VOL. 4. JULY 1828. No. 19.

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THE

PHILOSOPHICAL MAGAZINE
AND
ANNALS OF PHILOSOPHY:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE, THE LIBERAL
AND FINE ARTS, AGRICULTURE, MANUFACTURES,
AND COMMERCE.

NEW SERIES.

No 19.—JULY 1828.

BY
RICHARD TAYLOR, F.S.A. F.L.S. M. Astr. S. &c.
AND
RICHARD PHILLIPS, F.R.S. L. & E. F.L.S. &c.

ALERE FLAMMAM

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TO CORRESPONDENTS.

The Drawings of the Spots on the Sun will be acceptable.

We are authorized to announce the intention of **Dr. Prout** to reply in our next Number to the remarks of Drs. **Tiedemann** and **Gmelin**, a translation of which is inserted in the present Number.

The length of several articles has obliged us to defer till our next a notice of **Dr. Harwood**'s useful work "On the curative influence of the southern coast of England."

M. **Fayolle**'s communication has been received.

We have to thank Prof. **Hare** for his communication dated May 24.

Veritas, in reply to the adimadversions of $\alpha\,\beta$ on Mr. **Herapath**'s papers is under consideration. Calmness should be a characteristic of Truth; and we are not pleased when our correspondents lose their temper. Our duty of seeing fair play in scientific discussions seems to require us to state that Mr. H. or his advocate ought to have met the objections of $\alpha\,\beta$ and F.R.S., p. 96 and 97 of our last volume, before they took up any new ground.

⁂ The Editors request that all Communications intended for immediate insertion may be sent to the care of Mr. Richard Taylor, Printing Office, Red Lion Court, Fleet Street, London, at furthest by the 15th day of the month, or they will be too late to appear in the ensuing Number.

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NEW SERIES.

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TO CORRESPONDENTS.

Mr. **Watkins**'s "Popular Sketch of Electro-magnetism" has been received for review.

We fear that the paper on the conjoint study of Plane and Descriptive Geometry is not quite suited to our Journal. M. **Fayolle** has our thanks for his communication on the figure of the cells of the honeycomb; an extract from which will be given in our next Number.

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TO CORRESPONDENTS.

Mr. I. Lea's Memoir on *Unio*, Mr. Wallace's "Elements of Algebra," and the "Circular, explanatory of Skene's Patent," will be noticed in our next Number.

The Communication of T. W. L. will appear in our next.

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> "Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." Just. Lips. *Monit. Polit.* lib. i. cap. 1.

VOL. IV.

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JULY—DECEMBER, 1828.

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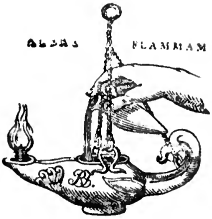
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THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

JULY 1828.

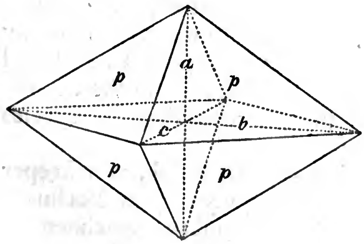
I. *On Herderite, a new Mineral Species.* *By* W. HAIDINGER, *Esq. F.R.S.E.*[*]

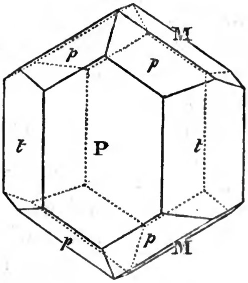
1. *General Description.*

FUNDAMENTAL form, a scalene four-sided pyramid, $P = 141° 16'$, $77° 20'$, $116° 3'$. (Fig. 1.) Ratio of the axes $a : b : c = 1 : \sqrt{2{\cdot}55} : \sqrt{0{\cdot}46}$.

Simple forms. $(\breve{P}-2)^4\,(o) =$, $149° 50'$, ; $(\frac{4}{3}\breve{P}-2)^3\,(n) =$, $134° 35'$, ; $P\,(p)$; $(\breve{P}r+\infty)^5\,(t) = 115° 7'$; $(\breve{P}+\infty)^6\,(s) = 42° 58'$; $\breve{P}r\,(M) = 115° 53'$; $\breve{P}r+\infty\,(r)$; $\bar{P}r+\infty\,(P)$.

Combinations observed. 1. $\breve{P}r \cdot P \cdot (\breve{P}r+\infty)^5 . \bar{P}r+\infty$. (Fig. 2.)





2. $\breve{P}r . (\breve{P}-2)^4 . (\frac{4}{3}\breve{P}-2)^3 . P . (\breve{P}r+\infty)^5 . (\breve{P}+\infty)^6 . \breve{P}r+\infty . \bar{P}r+\infty$.

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[*] Communicated by the Author.

Cleavage distinct, parallel to the faces M, but interrupted; also perpendicular to the axis, the latter only in detached portions of very bright and even faces, and faint indications parallel to P. Fracture small conchoidal.

Surface, M very smooth, and delicately streaked parallel to its edges of combination with P, and resembling in this respect all the faces of the pyramids, *n*, *o*, and *p*, situated between them.

The faces *r* and *s* are very narrow, and somewhat curved. Those marked *t* and P, have a peculiar granulated aspect, but they are at the same time pretty smooth, particularly the latter.

Lustre, vitreous, slightly inclining to resinous. Colour several shades of yellowish- and greenish-white; streak white, strongly translucent.

Very brittle. Hardness = 5·0, equal to that of apatite. Specific gravity =2·985.

2. *Observations.*

1. I observed and examined the characters of this species in the summer of 1823, but deferred publishing the description of it, with a view of collecting further observations on other varieties of the same species, an expectation which was not realized. The only specimen of herderite, at present known, is in the Wernerian Museum at Freiberg. It was pointed out to me by M. Von Weissenbach, then keeper of the museum, as containing crystals, whose forms he could not exactly refer to those of apatite, among the varieties of which it was exhibited. The different aspect of the faces *p* and *t*, the former being smooth or but faintly streaked parallel to their intersections with P, while the latter are granulated, showed that the forms did not belong to the rhombohedral but to the prismatic system; and I did not hesitate in pronouncing the mineral to be a new species, which I requested permission to examine more minutely. This permission was very liberally conceded. Mr. Breithaupt, who was then present, and had himself at a former period placed the specimen in the cabinet of Werner, likewise concurred in acknowledging the species to be a new one.

Through the kind intercession of Mr. Reich, now keeper of the museum, I was favoured, during my stay at Berlin in the winter of 1825, with some fragments of the specimen for analysis, by Baron Von Herder, the present Ober-Berghauptmann, or director of every thing connected with mining proceedings in Saxony. It is in compliment to that nobleman, that I propose the name of *Herderite* for the species; and I feel particularly gratified in thus expressing to one of my

earliest

earliest mineralogical friends, the acknowledgement of the many instances of his having communicated to me rare specimens for examination, particularly during my stay at Freiberg.

2. Herderite occurs imbedded in fluor, in the tin mines of Ehrenfriedersdorf, in Saxony. It resembles apatite, with which it was formerly confounded, in a remarkable degree; particularly some of those named asparagus-stone: such as the variety from Zillerthal, in Salzburg, and that from Hof in Gastein in the same country, which is found accompanying the axotomous iron-ore of Mohs, and still more so certain pale greenish-white masses of the same species, which occur, though in small quantity, along with the zoisite from the Saualpe in Carinthia. The resemblance among those species is sufficient to class the herderite in the genus *Fluor-haloide* of Mohs, in which it may be henceforth included as the "*prismati Fluor-haloide.*"

II. *Reply of* Drs. Tiedemann *and* Gmelin *to the Remarks of* Dr. Prout *inserted in the Annals of Philosophy* (*Second Series*), vol. xii. p. 405: *Communicated by* Thomas Thomson, *M.D. F.R.S. &c. Regius Professor of Chemistry in the University of Glasgow.*

THE more satisfied we are of the obligations which the doctrine of digestion lies under to Dr. Prout, and the less intention we had to attack him unjustly, the more do we consider it as our duty to discuss the complaints which he has made, so far as we are concerned,—to defend ourselves, where we think ourselves in the right, and to acknowledge our mistakes where we think ourselves in the wrong.

Dr. Prout's complaints are the following:

1. *We have led our readers to believe that Dr. Prout denies the presence of every other free acid in the contents of the stomach, except the muriatic; which is not the case.*

Yet we could draw no other conclusion from Prout's paper*, than that he denied the presence of every other acid. For

a. He says (page 118), "the experiments above mentioned seemed to preclude the possibility of the presence of any destructible acid; and the only known fixed acids likely to be present were the sulphuric and phosphoric; the muriate of barytes, however, neither alone nor with the addition of ammonia, produced any immediate precipitate, showing the absence of these two acids in any sensible quantity, and still further confirming the results as before obtained."

b. Now unless the absence of other free acids be taken for granted,

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* Phillips's Annals of Philosophy, vol. viii. p. 117.

granted, how can Prout's method of determining the free muriatic acid in the contents of the stomach be considered as answering the object in view? When free acetic acid, for example, is present, the potash employed to saturate the free acid will not only saturate the free muriatic acid, but also the free acetic acid. Now as Prout considers his method as quite accurate, he must necessarily presuppose the absence of all other free acids. Indeed Dr. Prout would have had reason to complain of us, if we had led our readers to believe that he admitted the presence of any other free acid in the liquid of the stomach;—acetic acid, for example (which is not the case in the paper to which we have alluded). For on such a supposition his method would be no longer accurate; and we should therefore have placed him in the situation of contradicting himself.

Dr. Prout, in his remarks upon our treatise, has for the first time, so far as we know, admitted that he has several times found acetic acid along with muriatic acid in the liquid of the stomach. Thus our observations have been confirmed; and it follows as a consequence, that his method of determining the quantity of free muriatic acid in the stomach cannot be relied upon. That the free acetic acid always proceeds from the food, we cannot believe; as we have frequently obtained it by the distillation of the liquid in the stomach of animals which had long fasted, and whose gizzards had been stimulated by the swallowing of stones, &c.

2. *We have in our account of Prout's method passed by the most important point of the whole, because it constituted a check upon the rest of the procedure.*

Undoubtedly the determination of the muriatic acid in the sublimed sal ammoniac, obtained after the saturation of the liquid of the stomach with potash, is very important; and it constitutes a still more important check, when one denies (as Prout evidently did in his first paper) the presence of any other free acid in the liquid of the stomach. But as we had discovered the presence of several volatile acids, particularly of acetic acid, we could not estimate this check as of the least value. For when the liquid of the stomach, together with muriate of soda (and potash), contains muriate of ammonia and free muriatic and acetic acids, and we neutralize it exactly with potash, evaporate it to dryness and sublime, the acetate of potash and sal ammoniac which it contains mutually decompose each other, and are converted into chloride of potassium and acetate of ammonia. So that in consequence of the presence of acetic acid, less sal ammoniac will sublime than the liquid of the stomach originally contained. Indeed none at all will sublime, if the quantity of acetic acid be sufficiently great.

great. It is probably owing to this cause that Prout found no sal ammoniac in the liquid from the human stomach in two cases; although the complete absence of this salt from such liquids is very unlikely[*]. From these observations it seems probable that the proof of the presence of free muriatic acid,—which Prout has lately endeavoured to deduce from the circumstance, that when the liquid of the stomach after having been neutralized with potash was evaporated to dryness, and the residue exposed to a red heat, this residue did not act as an alkali but constituted a neutral salt,—is not satisfactory. For a liquid of the stomach which contains no free muriatic acid, but muriate of soda, muriate of ammonia, and free acetic acid, must (if the quantity of acetic acid be not too great) after neutralization with potash and ignition contain only chloride of potassium and chloride of sodium.

We are of opinion that Dr. Prout himself in his last statement has admitted that when an organic acid is present, his process is insufficient, and has thus confirmed our own previous statements.

3. *We have misrepresented Prout's opinion respecting the appearance of albumen in the intestines, by making him maintain that no albumen exists in the liquid of the stomach even when the animal takes food containing albumen; but that it shows itself first in the duodenum, in consequence of the union of the liquid of the stomach with the bile and the pancreatic juice.*

After again perusing Prout's former paper[†], we must acknowledge that we have stated his opinion on this subject quite inaccurately. Whether this proceeded from misunderstanding his meaning, or from an inaccurate extract from his paper, we cannot say. We request the reader of our work to obliterate the passage which refers to this misunderstanding on our part.

We trust that these explanations and acknowledgements will obviate the complaints of this celebrated chemist and physician, to whom the chemical part of physiology and pathology lies under so many obligations. We have only to express our high satisfaction at his statement, that his observations on digestion agree with ours, and confirm them in the most important points.

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[*] It is true, Prout determined the quantity of sal ammoniac by another method. From the total quantity of muriatic acid contained in the liquid, he subtracted the portion united to a fixed alkali, and that which existed in a free state. The remainder must represent the portion combined with ammonia. But as the presence of acetic acid would lead him to overrate the quantity of free muriatic acid, the sal ammoniac as thus estimated would be too little or none at all.

[†] Annals of Philosophy (first series), vol. xiii. p. 12.

III. *On the Latitudes and Difference of Longitude of Beachy Head and Dunnose in the Isle of Wight, as laid down in the Trigonometrical Survey of England; and the Length of a Degree perpendicular to the Meridian at the Latitude of Beachy Head.* *By* J. IVORY, *Esq. M.A. F.R.S.*[*]

THE investigation of the figure of the earth by measurements of the meridian, has given rise to a question of great moment. Although the entire arcs agree very exactly with the elliptical figure, yet on comparing the parts into which the same arc is subdivided, the greatest irregularity is found to prevail. This is so much the case in the arc measured between Dunnose and Clifton, in England, that the length of a degree is found to decrease in advancing from south to north, instead of increasing as the theory requires. To what cause can so great an anomaly be ascribed? In attempting to throw some light on the irregularities of the English arc, I have been led to examine the operations at Beachy Head and Dunnose; and, reserving the discussion of the original question to a future occasion, my present intention is to communicate the observations I have made respecting the operations alluded to, as they materially affect a capital part of the Survey.

If a geodetical line be drawn through the station at Beachy Head, perpendicular to the meridian of Greenwich, the meridional distance of the line from Greenwich is, according to the Survey, 44888 fathoms: and if a plane parallel to the equator be drawn through the same station, this plane will meet the meridian 17 fathoms more to the south[†]; so that the meridional distance between Greenwich and the parallel of latitude passing through Beachy Head, is 44905[‡] fathoms. In order to find the difference of latitude between the two places, the terrestrial arc must be converted into degrees of a great circle of the heavens. In the Survey 60851 fathoms is allowed to a degree, which undoubtedly is too much. For if we divide the terrestrial arc measured by Col. Mudge, by its amplitude, we shall get 60826 fathoms for a degree at the latitude 52° 2′; and even this length must exceed a degree at the more southern point in the middle between Greenwich and Beachy Head. The latitudes of the two places being known nearly, I have employed the formula (C), p. 433, Phil. Mag.

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[*] Communicated by the Author.

[†] Survey, vol. i. p. 294.

[‡] This length should be multiplied by 1·00007, in order to bring it to a general standard for the purpose of comparison with other measurements. (Phil. Trans. 1821, p. 93). The same observation applies to all the other lengths that occur. I have omitted to make the correction, which however does not sensibly affect any of the conclusions.

Mag. for June last, and have found for the length of a degree,

At Greenwich 60826 fathoms;
At Dunnose 60815;

and the mean of these, or 60820·5, is the proper rate of conversion in the present instance. The difference of latitude between Greenwich and Beachy Head will now be 44′ 18″; and if the latitude of Greenwich be taken at 51° 28′ 39″, that of Beachy Head will be 50° 44′ 21″.

The distance between the parallels of latitude passing through Beachy Head and Dunnose, as found in the Survey, is 7376·5 fathoms; which being converted into degrees, at the rate of 60815 fath. to one degree, gives 7′ 16″·7 for the difference of latitude of the two stations. The latitude of Dunnose is therefore 50° 37′ 4″·3.

But as the azimuths at the extremities of the geodetical line drawn between the stations are given, we may deduce the latitude of Dunnose from that of Beachy Head by another method. Let B and D denote the azimuths, and λ and λ' the latitudes, of Beachy Head and Dunnose; then, a and $a(1-\varepsilon)$ being the axes of the terrestrial spheroid, the general property belonging to every geodetical line, will give this equation in which the square of ε is neglected,

$$\frac{\cos\lambda' \sin \mathrm{D}}{\sqrt{1-2\varepsilon\sin^2\lambda'}} = \frac{\cos\lambda \sin \mathrm{B}}{\sqrt{1-2\varepsilon\sin^2\lambda}};$$

from which we easily derive this formula, $\log.\ \cos\lambda' = \log.\left(\frac{\cos\lambda\sin\mathrm{B}}{\sin\mathrm{D}}\right) + \mathrm{M}\varepsilon(\sin^2\lambda - \sin^2\lambda')$, where $\mathrm{M} = \cdot 43429$ &c., the modulus of the common logarithms. Now, computing by this rule, we shall find $\lambda' = 50° 37' 5''\cdot 65$. This result is as little different from the former one as can reasonably be expected, considering that the methods of calculation are very different, and likewise proceed upon experimental data quite independent of one another. Both results are confirmed by actual observation, Capt. Kater having found 50° 37′ 5″·27 for the latitude of Dunnose*. We may therefore definitively fix the latitudes of the two stations as below:

Beachy Head..............	50° 44′ 21″
Dunnose....................	50 37 5

and it is very improbable that either of these results errs so much as 1″ from the truth.

The two latitudes we have found are so little different from those in the Survey, as to produce no sensible change in the ulterior calculations of the difference of longitude and the

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* Phil. Trans. 1819, p. 413.

length of a degree perpendicular to the meridian. According to the Survey, a degree perpendicular to the meridian, at the middle latitude between the two stations, is no less than 61182 fathoms, or about 200 fathoms more than in the spheroid, which has been found to agree so well with all the arcs of the meridian that have been most exactly measured. If therefore we admit that the method of investigation pursued in the Survey is exact, we should have an undeniable proof that the spheroid which represents distances on the meridian so exactly, fails entirely in the case of measurements, the extreme points of which are different in longitude. But a little reflection will show that the theorem laid down in the Survey for finding the difference of longitude is not rigorously exact. In the geometrical demonstration of the theorem it is tacitly assumed, that a geodetical line drawn between two points in different meridians, is contained in one plane. But such a line has a double curvature; and the two tangents which mark its initial and final directions are not both contained in any plane passing through the extreme points of the line. Therefore if the difference of longitude, and the latitudes of two points on the surface of a sphere and a spheroid, be the same, it is not strictly true that the sum of the azimuths in one case is equal to the like sum in the other case. The method is only an approximation; and it cannot be confidently relied on until it is proved that it approximates to the truth without sensible error; which is the more necessary to be done, because the whole investigation turns on very small quantities, a few seconds in the longitude producing a great variation in the length of the perpendicular degree. I have therefore been induced to view the matter in a different light, as in this problem: To find the difference of longitude of two points on the surface of a given spheroid, the latitudes of the points and the length of the chord drawn between them, being known. In solving this problem we may likewise assume that the two points are little different in latitude.

Let a and $a(1-\varepsilon)$ represent the axes of the spheroid; λ and λ' the latitudes of the two points; γ the length of the chord between them; and, neglecting the square of ε, put

$$p = \frac{\cos\lambda}{\sqrt{1-2\varepsilon\sin^2\lambda}}, \qquad u = \frac{\cos\lambda'}{\sqrt{1-2\varepsilon\sin^2\lambda'}},$$

$$q = \frac{\sin\lambda\,(1-2\varepsilon)}{\sqrt{1-2\varepsilon\sin^2\lambda}}, \qquad t = \frac{\sin\lambda'\,(1-2\varepsilon)}{\sqrt{1-2\varepsilon\sin^2\lambda'}},$$

then ap and au will be the perpendiculars drawn from the two points to the polar axis, and aq and at the perpendiculars to the plane of the equator. Put ω for the angle between the

the

the meridians of the two points, or the difference of longitude; then we shall have this equation

$$\frac{\gamma^2}{a^2} = (u-p\cos\omega)^2 + p^2\sin^2\omega + (q-t)^2\,;$$

and, because $\cos\omega = 1-2\sin^2\frac{\omega}{2}$, the same equation may be thus written:

$$\frac{\gamma^2}{a^2} = (p-u)^2 + (q-t)^2 + 4pu\sin^2\frac{\omega}{2}.$$

Now we have,

$$p-u=(\cos\lambda-\cos\lambda')\,\{1+\varepsilon-\varepsilon(\cos^2\lambda+\cos^2\lambda'+\cos\lambda\cos\lambda')\}$$
$$q-t=(\sin\lambda-\sin\lambda')\,\{1-2\varepsilon+\varepsilon(\sin^2\lambda+\sin^2\lambda'+\sin\lambda\sin\lambda')\}.$$

And if we put $m=\frac{\lambda+\lambda'}{2}$, $n=\frac{\lambda-\lambda'}{2}$; by substituting and neglecting the term multiplied by $\varepsilon\sin^3 n$, because n is a small angle, we shall get,

$$p-u = 2\sin n\sin m\,(1+\varepsilon-3\varepsilon\cos^2 m\cos^2 n)$$
$$q-t = 2\sin n\cos m\,(1-2\varepsilon+3\varepsilon\sin^2 m\cos^2 n);$$

and hence,

$$(p-u)^2+(q-t)^2 = 4\sin^2 n\left(1+2\varepsilon\sin^2 m-4\varepsilon\cos^2 m)\right);$$

or, which is the same thing,

$$(p-u)^2+(q-t)^2 = 4\sin^2\frac{\lambda-\lambda'}{2}\left(1-\varepsilon-3\varepsilon\cos(\lambda+\lambda')\right).$$

Again we have,

$$pu = \frac{\cos\lambda\cos\lambda'}{1-\varepsilon(\sin^2\lambda+\sin^2\lambda')}:$$

but as λ and λ' are nearly equal, we may take $2\sin^2\frac{\lambda+\lambda'}{2} = 1-\cos(\lambda+\lambda')$ for $\sin^2\lambda+\sin^2\lambda'$; consequently,

$$pu = \frac{\cos\lambda\cos\lambda'}{1-\varepsilon+\varepsilon\cos(\lambda+\lambda')}.$$

Lastly, we have $a=p\Delta$; Δ being the length of a degree on the equator of the spheroid, and p the number of degrees in an arc equal to the radius. All the values being substituted, we get,

$$\frac{\gamma^2}{4p^2\Delta^2} = \sin^2\frac{\lambda-\lambda'}{2}\left(1-\varepsilon-3\varepsilon\cos(\lambda+\lambda')\right)+\frac{\cos\lambda\cos\lambda'\sin^2\frac{\omega}{2}}{1-\varepsilon+\varepsilon\cos(\lambda+\lambda')}.$$

From this expression the arc ω may be computed by means of these formulas; viz.

$$\text{Log.}\sin u = \text{log.}\left(\frac{2p\Delta}{\gamma}\sin\frac{\lambda-\lambda'}{2}\right)-\frac{M\varepsilon}{2}-\frac{3M\varepsilon}{2}\cos(\lambda+\lambda')$$

$$\text{Log.}\sin\frac{\omega}{2}=\log.\left(\frac{\gamma\cos u}{2p\Delta}\right)-\tfrac{1}{2}\log.(\cos\lambda\cos\lambda')-\frac{M\iota}{2}+\frac{M\varepsilon}{2}\times\cos(\lambda+\lambda').$$

Applying this method to the case of Beachy Head and Dunnose, we have the latitudes as before determined: the chord between them, or γ, is equal to 339397·6* feet, or 56566·3 fathoms: and, with these data, we get, in the same spheroid as before,

$$\omega = 1^\circ\ 27'\ 5''\cdot78,$$

which is 18″ more than according to the Survey.

Now the length of a geodetical line drawn from Beachy Head at right angles to the meridian, and limited by the meridian of Dunnose, is 336119† feet, or 56020 fathoms. Let A be the amplitude of this arc; then we get, by the usual method,

$$\text{Tan A} = \cos\lambda\tan\omega,\quad A = 55'\ 7''\cdot57.$$

And if we lengthen the arc in the proportion of the amplitude to 1°, we shall get 60973 fathoms for a degree perpendicular to the meridian at the latitude of Beachy Head, which is 200 fathoms less than according to the Survey. This result may be verified by comparing it with the length of a perpendicular degree at the given latitude. The expression of this degree is,

$$\frac{\Delta}{\sqrt{1-(2\varepsilon-\varepsilon^2)\sin^2\lambda}}=\Delta.\left\{1+\varepsilon\sin^2\lambda+\varepsilon^2\left(\frac{3}{2}\sin^4\lambda-\frac{\sin^2\lambda}{2}\right)\right\}:$$

and, by substituting the numbers, the length comes out 60974, only one fathom more than what has been deduced from the measurements in the Survey.

The difference of longitude we have found is only 1″ more than what Dr. Tiarks has assigned (Phil. Trans. 1824) as resulting from his chronometrical observations. This is no doubt a great confirmation of the theory, but it has not the weight of a direct experiment; because it is deduced from the observed difference of longitude between Dover and Falmouth, by making a proportional allowance, which is a method of proceeding in some degree precarious. As there is no doubt about the accuracy of the observed quantities in the Survey, it might be worth while to compute from the data it contains, by rectifying all the calculations, the difference of longitude between Dover and Falmouth, in order to compare it with the result obtained directly by experiment.

The main purpose of this article is now accomplished. It has been clearly proved that the same spheroid which repre-

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* Survey, vol. i. p. 295.

† Ibid. p. 297.

sents with so much accuracy distances on the meridian, is no less exact when applied to measurements perpendicular to the meridian. At least this is the case in England in the instance we have examined; and a little time will show whether the same conclusion is confirmed or contradicted by the geodetical operations now executing on the continent.

June 13, 1828. J. IVORY.

IV. *Additional Remarks on the Artificial Production of Cold. By* RICHARD WALKER, *Esq., of Oxford.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

PERCEIVING an *erratum* in my communication inserted in the Philosophical Magazine for the present month, which renders my meaning rather obscure, I request you will have the goodness, in your next, to correct it thus:—at page 404, 8th line from the bottom, *for* "freely"—*read* "freshly."

I shall avail myself of this opportunity to present, in a cursory way, a few additional observations.

