate to attribute to them this character, on account of the extreme resemblance of their elements, and the short interval between their appearances. Now, all of a sudden comes a new comet to supply un unexpected confirmation of these views; for the circles which represent the planes of these three orbits cross each other at the same point in the heavens. The three planes cut each other in the same line of intersection. Thus this line is necessarily parallel to the direction of the initial movement common to the three bodies at the moment they entered into the sun's sphere of attraction." M. Hoek then gives the elements of their orbits, and states his belief that they had one common origin. Their aphelion points are situated at a considerable distance from the common point of intersection, or rather from the radiating point of their orbits. Their aphelion points are all on the same side of the line of radiation. Captain Jupman, who observed this comet at Portsmouth, in October, found it equal to a star of 8.0 or 8.1 mag., with faint coma and no tail.

New Planet (95).—This body was discovered by Dr. Luther, at Bilk-Dusseldorf, on the 23rd Nov., 1867. It appears of 10 to 11 mag.

New Stars near α Lyra.—Mr. Buckingham reports the discovery of three very minute stars near Vega. One, *c*, is in a line between the well-known B and the great star; *e* is in the same direction, on the other side of it; *d* is like *c*, near Vega, but to the left of B on the meridian. The observations were made with the large object-glasses made by Mr. Wray, one of which (new) is 21¼ inches in diameter, and, according to Mr. Buckingham's report, works well with powers up to 1800. *c* and *d*, in the large object-glass, are little brighter than the companion of Polaris, seen with an aperture of 1.7 inch. (See "Monthly Notices" for November.)

Conflagration Colours and Moonlight.—On the night of the 6th of December, the burning of Her Majesty's Theatre in the Haymarket occasioned many curious chromatic effects. Immense flames and flame-coloured clouds of highly luminous orange and red tints made the moon (about 11 days old) look positively *blue*. Sirius, which was flashing splendidly, varied in hue from blue to deep violet.

FECUNDITY OF THE AXOLOTLS.—These curious amphibians, of which in 1864 the museum in Paris possessed five males and one female, have multiplied in captivity, so that more than 3300 have been produced from their eggs in two years and nine months. Some have been consumed in experiments, others died young, but at least 2500 have survived. Axolotls may be seen in the tanks of the Zoological Gardens.

PARALLAX OF THE SUN.—Notwithstanding the efforts hitherto made by astronomers, the exact parallax, and consequently the exact distance of the sun from the earth is not fully settled, and great interest is felt in the opportunities that may be afforded by the transit of Venus in 1874 and 1882. Meanwhile Mr. Simon Newcombe (U.S.) has been at work discussing minutely the observations of Mars in 1862. His results, communicated by M. Delaunay to the French Academy, make the solar parallax 8″.85, with a probable error of $\pm$ 0″.013. This corresponds with a distance of the sun from the earth of a little more than 23,307 terrestrial radii, rather more than 148 millions of kilometres. Taking the earth as unity, the mass of the sun will be 326,800 $\pm$ 1360, and that of the moon $\frac{1}{81.44 \pm 0.33}$. Taking the sun's mass as unity, the mass of the earth and moon together will be $\frac{1}{322,800}$.

ERUPTION OF VESUVIUS.—M. Pisani, writing from Resina, 13th November, 1867, says: "At half-past twelve to-night, Vesuvius has opened a new crater, to the right of the two cones of last year. At the half (*à la moitié*) of the great cone on the side of Bosco Reale, another crater has opened, pouring forth a current of lava. In the same direction, and precisely in the plane of the lava of last year, two other little craters, which cast up many streams, have been formed. The principal cone is full of crevasses, through the strong shocks it has received.

EGYPTIAN LAND SURVEYING.—The British Museum has obtained possession of a papyrus containing, in hieratic characters, a fragment of a treatise on geometry applied to land surveying, with illustrative figures. It shows how to measure squares, parallelograms, and various triangles. It is supposed to belong to the date of the twelfth dynasty, contemporary with Solomon, and it is copied from a more ancient treatise.

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HARRILD, PRINTER, LONDON.