The drier and finer the mixed powder of sal ammoniac and nitre is, the better; and the pulverization is best effected, in the first instance, with a heated pestle. Glauber's salt in an efflorescent state, or which by long keeping or from access of air has changed to a powder, is unfit for the purpose; in this state producing heat by solution in water. The best way of preparing the frigorific mixture is by previously placing the powdered Glauber's salt, and giving it a level surface, at the bottom of the vessel, and upon that the mixed powder of sal ammoniac and nitre; adding first about half the quantity of water, and immediately after the remaining portion, stirring the whole together each time. The vessel containing the powdered salts, as above stated, may remain thus any convenient time before adding the water. [Care must be taken to stir the evaporating mixture towards the end of the process, and not to urge it too far.] Nitre being a much cheaper article than sal ammoniac, more easily reduced to powder, and producing about 16 degrees of cold by solution in water, may supersede the use of the mixed powder for cooling the water in which wine is placed. This powder, moreover, is useful, occasionally, as an addition to mixtures of ice and salt, to increase the power and accelerate the process.

The proportions of the articles given in my former paper are adapted to the temperature of 50°; at a higher tempera-

ture,

ture, of course, the water will dissolve a somewhat larger portion of the salts, and the effect will be proportionably greater. Thus the most powerful mixture, given in my table of frigorific mixtures, consisting of phosphate of soda, nitrate of ammonia, and diluted nitric acid, will, when mixed at the temperature of 50°, produce a cold of 21° below 0; and if mixed in due proportions at 100°, it will produce, in an instant, a cold of 20°; viz. a reduction of *eighty degrees*. By means of this mixture, as I have been informed, water has been frozen solid "under the line." I am, Gentlemen,

Your most obedient servant,

Oxford, June 10, 1828. RICHARD WALKER.

V. *Observations on the Geology of the Hyderabad Country*[*].

THE country around Hyderabad is composed entirely of granite, intersected by quartz, which generally runs north and south; and by trap, which has no definite direction.

The hills are generally in ridges. In some instances they are insulated, of a mamillary form, or abrupt and precipitous.

The ridges are covered with detached masses of rock, and frequently (when seen at a little distance) have more the appearance of heaps of loose stones than of solid hills. The mamillary hills are almost always devoid of vegetation, having a smooth surface, with large detached lamellæ lying loosely on their sides, and apparently ready to slide or tumble down on the slightest impulse into the neighbouring valleys.

The insulated hills often present on one or more sides a smooth, perpendicular surface, which makes a very sudden curve at the top, or undulates, and thus contracts the summit of the hill.

Sometimes we find the surface of the granite forming part of an immense curve, and rising very gently and to a small height above the surrounding plain. In other instances it is waved, and presents a great variety of outline.

Huge blocks of granite are every where strewed over the country, and are often piled over each other in the valleys, or on the sides or summits of the hills, giving rise to the most fantastic shapes, and often closely resembling ruined buildings. It is not uncommon to see three or four immense masses of granite placed above each other, with their surfaces nicely adapted, having somewhat the appearance of the ruin of an ancient

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[*] From the Transactions of the Literary Society of Madras. Part i. page 79.

ancient column, which might be expected to be soon levelled with the ground, by the agency of the weather.

All the granite of Hyderabad is stratified or lamellar. The strata and lamellæ vary in thickness, from less than an inch to many feet. They have no definite direction or dip; but are generally curved, sometimes to a small extent horizontal, waved, or perpendicular.

The granite on one side of a small hill, close to that of Shapoor, near the Beema, has the appearance (when seen at a little distance) of being columnar; but when it is examined more closely, it is evident that this appearance arises from the following circumstance:—The lamellæ of the granite are perpendicular, and had formerly made a very rapid curve at the top. By the influence of the weather, this curve has been worn down, and has thus allowed the inferior perpendicular part of the lamellæ to separate a little from each other; and accordingly, when seen transversely, they closely resemble columns.

The internal structure of the granite is almost always small granular *. The proportions of its constituent parts vary exceedingly. In many instances the mica is entirely wanting; and when situated near quartz, the granite and quartz are frequently found to pass gradually into one another.

The colour of the granite is sometimes red, in other instances gray, white, or blackish, according to the colour of the felspar, and according as one or other of the constituent parts predominate. Different colours often occur at very small distances in the same stratum, or lamella; and it is not uncommon to meet with strata of different colours resting on one another.

Frequently nodules and small veins of granite, having a very large proportion of mica, and occasionally veins of pure mica, are found in the common granite, from which (in some cases) they easily separate when the rock is broken; but in other instances they are intimately connected with, and gradually pass into the surrounding rock.

The quartz and trap, by which the granite is every where intersected, occur under the form of mountain masses and veins. Sometimes, though more rarely, the trap is found in nodules. The veins vary from a few inches to many miles in length. Their junction with the bounding rock is sometimes distinct, while in other cases they are intermingled at their sides with the neighbouring granite.

The quartz is sometimes intermixed with felspar, which

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* I will not venture to assert that it is invariably small granular, for my observations have not been sufficiently extensive.

makes it much more perishable than when pure; and accordingly when this is the case, we generally find it wearing down and becoming disintegrated.

The trap is found under the forms of greenstone and basalt. It is either tabular, massive, or in globular concentric lamellar concretions, with occasionally disseminated crystals of augite. The globular variety is very easily acted on by the weather, in consequence of which it is in many situations completely disintegrated and converted into a black soil. In some places, where this variety of trap occurs in great abundance, it is worn down into small detached globular masses, which are every where strewed over the ground.

Almost all the granite of Hyderabad is quickly disintegrated when exposed to the atmosphere, and assumes a globular or irregular form when decomposing. Every where there are immense accumulations of disintegrated granite, at the bottom of the hills and in the valleys. I have known instances of wells being dug through it to the depth of sixty feet, without penetrating to the original rock. At the surface of the ground it is loose, but at considerable depths it is more or less perfectly consolidated; and the deeper we penetrate into it, the more perfect is its cohesion. It is not uncommon to meet with small quartz veins running through this consolidated debris, in various directions; and in many instances there is an appearance of imperfect stratification.

All the low valleys are covered by a plastic blackish coloured soil, generally known by the name of cotton ground. It varies in depth from a few feet to many fathoms; and when a section of it is examined (which can be done in those places where it is worn down by rivers), it is generally found distinctly arranged in strata, which are sometimes separated by thin layers of sand or gravel. These strata vary in thickness, are sometimes horizontal, in other instances waved, or more or less inclined to the horizon.

I have not had an opportunity of analysing this clay; but that its composition is by no means uniform, may be inferred from the circumstance of its outward appearance varying considerably in different situations. Sometimes it is of a blackish gray colour, and is somewhat friable; while in other cases it has a yellowish or whitish gray colour, and is much more cohesive.

At first sight one would imagine, that the Hyderabad country has at one time been subjected to the agency of some great destroying cause which has fractured and torn asunder the hills, and precipitated their fragments into the neighbouring plains. But upon closer examination, I think we are naturally led to conclude, that the gradual operation of causes which are still in existence, have produced those effects which many would attribute to the operation of very powerful agents. In short, I believe that all these phænomena are the result of the long continued agency of the weather.

It is well known that masses of granite which have been detached from the neighbouring hills, are worn down and disintegrated by the weather; and also, that the lamellæ or strata of granite, which still retain their original situation, when exposed to the atmosphere, split and slide down into the adjoining valleys*. Since then we have ocular proofs of the hills being broken down and disintegrated by the weather, and since these effects are never known to be produced by any other cause, can we hesitate to conclude, that all the accumulations of debris and detached masses of granite have originated in the same manner? Effects are daily produced under our immediate observation, exactly similar to those to be accounted for; and although, at first sight, the magnitude of the effect may appear out of proportion to the cause, yet the latter will be sufficiently adequate, if it be admitted, that it has continued to operate through an immense lapse of ages,—a circumstance which no one can possibly doubt.

It may be argued, that earthquakes are much more powerful than the slow agency of the weather, and more adequate to produce the effects under consideration. Earthquakes are certainly among the most powerful causes with which we are acquainted, in effecting changes on the crust of our globe; yet their effects are very different from those I am attempting to account for. The lamellæ and strata of the Hyderabad granite gradually break up and scale off, exactly in the same manner as we detach successively the layers of an onion. But this appearance is very different from what we should be led to expect, had it been produced by earthquakes; for in that case the ruined appearance of the granite would not have been confined to the surface, but would have extended to the centre of the hills.

One of the most curious and interesting appearances in the geology of the Hyderabad country, is that already mentioned, of large masses of granite resting firmly on one another, in the form of ancient ruins. These are quite different from the masses which have been detached from the neighbouring hills, and afterwards heaped confusedly together; for their surfaces are closely adapted, and four or five masses are often placed

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* The same effects are produced upon granite in India, by great degrees of heat, alternating with moisture, as those that are produced upon granite in the Alps of Switzerland, by intense frost succeeded by thaw.

firmly on each other, as if by art. Sometimes they occur on the summit of a hill; in other instances, they are found completely insulated in a plain.

From all the circumstances connected with these masses, I think we must conclude, that at present they continue to occupy their original positions; that they are the slight remains of strata which have been gradually worn down all around them; and that they now stand as monuments of what the depth and nature of these strata formerly were. This conclusion is as legitimate as that the strata on the opposite coasts of England and France were once continuous, deduced from the circumstances of their corresponding in their nature, relative position, and direction. In order to show more clearly on what grounds I rest the above conclusion, I will consider the subject a little more in detail. We often observe a hill composed of successive strata or lamellæ, the most superficial of which are more or less detached and broken up; that round its base are large accumulations of debris and detached fragments; and that on its summit are three or four masses resting firmly on one another, with their surfaces accurately adapted, except perhaps at their edges, where they have been affected by the weather. Now as we have here ocular proofs that a number of strata (which formerly belonged to this hill) have been detached and worn down; and as it would almost amount to an absurdity to suppose that the masses on the summit have been conveyed from a distance, and placed there with their surfaces accurately corresponding, we must conclude that the hill was formerly much higher than at present; and that while a number of its strata have been gradually worn down and swept from its surface, the masses at its summit (which at one time formed part of these strata) have remained steadfast in their original situations, probably from their being more durable, or from their horizontal position. It is very evident how this must happen, when it is recollected how the lamellæ of the granite are broken down and separated from those beneath. They split in various directions, and in this manner form a number of separate masses, which slide down the sides of the hill. Now, it is clear, that the part of the lamellæ on the summit has every chance of remaining stationary, for it rests horizontally; and while all the detached pieces around it slide down into the neighbouring valleys, it will maintain its situation. When the next bed is exposed to the atmosphere, and becomes detached from that beneath, of course the part on the summit immediately under the fragment which remained stationary in the first instance, has every chance of continuing in its situation; and thus in the course of time the appearance above described will be produced. The same explanation is to be given of the origin of those masses which are found insulated in the plains. I imagine that they rest on the summit of what were formerly hills, but which are now completely buried under their own ruins.

The peculiar arrangement and structure of the quartz and trap in the granite of Hyderabad, afford abundant proofs of the correctness of Mr. Jameson's views of the formation of veins, viz. that they are of simultaneous formation with the rock which they traverse. In the Hyderabad country, we find quartz and trap under the forms of veins, nodules, and mountain masses, sometimes perfectly distinct from the surrounding granite, in other instances intermingling with it, and gradually passing into it. With these facts before us, can we doubt that these rocks are of cotemporaneous origin?

I have often been surprised that theorists, in their attempts to explain the various phænomena presented by the crust of our globe, have never employed causes of whose existence we have certain proof, and with whose effects we are well acquainted; but on the other hand have assumed the existence of causes of which we never had experience, and whose effects we never witnessed. Huttonians assume the existence of a central fire*, which they contend to be the cause of the consolidation of the debris of former hills, and consequently of its conversion into new rocks. But that such a supposition is by no means necessary, is evident from the circumstance, that this consolidation often takes place without the assistance of heat. I have already mentioned that the debris of the Hyderabad granite becomes gradually consolidated, merely by pressure; and that

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* The heat of the Huttonians must be an extremely convenient as well as powerful agent, for it can both liquefy and consolidate bodies. At one time it can inject a flood of melted basalt into the superincumbent rocks; at another time it can consolidate sandstone, and other secondary rocks, at the bottom of the ocean. There are two facts which are very hostile to this theory;—first, the greater the pressure, the greater is the obstacle to the fusion of a body; second, the greater the heat, the greater is the opposition to the consolidation of a body. Now, the Huttonian theory requires that the two great agents which it employs, viz. heat and pressure, should act in concert; the heat to liquefy, or (as occasion may require) to consolidate bodies; the pressure to prevent the escape of volatile substances, which might be otherwise dissipated. These two forces, however, must oppose each other; for heat is one of the most powerful agents with which we are acquainted in separating the particles of bodies, while pressure brings them closer to each other. The pressure of the ocean, therefore, although in all probability equal in itself to consolidate the debris of former hills into new rocks, may not be sufficient for that purpose, if opposed by a heat sufficiently powerful to liquefy granite and trap; and a heat that would be equal to the melting of trap at the earth's surface, would be by no means adequate to do so under the pressure of mountains.

the greater the pressure, the more perfect is the consolidation. This is a power with whose effects we are well acquainted. By bringing the particles of bodies closer to each other, pressure becomes a powerful cause of consolidation; and I am convinced that without the assistance of any other agent, it is one of the most general and powerful causes of the changes which happen in the mineral kingdom.

Camp Kulle-dghee, 1st July, 1824.

Rock Specimens from the Vicinity of Hyderabad.

The specimens from No. 1. to 13. are the most common varieties of granite in the Hyderabad country.

1. 2. 3. 4. are from Bowenpilly, several miles to the north of the city of Hyderabad.

5. and 6. are from Shumshabad, about twelve miles west of the city; 5. is from a stratum about half an inch thick, resting on that from which 6. was taken.

The specimens from 7. to 20. inclusive, are from Moula Alley.

Moula Alley hill is a large mass of lamellar granite, of a mamillary form, having a smooth surface, perfectly devoid of vegetation, except on a very few spots, where the disintegrated granite has formed a superficial bed of soil. The lamellæ of the granite in some places scale off, split in various directions, and gradually slide or fall down into the neighbouring valleys, where they continue to break down into still smaller masses, until they become completely disintegrated. The lamellæ vary from a few inches to many feet in thickness.

9. and 10. occur in great abundance in the hill of Moula Alley.

12. Red granite with very little mica. The bed from which this specimen was taken, rests upon No. 9.

13. Granite with the mica in large concretions.

14. White granite without mica.

15. Granite containing a vein of mica.

16. A variety of granite with mica predominating, from a nodule in one of the common kinds of granite.

17. From a nodule in the granite.

18. From a nodule of trap in the granite.

19. From a trap vein about twelve feet thick, with part of the contiguous granite adhering to it.

20. Trap passing gradually into granite.

21. 22. 23. 24. from a vein of quartz in the granite, extending from near the city of Hyderabad, several miles in a northerly direction. This vein is of a very considerable magnitude.

nitude. Being of a more durable nature than the granite, it has been much less affected by the weather; and while the granite in its vicinity has been worn down, and in a great measure levelled, it has remained in the form of a ridge. In several places the quartz is intermixed with felspar, which makes it more liable to be acted on by the weather; and accordingly we find that in these places it is worn down, and the continuity of the ridge is thus interrupted.

25. From a trap vein which extends from the cantonment of Secunderabad in a westerly direction. When it approaches the quartz vein described above, it divides into two or three branches, and penetrates the quartz in several places.

26. Red granite without mica, from the vicinity of the quartz.

27. Quartz and felspar in large concretions, from the vicinity of the quartz.

28. Granite with epidotic veins, associated with the quartz, near the place where it is penetrated by the trap.

29, 30. Granite without mica found near the quartz.

31. Disintegrated granite from a depth of four or five feet from below the soil, beginning to consolidate.

32. From immediately under the soil.

33. Nodular basalt from a trap vein.

34. Nodules of trap found loose on the surface of the ground.

VI. *On the Figure of the Cells of the Honeycomb.* *By* SAMUEL SHARPE, *Esq. F.G.S.**

REAUMUR mentions, in his History of Insects, vol. v. p. 39, that he employed Maraldi to measure a cell of a bee's honeycomb, and Kœnig to calculate what the proportions of the three-sided pyramid at the end should be, in order that the whole cell might be made with the least materials; it being easily shown that the contents of the cell would be the same, whatever the height of the three-sided pyramid, even if = 0, in which case the prism would have a plain end.

Their reports nearly agreed; but the difference still is not to be overlooked, as will be seen in the angles of the parallelograms of the pyramid:

Maraldi's measurement	109° 28′	and	70° 32′
Kœnig's calculation......	109 26		70 34

And neither naturalists nor mathematicians have accounted for the difference.

As, from the nature of the materials, the angles can hardly be measured by reflection from the sides with a reflective goniometer, we have no better means of measuring than Maraldi

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* Communicated by the Author.

had, and shall therefore consider his measurement to have been correct.

By the fluctional theorem *de maximis et minimis*, the calculated angles appear to be wrong, and should be 109° 28′ 16″, and 70° 31′ 44″; which must be held to agree with the measurement; as no one would pretend to make that more accurate than to the nearest minute, and the difference is much within those limits.

Kœnig's paper was read before the *Academie des Sciences* at Paris in 1739, and the results are mentioned in their Transactions for that year; but as his working is not added, I cannot compare mine with his to see where the error lies.

As it cannot be held unimportant to show that bees build their cells exactly in the form which, at length, by the differential calculus, we find to be best; and as I cannot expect my assertion to be preferred to that of Kœnig,—I add the working at length.

1st. As of those figures which can be brought together without leaving any interval, the hexagon is that which has the greatest number of sides, it is clearly the one which needs the least materials to inclose a given space.

2ndly. If a range of hexagonal cells be met by a range of similar cells, and no space be wasted, each cell must end either with a three-sided pyramid, or with a plane at right angles to the sides (*i. e.* a pyramid whose altitude = 0).

Query. What must be the altitude of the pyramid, in order that a cell of a given prism and given solid contents may be constructed of the smallest quantity of materials?

Let fig. 1. be any such regular three-sided pyramid on a six-sided prism.

Fig. 1.

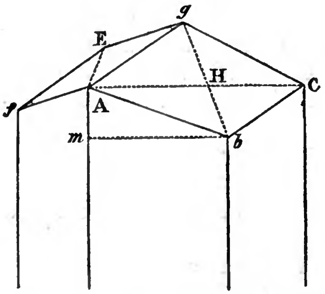


Fig. 2.

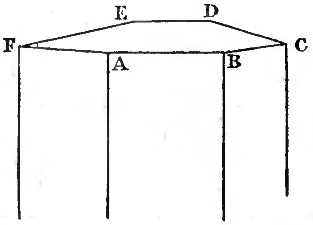
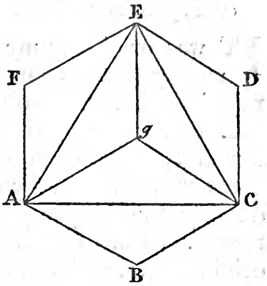


Fig. 2. the same prism with a plain end at right angles to the sides (*i. e.* the altitude of the pyramid = 0).

Fig. 3.

Fig. 3. the plain end of the above. Join the alternate angles ACE to the centre g, and to each other. Then if the centre g be raised and ACE remain fixed, the other angles (*solid* angles in the prism) BD and F will be lowered, and the solid contents of the cell will remain the same.

Fig. 3.



Again, by comparing fig. 1 and 2. we see that though the pyramid needs more materials than the plain termination, yet the sides of the former prism need less than those of the latter by the six little triangles Amb.

Now let AB (= mb) be........................... a
Am (the altitude of the pyramid) ... x
AH (half of AC) .... d

$$\mathrm{A}b = \sqrt{a^2 + x^2}$$

$$\mathrm{A}mb = \frac{ax}{2}$$

$$\mathrm{H}b = \sqrt{a^2 + x^2 - d^2},$$ and the quantity which we wish to be a minimum is

$3\,(\mathrm{A}g\mathrm{C}b) - 6\,(\mathrm{A}mb) = 6d\sqrt{a^2 + x^2 - d^2} - 3ax$ whose fluxion is $6d\,(a^2 + x^2 - d^2)^{-\frac{1}{2}}\,x\dot{x} - 3a\dot{x} = 0$

$$2dx\,(a^2 + x^2 - d^2)^{-\frac{1}{2}} = a$$

$$2dx = a\,(a^2 + x^2 - d^2)^{\frac{1}{2}}$$

$$4d^2x^2 = a^4 + a^2x^2 - a^2d^2$$

$$x^2 = \frac{a^4 - a^2d^2}{4d^2 - a^2}$$

but $d^2 = a^2 - \dfrac{a^2}{4} = \dfrac{3a^2}{4}$; therefore $x^2 = \dfrac{a^4 - \dfrac{3a^4}{4}}{3a^2 - a^2} = \dfrac{a^4}{8}$, and

$$x = \frac{a}{\sqrt{8}}$$

$$\mathrm{A}b = a\sqrt{\frac{9}{8}},$$

and Ab : AH :: radius : cos. HAb = $\dfrac{a\sqrt{\frac{3}{4}}}{a\sqrt{\frac{9}{8}}} = \sqrt{\dfrac{2}{3}}$ = cos 35° 15′ 51″·86, and the angle gAb = 70° 31′ 44″ nearly.
AgC = 109 28 16.

VII. *Che-*

VII. *Chemical Examination of the Oxides of Manganese. By* Edward Turner, *M.D. F.R.S. Ed. Professor of Chemistry in the University of London, and Fellow of the Royal College of Physicians of Edinburgh.**

It was originally my intention, in entering on this inquiry, merely to ascertain the composition of the ores, the mineralogical characters of which have been so ably delineated by Mr. Haidinger in the preceding paper†. I had advanced, however, but a short way in the investigation, when my progress was arrested by doubts both as to the manner of conducting the analyses, and as to the mode of calculating their results. In this uncertainty I found it necessary to extend my original plan, with the view of supplying by my own researches what appeared to be not sufficiently established by the labours of other chemists. I have accordingly divided the essay into two parts; attempting in the first division to ascertain the atomic weight of manganese, and the composition of the artificial oxides of that metal; and in the second, applying the facts thus established to illustrate the chemical constitution of the native oxides described by Mr. Haidinger.

Part I.

On the Atomic Weight of Manganese.—Analysis of the Carbonate of Manganese.

A pure carbonate of the protoxide of manganese was prepared in the following manner. The dark brown mass left in the process for procuring oxygen gas from the common peroxide of manganese by heat, was mixed with a sixth of its weight of powdered charcoal, and exposed to a white heat for half an hour. The protoxide thus formed was dissolved by muriatic acid, the solution evaporated to dryness, and the residue kept for some time in a state of fusion at a red heat. The resulting chloride of manganese was re-dissolved by distilled water; and after being filtered, was found to contain no impurity except a little lime, which was separated by the oxalate of potash. The manganese was then precipitated by a solution of the bicarbonate of potash, and the carbonate of manganese was carefully edulcorated and collected on a filter. After removing the upper layer, which had become rather brown by exposure to the air, the white carbonate was kept in a vacuum along with a vessel of sulphuric acid until it became

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* From the Transactions of the Royal Society of Edinburgh.

† On a future occasion we propose to give Mr. Haidinger's paper here alluded to, and also Dr. Turner's analyses of the ores which he has described.—Edit.

came quite dry. The salt thus prepared yielded a colourless solution, without any residue, when put into dilute sulphuric acid, and was therefore free from the red oxide of manganese.

Of this carbonate 8·805 grains were heated to redness in a green glass tube, and the water collected in a tube filled with fragments of the chloride of calcium. The quantity of water procured in this way amounted to 0·742 of a grain, equivalent to 8·427 per cent.

The proportion of carbonic acid was estimated by noting the loss of weight which the carbonate of manganese experiences when dissolved in dilute sulphuric acid. This mode of analysis, as commonly performed, is inaccurate; because the liquid retains carbonic acid in solution, while the gas during effervescence carries off with it an appreciable quantity of watery vapour. But when performed with the precautions which I adopted, it yields uniform results, and is susceptible of great precision. A known quantity of the carbonate is placed in a small glass phial fitted with a tight cork, in which two tubes are inserted. One of these tubes descends to near the bottom of the phial and then bends slightly upwards, so as to admit of the acid being gradually introduced without affording an exit to the gas. The other communicates with a tube filled with chloride of calcium, over which all the carbonic acid gas passes before escaping into the air. As soon as the effervescence has ceased, the carbonic acid retained by the solution is driven off by causing it to boil during the space of a few minutes; and the gas is by the same means expelled from the interior of the phial, into which on cooling the atmospheric air is admitted by the tube for introducing the sulphuric acid. The carbonic acid gas remaining with the chloride of calcium is replaced by atmospheric air, which is introduced by inhaling at one extremity of the tube while the other is open. The upper part of the tube for introducing the dilute sulphuric acid, when not required to be open, is of course closed with a cork in order to avoid loss by evaporation.

It was found by means of the preceding process that 20·68 grains of the carbonate, when dissolved in dilute sulphuric acid, lose precisely 7·18 grains, or 34·72 per cent of carbonic acid. It is accordingly composed, in 100 parts, of

Protoxide of manganese	56·853
Carbonic acid	34·720
Water	8·427
	100·000

Regarding

Regarding 22 as the equivalent of carbonic acid, we have the following proportions:—As 34·72 : 56·853 : : 22 : 36·024.

According to this analysis, 36 may be safely adopted as the combining proportion of the protoxide of manganese; and presuming the elements of this compound to be in the ratio of one equivalent of oxygen to one equivalent of metallic manganese, 28 will be the equivalent of the latter. This result, with respect to the acid and base, corresponds exactly with the analysis of Dr. Thomson, as mentioned in his First Principles of Chemistry, vol. ii. p. 350. It differs considerably from the proportions stated by Dr. Forchhammer. (Annals of Philosophy, N. S. vol. i. p. 54.) According to this chemist, 33·05 parts of carbonic acid combine with 51·755 parts of the protoxide of manganese, a proportion which would fix 34·45 instead of 36 as the equivalent of the protoxide. This estimate is certainly erroneous; and Dr. Forchhammer appears to have fallen into the mistake by supposing that the carbonate of manganese is converted by a red heat into the deutoxide, whereas according to my experiments the red oxide chiefly is then generated.

It appears doubtful whether the water found by analysis in the carbonate, after being dried *in vacuo* with sulphuric acid, is mechanically retained by it or is in a state of chemical union. As the proportion is not atomic, it is probable that the carbonate is really anhydrous. If the ratio were as 58 to 4·5 instead of 5·337, the salt might be regarded as a compound of two equivalents of the carbonate of manganese and one equivalent of water.

Composition of the Sulphate of Manganese.—The most recent analyses of the sulphate of manganese are by Dr. Forchhammer and Dr. Thomson, described in the works already quoted. Dr. Forchhammer precipitated the acid of a known quantity of the neutral sulphate of manganese by the nitrate of baryta, and inferred from the weight of the precipitate, that 100 parts of the sulphate of manganese are composed of 54·378 parts of sulphuric acid and 45·622 of the protoxide. According to this analysis, the atomic weight of the protoxide is 33·56, a number which is surely very far from the truth, and is inconsistent with the equivalent of that oxide derived from Dr. Forchhammer's own analysis of the carbonate.

Dr. Thomson analysed the sulphate of manganese by mixing that salt in atomic proportion with the muriate of baryta, and found, that, after the insoluble precipitate had subsided, no trace of sulphuric acid or baryta could be found in the solution. From this experiment he infers that 36 is the equivalent

equivalent of the protoxide. I am of opinion that the number assigned by Dr. Thomson is correct, but I am not so certain that the means by which he arrived at this conclusion are altogether free from objection. The principle of his method is unexceptionable, especially if the quantity of the precipitated sulphate be carefully observed at the same time; but it is essential to accuracy that the atomic weight of baryta be perfectly established. Dr. Thomson supplied this element in the inquiry in the following manner. He dissolved 88 parts or one equivalent of sulphate of potash, and 106 parts, or what he considered one equivalent, of the chloride of barium in separate portions of distilled water, and then mixed the solutions together. After the precipitate had subsided, the supernatant liquid was found to contain no trace either of sulphuric acid or baryta. It hence follows, if no error is committed, that 70 is the true equivalent of barium. But in a recent number of Poggendorff's *Annalen der Physik und Chemie* (vol. viii. p. 5), Berzelius denies the accuracy of the experiment. He declares that after mixing together the sulphate of potash and chloride of barium in the proportions mentioned by Dr. Thomson, 2½ per cent of the chloride of barium remained in the residual liquid; and on repeating this experiment for my own information, I certainly found that the whole of the baryta was not precipitated. I wish it to be distinctly understood, however, that I do not confidently rely on the accuracy of my result, having been hitherto unable, from want of leisure, to examine the subject with that care which I deem necessary before attempting to decide a point in dispute between chemists, for whose analytical attainments I entertain such high respect. Dr. Thomson will doubtless feel the necessity of verifying his conclusions without delay; since an error in the atomic weight of barium will at once vitiate an extensive series of his most elaborate analyses. My own observation, however, combined with the remark of Berzelius, has induced me in the mean time to secure my own researches as much as possible from any uncertainty respecting the atomic weight of barium, and I have been therefore induced to ascertain the composition of the sulphate of manganese synthetically rather than by analysis.

Nine grains of pure protoxide of manganese, prepared from the red oxide by means of hydrogen gas, were dissolved in dilute sulphuric acid, the solution was slowly evaporated to perfect dryness in a platinum crucible, and the dry salt exposed for half an hour to a red heat. It then weighed 19·01 grains; and regarding the increase in weight as owing to the acid combined with the protoxide, the resulting sulphate must consist of 9 grains of the protoxide of manganese, and 10·01 grains of sulphuric acid. The atomic weight of the protoxide indicated by this process, is 35·96. The experiment was repeated with 4·855 grains, and the resulting sulphate weighed 10·26 grains, indicating 35·93 as the equivalent of the protoxide of manganese.

As some chemists may doubt the accuracy of this process, I shall attempt to show the grounds on which its merits are to be estimated. Dr. Thomson says it is scarcely possible to expel all the water from the sulphate by means of heat, without at the same time driving off some of its acid. It is indeed very easy to effect the decomposition alluded to by Dr. Thomson; but I found no difficulty, by slow evaporation and raising the fire gradually, to keep the salt at a red heat for an hour or longer without decomposing a particle of it. If the heat should accidentally become so intense as to decompose a little of the salt, the defect is easily remedied by adding a drop or two of acid, and replacing the crucible in the fire.

Dr. Forchhammer has judiciously remarked, that in expelling an excess of sulphuric acid, a portion of the salt is very apt to be carried off mechanically by the acid vapour and lost. This accident has occurred to myself, and always happens when a large quantity of free acid is rapidly expelled. By employing a slight excess of acid, and raising the heat slowly, all loss from this cause may easily be avoided.

The dry salt obtained in my experiments was white, and dissolved readily and completely in distilled water.

Like many other neutral metallic solutions it reddened delicate litmus paper. It was nevertheless quite neutral; for a single drop of a dilute solution of potash occasioned a precipitate which was not in the slightest degree redissolved by agitation.

Analysis of the Chloride of Manganese.—In an excellent paper published in the Philosophical Transactions for the year 1812, Dr. John Davy states the chloride of manganese to be composed of 54 parts of chlorine and 46 of metallic manganese. The atomic weight of manganese calculated from these data is 30·67, a number which is considerably beyond the truth. Dr. Davy prepared the chloride by heating the muriate in a glass tube communicating with the atmosphere by a very small aperture. I have never failed by this method to decompose some of the chloride, a circumstance which complicates the analysis, and probably gave rise to Dr. Davy's error.

According to the analysis of M. Arfwedson (Annals of Philosophy, N. S. vol. vii. p. 274), the elements of the chloride of manganese are in the ratio of 8403 parts of chlorine to 6677 of of manganese. This result, in the accuracy of which M. Arfwedson does not place implicit confidence, would fix the equivalent of manganese at 28·61. He prepared the chloride by placing the carbonate of manganese in a spherical cavity blown in a barometer tube, transmitted over it a current of muriatic acid gas, and heated the carbonate by means of a spirit-lamp as soon as the atmospheric air was expelled from the tube. As it is difficult by this, as well as by Dr. Davy's process, to procure a perfectly pure chloride of manganese, I had recourse to the following method. A solution of the muriate of manganese was evaporated to dryness, the heat being carefully regulated so as not to decompose any of the salt, and the dry compound was placed in a spherical cavity in the middle of a barometer tube about six inches long. Muriatic acid gas was then transmitted through the tube, and heat applied by the flame of a spirit-lamp. The chloride entered into perfect fusion at a low red heat, and on cooling yielded a highly crystalline lamellated mass of a beautiful pink colour. Every trace of acid and moisture was expelled by heat; and while the tube was still hot, its extremities were closed by corks, so that the chloride might be weighed without attracting moisture from the air. In the sense above explained it was quite neutral. Of this chloride 12·47 grains were dissolved in distilled water, and formed a colourless solution without any residue. The muriatic acid was thrown down by the nitrate of silver, and yielded 28·42 grains of the fused chloride of silver, equivalent to 7·008 grains of chlorine. Consequently the chloride of manganese consists of

Manganese.............	5·462	28·06
Chlorine................	7·008	36

It follows from the preceding researches, that 28 is the true atomic weight of metallic manganese, and 36 the equivalent of that oxide of manganese which forms definite compounds with acids, and which I regard as the real protoxide of the metal. It is consequently composed of 28 parts of manganese and 8 parts of oxygen. These numbers agree with the atomic weight of manganese as stated by Dr. Thomson, but not with that given by Berzelius, who fixes it at 28·463. This estimate is made from an analysis of M. Arfwedson, who finds that the deutoxide of manganese is composed of 100 parts of the metal and 42·16 parts of oxygen; but it will appear from the sequel of this paper that the real quantity of oxygen united with 100 parts of manganese to constitute the deutoxide is 42·857 and not 42·16 as Arfwedson supposes.

On the Protoxide of Manganese.—By this term I mean the salifiable base of manganese, the only oxide of the metal which appears to me capable of forming regular salts with acids. I am of opinion that in this compound manganese is in its lowest degree of oxidation. The existence of the sub-oxides described by Berzelius and Dr. John of Berlin, has never been satisfactorily demonstrated; and I have reason to suspect that one or other of them would in some of my experiments have been generated, did there exist any tendency to their formation.

The protoxide may be formed, as was shown by M. Berthier in the 20th volume of the *Annales de Chimie et de Physique*, by exposing the peroxide, deutoxide, or red oxide of manganese to the combined agency of charcoal and a white heat; and Dr. Forchhammer has in the Annals of Philosophy described an elegant method of preparing it by means of hydrogen gas at a red heat. Arfwedson has likewise had recourse to this method, and I have employed it very extensively during the course of the present investigation. The mode of performing the experiment is as follows. The material for yielding the protoxide was either the red oxide, deutoxide, or peroxide of manganese; and, occasionally, the carbonate was used. When it was wished to employ a red heat only, the material was placed in a small tray of platinum foil, which was introduced into a tube of green glass, through which the hydrogen gas was transmitted. The heat was applied by means of a pan of burning charcoal. To prevent the tube from bending while softened by the heat, two or three pieces of tobacco-pipe were tied to it longitudinally by means of iron-wire. But when it was wished to prepare the oxide at a very high temperature, the material was put into a small tube of porcelain, and then introduced into a gun-barrel which was exposed to a full white heat in a common wind-furnace. A supply of hydrogen gas was procured in the usual manner from zinc and dilute sulphuric acid; but before coming in contact with the oxide of manganese, it was purified by being transmitted through a strong solution of potash, and then dried by the chloride of calcium. At the close of the process, the protoxide was of course preserved in an atmosphere of hydrogen gas until it was quite cold.

The abstraction of oxygen commences at a temperature below that of redness; and when the peroxide is employed, it becomes red hot by the caloric evolved during the formation of water, considerably before the tray which supports it is rendered luminous by the heat of the fire. It appears nevertheless from all my experiments that a strong heat is requisite in order to convert all the red oxide into the protoxide. When the process is conducted at a low red heat, I uniformly found

found that on putting the product into dilute sulphuric acid, which instantly dissolved all the protoxide, a portion of the red oxide came into view. This affords a sure criterion of the operation being complete; for the pure protoxide dissolves without residue in dilute sulphuric acid, and yields with it a perfectly colourless solution. There seems to be no risk of decomposing the protoxide by the employment of a high temperature. I have exposed the recently prepared protoxide a second time to the action of hydrogen gas and a long continued bright red heat without the weight being changed in the slightest degree; and after exposure to the same gas and a full white heat for an hour, it dissolves in dilute sulphuric acid without the slightest effervescence.

The protoxide of manganese is described by Forchhammer as being of a beautiful light-green, and by Arfwedson as of a pistachio-green colour. I have seen specimens with a tint very near the pistachio-green, but these always contained an admixture of red oxide. The colour of the pure protoxide is very near the mountain-green.

With respect to the action of air, my observations differ from those of Forchhammer, who found that recently prepared protoxide attracted oxygen from the atmosphere before he could weigh it. The protoxide procured in my experiments is far more permanent. I exposed fifteen grains of recently prepared protoxide to the free action of the air during the space of nineteen days, when it was found to have undergone no change either in appearance or weight. If, therefore, it does attract oxygen at all from the air, the operation must proceed very tardily. It absorbs oxygen very slowly even at a temperature of 400° F.; for 7·269 grains of the protoxide, after an hour's exposure to that degree of heat, did not gain in weight more than 0·021 of a grain. At a temperature of 600° F. it absorbs oxygen much more rapidly; and at a low red heat it loses its green tint, and becomes almost black in an instant. I have repeated this process frequently, but in no case did the protoxide take fire, as occurred in the experiments of Forchhammer and Arfwedson. I entirely agree with M. Arfwedson, however, in the statement, that the protoxide is converted, by simultaneous exposure to heat and air, into the red oxide. This is the uniform result at whatever temperature the oxidation is effected.

I have already mentioned my opinion, that, of the oxides of manganese, the protoxide is the only one which forms definite compounds with acids. It unites readily with this class of bodies, without effervescence, producing with them the same salt which is formed when the same acids act on the carbonate of of manganese. When it comes in contact with concentrated sulphuric acid, an intense heat is instantly evolved; and the same phænomenon is produced, though in a less degree, by strong muriatic acid. This oxide is likewise the base of the salts which are formed when sulphuric or muriatic acid is heated with the peroxide, deutoxide, or red oxide of manganese. As the accuracy of this statement, as respects sulphuric acid, has been denied by an acute chemist and good observer, I have been induced to examine the question with considerable care. I mentioned in my Elements of Chemistry, in explaining the process for procuring oxygen gas by means of sulphuric acid and the black oxide of manganese, that the peroxide loses a whole proportion of oxygen, and is converted into the protoxide, which unites with the acid, forming a sulphate of the protoxide of manganese. The gentleman who has done me the honour to review that work in the Annals of Philosophy, I apprehend Mr. Richard Phillips, has made the following remark on the preceding passage. "This statement is at variance with both Dr. Thomson's and also with the results of our experiments; for we find that 44 or one atom of peroxide of manganese yield 4·2 of oxygen, which is so much nearer 4 than 8, that there is no question but that the deutoxide, and not the protoxide is obtained by the action of sulphuric acid; that this is the case is further proved by the deep red colour of the solution of the sulphate, and by its losing that colour, as stated by Dr. Thomson, when mixed with sulphurous or nitrous acid."

To decide this point between the reviewer and myself, it is only necessary to heat the peroxide of manganese with concentrated sulphuric acid, so as to form a solution highly charged with the oxide of manganese, and decant off the solution while hot from the undecomposed peroxide. The liquid on cooling deposits a perfectly white salt, which possesses every property of the protosulphate of manganese. If the acid, which retains an amethyst-tint even when cold, be again heated, the red colour speedily disappears; because the red oxide, which is dissolved in small quantity by the sulphuric acid, is then also converted into the protoxide with the evolution of oxygen gas. The red colour disappears gradually even without the aid of heat; for the solution will be found after a few days to be almost and sometimes quite colourless, while a minute quantity of red oxide has subsided to the bottom. On applying a very gentle heat, the red oxide is redissolved, and the acid acquires a lively amethyst-red colour. It is easy, by operating in this way, to obtain satisfactory proof, that a minute portion of red oxide suffices to communicate a rich colour to a considerable quantity of sulphuric acid. The acid may be made to retain its red colour, either by diluting it with water, or by keeping it in contact with undissolved oxide.

On the Red Oxide.—I have followed the usage of most chemists in applying the term *red oxide* to that compound which Arfwedson has described under the name of *Oxidum manganoso-manganicum* (Annals of Philosophy, N. S. vol. vii. p. 267), and which is uniformly produced when the nitrate, peroxide, or deutoxide of manganese is exposed to a white heat. In my early experiments on this oxide, I entertained considerable doubt as to the uniformity of its composition. This opinion originated in the remark, that, on exposing the peroxide of manganese to a white heat, the quantity of oxygen lost by different portions of it, though agreeing perfectly in some experiments, differed widely in others; and that, on one occasion, I procured the green oxide almost in a state of purity. I subsequently discovered, however, that the disagreement in the results was occasioned by the want of a free current of air within the furnace. In some of the experiments the draft was unguardedly cut off, and consequently an atmosphere of carbonic oxide gas, collecting around the heated manganese, reduced it more or less nearly to the state of protoxide. On avoiding this source of fallacy, the results were no longer discordant; and I am now quite satisfied that the red oxide formed at a white heat and with free exposure to atmospheric air, is uniform in its composition. The accuracy of this inference is established by the occurrence of the red oxide in nature, as will appear in the sequel of the present communication.

The red oxide, when formed at a white heat and rubbed in a mortar to the same degree of fineness, is always of a brownish-red colour when cold, and nearly black while warm. The powder of the native red oxide has a reddish-brown tint, and the colour of the red oxide prepared by exposing the precipitated protoxide or the carbonate to a moderate red heat, has most commonly an admixture of yellow, something like rhubarb, though of a deeper hue; but both of these acquire the red colour when heated to whiteness.

The red oxide manifests little tendency to pass into a higher degree of oxidation by abstracting oxygen from the atmosphere, even by the aid of heat. Thus a portion of the red oxide, preserved for an hour at a low red heat, and freely exposed to the air at the same time, did not acquire any appreciable addition to its weight. The protoxide of manganese precipitated from the sulphate by an excess of pure potash, collected on a filter and washed, fully exposed to the air in its moist

moist state for twenty-four hours, and then heated in an open vessel to a moderate red heat, which was insufficient to decompose the deutoxide, lost only 0·218 per cent by subsequent exposure to a white heat. The quantity of deutoxide present, therefore, must have been very minute. The anhydrous protoxide, as already mentioned, always yields the pure red oxide when heated to redness in the open air. The carbonate, also, in similar circumstances, is converted into a red oxide containing but a very small proportion of the deutoxide. It will appear from these experiments that it is unsafe in analyses to heat the precipitated protoxide or carbonate to redness, and consider the product as the deutoxide; a practice which is calculated to lead analytical chemists into considerable errors, and indeed has actually done so. If it is wished to procure the deutoxide, the precipitate should be moistened with nitric acid, and then exposed to heat.

I have endeavoured to ascertain the composition of the red oxide by several methods. The first is by the combined agency of heat and hydrogen gas. In the first experiments 100 parts of pure red oxide, in being thus converted into the protoxide, lost 6·802 and 6·817 parts of oxygen; but as the resulting green oxide, when put into dilute sulphuric acid, was found to contain a little red oxide, the loss in oxygen must be rather below the truth. To avoid this error I exposed 44·256 grains of red oxide to hydrogen gas and a white heat for the space of one hour, when the loss amounted to 3·153 grains on 7·125 per cent.

Judging by the increase in weight which the protoxide acquires when heated in the open air, 100 parts of the red oxide consist of 93·05 parts of protoxide and 6·95 of oxygen. According to a similar experiment made by Arfwedson, the red oxide is composed of 93·153 protoxide and 6·847 parts of oxygen.

In an analysis already described, the carbonate of manganese was found to contain 56·853 per cent of the protoxide of manganese. When 100 parts of the same carbonate are exposed to air and a white heat, 61·18 parts of red oxide are obtained. From these data it may easily be calculated that the red oxide consists of 92·927 parts of protoxide, and 7·073 of oxygen.

As a mean of the numbers afforded by these three methods, it follows that the red oxide is composed of 92·951 parts of the green oxide and 7·049 of oxygen, or of 72·291 parts of metallic manganese and 27·709 of oxygen. According to M. Berthier*,

who

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* *Ann. de Chimie et de Physique*, tom. xx.

who reduced the red oxide to the metallic state by means of charcoal and a long continued intense heat, the oxygen is only 26·6 per cent. But this estimate, as M. Berthier himself suspects, certainly renders the quantity of oxygen too small; for though, guided by theoretical views, I am disposed to consider my own number not rigidly exact, yet from the care with which the experiments were made, I am satisfied their result cannot be far from the truth.

From this proportion of manganese and oxygen, we may consider the red oxide a compound either of 80 parts or two equivalents of the deutoxide and 36 or one equivalent of the protoxide, as M. Arfwedson supposes, or of 44 parts or one equivalent of the peroxide and 72 or two equivalents of the protoxide of manganese. If, on either of these suppositions, the composition of the red oxide in 100 parts be calculated, it will be found to consist of 93·104 parts of the protoxide and 6·896 of oxygen, or of 72·414 parts of metallic manganese and 27·586 of oxygen. These numbers approximate closely to those furnished by my experiments, and may serve perhaps to correct them.

The red oxide of manganese, when agitated with strong sulphuric acid, is dissolved in minute quantity, without appreciable disengagement of oxygen gas, and the solution is promoted by a slight increase of temperature. If the resulting liquid be separated from undissolved oxide, and exposed to heat, its amethyst-red tint quickly disappears, and the protosulphate of manganese is generated. When the red oxide is briskly heated with sulphuric acid, the protosulphate is formed, and oxygen gas evolved with effervescence.

On boiling the red oxide with an excess of very dilute sulphuric acid (in the proportion, for example, of two measured drachms of strong acid to five ounces of water), a colourless solution of the protosulphate is obtained; while a portion of peroxide is left, the quantity of which corresponds to the atomic view just given; that is, 116 parts of the red oxide yield 44 parts of the peroxide of manganese.

When the red oxide is mixed with strong muriatic acid, a portion of it is almost instantly dissolved, and communicates a deep red colour to the liquid. But the solution is not permanent. The odour of chlorine is perceptible from the beginning, even at a temperature of zero of Fahrenheit; the disengagement of that gas continues slowly, though without distinct effervescence, until in a few days the solution, if separated from undissolved oxide, becomes quite colourless. The red oxide dissolves in hot muriatic acid with effervescence, owing to the evolution of chlorine.

On the Deutoxide.—This oxide is prepared by exposing the nitrate or peroxide of manganese for a considerable time to a rather low red heat. I have found great difficulty in procuring it artificially in a pure state. After exposing the peroxide for an hour or longer to a moderate red heat, the residue frequently contains too much oxygen for constituting the deutoxide; and on augmenting the temperature slightly, the loss in oxygen is very apt to become excessive. The result is so much influenced by slight differences of temperature, that I do not feel confident in inferring the existence of the deutoxide from such researches. That there is such a compound, however, is demonstrated by its occurring in two different states in the mineral kingdom. My experiments as to its composition, as will afterwards appear, agree with the statement of Berzelius, Arfwedson, and Thomson. It is intermediate between the protoxide and peroxide, consisting of 28 parts or one equivalent of manganese, and 12 parts or one equivalent and a half of oxygen; or rather, to be consistent with the atomic theory, of two equivalents of the former to three of the latter. Its elements, it is obvious, are in such proportion, that it may be regarded as a compound of 44 parts or one equivalent of the peroxide, and 36 parts or one equivalent of the protoxide of manganese; and into these it may be resolved by being boiled in dilute sulphuric acid.

The colour of the deutoxide of manganese varies with the source from which it is derived. That which is procured by heat from the native peroxide or the hydrated deutoxide, has a brown tint; but when prepared from the nitrate of manganese it is almost as black as the peroxide itself, and the native deutoxide is of the same colour.

On heating a mixture of the deutoxide of manganese and concentrated sulphuric acid, oxygen gas is evolved with effervescence, and the protosulphate is generated. In the cold the acid acts upon it slowly, and acquires an amethyst-red colour; but this effect does not take place so readily as with the red oxide. The solution is attended with the disengagement of a little oxygen, a circumstance from which it may be inferred that a portion of deutoxide is resolved into oxygen and the red oxide, and that the latter, on being dissolved, is the cause of the red colour. Arfwedson represents the deutoxide as yielding a deep grass-green coloured solution with sulphuric acid; but I have never been able to observe this phænomenon.

Strong muriatic acid acts upon the deutoxide in the same manner as on the red oxide of manganese, excepting that the acid acquires the deep red tint more rapidly with the latter than

than when the former is employed. It is hence probable that the red colour is really communicated by the red oxide.

Peroxide of Manganese.—To procure a pure peroxide of manganese, a solution of the protonitrate was evaporated to dryness, and the heat continued until the whole of the salt was converted into a uniform black mass. It was then reduced to fine powder, carefully washed with distilled water, and dried by exposure for several hours to a temperature of 600° F. On heating a portion of this peroxide to redness in a glass tube, a little moisture was expelled, which reddened litmus paper powerfully. Consequently the peroxide still retained a little nitric or nitrous acid, which I found it impossible to expel entirely, except by the employment of a temperature bordering on a commencing red heat. The peroxide, after exposure to that degree of heat, was quite free from acid, but still retained a trace of moisture. On exposure to a white heat it lost only 10·82 per cent of oxygen, whereas had the peroxide been pure, it should have yielded 12·122 per cent. It appears therefore that the heat required to expel the last portions of the nitric acid, decomposes some of the oxide itself; and this circumstance induced me not to rely on the analysis of the artificial peroxide of manganese.

From my examination of the native peroxide of manganese, I conclude with all other chemists who have of late years studied the oxides of manganese, that it contains twice as much oxygen as the protoxide. It is accordingly composed of 28 parts or one equivalent of manganese, and 16 parts or two equivalents of oxygen; and in being converted by a white heat into the red oxide, it should yield 12·122 per cent of oxygen gas.

Sulphuric acid acts very feebly on the peroxide of manganese. At first I could observe no action at all; but on employing a considerable quantity of the oxide, and agitating the mixture frequently, the acid after an interval of two or three days acquired an amethyst-red tint, a minute quantity of oxygen gas being at the same time disengaged. The nature of the change which is produced when sulphuric acid is heated with the peroxide of manganese, has already been discussed.

Muriatic acid, as is well known, acts upon the peroxide of manganese at common temperatures, chlorine gas being disengaged with effervescence. If heat and an excess of acid be employed, a colourless muriate of the protoxide is procured; but in the cold, or if the oxide be in excess, in addition to the protomuriate, a deep red coloured solution is formed, similar to that already mentioned in the description of the red oxide.

[To be continued.]

VIII. *Experiments on the Pressure of the Sea, at considerable Depths.* *By* Jacob Green, *M.D. Professor of Chemistry in Jefferson Medical College, Philadelphia, United States, North America.*[*]

AMONG the various expedients resorted to for the purpose of relieving the tedium and monotony of a sea-voyage, no one is more common during a calm, than to attach to a long line (the log) an empty bottle, well corked, and then to sink it many fathoms in the sea. In all such experiments it is well known, that the bottles upon being drawn up are either full or are partially filled with water. The manner in which the water gets into the bottle is in some instances perfectly obvious, but in others very perplexing, if not wholly inexplicable. Sometimes the cork, however well secured and sealed, is driven into the bottle, and when drawn up the vessel is of course found filled with water; and in such cases, what is a little surprising, the cork is often found occupying its original position in the neck of the vessel, being forced there no doubt by the expansion of the dense sea-water on being drawn near the surface. This seems to be proved by the cork often being in an *inverted* position. In the above experiment, and in some others to be mentioned presently, the bottle appears to be filled instantly; as the person who lowers the bottle down often feels a sudden increase of weight, somewhat similar to the sensation produced when a fish takes the hook on a dipsey line.

Sometimes the above experiment is varied by filling a vessel with fresh water, which on examination is found to be replaced by salt water; the cork remaining apparently undisturbed.

Sometimes when the previously empty bottle is only half-full of water, this when poured into a tumbler effervesces like water highly charged with carbonic acid gas. This is readily explained: for when the bottle descends it is full of air, and when the water enters, it will of course absorb the air; especially when the dense water itself expands as it is drawn towards the surface.

Sometimes the experiment is performed by first corking the bottle *tight*, and then tying over the cork a number of layers of linen dipped in a warm mixture of tar and wax; in fact, every device seems to have been tried to prevent the entrance of the water by the cork. In many of these cases, when the bottle

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[*] Communicated by the Author.

bottle is drawn up from a depth of 200 or 300 fathoms, it is found filled or nearly filled with water, the cork sound, and in its first situation, and the wax and tar unbroken. Two experiments are mentioned, in which vessels with air-tight glass stoppers were used. In one case the bottle was broken, and in the other some drops of water were found in it.

How does the water find its way into the bottles? There are two opinions: One is, that it passes through the cork and all its coverings, in consequence of the vast pressure of superincumbent water, in the same manner as blocks of wood are penetrated by mercury in the pneumatic experiment of the mercurial shower. The other and less popular opinion is, that the water is forced through the pores of the glass*.

The following experiment, which I made on the 7th of May 1828, in latitude 48 + longitude 24° 34′, will perhaps throw some light on this subject.—Mr. Charles Dixey, the obliging and intelligent master of the packet-ship Algonquin, had a boat rowed off from the ship for me, to the distance of about half a mile, when the sea was almost perfectly calm. A hollow glass globe hermetically sealed, which I had previously prepared in Philadelphia, was then fastened to a line, and sunk, with a heavy mass of lead, to the depth of 230 fathoms, or 1380 feet. On the same line, and 30 fathoms above the glass globe, was fastened a small bottle with an air-tight glass stopper; 50 fathoms above this, a stout glass bottle with a long neck was tied; a good cork was previously driven into the mouth of this bottle, which was then sealed over with pitch, and a piece of linen dipped in melted pitch was placed over this; and when cool, another piece of linen treated in the same way was fastened over the first. Twenty fathoms above this bottle, another was attached to the line, much stouter, and corked and sealed like the first, except that it had but one covering of pitched sail-cloth. Thirty fathoms above this was a small thin bottle filled with fresh water closely corked; and 20 fathoms from this last there was a thin empty bottle corked tight and sealed, a sail-needle being passed through-and-through the cork, so as to project on either side of the neck.

Upon drawing in the line, thus furnished with its vessels, and which appeared to have sunk in a perpendicular direction, the following was the result:

The empty bottle with the sail-needle through the cork,

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* See Perkins on Pressure, Phil. Mag. vol. lvii. p. 54. J. Deuchar's Remarks on the same, Ibid. vol. lviii. p. 201. Campbell's Travels, 1st series, p. 335. Silliman's Journal, vol. xiv. p. 194. Deuchar's Mem. in the Trans. of the Wernerian Soc. 1821—2—3.

and which came up the first, was about half full of water, and the cork and sealing as perfect as when it first entered the sea.

The cork of the second bottle, which had been previously filled with *fresh* water, was loosened and a little raised, and the water was *brackish*.

The third bottle, which was sealed and covered with a single piece of sail-cloth, came up empty, and in all respects as it descended.

The fourth bottle, with a long neck, and the cork of which was secured with two layers of linen, was crushed to pieces, all except that part of the neck round which the line was tied; the neck of the bottle both above and below the place where the line was fastened had disappeared, and the intermediate portion remained embraced by the line. This I thought a little remarkable; and perhaps may be explained by supposing that the bottle was first filled by the superincumbent pressure with dense sea-water, which expanded on being drawn up near the surface. Had the vessel been broken by external pressure, that part surrounded with the line ought to have been crushed with the rest.

The fifth bottle, which had been made for the purpose of containing French perfumery or æther, and which was therefore furnished with a long close glass stopper, came up about one-fourth filled with water.

The hollow glass globe, hermetically sealed, which was the last and had been sunk the deepest of all, was found perfectly empty, not having suffered the smallest change. It is therefore concluded, that at the depth of 230 fathoms the water enters glass vessels through the stoppers and coverings which surround them, and not through the pores of the glass. What the effect of a pressure of 400 fathoms or more will have on the glass globe above mentioned, Captain Dixey has engaged to ascertain for me on his return to America, if opportunity shall offer.

IX. *Notices respecting New Books.*

A Geological Memoir on a Part of Western Sussex; with some Observations upon Chalk-Basins, the Weald-Denudation, and Outliers-by-protrusion. By P. I. MARTIN. London, 1828; 4to; pp. 100, and Synoptical Table; coloured Plates iii, and a Geological Map.

ON the occasion of reviewing Mr. Mantell's admirable "Illustrations of the Geology of Sussex," in the Philosophical Magazine for December last, we expressed a hope that the example of that

that gentleman, in carefully and minutely examining the strata and organic remains occurring in his own vicinity in Sussex, would be extensively and zealously followed, and that every important assemblage of strata in our island, might have its respective local inquirer. Since the publication of that review, the same means of augmenting our knowledge of the mineral structure of our country, and of promoting the advancement of geology in general, have been urgently recommended from the Chair of the Geological Society; in an Anniversary Address, as replete with comprehensive and correct ideas on the present state and requirements of the science, as it is with attempered views of geological theory, and the good-feeling to which the social pursuit of useful knowledge can never fail to give rise*. But we did not expect so soon to have the pleasure of directing our readers' attention to another highly interesting work of local geology, from which it appears, that, in one instance at least, our hopes of the benefits that might accrue from the plan of inquiry we ventured to suggest, have been fully justified. We observed, on the occasion alluded-to, that the "local inquirer," "bringing the general ascertained facts of the science to bear upon the peculiar phænomena of his own district, might obtain results reciprocally illustrating those general facts, with the same success that has attended the active labours of Mr. Mantell." Now this has been precisely the case with the researches of Mr. Martin, detailed in the work before us. For, having applied his general knowledge of the structure of the earth to the particular examination of a portion of the "Weald-denudation," he has become acquainted with facts, to a certain extent peculiarly observable in this district, which have led him to a *theory*—not, be it observed, an *hypothesis,*—of derangement and denudation, and of the origin of Chalk-basins, which will probably contribute materially to alter the views hitherto prevalent among geologists, of the history of the superior and supermedial strata in general. Nor is this result the less valuable, because ideas of a similar theory had been previously promulgated, without the author's knowledge, by two such accurate observers as Mr. Poulett Scrope and Professor Buckland. And there is yet another point of view in which the present Memoir becomes interesting; for since the research which led to its composition was made many months before either the delivery of Dr. Fitton's address to the Geological Society referred to above, or the publication of our own review of Mr. Mantell's "Illustrations," we may regard it as a proof that the importance of specific local investigations has already been appreciated and acted upon by geologists; and that we may confidently expect, at no distant period, memoirs of equal utility on other districts and formations.

Mr. Martin, willing, we apprehend, to enlist all classes of intellectual inquirers into the service of geology, prefaces his Memoir with an "Advertisement to the general reader." In this he briefly describes the Weald-denudation, illustrating his account by a profile of that remarkable tract, and also adverts to the interest of the

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* See Phil. Mag. and Annals, N. S. vol. iii. p. 299.

stupendous convulsions which must have been concerned in producing the phænomena it exhibits; quoting in conclusion the subjoined apposite observations by the Father of inductive science: "Men use commonly to take a prospect of nature, as from a high turret; and to view her afar off; and are too much taken up with generalities. Whereas, if they would resolve to descend and approach nearer to particulars, and more exactly and considerately look into things themselves, there might be made a more true and profitable discovery and comprehension."

The Advertisement is succeeded by fourteen pages of "Introductory Remarks." It is here stated that the substance of the following Memoir was read before the Geological Society in March 1827; (See Proceedings of the Geological Society, No. 2; or Phil. Mag. N. S. vol. i. p. 388.) and that it then attracted some attention, among other causes, from its bringing again into discussion the arrangement and nomenclature of the beds immediately below the chalk. This subject is succinctly discussed in these Remarks, and, as it appears to us, in a luminous and satisfactory manner; the "upper shale" of the "Survey of the Yorkshire Coast" being regarded as identical with gault; and the whole suite of sands and clays between the chalk and the Weald-sands, &c. grouped together, in accordance with the observations of Messrs. Sedgwick and De la Beche, under the appellation of *glauconite*. For the upper member of this series, embracing every bed between the chalk and the gault, the name of *malm* is substituted, in place of the terms *firestone* and *upper green-sand*, successively employed by Dr. Fitton, and *malm-rock*, adopted by Mr. Murchison*.

The weald-clay and the iron- or Hastings-sand are regarded as deposits of common character and single origin,—as constituting one formation; and since Hastings-sand or iron-sand would be as little designative of the whole thing signified as Weald-clay, and to avoid the inconvenience of the periphrasis of Weald-sands and-clays, Mr. Martin proposes, as any compound from Weald must have a Saxon termination, to call the whole formation the *Wealden*. In the choice of

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* We are not aware that either of the designations here proposed can be objected to; but at the same time we are unwilling to relinquish the term firestone; for, although it be very true, as Mr. Martin observes, that "any stone of a particular combination of lime, argil, and silex, may be a firestone," (*i. e.* a stone that will sustain a high temperature without alteration, and may thence be applied to such purposes in the arts as require a stone of this quality,) yet the term having been exclusively applied by English geologists to a species of stone occurring in the upper member of the glauconitic series, and derivatively to this subordinate formation itself, whatever its mineral nature, is not liable to misconstruction; and some circumstances in its history which Mr. M. has not alluded-to, render us very desirous that its use should be retained by geologists. The beds of this substance in the neighbourhood of Godstone, in Surrey, and other localities, were extensively quarried by our ancestors, for the erection of many of their ecclesiastical and other edifices, as well as for the purposes of sculpture; examples of which may be seen in parts of Westminster Abbey, in the repaired south-east angle of the keep of Rochester Castle, &c.: and thence the name, *as applied*

of this appellation, he observes, he has been "guided by a wish to do as little violence as possible to inveterate habit, as well as to adhere to the useful practice of deriving it from the locality in which the type is best exemplified."

The Introduction concludes with some remarks on the nature and difficulties of the research which led to the composition of the Memoir, and on the theory of the Weald which that research induced the author to form. It is here stated that down to the time of the memoir's being read before the Geological Society, "the writer was entirely unacquainted with the existence of any attempt to explain the act of denudation by any other agency than that of watery flood." His own speculations upon the structure of the country "had produced a conviction of some other agency besides that of water having been called into action, and that that agency had at the same moment of convulsion formed what are called the Chalk-basins of London and Hampshire, and in that act broken up what is now the cavity of the Weald." By an extension of his reading, however, he has found that Mr. Scrope, in his work on Volcanoes, published in 1825, promulgated a sketch of this theory of the Weald; and that, at about the same time, Prof. Buckland, in a paper read before the Geological Society in 1825, and published in the following year, gave a conjectural explanation of the same kind. If by these circumstances, Mr. Martin observes, "he has been deprived of the satisfaction of believing himself the first to promulgate this discovery, he has the pleasure of finding his opinions backed by high authority; and is emboldened to carry on the research to a satisfactory exposition of many of the facts which bear upon this theory, and are strong presumption, if they do not amount to a perfect proof, of its truth."

The Introduction is succeeded by the "District Survey," illustrated by a map extracted from the Ordnance Survey, coloured geologically, and comprising that part of Sussex which extends from the Adur, between Steyning and West Grinstead, on the east; and the little stream (called for convenience the Lod,) which runs into the Rother by Lodsworth and Half-way-bridge, between the chalk-downs at Graffham and the foot of Blackdown, on the west. The chalk, malm, galt, Shanklin-sands, wealden, diluvium and alluvium of this district, are successively described, more or less at length, according to the novelty of the information to be imparted; but in all cases the descriptions are illustrated by tables of the

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applied to this stone, has become familiar to antiquarian and topographical writers on the South of England in general, and also to architects. Thus this stone is emphatically denominated "Firestone" by Sir Christopher Wren, as may be seen in the '*Parentalia.*' We allude to these circumstances the more readily, as we perceive, from various remarks in his Memoir, that Mr. Martin is fully aware of the importance to the increase and unity of knowledge, of preserving in scientific disquisitions those popular appellations which have been from time immemorial bestowed on the objects of research; and of adopting in science the few *well-understood* denominations of the arts.

mineral and organic contents of each formation respectively. The two groups of the Shanklin-sands are described in a very discriminative and particular manner; and an extract of a letter from Dr. Fitton is annexed, stating his confirmed opinion that the tract of country in Sussex, consisting of these sands, is geologically identical with that of the vicinity of Folkstone in Kent.

The "Wealden" includes "the Weald-clay, Hastings-sand, iron-sand, and Tilgate-beds of various geological writers."

In this section of the work, after describing the transition from the green-sand to the weald-clay, and stating that the escarpment of the former is every where prolonged by a considerable slope of the adjacent clay, Mr. Martin describes the beds assimilating to the Hastings-sand, which he has discovered in the Weald, in the following terms:

"Besides this slope, there is from the bottom of the green-sand a breadth of from a quarter to half a mile of clay, giving together an average depth, perhaps of 150 or 200 feet. At a moderate depth from the surface, this clay is generally blue, running into layers of hard blue shale, often impressed with the Cypris faba; and containing nodular concretions in concentric layers of ferruginous clay, sometimes containing calcareous matter. These argillo-calcareous Septaria are sometimes coated with a ferruginous concrete, containing casts of shells of the genera Cyclas, Cyrena, and Paludina, with the Cypris faba. At the top of this stratum, also, at its junction with the green-sand, in one locality, the author has discovered large bones of vertebrated animals* inclosed in a ferruginous concrete of sand and clay, but too imperfect to be appropriated.

"At the bottom of this first layer of the weald-clay, appears the first bed of sand, of which the thickness is uncertain. Sections have been made in it to the depth of twenty or thirty feet, and it is probably as much more. It is a brownish-yellow micaceous sand, abounding in white argillaceous veins, and with a coarse iron-rag†, sometimes containing casts of Cyclades, the teeth and scales of fishes, and vegetable impressions‡, and in every respect assimilating to what has been hitherto considered the true Hastings-sand. The course of this bed of sand has been particularly attended to, and it has been traced through all the line of country here attempted to be described. From Mulsey (in the line of section of the Arundel and Bognor road), tracing it westward, it may be found at

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* "At Henfield between the village and the turnpike-gate, on the Horsham road, associated with Vivipara."

† "The sand is sometimes sufficiently indurated to form a building stone. And the iron-rag frequently becomes a conglomerate of sand and clay, with angular, and sometimes slightly rolled fragments of chert and sandstone. It has been extensively quarried in this part of the country, anciently, for smelting."

‡ "A specimen of Endogenites erosa from this course of sand, was found near Mulsey, and is now in the possession of Mr. Sowerby. It measures about ten inches in length, and six in circumference, and has lost a few inches at its apex. At the base, it is broader than that figured in Mantell's Tilgate Forest. The petrifying matter is silex."

Bignor-farm, under Bedham Hill, Buckfold, Parkhurst, Lickfold, and within half a mile of Blackdown, near Lurgershall, where there is a fine bank of it exposed at Northhurst-farm. Eastward it runs by Willets and Spear Hill, and crosses the Worthing road, at Wincaves; from whence its course is a good deal disturbed by the disruption of the Vale of Greenhurst; but it is found at Jessups, and again a little north of Henfield*."

The first course of the well-known concrete of fossil shells of Helix or Vivipara, called Sussex marble, is followed by another succession of clays, of much less depth than either of the former; and to this follows a second bed of sand more micaceous and of a deeper brown, with less admixture of clay, and carrying Horsham grit. Next succeeds the thickest and finest bed of Sussex marble: there are then beds of blue and red clay, and a third course of fawn-coloured micaceous sand.

"Immediately below this course of sand, a thick bed of red clay succeeds, and then the calcareous grit, sand-stone, and clays of what has generally been considered the 'forest range' of the weald.

"By this sketch of the contents of this part of the weald, it will be seen that there are two distinct beds of sand above the Sussex marble, the highest of which has all the character of the 'Hastings-sand,' and the second carries Horsham grit.

"There is therefore no line of demarcation to distinguish the weald from the Hastings-sands and -clays, except a slight elevation of the line of country, a more stony structure, and greater sterility."

To the "District Survey" succeeds the "Theory of Derangement and Denudation," which is certainly the most important part of the work. But we find it difficult to convey an adequate idea of this theory by extracts. Those which we subjoin, however, will impart some idea of it.

After stating that the Weald-denudation is understood to be bounded on each side by what are called the chalk-basins of London and Hampshire, the author observes, that, although the contents of these basins have been carefully examined and described, no satisfactory explanation of the mechanism or mode of formation of the basins themselves has yet been given.—He then proceeds to give his own theory, and partly in the following manner:

"*The strata which compose these basins, then, previously in a horizontal position, suffered disruption; and in the act of basining (whether by the elevation of the sides, or the subsidence of the central parts, is not now material), all their parts were deeply and extensively fissured, in an order correspondent with that act;—producing, with the help of diluvian action, a system of longitudinal and transverse valleys answering to the double inclination (the dip and lateral bearings, or obliquity of the plane) of their fractured masses, and a consequent removal of the broken materials brought within the range of the denuding force.*

"The effect of raising from the horizontal position, or in any other

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* "The irregularity of the denudation between Warminghurst and Henfield, seems to have left outliers of this sand, as well as of the upper bed of weald-clay, out of the usual course in that line of country."

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way stretching, a ponderous and frangible body, is to produce a division of its parts in such order and direction as its varying strength and tenacity dictates; the fractured parts taking their places, according to their magnitude or gravity, or the disposition of those which support them. This irregular fracture, alternate elevation and subsidence, and settling of parts thus disturbed, are well exemplified in the familiar operation of the heaving of the spade in digging. If the earth be tenacious and the action steady, it tears with such a divergence of the principal rents as will be here described; and the more friable parts are seen dropping in in such a way, and in such proportion, as the moving power dictates, and their structure allows. If another illustration were necessary, it might be found in what we observe in the elevation and cracking of the flour which covers the fermenting nucleus in a baker's trough.

"Where opportunities occur for tracing these appearances in the weald, they are found to be in perfect accordance with this theory. These opportunities present themselves frequently in the clay districts; but they are more distinctly traceable in the stony, in the dip and variable lateral bearings of the several masses. It may be safely said, that undulation, at the time of deposit, had very little share in these phænomena, or in the construction of the hills and valleys of these districts. Every variation in dip or lateral bearing has its commencement in a fracture, or if the displacement be moderate, such a contortion as would be produced by the gravitation of bodies like these, moving under great superincumbent and lateral pressure.

"The general dip of the chalk-hills is southward, but the lateral bearings of the several masses are variable*, and the inclination also different in different localities. Next to these succeed the more broken strata of the green-sand; and lastly, the smaller lacerations of the wealden formation, the widely spreading transverse fissures of which concur to produce the effect of longitudinal ones over all the convexity of the 'forest ridge.' But it is not to be understood, that there is any difference in the general disposition of all these parts. The convexity extends from the bottom of the English Channel to the bottom of what is called the London basin. This convexity may be likened to a dome, and the loss of a part of the crown of the dome is the weald vacuity. In other words, the commencement of each basin is in the anticlinal line of the weald valley. From this point, all the strata begin to slope. Both basins, therefore, may be said to be entire in a part of the wealden, although they have lost a part of their rims in the chalk and the glauconite.

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* "In ordinary geological language, there is not sufficient precision used in these terms; and lateral bearings are confounded with the dip, which should express the backward and downward inclination only. Thus, of the strata in question, sometimes we are told that they dip S.E., sometimes S.W. The fact is, that they all *dip* to the south, generally speaking, but the obliquity of the plane, or *lateral bearing* of the different masses, is sometimes east and sometimes west."

"The principal transverse fissures, some of which were destined to become river-channels, have a remarkable correspondence on each side of the valley, particularly in the chalk, and in several instances are directly opposed to each other; which could not have happened without a simultaneous action and common consent and continuity of parts. The direction of a rent would be ruled by the density and tenacity of the different parts of the stratum; occasionally deviating from the straight line, it might be lost in one part, and taken up and carried on by another, giving less resistance. The coincidence is therefore the more remarkable, and proves not only the continuity of the chalk strata at the moment of convulsion, but also their uniform density and strength. Of the valleys thus opposed to each other by the continuity of the greater transverse fissures, the most remarkable are,—the defiles of the Arun in the South, and the Wey in the North Downs; the vale of Leatherhead, or the Mole, and that of Findon, or the Worthing road; of the Adur and Smitham-bottom, or the pass of Merstham and Croydon. The Ouse is also opposed to the Darent, and the Cuckmere to the Medway.

"But it must not be supposed that this simple transverse fissure is the only appearance of displacement exhibited by the chalk strata. They have suffered in common with the other rocky strata, that adjustment of parts which might be expected from the nature of the material on which they rest. If the fissile character of the stony strata determine their division in straight and broad lines, it would also be the character of the wealden formation to be torn and contorted in a manner widely different. For a stratum of clay of great thickness, carrying stone barely sufficient to give it stability, would tear rather than split in the act of displacement; and such a divergence of the fissures as might be expected in so tenacious a mass, can be readily traced in every part of the weald surface. This divergence and laceration has therefore modified the disposition of the stony strata still superincumbent upon the clay; and the subsidence, elevation, and contortion consequent thereon, are everywhere visible in the dip and variable bearings of all their masses. In appreciating the evidence of these acts of laceration and fracture, it must not be forgotten also, that strata of various structure far below these under review, have suffered the same disruption; and by the variable nature of their fracturings have operated to modify, and in some cases to obscure, a great part of the direct testimony of the order here described. The pressure of superincumbent strata of unknown thickness and kind must also be taken into account; and it will not be thought wonderful that, diluvian action and the operation of more modern causes apart, there should be so little direct evidence of fissure upon the surface.

"The divergence or distribution of the transverse fissures is to be traced in the upper stony strata, as well as in the minuter divisions of the clay districts. If a fissure of this sort be followed from its termination in any of the hilly counties, it will be found to present, first a little coomb, into which the stone inclines on both sides, and at first carrying no water. By-and-bye springs burst forth, (the natural

natural consequence of this convergence of layers of stone,) and it becomes a valley with a rivulet; both the valley and the rivulet enlarge by the accession of other coombs and rivulets, the effects of the branches of one greater river fissure; and the eye of the observer may, from any considerable eminence, embrace the courses of these valleys, as they converge towards some of the river outlets*."

The theory is satisfactorily illustrated from the phænomena observable in the valley of the river Arun, and in the vale of Greenhurst. A few pages of concluding observations present some acute criticism on the reasoning of the French naturalists on the æra of the formation of chalk-basins, &c.: and here occurs a remark on the geological site of the Thames Tunnel, which, as this analysis has occupied more space than was originally intended, we shall offer a reply to in our next Number.

The last section of the memoir, "On Outliers-by-protrusion," we give entire; and also, as a summary of the facts relating to the geological structure of the weald, we copy Mr. Martin's Synoptical Table.—Our opinion of the merits of the work is sufficiently evinced by our remarks in the commencement of this article, and the full account we have given of its contents, without the necessity of expatiating further on the subject.

"*On Outliers by Protrusion.*—In reviewing the outskirts of the district made the object of the 'Survey' of the foregoing Essay, the writer's notice was drawn to a remarkable chalk-eminence upon the coast, between Worthing and Little Hampton, called *High-Down.*

"High-Down stands considerably in advance of the general line of chalk-hills, and is insulated by a breadth, between them, of two miles of plastic clay, covered by the woods of Patching, Clapham, and Castle-Goring. It has, therefore, the character of an outlier; and upon a closer inspection, was found to present an escarpment to the sea, from which it is about two miles distant, and to have a northerly dip,—in opposition to the general inclination of the South Downs. The observation of this phænomenon immediately suggested the thought, that the well-known outlier of *Ports-Down*, in Hampshire, would be found to be in the same predicament. And as there is nothing to be observed of High-Down, which will not apply to the larger outlier above-mentioned, a description of the latter will suffice †.

"Ports-Down is a long narrow ridge of chalk, running east and west, which, rising three or four hundred feet above the level of the sea, overlooks the Island of Portsea, and the several islets and in-

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* "It will not be supposed that the author means that this should apply to the courses of all rivers, and in all their parts. He is now talking of the Arun and the Adur, and not of the greater rivers of the globe. But the principle is capable of extension to the tributary streams of these also; and all perennial rivers must have their sources in disruption,—for disruption and displacement are the essence of springs and fountains."

† "The reader may take the Ordnance Survey, or any other good map which marks the high grounds, for a guide."

lets of its celebrated harbour. To these, and to the south, it presents an abrupt escarpment; on the other side, it slopes rapidly northward, and is quickly lost, under the plastic clay and sands of the 'Forest of Bere;' of which there is about five or six miles, between it and the main body of the chalk of the South Downs, with which it forms a trough or basin. In advance, and at more than double the distance, are the chalk-hills of the Isle of Wight. It therefore distinctly belongs to, and is an emanation from, the north side of the Hampshire basin.

"At the eastern extremity, the chalk rises out of the plastic clay at Bedhampton, and, taking a direct course westerly, gradually attains its greatest elevation between Cosham and Portchester; it then gradually declines, and, after a course of about seven miles, sinks again under the plastic clay, at Fareham. Here it ceases to be an outlier, but the line of elevation can be traced further westward, and the chalk is sometimes quarried through the overlying strata, beyond Fareham, and comes to the surface again, at Titchfield and Funtley; beyond which, this research has not been carried.

"At the eastern extremity of the ridge, where it emerges, at Bedhampton, it dips gently northward, with a lateral bearing to the *east.* In the centre the inclination is much greater. There is no good section where it appears to be the greatest, but where the hill is intersected by the Portsmouth road, it amounts to twenty-five or thirty degrees, and at the highest, is perhaps nearly forty. Westward from thence, it is again diminished, and in the chalk-pits near Fareham, is found not only to have lost all its northward dip, but also to have returned to the general southward declination of the Hampshire Downs, dipping five degrees in that direction, with a lateral bearing *westward.* In inclination, therefore, it traverses an arc of forty-five degrees, in the space of about four miles. To answer to this contortion, a course of fissures may be traced, and these are particularly well displayed in the chalk-pit, close to Fareham, where, as the outlier sinks under the plastic clay, they have not been exposed to obliteration by denuding causes. Through a gap begun by some of these fissures, or a larger disruption of the whole mass, the rivulet passes, which takes its course transversely to the chalk, into the Fareham inlet; for west of it, the general bearing of the ground, by Upland-House, and on towards Funtley, is indicative of a resumption of the northerly dip.

"A moment's consideration will show, that such an outlier as this is very differently circumstanced from the more common one, or that which is entirely detached from the main body; separated by the removal of the intervening parts, and therefore properly the *outlier of erosion.* This, although it is an outlier in reference to the surrounding parts upon the surface, is still connected with, or incumbent upon, or in juxtaposition with, the kindred stratum below; and may therefore be called an *outlier-by-protrusion.*

[*Concluded on* p. 50.]

SYNOPTICAL TABLE.

FORMATIONS.	SUBDIVISIONS.	NATURAL CHARACTERS.	LOCALITIES.
A. CHALK.	1 Upper Chalk. 2 Lower Chalk.	Soft, with flint nodules. Hard, without flint.	South Downs.
B. GLAUCONITE.	1 Malm.	Blue-chalk-marl above, graduating into indurated, argillaceous limestone, or malm-rock; with subordinate beds of *green-sand.* Containing Ammonites, Pectines, Inocerami, &c. Soil, moist and fertile.	Sutton, Bury, Amberley, Washington, Steyning—the high grounds immediately under the chalk-hills.
	2 Galt.	Upper part,—harsh and shaley brown clay, mottled blueish;—	Bottom of Sutton and Bury hollow-ways, Washington, Rowdell, Fulking, &c.
		Lower beds,—blue and black shale, and stiff clay; sometimes containing ferruginous concrete;—	Bignor Park, Bury Common, New Woods, Hardham.
		and marl, as at	Wiggonholt*,
		Ammonites,—other fossils said to have been found in wells.	
		Soil, good for pasture ground, and for the growth of oak and elm.	
	Ferruginous Sand.	Coarse red-sand, with layers of ironstone, compact and cellular.	Burton, Redhill near Bignor, Sandgate, Sullington, Pulborough, Fittleworth, Henfield.
		White, yellow, brown, and black sand with quartz grains, and occasionally green particles;—with	Graffham Common, Cold-Waltham, West-Chiltington Common, Sullington, Wiston-Parsonage, &c.
		Veins of ochreous clay, and subordinate beds of black shale and clay.	
		Terebratulæ and other fossils abundant at.........	Parham, Sparright Lodge, Pulborough, West Chiltington Common.
		Soil, for the most part arid and barren.	
	3 Shanklin Sands.	Sand, full of green particles, alternating with courses and large concretional masses of blue calcareous grit.	West-Chiltington, Thakeham, Henfield, Ashurst, Pulborough, Bognor (in Fittleworth parish), Tillington, &c.
	Lower Green-sand.	Green sand-rock or Pulborough stone.	
		The same, siliceous, and passing into chert.	Pulborough Quarries, Pitt's Hill, Bognor Quarries, &c.
		Containing Ammonites, Pectines, Myæ, Pholadomyæ, &c,	Bedham Hill, Brinkshole, Petworth.
		Soil, moist and fertile.	

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* Since the Memoir was sent to press, the writer has found marl in the galt at Wiggonholt.

FORMATIONS.	SUBDIVISIONS.	NATURAL CHARACTERS.	LOCALITIES.
C. WEALDEN.		Stiff clay, brown at the surface, blue and shaley below; containing concretional iron-stone with *bones of vertebrated animals*, casts of Paludinæ, Cyclades, bones of Fish, Cypris faba, &c.	Broadmere Common, Henfield, Wappingthorn Hill, Ashington, Greenhurst; — Range of country below the escarpment of the glauconite.
	1st Course of Wealden-Sand.	Yellow and fawn-coloured sand, with beds of red clay, and iron-rag-conglomerate of sandstone and chert. Endogenites, and other vegetable remains.	Mulsey, Spear Hill, Wincaves, Buckfold, Parkhurst, Northhurst, near Lurgershall.
	1st Course of Sussex-Marble.	Clay, with interrupted course of Sussex-marble*. Sometimes iron-sand, blue-marl, and selenite. Bones, Vivipara, Cypris faba, &c.	Pococks, Hungar Hill, Battlehurst, Marshalls, &c.
	2d Course of Wealden-Sand.	Micaceous fawn-coloured sand, with beds of red clay and concretional masses of calcareous grit, and flag-stones of the same; occasionally a friable sandstone, with quartz pebbles.	Andrew's Hill, Butterstalks, Knep Castle, Lowfold Sand-Coppice Eberknoll, &c.
	2d Course of Sussex-Marble.	Blue and brown clay, containing a course of Sussex-marble, more interrupted than the former—with Vivipara, Cyprides, unnamed bivalve (perhaps Unio?) &c.	Slaughter Farm, Kingsfold, Steers Common by Kirdford, Plaistow.
	3d Course of Wealden-Sand.	Micaceous fawn-coloured sand, alternating with beds of red clay, friable sandstone, and calcareous grit. *Bones of vertebrated animals*, &c. Soil, a clay-country of great uniformity of aspect, and of moderate fertility only, best for oak-timber.	Parbrook Hill, Billingshurst, Sprenks and Brick-kilns in Shipley, Wisborough Green, and Kirdford.

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* Sussex-marble is a well-known shell-limestone (chiefly of the genus Vivipara), supposed to be fluviatile.

"The

"The relations of the two specimens of Ports-Down and High-Down are exceedingly simple, and their history extremely well displayed. The opposing dip, contortion, and form of both eminences, are satisfactory proof of their protrusion from the parent stratum below;—whether effected by a separate and distinct propelling impulse, or simply *by arrest, by the interposition of some opposing substance, during the subsidence of the main body*, it is not now material to inquire. The mass thus detached and elevated, a part of which forms Ports-Down, must have been covered, as some portion of it still is, by the overlying strata, and is an outlier only where its highest parts have been exposed to the denuding forces.

"No line of country exists, indicative of any connexion between Ports-Down and High-Down, which are twenty-four miles asunder.

"It belongs to the general history of chalk-basins, and would pass the limits prescribed to this research, to endeavour to show which of the actions above referred to, have produced these outliers. Either way, they tend powerfully to illustrate the theoretical parts of the foregoing Essay, and to prove the disruption and displacement of the chalk,—the act of basining,—posterior to the deposit of the higher strata.

"The Isle of Thanet is probably an outlier of this description, and the writer is informed that Windsor stands upon chalk, which must therefore be also an outlier-by-protrusion, and perhaps so also the chalk islands in the Paris basin.

"It will be easily seen, that it is not necessary that such outliers should have a dip and an inclination opposite to the main body. In the elevation of the former, or the subsidence of the latter, they may both preserve the same parallelism, or nearly similar relations to the horizontal line. It is enough, if it be proved, that they are out of the direct line with each other below; and that the detached portions have been exposed to the flood of denudation upon the surface, and are outliers where they have been elevated within the range of the denuding force." [B.]

Elements of Chemistry. By ANDREW FYFE, M D. F.R.S.E. *&c.* 1827.

IN the Philosophical Magazine for November last we offered some observations on Dr. Fyfe's "Manual of Chemistry," without any anticipation that it would so soon fall to our lot to notice two octavo volumes on the same subject by the same author. We presume that the success which has attended Dr. Fyfe's first work, has stimulated him to fresh exertion; and we have with no slight attention examined nearly the whole of the work now under consideration, in the hope of being able to give a more favourable opinion of it, than that to which we conceived the Manual was entitled.

We shall not occupy either our own time or that of the reader with a minute examination of the arrangement adopted in the present work: it is materially altered from that of the Manual; and we do not perceive that the change is accompanied with the improvement, for which there was so ample room. The Elements commence with the subject of Heat, while in the Manual, and in our opinion with better judgement,

judgement, Attraction was first treated of. Dr. Fyfe prefers the term *caloric* to that of *heat*, observing that "by heat we are to understand the sensation produced by a warm body; by caloric, the active cause of this sensation." Having made this distinction between cause and effect, our author proceeds to state, that "different bodies have different quantities [of caloric], and on this depends their temperature.' This is an error of very considerable importance; and if one mistake could be compensated for by another, Dr. F. has done all that can be required of him, by asserting that "our sensations give us no indication whatever" of temperature; *ergo*, our sensations indicate no difference between a cold bath and a warm one.

When treating of Pyrometers, Dr. F. has given a description of Wedgwood's instrument, and on many occasions he refers to it as a standard for determining the fusing-point of bodies; and yet he admits the fact, ascertained we believe by Sir James Hall, that this pyrometer is liable to one great objection, viz. that "if the clay be exposed to a moderate heat for a long time, it will contract nearly as much as if heated intensely." Being aware of this circumstance, all notice of the instrument ought surely to have been omitted, for it is worse than useless to quote that as authority which we do not believe to be true.

Under the head of Cohesive Attraction, some attention is naturally bestowed by our author upon the subject of Crystallization. But the little which he has said respecting it is so inaccurate and incomplete, that it would have been better altogether omitted. No mention whatever is made of a goniometer of any sort; and in treating of Salts in the various parts of the work, their crystalline forms are very erroneously described. Thus with respect to carbonate of soda, it is stated that it crystallizes in octohedrons composed of two four-sided pyramids joined by their bases; and Alum is correctly described as possessing the octohedral form. We may therefore conclude that in Dr. Fyfe's opinion there is no difference between the crystals of these very different salts. The fact however is, that, although the *apparent* form of carbonate of soda is an octohedron, yet it has a rhombic base and it is elongated, whereas the octohedron of alum is a regular one. We have said the *apparent* form is that of an octohedron, but this is not the real form of the crystal; Mr. Brooke has shown that it is an oblique rhombic prism. Various other salts are very incorrectly described, but we have not room for further observations on this subject.

We are told by Dr. Fyfe, when treating of Acidifying and Alkalifying principles, that the merit of the discovery of oxygen is due to Priestley, Lavoisier, and Scheele, the priority of it, only, being assigned to Priestley. It is however quite clear from Dr. Priestley's statement, (Doctrine of Phlogiston Established, p. 88. 1800.) that Lavoisier knew nothing whatever of the existence of oxygen, until Dr. Priestley mentioned it to him during a visit to Paris. On this subject there is also another error, which we should not have expected in the work of a medico-chemical writer. Dr. Fyfe says that Dr. Priestley procured oxygen gas from red precipitate, whereas he particularly mentions that he obtained it by employing *mercurius calcinatus per se:* this circumstance

cumstance he on one occasion especially notices, observing that no nitric acid had been used in preparing it, and consequently that the oxygen could not be derived from the decomposition of nitric acid, a portion of which is well known sometimes to remain in red precipitate.

No directions are given for preparing oxygen gas in the section which treats of its properties. We are merely told that recourse is to be had to the decomposition of its compounds when we wish to prepare it; and in defiance of all propriety, and neglect of all convenience, we are directed to *see* Manganese, Red Oxide of Lead, Red Oxide of Mercury, and Chlorate of Potassa,—all of which are treated of in the second volume, while the properties of oxygen are described in the first.

With respect to Hydrogen Gas no advice is given to the young experimenter to allow it to escape for a short time previously to inflaming it, or to cover the vessel from which the gas is evolving, in order to prevent the ill effects which might arise from an explosion; and as to the means by which hydrogen gas is obtained, the omissions are, if possible, more glaring than those noticed as to the preparation of oxygen gas. Not only are there no directions given for this purpose, but we are not even told that they are to be found in a subsequent part of the work. In one experiment with this gas mention is indeed made of "a mixture which will furnish hydrogen;" but as to its composition, no more is said than if it were a profound secret and so intended to remain. It is indeed true that some hints are given as to the preparation of hydrogen gas when Water is treated of, but they are by no means so ample as they ought to have been.

In the observations prefixed to the section on Acids, Dr. F. remarks, "though Davy considered chlorine and iodine as acidifying principles, yet others maintained that hydrogen is the principle of acidity in those [acids] not containing oxygen. From the arrangement I have adopted, it will be perceived, that if we are really to attach a principle of acidity to certain bodies, it should be given to hydrogen, because we find that sulphur, chlorine and iodine, unite with oxygen, and form one set of acids, and with hydrogen to generate another." Now without pretending to feel the force of this reasoning, which we do not understand, there are sufficient facts stated in the quotation to induce us to conclude that no acidifying principle whatever exists, especially since oxygen and hydrogen both enter into the composition of several alkalies. Indeed, to admit of the existence either of an acidifying or an alkalifying principle, is in our estimation no more required than to allow of a principle of form or of colour.

We have neither time nor inclination to present the reader with all the observations which have occurred to us while perusing the section on the Metals. There are, however, some statements respecting a few of them which call for remark, and more especially as to iron and its compounds. Rust of iron is stated by Dr. Fyfe to be a carbonate: but this is not the case; for no solid compound of carbonic acid and peroxide of iron can be formed, and yet similar assertions occur twice in subsequent parts of this section. "The only compounds of any interest

interest of iron and the simple acidifiable bodies are those with carbon, sulphur and cyanogen :" this last, however, we need hardly state, is a compound of two simple acidifiable bodies. The protosulphuret of iron is rather a scarce substance ; and yet Dr. F. states that it is employed in the preparation of the sulphate of iron by exposure to air and moisture :—now it is the persulphuret, which is a very plentiful mineral, that is used for this purpose.

Respecting the *liquor ferri alkalini* of the London Pharmacopœia Dr. Fyfe has committed several mistakes. In the first place "It is" *not* "much used ;" secondly, the solution of carbonate of potash must *not* be added to the solution of pernitrate of iron, but the latter to the former. The following remarks show indeed that Dr. F. is equally ignorant of the nature of the process, and of the product obtained by it. "In the first part of the process, a pernitrate of iron, but with a large excess of acid, is formed ; and in the second, this excess is merely saturated by the alcaline solution, a part of the iron being precipitated in the state of a carbonate, but which is instantly dissolved by the nitric acid ; so that the product is a mixture of nitrates of iron and of potass." Now as the acid solution is added to the alkaline one, instead of the reverse as here stated, the precipitate formed is *not* dissolved by the nitric acid, but by the carbonate of potash ; so that the product is *not* a mixture of nitrates of iron and potash, but a solution of carbonate of potash holding peroxide of iron in combination, and mixed with nitrate of potash. That the solution contains no nitrate of iron might almost have been learned from the name, absurd as it is, which the London College have given to this preparation. It is sufficiently ridiculous to speak of alkaline iron ; but it would have been worse than this to have bestowed a name denoting alkalinity, where none was in existence.

The *sulphas ferri exsiccatus* of the Edinburgh Pharmacopœia is *not* deprived of the whole of the water of crystallization ; it retains one atom of water. According to Dr. Fyfe, colcothar is used "for making razor-strops :" we supposed they had been made of wood and leather, and merely covered with colcothar. When the carbonated alkalies are employed to decompose sulphate of iron, the protocarbonate is *not* converted into percarbonate by absorbing oxygen, no such compound exists ;—it becomes a mixture of protocarbonate and peroxide of iron. "Permuriate [of iron] with the maximum oxid" *cannot* "be prepared by dissolving that oxide or the carbonate in the acid :" it must be "that oxide," for the carbonate contains protoxide : by the bye, as *permuriate with the maximum oxide* is so particularly mentioned, may we inquire whether there is any permuriate *without* it ? In the London Pharmacopœia it is *not* the red oxide of iron which is used for preparing the *tinctura ferri muriatis*, but the *ferri subcarbonas*, which is a mixture of protocarbonate and peroxide : the Edinburgh process for the same preparation does *not* at first yield a protomuriate, for the scales of iron employed are a mixture, perhaps a compound, of protoxide and peroxide of iron.—There are several other statements respecting the compounds of iron which we are precluded from noticing merely for want of room, for we have still a few observations to make with regard to some other metallic compounds.

Copper, according to Dr. Fyfe, is not an abundant production, and yet the county of Cornwall alone produces nearly ten thousand tons annually. Sulphate of copper according to our author is "always" procured by exposing the natural ore containing sulphur and copper to the air. We venture to assert that this salt is never now so prepared, nor do we believe that it ever was. Is Dr. Fyfe aware of the fact, that with few exceptions, the ore of copper is a double sulphuret of that metal and iron? And if a salt were formed from it by the action of air and moisture, it would undoubtedly be the double sulphate of copper and iron, which is a well known compound.

Dr. Fyfe has, we think, entirely mistaken the nature of the *pulvis antimonialis*. He says that "the oxide of antimony and phosphate of lime enter into union and form a triple phosphate of antimony and lime." Now it appears to us that there is not the slightest evidence of combination existing between the oxide and the phosphate; indeed of all substances in nature, phosphate of lime, from its extreme inertness, is one of the least likely to combine with a metallic oxide. Nor can we assent to the assertion that *pulvis antimonialis* is one of the best of the antimonial preparations: on the contrary, there is the strongest evidence to prove that it is generally inert; and when it possesses power, it is impossible to determine the degree of its activity by any ordinary means.

Dr. Fyfe is not more careful in representing the opinions of others than in detailing his own; thus he says, "according to Phillips (Ann. of Phil. N. S. iv.), when properly manufactured it (*pulvis antimonialis*) should be composed of phosphate of lime and protoxide; whereas it frequently contains the peroxide, and therefore differing from James's Powder, which from the analysis of Pearson and Phillips is composed of

Phosphate of lime........	43
Protoxide of antimony....	57.

He has found, also, that instead of the oxide and the phosphate being in combination, they are frequently merely mixed, and must therefore be totally inert as a medicine."

Now as we readily acquit Dr. Fyfe of all intentional misrepresentation, we have no alternative but to suppose that he never read the paper to which he above alludes, and from which he appears to quote. On referring to Dr. Pearson's analysis, it will be observed that not a word is stated with respect to the state of the oxidizement of the antimony; and for a very sufficient reason—nothing at that time, (more than thirty years since,) was known on the subject; and Phillips is so far from attributing the inertness of *pulvis antimonialis* to the ingredients being merely mixed and not combined, that he considers them always mixed and never combined; and he distinctly mentions that he found the antimony in James's Powder to be peroxide, not protoxide as asserted by Dr. Fyfe.

It is quite needless to add more instances of Dr. Fyfe's want of precision

precision with regard to his statements. We may observe that the wood-cuts which he has introduced "are few and far between;" but their quality is such, that whether intended for use or ornament, we cannot lament their scarcity.

Unless Dr. Fyfe writes for medical pupils only, he should be careful to avoid such terms as *aqua potassæ* and *aqua ammoniæ,* which common readers might find it difficult to comprehend.—We cannot omit to notice the extreme facility with which Dr. Fyfe alters the names of the various authors whom he quotes:—thus we have Herschell for Herschel, Allan for Allen, Sommerville for Somerville, Philip for Phillips, Mayou for Mayow, Creighton for Crichton, Chevreuil for Chevreul, Liebeg and Leibeg for Liebig, Daniells for Daniell, Arrago for Arago, Dobereigner and Doboreigner for Döbereiner, and many other similar mistakes. We observe also that Cryophorus is three times written Creophyrus.

We mark these merely as indications of that want of care and correctness which pervades every part of the work; and all we can say in its favour, if indeed that be any thing, is to admit that it is not unworthy of the author of the Manual.

X. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

May 8.—A COMMUNICATION was read to the Society, containing some "Particulars of the Earthquake felt in the Netherlands, and in some of the Frontier Towns of France, on the 23d of February last." Extracted from a letter to Captain Sabine, from Professor Quetelet, Director of the Royal Observatory at Brussels.

The number of earthquakes which are on record as having been experienced in the Netherlands, for many centuries past, does not exceed six or eight; and none of them have been productive of disastrous effects. Within a space of ten years, during the last century, three only took place, one of which happened in 1755, immediately after the great earthquake at Lisbon; and the last was in 1760. The one which has lately occurred was particularly felt along the banks of the Meuse; and its greatest violence was felt in the towns of Liège, Tongres, Tirelemont, and Huy: many of the walls and buildings of which suffered considerable injury; but, happily, no lives were lost. In the adjacent towns of Maestricht, Namur, Louvain, and Brussels, strong shocks were also experienced; but their violence diminished in proportion to the distance from the former, or principal, seat of concussion. They appear also to have been sensibly felt at Bonn, Dusseldorf, and Dordrecht, on one side, and at Flushing, Middleburg, and Dunkirk, on the other; although they were not perceptible at many of the intermediate towns. Slight shocks were also experienced at several of the frontier towns of France, as Avesnes, Commercy, and Longuyon; as also at the coal-mines near Liège, at the depth of from fifty to sixty toises; in which latter case they were accompanied by a hollow sound, resembling that of a heavily laden waggon. The direction in which the shocks were propagated appears to have been from east to west.

For some time before the earthquake the weather had been fine; but it became cloudy on the evening which preceded it, and continued so for several subsequent days. At Brussels the barometer had fallen during the three preceding days from 29·421 inches to 29·044; on the night before the earthquake it had risen to 29·126; and a few moments after the event, it stood at 29·233. It continued afterwards to rise; and on the 27th it had reached 30·166. At Liège, however, the barometer remained very low after the earthquake.

The shocks lasted about eight or ten seconds.

There have been experienced, since the 23d of February, slighter shocks; and these also were preceded by a great depression of the barometer.

"Another communication was also read, giving "an Account of some Particulars concerning an Earthquake experienced at Bogota, and in the Cordillera between Bogota and Popayan, on the 16th of November 1827, and the following days." Contained in a letter from Colonel Patrick Campbell, Secretary of Legation, to James Bandinel, Esq. of the Foreign Office. Communicated by Captain Sabine.

The earthquake is described by the narrator as occurring suddenly, at half-past six o'clock in the evening, whilst he was at dinner. It was announced by a loud rumbling noise; the whole house shook with violence; the decanters and glasses on the table being thrown down. The family ran for shelter under the door-way of the principal floor, which they had no sooner reached than they witnessed the fall of the towers of the cathedral opposite to them, with a dreadful crash. The whole tremor lasted about a minute. The first shock consisted of a long, undulating motion; the next was quick and violent; and the party found it difficult to preserve their balance, and were affected as if from sea-sickness. The damage sustained by the town of Bogota is immense, and has been estimated at about two millions of dollars, independently of the destruction of the cathedral, which had been completed about nine years ago, and the building of which cost 800,000 dollars. The government palace, and almost all the public offices and barracks, have either been rendered useless, or severely shattered. Of the churches, only those of the Capuchins, Carmelites, and the chapel of the convent "de la Ensenanza," can be said to have escaped without injury. Few of the houses above one story high are habitable, and even many of the low houses have been thrown down. The whole of the upper part of the Barrio del Rosorio, consisting of buildings of this latter description, now presents nothing but a heap of ruins. Many habitations which had withstood the first shocks, have given way under those which followed, although incomparably less violent. The injury to dwellings has been remarkably unequal in different parts of the town—some streets having only partially suffered, while others are totally destroyed. Amidst this widely spreading destruction, it is fortunate that the loss of of lives has been very inconsiderable, being, in the city of Bogota, limited to only five or six persons.

It appears that the earthquake was not felt much to the north of Bogota; but to the south the devastation has been most extensive. Throughout the whole of the plain of Bogota, as far as the towns of Purificacion and Neiva, there remains no church or public edifice of importance that has not been either overthrown or materially damaged. In the towns of Purificacion and Ibogué, the shock was so powerful as to throw down many houses constructed of cane, with thatched roofs. In Neiva, not only were all the public buildings destroyed by the earthquake, but torrents of rain conspired to increase the havoc. Even straw-huts were levelled with the ground; and the roofs of some of them taking fire, added to the horror of the scene, and to the extent of the calamity. Great part of the plain of Neiva was inundated: this was productive of considerable loss of lives, particularly on the banks of the Magdalena, the current of which was at first considerably lessened; but a great flood succeeded, and swept down vast quantities of mud and other substances, emitting a strongly sulphureous vapour, and attended with a general destruction of the fish.

These and other facts render it probable that some volcanic eruption took place in Tolima, an old volcano of Tocaima, from the mouth of which it is reported, that, of late, dense columns of smoke have been seen to arise, and more remarkably so on the day of the earthquake; as also from the ridge of mountains of Santa Anna in Maraquita, and the Paramo of Ruiz, which is a part of the same Cordillera, and contiguous to that of Tolima.

Popayan, which is 200 geographical miles S.S.W. of Bogota, has also suffered much from the same earthquake; many houses having fallen in consequence of the violent shocks that continued to succeed each other every six hours down to the evening of the 18th, which is the date of the latest intelligence from that place. The torrents of rain with which they were accompanied, have proved a great aggravation to the misery they have created. At Patea, still further to the S.S.W. the devastation has been still greater; some of the largest trees having been thrown down by the concussions. It is hence inferred, that eruptions have taken place at the same period in the volcano of Pasto; and the wide crevices which have appeared in the road of Guanacas, leave no doubt that the whole of the Cordillera has sustained a powerful shock.

In the plains of Bogota considerable crevices have also opened, and the river Tunza has already begun to flow through those which have appeared near Costa. In other parts of the Cordillera, although the earth has continued in motion for a quarter of an hour without intermission, the movement has been nearly insensible, and observable only by means of the compass or the pendulum.

May 15.—A paper was read, entitled "A Comparison of the Changes of Magnetic Intensity in the Dipping and Horizontal Needles throughout the day, at Truernberg Bay, in Spitzbergen."—By Captain Henry Foster, R.N. F.R.S.

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The observations made by the author at Port Bowen, in 1825, on the diurnal changes of magnetic intensity taking place in the dipping and horizontal needles, appeared to indicate a rotatory motion of the polarizing axis of the earth, depending on the relative position of the sun, as the cause of these changes. By Captain Foster's remaining at Spitzbergen during the late northern voyage of discovery, a favourable opportunity was afforded him of prosecuting this inquiry. Instead of making the observations with a single needle, variously suspended, as had been done at Port Bowen, two were employed; the one adjusted as a dipping needle, and the other suspended horizontally. The relation between the simultaneous intensities of the two needles could thus be ascertained, and inferences deduced relative to the question, whether a diurnal variation in the dip existed as one of the causes of the observed phænomena; or whether, the dip remaining constant, they were occasioned by a change in the intensity.

The dipping needle used, was one belonging to the Board of Longitude, and made by Dollond:—both this and the horizontal needle were made in the form of parallelopipedons, each 6 inches long, 0·4 broad, and 0·05 thick. The experiments were continued from the 30th of July to the 9th of August, and were so arranged, that in the course of two days an observation was made every hour in the four-and-twenty; that is, part of them in one day, and another part in the other day.

The observations on the horizontal needle were made in the following manner. After being freely suspended by a silk thread divested of torsion, the needle was turned somewhat more than 40° out of the magnetic meridian, and the oscillations counted only when the arc of vibration had decreased to 40°. The times of performing ten oscillations were then noted successively, until two hundred were completed: the terminal arc, and the temperature of the instrument, were also registered. The oscillations of the dipping needle were taken as follows:—one hundred with the face of the instrument east, previous to those of the horizontal needle being observed; and another hundred after the latter, with the face west,—a process which gives the mean time of observation nearly the same for both needles. Two tables are given: the first containing a register of the observations; and the second, the mean proportional intensities at every hour, in each needle, deduced from the respective times of the performance of one hundred oscillations. From a comparison of the changes occurring in the two needles, it appears, that at the time when an increase took place in the intensity of the dipping needle, that of the horizontal needle underwent a corresponding diminution, and *vice versâ*. On comparing these results with the hypothesis of a rotation of the general polarizing axis of the earth about its mean position as a centre, and employing for this investigation the formulæ given by Mr. Barlow in his Essay on Magnetic Attractions, it is found, that the radius of this circle of rotation is very nearly eight minutes. The magnitude of this radius, however, will be considerably influenced by the sun's declination.

The change of intensity of the dipping needle, in as far as it is owing to a variation of the dip, would only be in the proportion of 3726 to 3732; whereas, its actual amount is found to be one eighty-third part of the whole. This, therefore, seems to imply changes in the general magnetic intensity of the earth; but the author, limiting his present inquiry to the variations in the dip, concludes that the times of the day when these changes are the greatest and the least, are such as indicate a constant inflection of the magnetic pole towards the sun during the diurnal rotation, and to point to the sun as the primary agent in the production of these changes.

May 15.—A paper was also read, entitled, "Experiments relative to the Effect of Temperature on the Refractive Index and Dispersive Power of Expansible Fluids, and on the Influence of these Changes in a Telescope with a Fluid Lens." By Peter Barlow, F.R.S.

In a paper lately read to the Society, the author stated that he had not detected any change in the focal length of the telescope by changes of temperature; but he has since ascertained that, in order to obtain the brightest and most perfect image, the distance of the object-glass requires a minute adjustment, amounting to 0·134 of an inch, corresponding to an elevation of temperature from 57° to 84°, or a depression from 57° to 31°.

In order to introduce greater clearness and precision, the author proceeds to define certain terms which he finds it necessary to employ. By the *length of the telescope,* he would be understood to mean the distance between the object-glass and the focus; by the *fluid focus,* that between the fluid lens and the focus; and by the *focal power* of the telescope, he means the focal length of a telescope of the usual construction, which gives the same convergency to the rays, or produces an image of the same size.

As it is difficult to determine the refractive index of the fluid under different circumstances, from which their effect on the focal power of the telescope might be computed, Mr. Barlow endeavoured to ascertain by direct observations the effect of changes of temperature on the power of the telescope, and thence computes the corresponding change in the refractive index of the fluid. The result is the amount of adjustment already stated. The correction for angular measurements was the 60th part of a second in every minute for every degree of thermometric change; a quantity which, he observes, is too small to deserve notice, except in cases of extreme delicacy. The dispersions at 31° and at 84° are in the ratio of 3067 to 3084. The change in the refractive index between 32° and 212°, supposing it to increase uniformly, would be about one tenth of the whole, a proportion which is very nearly the same as the actual expansion of the fluid. Hence the author considers it as probable that in this, and all other expansible fluids, the index of refraction varies directly as the density: on the other hand, it would appear that the dispersive ratio remains at all temperatures constantly the same.

May 22d.—A letter was read from Thomas Andrew Knight, Esq., addressed to the President, containing "An Account of some Circumstances relating to the Economy of Bees."

In a former paper the author stated his having observed that, several days previous to the settling of a swarm of bees in the cavity of a hollow tree adapted to their reception, a considerable number of those insects were incessantly employed in examining the state of the tree, and particularly of every dead knot above the cavity which appeared likely to admit water. He has since had an opportunity of noticing, that the bees who performed this task of inspection, instead of being the same individuals, as he had formerly imagined, were, in fact, a continual succession of different bees: the whole number in the course of three days being such as to warrant the inference, that not a single labouring bee ever emigrates in a swarm without having seen its proposed future habitation. He finds that the same remark applies not only to the permanent place of settlement, but also to the place where the bees rest temporarily, soon after swarming, in order to collect their numbers.

The swarms which were the subjects of Mr. Knight's experiments showed a remarkable disposition to unite under the same queen. On one occasion, a swarm which had arisen from one of his hives settled upon a bush, at a distance of about twenty-five yards; but instead of collecting together into a compact mass, as they usually do, they remained thinly dispersed for nearly half an hour, after which, as if tired of waiting, they singly, and one after the other, and not in obedience to any signal, arose and returned home. The next morning a swarm issued from a neighbouring hive, and proceeded to the same bush upon which the other bees had settled on the preceding day, collecting themselves into a mass, as they usually do when their queen is present. In a few minutes afterwards a very large assemblage of bees rushed from the hive from which the former swarm had issued, and proceeded directly to the one which had just settled, and instantly united with them.—The author is led from these and other facts to conclude, that such unions of swarms are generally, if not always, the result of previous concert and arrangement.

He next proceeds to mention some circumstances which induce him to believe that sex is not given to the eggs of birds, or to the spawn of fishes or insects, at any very early period of their growth. Female ducks, kept apart from any male bird till the period of laying eggs approached, when a musk drake was put into company with them, produced a numerous offspring, six out of seven of which proved to be males.

The mule-fishes found in many rivers where the common trout abounds, and where a solitary salmon is present, are uniformly of the male sex: hence the spawn must have been without sex at the time it was deposited by the female.

Mr. Knight states that he has also met with analogous circumstances in the vegetable world, respecting the sexes of the blossoms of monoecious plants. When the heat is excessive, compared with the quantity of light which the plant receives, only male flowers appear: but if the light be in excess, female flowers alone are produced.

At this meeting His Royal Highness the Duke of Sussex was elected a Fellow of the Royal Society.

June

June 5th.—A paper was read, entitled "Description of a Sounding-Board in Attercliffe Church, near Sheffield."—By the Rev. John Blackburn, minister of Attercliffe.

The church of Attercliffe had long been remarkable for the difficulty and the indistinctness with which the voice from the pulpit was heard: these defects have been completely remedied by the erection of a concave sounding-board, having the form resulting from half a revolution of one branch of a parabola on its axis. It is made of pine-wood; its axis is inclined forwards to the plane of the floor at an angle of about 10 or 15°; it is elevated, so that the speaker's mouth may be in the focus; and a small curvilinear portion is removed on each side from beneath, so that the view of the preacher from the side galleries may not be intercepted. A curtain is suspended from the lower edge, for about eighteen inches on each side. The effect of this sounding-board has been to increase the volume of the sound to nearly five times what it was before; so that the voice is now audible, with perfect distinctness, even in the remotest part of the church; and more especially in those places, however distant they may be, which are situated in the prolongation of the axis of the paraboloid. But the side galleries are also benefited, probably from the increase of the secondary vibrations excited in a lateral direction. Several experiments are related illustrative of these effects; among which the most striking was one in which a person placed so as to have one ear in the focus of the paraboloid, and the other towards a person speaking from the remote end of the church, heard the voice in a direction the reverse of that from which it really proceeded. The superior distinctness of sounds proceeding from the focus, is accounted for by their all arriving at the same moment of time, at a plane perpendicular to the axis, after reflection from the surface of the paraboloid; which is a consequence of the equality of the paths which they have described.

LINNÆAN SOCIETY.

June 17.—A paper was read, entitled, "Description of a species of *Tringa* killed in Cambridgeshire, new to England and Europe," by Wm. Yarrell, Esq. F.L.S.

The author describes a singularly marked *Tringa*, which was shot in Cambridgeshire in the month of September 1826.

This bird is rendered more than usually interesting from the circumstance that it is not only new to this country, but is acknowledged by the best practical ornithologists of the day, to be also entirely new to Europe. It is described by Monsieur Vieillot, under the name of *Tringa rufescens*, as having been found in Louisiana; and a single specimen deposited in the Paris Museum has furnished the only records known.

A description of the plumage, and the measurement of various parts, are given in detail; and the paper concludes with a list of the more recent additions to British ornithology, accompanied by references to the various authorities from whom the first notices of these addenda have emanated.

ASTRONOMICAL SOCIETY.

May 9.—A paper was read, entitled " Approximate Places of Double Stars in the Southern Hemisphere, for 1827, as observed at Paramatta, N. S. Wales. By Mr. James Dunlop."

After the departure of Sir T. M. Brisbane from the Colony of New South Wales, the author, finding himself in the possession of reflecting telescopes capable of adding considerably to our knowledge of the nebulæ and double stars of that portion, resolved to remain, for the purpose of making a general survey, of the heavens, from the south pole to 30° of south declination. The dark nights in the absence of the moon were devoted to observations of the nebulæ, and the moonlight to those of double stars, of which however only a part could be subjected to exact micrometrical measurement. The apparatus employed for this purpose consisted of a 46-inch achromatic telescope, equatorially mounted, and furnished with two micrometers;—one a parallel-line micrometer, the author's own workmanship; the other, a double-image micrometer, on Amici's principle. Those which could not be micrometrically measured, had their positions and distances noted by estimation while passing the field of the 9-feet reflector, with which they were discovered in the sweeps for nebulæ, and their places are given as determined in the sweeps.

The author prefaces his catalogue with the details of the micrometrical measures of about 30 principal Southern double stars, the most remarkable of which are *α Crucis* and *α Centauri*, the former bearing a great resemblance, both in the magnitudes and the mutual distance of its individuals, to *Castor;* the latter being a star of the first magnitude, accompanied by one of the fourth, at about 20″ distance,—a remarkable combination, such as does not occur in our hemisphere.

A Catalogue of 254 double stars arranged in order of right ascension follows, in which the right ascension to seconds of time, and declination to the nearer minute of space,—the position, quadrant, distance, the differences of right ascension and declination when observed, and the magnitudes, are set down in separate columns. They comprise double stars of all classes and of every variety. One very remarkable is the star 1 k *Argus*, Æ 8^h 4^m, declin. $-42°$ 7′, which consists of individuals of the sixth and eighth magnitudes, the large star being blue, and the small one dusky red. This affords almost the only instance known of a combination of two considerably bright stars differing decidedly in magnitudes, where a marked excess of the less refrangible rays enters into the composition of the light of the smaller star, and of the more refrangible into that of the larger. Among the double stars is set down also one of the seventh magnitude, right ascension 1^h 19^m 43^s, declin. $-33°$ 31′, of that singular deep red purple colour of which examples are not wanting in our own hemisphere.

An extract of a letter was read from Professor Harding, of Göttingen, to Dr. Tiarks, in which he alludes to a phænomenon which had recently been observed by several astronomers on the continent, relative to an inequality of the dark space between the body of of Saturn and its ring. This appearance was first noticed by M. Schwabe on December 21, 1827, and has since been confirmed by several persons to whom M. Harding had communicated the circumstance. It seems that the space on the eastern side of the planet appears larger than the space on the western side. M. Harding was at first inclined to treat the whole as an optical deception, till the fact was confirmed by others, when he was induced to attempt an explanation of the phænomenon. He endeavoured to account for it by the present position of Saturn; but the result of his calculation proved that that cause would not increase the space (in March) more than $\frac{1}{88}$; a quantity probably too small to become perceptible to the eye. He indeed imagined that the appearance might be caused by the shadow of the body, which at present falls much beyond the south-eastern part of the ring, and which might render it impossible to perceive the equality of the two spaces. But this, he says, is disproved by the observation of M. Schwabe, who saw the same phænomenon on the 31st of December, three weeks before the opposition, when the shadow was on the western side, and could be but faintly discerned. M. Harding is unable to explain it as an optical deception, and yet cannot consider it in any other light at present. Actual measurement, he says, can alone decide the question. He has already written to M. Struve to take some measures with his powerful telescope, and he requests that this communication may, with the same view, be forwarded to Messrs. Herschel and South, who have the best means, in this country, of determining this singular phænomenon.

Mr. South then read a note, which he had annexed to the above communication, stating that in compliance with M. Harding's wishes, Mr. Herschel and himself had directed their attention to Saturn, but that they did not detect any inequality in the two spaces above alluded to, by means of micrometers attached to his 5-feet equatorial. The mean of 35 measures, taken on April 26, April 29, and May 8, gave the preceding (or western) space 3″·532; and the following (or eastern) space 3″·607. At the same time he remarks that the mean of 20 measures taken on April 26 (viz. 10 by Mr. Herschel and 10 by himself) gave the spaces precisely the same; each being 3″·472. Mr. Herschel's measures gave the preceding (or western) space 3″·612; and the following (or eastern) space 3″·442; whilst his own gave the former 3″·331, and the latter 3″·502. Mr. South adds, however, that Mr. Herschel, after a careful examination, thought that, beyond all doubt, the following (or eastern) space appeared the larger: and it is a remarkable fact, that of seven persons who were present in Mr. South's observatory shortly afterwards, and who successively viewed Saturn through his 5-feet equatorial, six of them gave it as their opinion that the apparent right (or eastern) space was the larger: whilst the other observer declared he could not distinguish any difference. The situation, however, of Saturn was so low, as to render most of these observations far from satisfactory.

M. Harding also alludes in his letter to the reappearance of the variable

variable star in the constellation *Serpens*, mentioned in No. 5. of the Society's monthly notices. (See Phil. Mag. N. S. vol. ii p. 226.) He says, it is now again become visible, and has already attained the 8th or 9th magnitude. Its position for the beginning of this year is

$$\text{Æ} = 15^{h}\,46^{m}\,45^{s} \quad \text{Decl.} = +\,15^{\circ}\,39'\,30''$$

and he invites astronomers to watch this star during the period of its changes.

A communication was then read from Mr. Rumker of the observatory at Paramatta in New South Wales, giving an account of his observations for determining the absolute length of the pendulum vibrating seconds there, according to Borda's method. The apparatus, with which these experiments were made, was constructed by Fortin, of Paris, and taken out to the colony by Sir Thomas Brisbane. There are some slight alterations from the apparatus described by M. Biot, which are pointed out by Mr. Rumker: and he also alludes to a new method of observing the coincidences. In Borda's method, the coincidence is determined by the intersection of the wire of the pendulum of experiment with a cross marked on the bob of the pendulum of the clock. In lieu of this cross, Mr. Rumker placed a small graduated arc, and the determination of the coincidence resolves itself into observing the moment when the wire describes its minimum amplitude on the arc. Mr. Rumker likewise adopts a new mode of determining the correction for the arc of vibration. He finds that in large arcs (such as 8 or 9 degrees, to which his arcs sometimes extend) the decrease is not in a geometrical progression, when the times are in arithmetical progression. He has therefore formed a table of the actual decrease of the arcs as observed by himself, at equal intervals of five minutes each; and given the corresponding corrections for each interval. In the course of his reductions he notices some errors in the formula given by M. Biot for finding the centre of oscillation of a pendulum constructed according to the method of Borda. The mean of 41 series of experiments gives the length of the pendulum, vibrating seconds at Paramatta, *in vacuo*, at the freezing point, and at the level of the sea, equal to 992·412801 millimetres, or 39·071618 English inches.

PROCEEDINGS AT THE FRIDAY-EVENING MEETINGS OF THE ROYAL INSTITUTION OF GREAT BRITAIN.

May 23.—Mr. Brockedon on a new method of projecting shot.—This method belongs to Mr. Sievier. It consists in making the shot with a cylindrical chamber, so as to pass freely on to a maundril or bar fixed on trunnions, a powder-chamber being formed at the bottom of the cylindrical cavity in the shot. The powder is inflamed by means of a touch-hole in the shot, in the usual way. A charge of powder thus used is found to produce effects very much surpassing that occasioned when a shot of equal weight is thrown from a cannon; and this is accounted for by supposing that the force of recoil, which in a cannon is so great as to throw it a considerable distance backwards,

backwards, is added in the new form of shot to the usual quantity of projectile force. The experiments made with shot weighing up to twenty-five pounds, were successful both as to force and direction; and the extraordinary advantage gained as to lightness in the apparatus necessary to throw the shot, was proved by one man taking all that was necessary to Primrose-hill, the place of experiment.

Some fine fulgurites or lightning sand-tubes were placed on the library tables.

May 30.—Mr. Curtis gave a lecture on the structure and physiology of the Ear in man and animals, illustrated by drawings and anatomical preparations.

June 6.—Mr. Burnet gave an illustrated account of the experiments recently made by himself and Mr. Mayo, on the irritability of the sensitive plant, and extended his observations to the irritability and supposed nervous structure of plants in general. Their experiments accord with those of Dutrochet, as far as the two series run parallel. When a sensitive plant has been made to droop, Mr. Burnet finds that if the part in which the moving power resides is blackened so as to absorb the light of the sun, the restoration of the plant to its natural state is very much longer before it takes place. He also found that at the moment the expansion at the foot of the leaflets or other parts were touched to produce the motion of the plant, it changed colour.

June 13.—A full account of the recent and present state of the Thames Tunnel was given by Mr. Faraday, illustrated by Mr. Brunel's drawings and models. The peculiar nature of the ground in which the tunnel lies, the occurrence of springs in the soil, the extraordinary manner in which they affect it during the rise and fall of the tide, were stated and explained; and then the present state of the tunnel, now perfectly free from water, and the intentions of the engineer with regard to its future progress, were described.

These evening meetings then closed for the season.

XI. *Intelligence and Miscellaneous Articles.*

DIRECT METHOD OF ASCERTAINING THE VELOCITY OF CANNON-BALLS.

LIEUT.-GEN. HELVIG, in the Prussian service, has invented a direct and certain method of measuring the time which a cannon ball or bullet takes to pass through a certain space. His process consists in disengaging by means of the ball or bullet the detent of a third's watch (*une détente de montre à tierce*) at the moment when the ball or bullet quits the mouth of the piece, and to stop the same watch by means of the ball or bullet at the instant when it reaches the mark. The numerous experiments which he has made, present already the most interesting results. He has communicated this notice in order to establish his right to the invention, but intends shortly to publish a full detail of his experiments upon the subject.—*Bulletin des Sciences Militaires*, p. 119.

CHRYSOLITE IN THE CAVITIES OF OBSIDIAN.

Professor Gustavus Rose of Berlin has found in the cavities of obsidian, in the Jacal Rock near Real-del-Monte in Mexico, little crystals, greenish, and reddish-yellow, and transparent, which belong to the species of prismatic chrysolite.—Poggendorff's *Annalen*, vol. x. p. 323.

METEOR OF A GREEN COLOUR.

[Communicated by Mr. B. D. Silliman, in a letter dated New York, March 1, 1828.]

On the night of the 11th of February, between 11 and 12 o'clock, as I was crossing the East River, between this city and Long Island, I observed a beautiful meteor which was visible for about the space of two seconds. Its course was from a point perhaps 5° below the zenith, toward the horizon in a N.E. direction. It described an arc of perhaps 20°, when it apparently exploded, but without any report that I could hear. Its colour was a singularly pure grass green, of a light shade; the trail which it left was of the same colour, and so were the scintillations which accompanied its apparent explosion. The latter were distinct, like those accompanying the bursting of a rocket, but by no means so numerous.—Two gentlemen who were in the boat with me at the time, also saw it.—*Silliman's Journal.*

BITTER OF ALOES.—CARBAZOTIC ACID.

It is well known that the peculiar substance produced by the action of nitric acid upon aloes, combines with bases, and forms salts which detonate by heat; this substance is the aloetic acid of M. Braconnot. Mr. Liebig formerly made some experiments on this substance, (*Ann. de Chim.* Mai 1827,) but they were not satisfactory. He has lately renewed his experiments, and finds that the detonating principle is carbazotic acid.

The bitter of aloes is plentifully obtained by the action of nitric acid of sp. gr. 1·25. With potash it forms a purple salt, which is but slightly soluble, which precipitates the salts of barytes, lead, and peroxide of iron in flocks of a deep purple colour; the protonitrate of mercury is precipitated of a light red. In order to decompose the salt of potash, it was decomposed by acetate of lead; and, contrary to all expectation, the weight of the precipitate was less than that of the potash-salt employed. The washings were of a yellow colour, and deposited crystals of the same. These crystals, treated with heat and sulphate of potash, yielded carbazotate of potash, from which the carbazotic acid was separated.

When aloes are heated with nitric acid of 1·432 as long as vapours of nitrous acid are disengaged, and on afterwards mixing the liquor with a little water to separate the bitter, there may be obtained by saturating the liquor with potash and evaporation, a large quantity of carbazotate of potash in fine crystals. The bitter of aloes is consequently a compound of a peculiar substance, possessing the properties of the resins, and carbazotic acid.

Wool, morphia, narcotine, and myrrh, yielded no carbazotic acid when treated with nitric acid.—*Annales de Chimie*, Fev. 1828.

HEAT DEVELOPED DURING COMBUSTION.

M. Despretz finds that when equal quantities of oxygen are used for the combustion of the following substances, the annexed proportions of heat are developed:

Hydrogen	2578°
Charcoal	2967
Iron	5325

Phosphorus, zinc, and tin give nearly the same quantities as iron. It appears then that of all bodies, hydrogen develops the least heat for the same proportion of oxygen gas absorbed; the metals disengage the most. It is remarkable that carbon, which does not alter the volume of the gas, evolves a quantity of heat which is equal to three-fifths of that given out by iron and the metals in general.—*Ibid.*

ON THE SUGAR OF LIQUORICE-ROOT.

Döbereiner and Robiquet have long since given processes for the purification of this substance; the latter precipitates it by vinegar. Berzelius separates it in the following manner. The liquorice-root is to be sliced and infused in boiling water; when cold the infusion is to be filtered, and sulphuric acid added to it gradually, as long as precipitation occurs. This precipitate is a compound of the acid with the saccharine matter. It is first to be washed with acidulated cold water, and then with pure water, till it ceases to be rendered acid: the precipitate is afterwards to be digested with alcohol which separates the vegetable albumen and dissolves the compound of sugar and sulphuric acid; there is then to be gradually added to the solution carbonate of potash or soda in fine powder, and when it ceases to be acid, it is to be decanted and evaporated. It is proper to leave a very slight excess of acid in the solution, and for this purpose it is convenient to set aside a portion to be afterwards added to the saturated solution, until it is rendered weakly acid. The liquor is then to remain in order that the sulphate of potash may separate, and afterwards it is to be evaporated.

The saccharine matter is obtained in the form of a yellow transparent mass, which breaks into a coarse powder resembling amber—when heated in the air it swells up, inflames, and burns with a bright flame, but with smoke. When in powder it burns like the lycopodium or powdered resin. It suffers no change by exposure to the air. The aqueous solution is precipitated by all acids, and the more perfectly as the solution is more concentrated, and especially if excess of acid be used. The washed precipitates have no sour taste, but on the contrary a pure saccharine flavour which is developed in a short time. The precipitates are soluble in boiling water, and on cooling a yellow transparent jelly is formed if the solution be concentrated. Alcohol also dissolves them, and they burn without leaving any residuum.

The saccharine matter of liquorice combines also readily with bases; it is on this account very difficult to separate it from acids, without its retaining a portion of the bases employed for that purpose. The compounds with the alkalies dissolve readily in water, but with difficulty in alcohol; when they are perfectly saturated they contain no trace of carbonic acid, even when bases combined with carbonic acid have been employed, and their taste is purely saccharine, without mixture of alkalinity. The compounds formed with barytes and lime are soluble and are not precipitated by carbonic acid; this saccharine matter forms insoluble compounds with the metallic acids,—when poured into a solution of acetate of lead, a precipitate is formed, which when decomposed by sulphuretted hydrogen, forms a black liquid, in which the sulphuret of lead remains suspended; if it were not for this, it would be a good method of obtaining pure saccharine matter: the same substance is obtainable from the inspissated liquorice juice; but it is black and cannot be decolorized. It unites not only with acids and bases like the yellow saccharine matter, but also with salts, such as the sulphates of barytes, lime and potash. It precipitates many metallic salts.—*Ibid.*

SOLUTION IN SULPHURIC ACID WITHOUT OXIDIZEMENT.

Vogel of Bayreuth, whilst examining anhydrous sulphuric acid, found that sulphur by being put into contact with it, imparted to it a fine blue colour, which passes to green or brown by the addition of a greater quantity of sulphur. Water precipitates sulphur from these combinations, and heat decomposes them. It appeared probable that the sulphur was simply held in solution by the sulphuric acid, and M. Magnus mentions several analogous cases, which leave no doubt on the subject.

Müller of Reichenstein discovered long since that powdered tellurium when sprinkled with concentrated sulphuric acid, was dissolved and became a perfectly transparent fluid of a fine crimson-red colour without observing any evolution of gas, or smell of sulphurous acid. On the addition of a proper quantity of water the tellurium is precipitated in the state of a deep blackish-brown metallic powder. This solution may be kept for a long time in a close vessel, without any alteration; but if it attract moisture from the air, it gradually changes into sulphate of oxide of tellurium, and continually exhales the odour of sulphurous acid. This change is readily effected with the assistance of heat. Selenium is also dissolved by sulphuric acid, the solution is of a very fine green colour, and a few drops of water precipitate the selenium of a red colour.

Tellurium and selenium act like sulphur with sulphuric acid; except that sulphur requires for its solution that the acid should be anhydrous. These three bodies are oxidized when the sulphuric acid attracts moisture gradually, and exhale an odour of sulphurous acid; but if the water be added quickly, they are then precipitated. Lastly, the three solutions are coloured—that of the sulphur being blue, green or brown, the tellurium crimson-red, and the selenium green.

According to Bussy, iodine is also soluble in anhydrous sulphuric acid, and gives it a blueish green colour.

It follows from these facts that sulphuric acid has the property not only of dissolving compound bodies without oxidizing them, as Berzelius has shown with respect to the metallic cyanurets, but it dissolves some simple bodies, such as sulphur and selenium, for the oxides of which it has no affinity, and also tellurium, with the oxide of which it forms a crystallizable compound.—*Ibid.*

VEGETABLE ALBUMEN AND GELATINE.

Beccaria discovered, as is well known, a peculiar glutinous principle in wheat, which is obtained by working the flour in water, and which he called gluten. Taddei has given an account of two new peculiar principles which he supposes he has found in gluten, and which he has named *gliadine* and *zymome.* The other kinds of grain yield no principle similar to the gluten of Beccaria. But Einhof, in his remarkable analysis of rye, barley and pease, has shown that these seeds contain a substance analogous to the gluten of wheat, but which dissolves in water during the manipulation. Having had occasion to make some experiments on the gluten of Beccaria, I found that Taddei had only given two new names to the known and common principles of plants, particularly the seeds of the *gramineæ.*

If the gluten of Beccaria be boiled with alcohol, as long as this fluid grows turbid on cooling, a considerable portion of the mass is separated; if water be added to this spirituous solution, and the mixture be distilled, the watery fluid remaining in the retort deposits on cooling a coherent glutinous matter, perfectly resembling gluten. This is vegetable gelatin, the gluten, of the same nature as the matter separated, according to Einhof's method, from rye and barley. The matter insoluble in alcohol, whilst moist is semitransparent, and so much like animal albumen, that it is impossible to distinguish by its appearance only, that it is vegetable albumen, or, as Wahlenberg calls it, with good reason, the *white* of grain. Caustic alkali, when the solution is weak and cold, dissolves vegetable albumen, and leaves the filaments of starch which it has retained. The following are the principal properties of vegetable albumen. This matter, obtained after the evaporation of the alcohol from the remaining liquor, is of a yellowish gray colour, adhesive, glutinous, and very elastic; it has no taste, but it has a peculiar smell. In a dry atmosphere it becomes shining on the surface, and gradually dries into a mass of a deep yellow colour, and is perfectly transparent, resembling dry animal matter. It dissolves in alcohol, and the solution is of a pale yellow colour, and remains after the evaporation of the spirit, in the form of transparent yellow varnish. When vegetable gelatine is treated with cold alcohol, a milky fluid is obtained, and a viscid white matter remains. This matter is not vegetable gelatine; it is dissolved by boiling, but the liquor becomes milky on cooling. If the vegetable gelatine be dissolved with heat in weak spirit of wine, it precipitates on cooling, retaining its glutinous property; it dissolves in vinegar, leaving a white viscid matter, which the acid does not dissolve even when boiling, but which partly passes through the filter. When precipitated from its solution in vinegar by an alkali, it it retains its glutinous state. With the mineral acids it forms a glutinous compound, insoluble in water, until the excess of acid is removed, and it is then as perfectly precipitated from this solution as from that in vinegar, when more acid is added. The phosphoric acid is however an exception, for it does not precipitate the acid solutions. Vegetable gelatine also combines with the caustic alkalies, and when the gelatine is in excess, a solution is obtained, which is so perfectly neutral that no alkaline taste remains. It gives by evaporation a transparent mass, which is again soluble in water, which leaves undissolved the greater part of the viscid principle. Ammonia and lime-water precipitate vegetable gelatine from solution in acids, and redissolve it; but if it be aggregated these alkalies do not dissolve it, or at least the solution is slowly effected. With the earths and the metallic oxides, vegetable albumen forms insoluble compounds; the alkaline carbonates precipitate vegetable albumen from solution in the caustic alkalies or in the acids. The precipitate is a compound of the gelatine with the alkali, which without the liquid is not gelatinous. The persulphate of iron does not precipitate vegetable gelatine from solution in vinegar. On the contrary, it is precipitated from its acid solutions by the ferrocyanate of potash, in a hard, white, semitransparent mass, which is deposited on the sides of the vessels. It is also precipitated from solution, either in acid or alkali, by the permuriate of mercury and tincture of galls. The gelatine, in the solid state, is *tanned* in the two solutions, exactly like animal gelatine. The viscid principle, which has been several times mentioned, has not had its properties examined. The best method of separating it is to treat vegetable gelatine with concentrated vinegar, and when the mass is thoroughly penetrated, to mix it in the cold with weak alcohol, which dissolves the acetate of gelatine, and the undissolved matter is also to be washed with cold weak spirit. It dries into a colourless transparent body, which yields ammonia by distillation. It swells in alcohol and becomes viscid; when heated in it, solution takes place, but it is precipitated on cooling.

Vegetable albumen, when dissolved to saturation in weak alkaline solutions, possesses in so great a degree the properties of white of egg, that, as is well known, it has been mistaken for it. Its solution in potash, when the latter is not in excess, has no alkaline taste whatever. It coagulates slightly by ebullition, but it is generally retained by the alkali; it combines with acids. The solution when perfectly saturated is soluble in water, but an excess of acid precipitates it; vinegar and phosphoric acid, however, are exceptions to this, for they may be added in large quantity, without occasioning precipitation. Before treatment with potash, vegetable albumen when boiled in alcohol dissolves sparingly in vinegar or phosphoric acid; but when boiled with these acids, it forms a transparent jelly, which is colourless and bulky. With permuriate of mercury, tincture of galls, and ferrocyanate of potash, it acts like animal albumen.

The French chemists have considered the azotized principle contained in emulsive seeds as analogous to cheese in milk. Soubeiran has shown that this principle in almonds, similar to that which has been

been described, possesses the properties of white of egg, but not those of cheese; and Payen and Henry, who had considered the results obtained by Soubeiran as opposed to theirs, are convinced by new trials, that this principle cannot be considered as *caseum*, but that it ought to be called *albumino-caseous*. I add, that according to its properties, it is rarely identical with vegetable albumen.—*Ibid.*

Berzelius.

ANHYDROUS CRYSTALS OF SULPHATE OF SODA.

In the Number for April of the Royal Institution Journal, Mr. Faraday makes the following observations with respect to this salt:—If a drop of a solution of sulphate of soda be placed upon a glass plate and allowed to evaporate spontaneously, it will leave crystals which may be distinguished by their form and alternate efflorescence as being the salt in question. Most of the potash and soda salts may be distinguished as to their base by such an experiment. They are easily converted into sulphates by a drop or two of sulphuric acid and ignition; and then being dissolved and tried as above, will yield crystals which may be known by their forms, and more especially by their efflorescence if of soda, and their unchangeable state if of potash. This test is, however, in some circumstances liable to uncertainty, arising from a curious cause. If the drop of solution on the glass be allowed to evaporate at common temperatures, then the efflorescence takes place, and the distinction is so far perfect; but if the glass plate with the drop upon it be placed upon a warm part of a sand-bath or hot iron-plate, or in any other situation of a certain temperature considerably beneath the boiling point of the solution, the crystals which are left upon evaporation of the fluid are smaller in quantity, more similar in appearance to sulphate of soda, and finally *do not* effloresce. Upon examining the cause of this difference I found they were *anhydrous*, consequently incapable of efflorescing, and indeed, exactly of the same nature as the crystals obtained by Dr. Thomson from certain hot saturated leys.—*Ann. Phil. N. S.* xx. 201.

Hence it would appear, that a mere difference in the temperature at which a solution of sulphate of soda is evaporated, will cause the formation of hydrated or anhydrous crystals at pleasure, and that whether the quantity of the solution be large or small. This indeed might have been expected from what takes place when hydrated crystals of sulphate of soda are carefully melted; a portion dissolves, and a portion separates,—the latter in an anhydrous state. (*Quarterly Journal*, xix. p. 153.) I find that, if it were desirable, crystallized anhydrous sulphate of soda might easily be prepared for the market; though, as the pure salt is now but little used, it is not likely this condensed form will be required. Whenever a salt of soda is to be distinguished from one of potash in the manner above described, this effect of temperature must be carefully guarded against.

CASEOUS OXIDE, AND CASEIC ACID.

The results obtained by Proust relative to the substance produced by the fermentation of cheese, have been described and examined by M. Henri

M. Henri Braconnot. The substance which Proust distinguished as caseous oxide, he shows to have no claim to such a title, and proposes to call it *aposepedine*, as being produced by putrefaction. It also appears to be produced in certain diseases. The properties which Proust has assigned to *caseic acid*, belong, according to M. Braconnot, to various contaminating substances, none of which have any title to be considered as a particular acid. The substances present are free acetic acid; aposepedine; animal matter, soluble in water and insoluble in alcohol (ozmazome); animal matter, soluble in both water and alcohol; a yellow, acrid, fluid oil; a brown resin; acetate and muriate of potash, and traces of acetate of ammonia.

On examining the fatty matter of cheese, Braconnot found it to consist of margarate of lime with margaric and oleic acids; the butter having undergone the same kind of change during the fermentation of cheese, as that produced when it is saponified by the action of alkalies or other bodies.—*Ann. de Chim.* xxxvi. p. 159.

RIB OF A WHALE FOUND IN THE DILUVIUM OF BRIGHTON CLIFFS.

A short time since some labourers employed in collecting flints from the beach near Kemp Town (a new suburb erecting to the east of Brighton), observed the extremity of a large bone projecting from the base of the cliff. They immediately broke off a portion of it, but the remainder was fortunately so impacted in the rock that they were unable to remove it without more labour than they were willing to bestow. Intelligence of the discovery having reached Mr. Mantell of Castle Place, Lewes, he visited the spot, and assisted by the labourers, succeeded in making an excavation to the extent of three or four yards in the cliff, and completely exposed the bone without injuring it in the slightest degree; but unfortunately in attempting to remove it subsequently, it fell to pieces*. This fragment of bone (for it evidently was but a small portion of the original) measured nine feet in length, the piece destroyed by the workmen was estimated at about three feet, so that the specimen when first discovered must have been twelve feet long; from its slight degree of curvature it could not have been less than thirty feet when entire. The circumference of the largest extremity was thirty-four inches, and the bone gradually diminished in size, terminating obtusely. The surface was almost flat on the inner side of the curvature, and convex on the outer, corresponding in this respect with the ribs of the common whale. From a mere fragment of bone, however gigantic, it is of course impossible to decide positively as to the animal to which it belonged; yet as this example was too enormous to have belonged to any terrestrial animal, and not only in form but also in structure bore a close analogy to the rib of a whale, it may with but little hesitation be considered as the sternal portion of a rib of that animal. According to

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* A fragment five feet long was, however, removed to Mr. Mantell's museum.

Mr.

Mr. Mantell's description of the cliffs at Brighton, (Geology of Sussex, p. 277,) they consist of

1. *Calcareous bed*, composed of the ruin of chalk strata with clay, &c., fifty to sixty feet thick.
2. Bed of shingle or pebbles, five to eight feet.
3. Sand, three to four feet, with boulders of granite, porphyry, slate, &c.
4. Upper chalk, forming the sea-shore.

The bone was imbedded in the sand No. 3, lying beneath the shingle bed and upon the chalk. Vast quantities of the teeth of the horse, and a few of a species of ox, and of the elephant (*E. primigenius*), have lately been discovered in the calcareous bed.

INEQUALITY OF THE DARK SPACE BETWEEN THE BODY OF SATURN AND ITS RING.

Do the observations of Sir W. Herschel on an apparent irregularity in the figure of Saturn, (recorded in the Philosophical Transactions for 1808, p. 160,) throw any light upon the recent observations of MM. Schwabe and Harding, and of Messrs. Herschel and South, on the apparent *inequality* of the dark space between the body of this planet and its ring, as noticed in No. 12 of the Monthly Notices of the Astronomical Society, which has just been circulated?

INQUIRER.

NATIVE IRON? SLIGHTLY ARSENIURETTED.

The substance described below, was brought to me two or three weeks since, by Mr. Philo Baldwin*, who stated that it was from Bedford county, Pennsylvania, in which county we believe Mr. B. lives.

Perceiving that it was a singular modification of iron, and different from any thing I was acquainted with,—it was, at my request, submitted by Mr. S. to chemical examination.

My impressions are, that it is a new variety of native iron, and that it differs from that substance only by containing a little arsenic, with a little plumbago. Measures will be taken to obtain a greater supply, as it is stated to be abundant, and will at least form an interesting addition to our cabinets.

Chemical examination.—The fragment weighed, I should judge, two or three ounces; and although it had sustained considerable injury, it evidently formed a distinct crystal. By observing a symmetrical modification which this crystal had undergone, in the truncation of two of its alternate obtuse solid angles, I was able easily to ascertain, that it belonged to the class of rhombic prisms, but whether the prism was right or oblique, I could not determine. The natural planes were not sufficiently even, to allow of the determination of their

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* Mr. Baldwin went to Newtown, Connecticut, where he formerly resided, and was to return in a week to learn the nature of the mineral, but has not yet called, which prevents me from stating the exact locality.—*B. S.*

their angles with perfect accuracy: neither were the results, from numerous cleavage-planes, uniform enough for this purpose; although in the latter case the reflective goniometer was used with the utmost convenience. The inclination of the primary planes may be regarded as an approximation to 121° and 59°, and those of the secondary (intersecting the base parallel to its greater diagonal) to the primary 146°. With the cleavage-crystals the following angles were obtained, 120°, 121°, and 122°; a diversity very remarkable, as the cleavages appeared to the eye quite perfect, and the planes highly uniform.

The cleavage parallel to the lateral planes is effected without much difficulty, whilst no terminal one is visible; it breaking in that direction with great difficulty, and presenting an uneven and sub-hackly fracture. The external planes of the crystals before being broken, were dull and nearly black, owing to a thin coating of brown oxide of iron; but fresh cleavages presented a fine metallic lustre, and a colour between silver-white and steel-gray. It breaks with the greatest difficulty, and small masses often flatten under the blow of the hammer, like pure iron. Its hardness is almost that of ordinary steel. Specific gravity, in distilled water at 60° F., 7·337. It is highly magnetic, with polarity so distinct as to take up iron filings. Before the blowpipe it melts.

Fragments of the size of a pea, brought within the exterior flame of the compound blowpipe, emitted a very slight vapour, in which the well-known odour of arsenic was detected: and immediately on coming within the inner cone of flame, they burnt with intense energy, and with a most brilliant light, throwing out a profusion of scintillations, after the manner of pure iron, or more like a burning watch-spring. No odour of sulphur was perceived in these trials. In order, however, to make myself sure of the absence of sulphur, I resorted to the following experiment. A portion of the metal was dissolved in dilute nitric acid: the solution was supersaturated with potash and boiled in the alkaline liquor; the precipitate was separated, and the supernatant fluid neutralized by nitric acid, to which was afterwards added nitrate of lead; the precipitate was separated, and found to be perfectly soluble in dilute nitric acid, thus evincing the absence of sulphate of lead, which must have formed part of the precipitate, provided sulphur had existed in the mineral under examination.

After having examined it in the usual modes, for silver, gold, and other metals, and not discovering any to be present*, I dissolved fifty grains in nitric acid, with a view to ascertain merely the proportion of iron present. After the solution appeared to be effected, I observed a number of little black flakes floating in the liquid, which resisted the action of the acid. These being separated by the filter, were examined and found to be plumbago, which, under somewhat similar

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* After the iron had all been removed from the nitric solution by ammonia, and the fluid boiled, hydro-sulphuret of ammonia gave no cloudiness, thus evincing the absence of nickel.

similar circumstances, though less disguised and more abundant, was found in the native iron of Canaan. They weighed 0·2 grs. and from other trials, appear to exist in the mineral pretty constantly in this proportion. The nitric solution was precipitated by ammonia, and the residuum after drying indicated 48·7 grs. of metallic iron.

I afterwards repeated my examination with greater care in the following manner. Twenty-five grs. were dissolved in dilute nitric acid. This solution was boiled for some time with an excess of soda, and deposited 35 grs. of the peroxide of iron. The supernatant liquor with the washings of the precipitate being evaporated and neutralized by nitric acid, was decomposed by nitrate of lead, and afforded a precipitate weighing 1·5 gr. which upon burning charcoal gave the smell of arsenic, and was entirely soluble in nitric acid, and therefore consisted wholly of arseniate of lead. The result of my trial, then, would be as follows, after deducting the weight of the plumbago: for 24·9 of the mineral,

Iron	24·263
Arsenic	·389
	24·652
Loss	·248
	24·9

Which gives per hundred of the mineral, free from the plumbago,

Iron	97·44
Arsenic	1·56
	99.
Loss	1
	100

This therefore cannot but be regarded as a singular substance, especially as it affords us an instance of the remarkable effect produced by a small proportion of arsenic in disguising the natural properties of iron. Whether it coincides with the species described by Mohs under the name of axotomous arsenical pyrites, (to which opinion I am rather inclined, from its crystalline character and specific gravity,) or whether it constitutes a distinct species in mineralogy, I will not at present venture to assert. When an additional supply of this substance shall be furnished us for examination, and the means of comparing it with some genuine specimens of the above-mentioned species shall occur, it will be very easy to decide upon this point.

Yale College, March 4th, 1828. CHARLES U. SHEPARD.

ARSENIATE OF COBALT.

Arseniate of cobalt has been lately discovered at the lead mine of Tyne Bottom, about three miles south of the town of Alston in Cumberland, by Mr. H. L. Pattinson, Assay Master for the Commissioners and Governors of Greenwich Hospital, in the Manor of Alston Moor. It occurs in the form of a rose-coloured efflorescence, investing hepatic and common pyrites; and specimens in great plenty are to be picked up on the old mining heaps. The veins at Tyne Bottom bear nearly east and west, and are worked in a limestone stratum called the Tyne Bottom Limestone in Mr. Westgarth Forster's section of the strata which occur in that district. They were formerly very productive of lead-ore; and beautiful specimens of transparent and finely crystallized carbonate of lime were obtained, but for a few years past the quantity of ore yielded has not been considerable.

SOLAR SPOTS, &C.

On the 27th of May, thirty-two maculæ or black spots, in groups, were observed on the sun's disc; the largest with its umbra exceeded by admeasurement the circular extent of the earth, and was situated near the central part of the arc which formed the lower right-hand quadrant. The nucleus of this spot, or the opening in the sun's atmosphere (a rational hypothesis of the late Dr. Herschel), was in *the shape of a man's hat*, and the well-defined speckled umbra nearly so, with the exception of the angular parts. Seven of the largest spots were in a line near the sun's centre, and four near the upper limb; most of the others were interspersed about the largest, which went off the visible part of the disc by means of the sun's motion on its axis in the night of the 29th.

The apparent angular distance of the planet Venus from the sun's centre at the time of its greatest eastern elongation on the 19th, was $45° 28' 30''$, when its appearance was like the moon at her last quarter with an inverting telescope, or at her first quarter without an inversion. This planet, which is the most radiant in the solar system, and which now casts a faint shadow in the evening after twilight, may be seen with the naked eye in the open day in clear weather during the next four weeks.

LIST OF NEW PATENTS.

To W. Marshall, of Fountain Grove, Huddersfield, for improvements in machinery for cutting or shearing, cropping and finishing cloth, &c.—Dated the 26th of April 1828.—2 months allowed to enrol specification.

To T. Breidenback, of Birmingham, for a machine or improved mode for forming tubes or rods, &c.—26th of April.—4 months.

To J. Griffen, of Withy Moor Works, near Dudley, for an improvement in the manufacturing of scythe backs, chaff-knife backs, and hay-knife backs.—26th of April.—6 months.

To J. J. Watt, of Stracey-street, Stepney, for his discovery of the application of a certain chemical agent by which animal poison may be destroyed and the disease consequent thereon effectually prevented.—26th of April.—6 months.

To C. C. Bompas, of the Inner Temple, Esq., for his improvements in the propelling of locomotive carriages and machines, and boats and other vessels.—29th of April.—6 months.

To T. Hillman, of Mill-wall, Poplar, for improvements in the construction and fastening of masts.—1st of May.—6 months.

To J. Brownill, of Sheffield, for his improved method of transferring vessels from a higher to a lower level, or from a lower to a higher level on canals, and also for the more conveniently raising or lowering of weights, carriages, or goods, on rail-roads, &c.—1st of May.—6 months.

To J. Palmer, of Globe-road, Mile-End, for improvements in the moulds, machinery or apparatus, for making paper.—6th of May—6 months.

To T. Adams, of Oldbury, Salop, for improvements on trusses, or apparatus for the relief or cure of rupture.—6th of May.—6 months.

To F. Westby, of Leicester, for his apparatus to be used for the purpose of whetting or sharpening the edges of the blades of knives, &c.—6th of May.—2 months.

To Rear Admiral Brooking, of Plymouth, for a turning or shipping fid for securing and releasing the upper masts of ships and vessels.—6th of May.—6 months.

To M. Fulwood, of Stratford, Essex, for a cement, mastic or composition, denominated German Cement.—6th of May.—2 months.

To J. B. Macneil, of Foleshill, Coventry, for improvements in preparing and applying materials for constructing or rendering more durable roads, which materials are applicable to other purposes.—6th of May.—6 months.

To T. Jackson, of Red-Lion-street, Holborn, for a new metal stud to be applied to boots, shoes, and other like articles of manufacture.—13th of May.—6 months.

To J. Ford, of Wandsworth-road, Vauxhall, for improvements in machinery for clearing, opening, scribbling, carding, combing, slubbing and spinning wool, and for carding, roving, or shivering and spinning cotton, short-stapled flax, hemp and silk, either separately or combined, and for spinning or twisting long-stapled flax, hemp, silk, mohair, &c. and either separately or combined.—13th of May.—6 mo.

To T. Bonsar Crompton, of Tamworth, in Lancashire, and E. Taylor, of Marsden in Yorkshire, for improvements in the process of paper-making which relates to the cutting.—13th of May.—2 months.

To C. Chubb, of St. Paul's Churchyard, London, for improvements in the construction of door-latches.—17th of May.—6 months.

To T. W. and J. Powell, of Bristol, for improvements in the process of forming moulds for refining sugar, and in the application of materials hitherto unused in making the said moulds.—17th of May.—2 months.

To T. Aspinwall, of Bishopsgate Churchyard, London, Esq., for an improved method of casting printing types by means of a mechanical process. Communicated from abroad. 22nd of May.—6 months.

To S. Hall, of Basford, Nottinghamshire, for an apparatus for generating steam and various gases to produce motive power, and for other useful purposes.—31st of May.—6 months.

To J. Moffat, of King's Arms-yard, Coleman-street, London, for an improvement in apparatus for stoppering and securing chain cables;

bles; also for weighing anchors attached to such chain or other cables, either with or without a messenger.—3rd of June.—6 months.

To D. Jobbins, of Uley, Gloucestershire, for an improved method, by certain machinery applicable to stocks or fulling-machines, of milling and scowering woollen cloths, &c.—3rd June.—2 months.

To Baron Charles Wettersted, of Commercial-place, Commercial-road, for a liquid or composition for water-proofing and strengthening leather.—4th of June.—6 months.

To R. Wilty, of Hauley, Staffordshire, for improvements in apparatus for making coal-gas.—10th of June.—6 months.

To E. G. Atherley, of York-place, Portman-square, for an apparatus for a method of generating power.—12th of June.—6 months.

To W. Strachan, of Avon Eitha, Ruabon, Denbighshire, for an improvement in the making of alum.—12th of June.—4 months.

To J. Bartlett, of Chard, Somersetshire, for a new method of preparing flax-thread or yarn for use in the manufacture of boots, shoes, sadlery; and of sail and of other cloths and bagging.—16th of June. —2 months.

To G. J. Young, of Newcastle-upon-Tyne, for a machine whereby an additional and improved purchase or power will be given in working ships, windlasses, and capstans.—21st of June.—6 months.

METEOROLOGICAL OBSERVATIONS FOR MAY 1828.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·32 May 1. Wind NE.—Min. 29·36 May 24. Wind S.
Range of the index 0·96.
Mean barometrical pressure for the month .... 29·826
Spaces described by the rising and falling of the mercury............ 4·120
Greatest variation in 24 hours 0·440.—Number of changes 18.
Therm. Max. 76° May 16. Wind S.—Min. 42° May 8. Wind N.E.
Range 34°.—Mean temp. of exter. air 58°·76. For 31 days with ☉ in ♉ 56·42
Max. var. in 24 hours 24°·00—Mean temp. of spring water at 8 A.M. 51°·29

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the evening of the 11th.............. 84°
Greatest dryness of the air in the afternoon of the 15th 40
Range of the index.. 44
Mean at 2 P.M. 53°·0—Mean at 8 A.M. 57°·0—Mean at 8 P.M. 64·9
—— of three observations each day at 8, 2, and 8 o'clock......... 58·3
Evaporation for the month 3·95 inches.
Rain near ground 2·29 inches.
Prevailing wind, S.E.

Summary of the Weather.

A clear sky, 5; fine, with various modifications of clouds, 12½; an overcast sky without rain, 8; rain, 5½.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus
23	20	27	0	27	24	21

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
1	5	4	7	2½	5½	3	3	31

General

General Observations.—The state of the weather this month has been changeable, except in the second week, and showery, with several frosty mornings, and intervals of hot sunshine; but upon the whole it has been a fine growing month for the corn and vegetation, with mild nights in general. The hoar frosts in the mornings of the 6th, 7th, 9th and 10th, and the cold blighting winds on several subsequent days, have much injured the late bloom of the wall and other fruit trees, and caused a great part of the fruit that was set to fall off. The vines will not be so prolific this year as they have been for two or three years past. The grass fields in this neighbourhood have been much improved by the recent showers, and from their fine appearance a good crop may be expected: the grass in several fields is already cut.

The chaffers were first observed here in the evening of the 6th, and have been unusually numerous, having been seen on the wing every fine day since. On the 14th, a quarter of an hour before sunset, a large meteor was observed in the N.W. at an altitude of about 40 degrees. Its light was vivid, and its descent rapid and nearly perpendicular; the disjoined parts continued luminous several seconds of time after its explosion. Its appearance so early was remarkable, as meteors are very seldom seen till after the evening twilight.

In the night of the 15th there was thunder, and sheet-lightning the following night for several hours, after a very warm day: thunder and lightning also occurred in the evening of the 23rd.

The mean temperature of the external air this month is more than three degrees higher than the mean of May for the last twelve years.

The atmospheric and meteoric *phænomena* that have come within our observations this month, are one lunar and two solar halos, three meteors, thunder and lightning twice; and six gales of wind, or days on which they have prevailed; namely, one from the North-east, three from the South-east, one from the South, and one from the West.

REMARKS.

London.—May 1. Very fine. 2. Fine: slight rain at night. 3. Drizzly: Cloudy. 4. Fine: rain at night. 5. Cloudy. 6. Sultry: with thunder. 7. Fine: drizzly at night. 8. Fine. 9. Showery. 10. Fine. 11. Cloudy. 12—15. Very fine. 16. Sultry: much lightning at night. 17—20. Very fine. 21. Cloudy: with showers. 22. Cloudy morning: fine. 23. Very fine. 24. Heavy rain in morning: showery. 25. Fine. 26. Showery. 27. Fine morning: showery. 28. Fine. 29. Showery. 30. Very fine. 31. Fine.

Boston.—May 1, 2. Fine. 3. Cloudy. 4. Cloudy: rain P.M. 5. Rain. 6. Fine. 7. Cloudy. 8, 9. Fine. 10, 11. Cloudy. 12—15. Fine. 16. Cloudy. 17—19. Fine. 20. Cloudy. 21. Fine. 22, 23. Cloudy. 24. Rain. 25, 26. Cloudy. 27, 28. Fine. 29, Rain. 30, 31. Fine.

Penzance.— May 1. Clear. 2. Fair. 3. Fair: a shower. 4. Clear: showers. 5—10. Clear. 11. Fair: clear. 12, 13. Clear. 14. Clear: fair. 15. Clear: rain. 16. Fair: rain at night. 17. Rain: clear. 18. Clear: fair. 19. Rain. 20. Cloudy: rain. 21. Rain: showers. 22, 23. Fair: showers. 24. Rain: blowing strong. 25. Fair. 26. Rain: showers. 27, 28. Fair: showers. 29. Clear. 30. Clear: fair. 31. Rain: clear.—Rain-gauge ground level.

Meteorological Observations made at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1828.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.									
May 1	30·340	30·297	30·25	30·20	30·32	30·25	29·75	66	38	60	50	66	47	54	SE.	SE.	NE.	calm	...	...	...	...	...
2	30·263	30·142	30·02	30·00	30·19	30·07	29·74	62	47	60	49	64	52	54·5	E.	SE.	E.	E.	...	·05	...	0·045	...
3	30·024	29·997	30·02	30·00	29·94	29·92	29·60	61	49	60	50	60	52	54	SE.	NW.	SE.	E.	0·35	·03	...	·040	...
4	29·791	29·754	29·94	29·93	29·76	29·74	29·33	64	40	55	49	62	47	55·5	S.	NW.	NW.	calm	...	·13	0·060	...	...
5	29·740	29·702	29·90	29·86	29·70	29·68	29·20	61	35	55	46	60	45	51	N.	NW.	NW.	calm	...	·02	0·080	·010	0·30
☾ 6	29·848	29·742	29·80	29·80	29·76	29·70	29·22	63	36	56	46	66	43	56	SW.	NW.	SW.	calm	·40	...	...	...	·26
7	29·914	29·847	29·84	29·80	29·84	29·80	29·32	64	46	58	44	63	48	50	N.	N.	NE.	NW.	...	·05	...	·020	...
8	29·990	29·912	30·00	29·90	29·90	29·82	29·44	61	35	57	48	61	42	53	NW.	N.	NE.	NE.	...	...	...	...	...
9	30·168	30·075	30·25	30·20	30·12	30·03	29·57	60	36	58	46	65	44	54	W.	N.	SW.	NW.	·40	·04	...	...	...
10	30·191	30·132	30·25	30·24	30·17	30·10	29·60	64	48	56	48	68	48	53·5	W.	NW.	W.	W.	...	...	...	...	...
11	30·110	30·084	30·25	30·24	30·08	30·06	29·50	65	41	62	51	68	48	58	N.	NW.	W.	W.	...	...	...	...	...
12	30·302	30·239	30·26	30·26	30·25	30·20	29·66	67	38	64	50	63	46	57	NE.	NE.	SE.	NW.	·40	...	...	...	...
● 13	30·318	30·225	30·28	30·25	30·28	30·18	29·78	72	42	66	48	59	47	57·5	NE.	NE.	SE.	W.	...	...	...	...	...
14	30·203	30·138	30·18	30·10	30·14	30·04	29·65	71	44	65	49	64	52	61	E.	SE.	E.	NW.	...	...	...	...	...
15	30·072	29·996	29·96	29·94	29·99	29·92	29·61	69	54	66	55	74	58	57	E.	SW.	SE.	E.	·65	...	...	...	...
16	29·901	29·856	29·96	29·94	29·83	29·77	29·45	71	52	65	55	76	58	56·5	E.	NW.	N.	E.	...	...	0·665	·050	...
17	29·860	29·814	29·75	29·75	29·77	29·74	29·40	70	45	61	54	69	56	60	E.	NW.	SE.	E.	...	...	0·560	·170	...
18	29·847	29·823	29·75	29·75	29·72	29·72	29·36	66	42	56	51	71	50	59	NE.	SE.	NE.	NE.	·35	...	...	...	...
19	29·836	29·818	29·75	29·75	29·76	29·76	29·34	67	42	59	52	65	49	62	NE.	SE.	E.	NE.	...	...	0·400	...	...
20	29·786	29·715	29·73	29·60	29·70	29·64	29·32	65	47	65	52	67	55	55·5	E.	SE.	E.	NE.	...	·03	0·100	·210	...
☽ 21	29·584	29·569	29·50	29·48	29·54	29·51	29·20	65	49	64	53	69	55	58	E.	S.	SE.	NE.	·35	·03	0·125	·040	...
22	29·595	29·587	29·46	29·45	29·51	29·51	29·13	61	48	66	54	69	54	57	E.	SE.	SE.	NE.	...	...	0·050	·160	...
23	29·602	29·592	29·50	29·35	29·56	29·53	29·11	66	52	62	55	71	56	56	E.	S E.	SE.	NE.	...	...	0·205	·140	...
24	29·520	29·440	29·35	29·15	29·43	29·36	28·93	67	53	58	53	67	54	56·5	S.	SW.	S.	NE.	·30	·34	0·425	·260	·31
25	29·844	29·697	29·65	29·65	29·81	29·72	29·04	66	47	62	50	68	54	60·5	SW.	SW.	SW.	W.	...	...	0·340	·080	·23
26	29·735	29·624	29·65	29·60	29·67	29·57	29·24	70	47	63	54	64	53	59	S.	SW.	SE.	E.	...	·13	0·075	·090	·04
27	29·594	29·545	29·40	29·35	29·54	29·47	29·00	68	57	60	50	65	52	63	S.	SW.	S.	calm	·25	·34	0·305	·840	...
28	29·673	29·608	29·55	29·55	29·63	29·55	28·90	67	54	60	48	65	55	62·5	S.	SW.	SW.	calm	...	...	0·155	·090	·18
○ 29	29·762	29·708	29·76	29·63	29·73	29·64	29·10	67	50	63	53	73	52	62	SW.	NW.	SW.	W.	...	.12	0·115	...	·06
30	29·957	29·920	29·94	29·94	29·95	29·90	29·25	75	52	65	53	72	54	62	S.	NW.	SW.	SW.	...	·09	...	·040	·26
31	29·933	29·860	29·96	29·90	29·92	29·84	29·23	69	50	62	54	70	53	60	SW.	NW.	W.	W.	·50	...	0·105	·005	·04
Aver. : .	29·913	29·853	30·28	29·15	30·32	29·36	29·35	66	45	66	44	76	42	57·2					3·95	1·40	3·765	2·290	1·68

THE
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[NEW SERIES.]

AUGUST 1828.

XII. *On Websterite found in the Plastic Clay of Auteuil, near Paris.* *By* M. Alexandre Brongniart, *Member of the Royal Academy of Sciences, and Professor of Mineralogy at the Jardin du Roi, Paris.*[*]

THE occurrence of the same geognostic circumstances, in districts considered to be of the same formation though situated very remotely from each other, exhibiting even in the beds least developed, a repetition of the most minute particulars,—presents a phænomenon that cannot but attract the attention of naturalists; and appears to point out, that causes, simple, but powerful and general, have concurred in producing the several strata deposited in each successive epoch.

These reflections have followed from a discovery I have made in the environs of Paris, of a substance which, in itself, is comparatively of little importance: but it is precisely because the beds in which it is found are so feebly and irregularly developed as scarcely to be entitled to rank as a formation, and because this substance, occurring in small nodules, is possessed of characters not very important when taken separately, that we are struck with its appearance in so many places situated widely apart.

We are not surprised at finding granite of similar composition in Europe, Asia, and America: but it is more singular to observe Websterite always in the same formation in Germany, England, in several parts of France, and even at the gates of Paris.

The mineral substance which forms the subject of the present communication, is the subsulphate of alumina, which was found first at Halle in Saxony, and which had been long known by the

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[*] Extracted from the "*Annales des Sciences Naturelles,*" for March 1828.

the erroneous appellation of *native alumina;* afterwards by that of *aluminite* (already appropriated to aluminous schist), and which I have in another place* named *Websterite*, dedicating it to Mr. Webster of London†, who first discovered this substance at Newhaven, near Brighton.

The history of this mineral, independently of the geological circumstances connected with it, is very remarkable‡. It was at first, and for a long time, taken for pure alumina; though, as it was difficult to imagine how such a substance could exist in a state of perfect purity in the midst of very recent beds, its origin was rather attributed to some of the processes of a manufacture which formerly existed in the spot where it was found. In fact, its aspect, and its form (that of nodules about the size of nuts), its position so near the surface of the earth, and its being the only example which had till then occurred of this substance; lastly, the complete ignorance in which we were of the date of the stratum in which it had been met with,—all contributed to excite the idea that it was merely a product of art accidentally buried in the loose soil.

Afterwards its properties were more carefully examined: first Mr. Schreiber observed its crystalline structure, which is not visible but by the microscope§; then MM. Simon, of Berlin, and Bucholz detected the presence of sulphuric acid. M. Chenevix supposed that it was a sulphate of alumina having the base in excess; and finally, M. Stromeyer proved that it was a subsulphate of alumina in definite proportions, containing 47 per cent of water, or a combination of one atom of alumina, one atom of sulphuric acid, and 9 atoms of water. $Al . S + 9 Aq$.

Mr. Webster having discovered a similar mineral at Newhaven‖, M. Stromeyer determined its composition to be the same as that found at Halle: afterwards M. de Basterot meeting with a white

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[*] See the Supplement to Vol. iii. of the *Dictionnaire des Sciences Naturelle*, article *Argile Native*.

[†] Late Secretary and Curator of the Museum of the Geological Society of London, and now Professional Geologist and Lecturer on Geology.

[‡] This history was given much in detail by Keferstein (*Leonh. tasch.*, 10th year 1816, p. 33); and M. Bonnard has inserted an abridgement of it in the *Annales des Mines*, 1821, tom. vi. p. 588.

[§] I have verified this observation, and have described it in my *Traité élémentaire de Minéralogie*, published in 1807, t. i. p. 515; M. Keferstein repeated it, and rendered the results more interesting by comparing them with the microscopic appearance of other earthy substances.

[‖] In the enumeration of facts respecting the history of this mineral substance, it may be proper to observe, that it was in 1812 that Mr. Webster found it at Newhaven: shortly afterwards it was determined by Dr. Wollaston and Mr. Tennant to be a subsulphate of alumina; and the latter gentleman a white earthy substance at Bernon, near to Epernay, in the lignite of that canton, M. Lassaigne analysed it, and found it to be also a subsulphate of alumina, but differing somewhat in the proportion of its constituents, owing probably to some impurities; for it is proper to state that Websterite appears always as a white friable earth, and that it is difficult to detach it entirely from the clayey matrix which surrounds it.

But it is a singularity in this mineral, which I have constantly observed in the three examples just mentioned, that it is composed of an infinity of minute acicular crystals, so small that they cannot be seen without a microscope with a magnifying power of at least 400 times: then the crystals are very distinct. M. Schreiber had remarked them in the Websterite of Halle: I found them in that of Newhaven and Epernay; and by means of the fine microscope of Amici, I have been enabled to determine that they consist of six-sided compressed prisms terminated by two culminating facets, consequently having a form incompatible with that of alum.

The three examples of Websterite found in places very distant from each other, possess therefore the two classes of characters which essentially constitute mineral species, particular composition and form. Let us now examine their geological situation; and this will not be a useless repetition, since we may thus avoid describing the same circumstances in detail, when speaking of the Websterite of Auteuil.

The Websterite of Newhaven has shown clearly the geognostic position of this mineral: it is there in nodules of from one inch to two or three inches in diameter, imbedded in an ochrey clay mixed with gypsum, which is placed upon the chalk, and which penetrates in irregular veins the superior and disintegrated part of the rock. That of Bernon, near Epernay, found by M. Basterot, occurs also in veins and nodules, in the plastic clay above the chalk, accompanied by lignite and gypsum.

If, after having acquired these ideas respecting the position of Websterite in two points more than 100 leagues asunder, we should extend our observation to Halle in Saxony, 200 leagues further, we shall there find, instead a supposed ordinary alluvial soil, the plastic clay with its gypsum, its lignites, its amber, and its Websterite disseminated in nodules through the formation.

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gentleman inserted a notice respecting it in the *Journal de Physique*, for September 1814. Previous to that time all the knowledge respecting it in England, seemed to be confined to the notice of the substance found at Halle, and which was described in our elementary books as native alumine. —Edit.

mation. At Morl also, not far from the last-mentioned spot, we meet with a similar substance, determined by M. Stromeyer to contain the same principles as that of Halle.

We have next to consider a new variety of this mineral, which is met with at Auteuil, and which is properly the subject of this memoir.

The chalk which supports all the superior sedimentary strata in the basin of Paris is seen uncovered at Meudon, but does not appear on the right bank of the Seine; it is however very near the surface under the hills called Point-du-Jour; and also near Auteuil it carries the plastic clay, which covers it in many points. Indeed, this clay is worked at the foot of the village of Auteuil, in a place called la Glacière, and is used for making bricks and other purposes. It was in this spot, or very near it, that M. Becquerel found in the plastic clay, lignite, pyrites, sulphate of strontian, phosphate of lime, and even a little blende: there also are procured the large well-defined and clear crystals of gypsum, so much prized by amateurs of fine minerals. This locality, in the part where I have examined it, exhibits, immediately under the vegetable soil, a plastic clay yellowish and very sandy, having little tenacity, traversed by veins of yellowish clay still more sandy, ochrey, and divided into many small portions. Beneath, is a blueish plastic clay that is more tenacious, and contains a good deal of pyrites and gypsum. Still lower, is a bed of sand, or rather yellow ferruginous coarse gravel; and below that another bed of clay. In this upper yellowish clay we find, and rather in nodules than in veins, some parts that are whitish and friable, composed of a multitude of small roundish grains, closely connected together, yet admitting a greyish clay in the interstices. When these little masses are cut across, they present the aspect of an oolite consisting of white grains in a greyish paste or cement. This is Websterite. Each grain, when closely examined, appears to be a little spheroid of a structure indistinctly radiated. When crushed, the powder is very brilliant and soft to the touch; and when examined by the microscope, exhibits wedge-shaped masses composed of prisms, but so ill-determined, that it is necessary to be aware of their crystalline structure to recognize them.

It is from these characters that I conjectured this white oolitic substance to be Websterite; but the complete chemical analysis made by M. Dumas leaves no doubt as to its nature. It does not effervesce with nitric acid, which proves that the argillaceous interposed part is not marl, but plastic clay. When heated in a glass tube, water rises at first; but when the tube becomes red hot, sulphurous acid is disengaged in great

great abundance. Treated by the blowpipe with nitrate of cobalt, it assumes the fine blue colour which denotes alumina.

It dissolves almost entirely in caustic potash; and this solution affords by nitric acid a precipitate which is redissolved by an excess of acid. This last solution is precipitated by ammonia and by barytes.

These experiments sufficiently prove the presence of water, alumina, and sulphuric acid, and also the absence of silica.

The complete analysis by M. J. Dumas gives

Sulphuric acid................	23
Alumina	30
Water...........................	47

and this result agrees in the constituent principles and their proportions with those of the Websterite of Halle and Newhaven.

Thus, we perceive, as I have stated in the commencement of this notice, that this friable substance, which has more the appearance of an adventitious earthy mixture than of a mineral species, presents in its composition, an identity of principles, together with a precision in their proportions, rarely found in crystallized minerals, which indicate, by their solidity and limpidity, species completely limited. We see it also placed in geological positions and circumstances of which the constancy is no less striking. There is, however, between the Websterite of Autueil, and that of other localities, a slight difference of structure, which may serve to establish a variety in this species. It has the oolitic structure; and we may therefore distinguish it by the name of *Oolitic Websterite of Auteuil.*

XIII. *On the Phænomena of Volcanoes.* *By Sir* HUMPHRY DAVY, *Bart. F.R.S.*[*]

WHEN in the years 1807 and 1808 I discovered that the alkalies and the earths were composed of inflammable matter united to oxygen, a number of inquiries suggested themselves with respect to various parts of chemical science, some of which were capable of being immediately assisted by experiment, and others required for their solution a long series of observations, and circumstances obtained only with difficulty. Of the last kind were the inferences concerning the geological appearances connected with these discoveries.

The metals of the alkalies, and those of such of the earths as I had decomposed, were found to be highly combustible, and altered by air and water even at the usual temperatures of

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[*] From the Philosophical Transactions, for 1828. Part I.

of the atmosphere; it was not possible, consequently, that they should be found at the surface of the globe, but probable that they might exist in the interior: and allowing this hypothesis, it became easy to account for volcanic fires, by exposure of the metals of earths and alkalies to air and water; and to explain, not only the formation of lavas, but likewise that of basalts and many other crystalline rocks, from the slow cooling of the products of combustion or oxidation of the newly-discovered substances.

I developed this opinion in a paper on the decomposition of the earths, published in 1808; and since 1812 I have endeavoured to gain evidence respecting it by examining volcanic phænomena of ancient and recent occurrence in various parts of Europe.

In this communication I shall have the honour of laying before the Royal Society some results of my inquiries. If they do not solve the problem respecting the cause of volcanic fires, they will, I trust, be found to offer some elucidations of the subject, and may serve as the foundation of future labours.

The active volcano on which I have made my observations is Vesuvius; and there probably does not exist another so admirably fitted for the purpose: its vicinity to a great city; the facility with which it may be ascended in every season of the year; and the nature of its activity,—all offer peculiar advantages to the philosophic inquirer.

I had made several observations on Vesuvius in the springs of 1814 and 1815, which I shall refer to on a future occasion in these pages; but it was in December 1819, and January and February 1820, that the volcano offered the most favourable opportunity for investigation. On my arrival at Naples, December 4, I found that there had been a small eruption a few days before, and that a stream of lava was flowing with considerable activity from an aperture in the mountain a little below the crater. On the 5th I ascended the mountain, and examined the crater and the stream of lava. The crater emitted so large a quantity of smoke, with muriatic and sulphurous acid fumes, that it was impossible to approach it except in the direction of the wind; and it threw up every two or three minutes showers of red hot stones. The lava was flowing from an aperture about one hundred yards below it, being apparently forced out by elastic fluids with a noise like that made by the steam disengaged from a pressure engine; it rose, perfectly fluid, forming a stream of from five to six feet in diameter, and immediately fell, as a cataract, into a chasm about forty feet below, where it was lost under a kind of bridge formed of cooled lava; but it re-appeared sixty or seventy yards further down.

down. Where it issued from the mountain, it was nearly white hot, and exhibited an appearance similar to that which is shown when a pole of wood is introduced into the melted copper of a foundry, its surface appearing in violent agitation, large bubbles rising, which in bursting produced a white smoke; but the lava became of a red colour, though still visible in the sunshine, where it issued from under the bridge. The force with which it flowed was so great, that the strength of the guide, a very stout young man, was insufficient to keep a long iron rod in the current. The whole of its course, with two or three interruptions where it flowed under a cooled surface, was nearly three quarters of a mile, and it threw off clouds of a white smoke. It smoked less as it cooled and became pasty; but even where it terminated in moving masses of scoria, smoke was still visible, which became more distinct whenever the scoria was moved, or the red hot lava in the interior exposed.

Having ascertained that it was possible to approach within four or five feet of the lava, and to examine the vapour immediately close to the aperture, I returned the next day, having provided the means of making a number of experiments on the nature of the lava, and of the elastic fluids with which it was accompanied. I found the aperture nearly in the same state as the day before, but the lava spread over a larger surface, forming an eddy in the hollow of the rock, over which it fell, from which it could be raised in an iron ladle more easily than from the current, and where there was much more facility of placing and withdrawing substances intended to be exposed to its agency.

One of the most important points to be ascertained was, whether any combustion was going on at the moment the lava issued from the mountain. There was certainly no appearance of more vivid ignition when it was exposed to air, nor did it glow with more intensity when it was raised into the air by an iron ladle. I put the circumstance, however, beyond the possibility of doubt: I threw some of the fused lava into a glass bottle furnished with a ground stopper, containing siliceous sand in the bottom: I closed it at the moment, and examined the air on my return. A measure of it mixed with a measure of nitrous gas gave exactly the same degree of diminution as a measure of common air which had been collected in another bottle on the mountain.

I threw upon the surface of the lava nitre, both in mass and in powder. After this salt had fused, there was a little increase of vividness in the ignition of the lava, but much too slight to be referred to pure combustible matter in any quantity; and on making the experiment on a portion of lava taken up in the ladle, it appeared that the disengagement of heat was partly owing to the peroxidation of the protoxide of iron, and to the combination of the alkali of the nitre with the earthy basis of the lava; for where the nitre had melted, the colour had changed from olive to brown. This conclusion was still further proved by the circumstance that chlorate of potash thrown upon the lava did not increase its degree of ignition so much as nitre. When a stick of wood was introduced into a portion of the lava so as to leave a little carbonaceous matter on its surface, nitre or chlorate of potassa then thrown upon it caused it to glow with great brilliancy. Some fused lava was thrown into water, and a glass bottle filled with water held over it to collect the gas disengaged; it was in very minute quantity only, and when analysed on my return proved to be common air a little less pure than that disengaged from the water by boiling. A wire of copper of $\frac{1}{20}$th of an inch in diameter, and a wire of silver of $\frac{1}{30}$th, introduced into the lava near its source, were instantly fused: an iron rod of $\frac{1}{5}$th of an inch, with a piece of iron wire of about $\frac{1}{30}$th, were kept for five minutes in the eddy in the stream of lava; they were not fused; they did not produce any smell of sulphuretted hydrogen when acted on by muriatic acid. A tin-plate funnel filled with cold water was held in the fumes disengaged with so much violence from the aperture through which the lava issued: fluid was immediately condensed upon it, which was of an acid and subastringent taste. It did not precipitate muriate of baryta; but copiously precipitated nitrate of silver, and rendered the triple prussiate of potassa of a bright blue. When the same funnel was held in the white fumes above the lava where it entered the bridge, no fluid was precipitated upon it, but it became coated with a white powder which had the taste and chemical qualities of common salt, and proved to be this substance absolutely pure. A bottle of water holding about $\frac{3}{4}$ of a pint, with a long narrow neck, was emptied immediately in the aperture from which the vapours pressing out the lava issued, and the neck was immediately closed. This air examined on my return was found to give no absorption with solution of potassa; so that it contained no notable proportion of carbonic acid, and it consisted of 9 parts of oxygen and 91 of azote. There was not the least smell of sulphurous acid in the vapour from the aperture, nor were the fumes of muriatic acid so strong as to be unpleasant; but during the last quarter of an hour that I was engaged in these experiments, the wind changed, and blew the smoke from the crater upon the spot where I was standing: the sulphurous acid gas in the fumes was highly irritating to the organs of respiration, and I suffered so much from the exposure to them that I was obliged to descend; and the effect was not transient, for a violent catarrhal affection ensued, which prevented me for a month from again ascending the mountain.

On the 6th of January I made another visit to Vesuvius. I found the appearance of the lava considerably changed; the bocca from which it issued on the 5th of December was closed, and the current now flowed quietly and without noise from a chasm in the cooled lava about three hundred feet lower down. The heat was evidently less intense. I repeated my experiments with nitre with the same results, and exposed pure silver and platinum to the fused lava: they were not at all changed in colour. I collected the sublimations from various parts of the cooled lava above. The rocks near the ancient bocca were entirely covered with white, yellow, and reddish saline substances. I found one specimen of large saline crystals in a cavity, which had a slight tint of purple: this examined, proved to be common salt with a minute portion of muriate of cobalt. The other sublimations consisted of common salt in great excess, much chloride of iron, some sulphate of soda; and by the test of muriate of platinum, there appeared to exist in them a small quantity of sulphate or muriate of potassa; and a solution of ammonia detected the presence of a minute quantity of the oxide of copper.

During the months of January and February I made several visits to the top of Vesuvius: I shall not particularize them all; but shall mention only such as afforded me some new observations. On the 26th of January, the lava was seen nearly white hot through a chasm near the place where it flowed from the mountain. I threw nitre upon it in large quantities through this chasm, in the presence of H. R. H. the Prince of Denmark, whom I had the honour of accompanying in this excursion to the mountain, and my friend the Cavaliere Monticelli: there was no more increase of ignition than when the experiment was made on lava exposed to the free air. The appearance of the sublimations was now considerably changed: those near the aperture were coloured green and blue by salts of copper; but there was still a great quantity of muriate of iron. I have mentioned, that on the 5th the sublimate of the lava was pure chloride of sodium: in the sublimate of January 6th, there were both sulphate of soda and indications of sulphate of potassa. In the sublimates that I collected on the 26th, the sulphate of soda was in much larger quantities, and there was much more of a salt of potassa. From the 5th of December to the 20th of February, the lava flowed in larger or smaller quantities, so that at night a stream of ignited matter

ter was always visible, more or less interrupted by cooled lava. It changed its direction according to the obstacles it met with; and never, according to appearances, extended so much as a mile from its source. During the whole of this time the craters, of which there were two, were in activity. The large crater threw up showers of ignited ashes and stones to a height apparently of from 200 to 500 feet; and from a smaller crater, to the right of the large one on the side of Naples, steam arose with great violence. Whenever the crater could be approached it was found incrusted with saline incrustations; and the walk to the edge of the small crater on the 6th of January was through a mass of loose saline matter, principally common salt coloured by muriate of iron, in which the foot sunk to some depth. It was easy, even at a great distance, to distinguish between the steam disengaged by one of the craters, and the earthy matter thrown up by the other. The steam appeared white in the day, and formed perfectly white clouds, which reflected the morning and evening light of the purest tints of red and orange. The earthy matter always appeared as a black smoke, forming black clouds; and in the night it was highly luminous at the moment of the explosion.

On the 20th of February, the small crater which had been disengaging steam and elastic matter, began to throw out showers of stones; and both craters from the 20th to the 23rd were more than usually active. On the night of the 23rd, at half past 11 o'clock, being in my bed-room at Chiatimone, Naples, I heard the windows shake; and going to the window, I saw ascending from Vesuvius a column of ignited matter to a height at least equal to that of the mountain from its base; and the whole horizon was illuminated, notwithstanding the brightness of the moon, with direct volcanic light, and that reflected from the clouds above the column of ignited matter. Several eruptions of the same kind, but upon a smaller scale, followed at intervals of a minute and a half or two minutes; but there were no more symptoms of earthquake, nor did I hear any noise. On observing the lava, it appeared at its origin much broader and more vivid; and it was evident that a fresh stream had broken out to the right of the former one. On the morning of the 24th I visited the mountain; it was not possible to ascend to the top, which was covered with clouds, nor to examine the orifice from which the lava issued. The stream of lava near the place where it terminated was from 50 to 100 feet broad. It had precisely the same appearances as the lava which had been so long running. I collected the saline matter condensed upon some of the masses of scoria which were carried along by the current and deposited on the

edge

edge of the stream; they proved to be the same in the nature of their constituent parts as those of the lava of the 26th of January, but with a larger proportion of sulphate of soda, and a smaller proportion of muriate of iron; and I have no doubt that the dense white smoke which was emitted in immense columns by the lava during the whole of its course, was produced by the same substances.

I shall now mention the state of the volcano at some other periods.

When I was at Naples in May 1814, the crater had the appearance of an immense funnel, closed at the bottom, with many small apertures emitting steam; and on the side towards Torre del Greco, there was a large aperture from which flame issued to a height of at least 60 yards, producing a most violent hissing noise. This phænomenon was constant during the three weeks I remained at Naples. It was impossible to approach sufficiently near the flame to ascertain the results of the combustion; but a considerable quantity of steam ascended from it. When the wind blew the vapours upon us, there was a distinct smell both of sulphurous and muriatic acids. There was no indication of carbonaceous matter from the colour of the smoke; nor was any deposited upon the yellow and white saline matter which surrounded the crater, and which I found to be principally sulphate and muriate of soda, and muriate of iron: in some specimens there was a considerable quantity of muriate of ammonia.

In March 1815, the appearances presented by the crater were entirely different. There was no aperture in the crater; it was often quiet for minutes together, and then burst out into explosions with considerable violence, sending fluid lava and ignited stones and ashes to a considerable height, many hundred feet, in the air.

These eruptions were preceded by subterraneous thunder, which appeared to come from a great distance, and which sometimes lasted for a minute. During the four times that I was upon the crater in the month of March, I had at last learnt to estimate the violence of the eruption from the nature of the sound: loud and long continued subterraneous thunder indicated a considerable explosion. Before the eruption the crater appeared perfectly tranquil; and the bottom, apparently without an aperture, was covered with ashes. Soon, indistinct rumbling sounds were heard as if at a great distance; gradually the sound approached nearer, and was like the noise of artillery fired under our feet. The ashes then began to rise and to be thrown out with smoke from the bottom of the crater; and lastly, the lava and ignited matter was ejected with a most violent

violent explosion. I need not say that when I was standing on the edge of the crater witnessing this phænomenon, the wind was blowing strongly from me: without this circumstance it would have been dangerous to have stood on the edge of the crater; and whenever from the loudness of the thunder the eruption promised to be violent, I always ran as far as possible from the seat of danger.

As soon as the eruption had taken place, the ashes and stones which rolled down the crater seemed to fill up the aperture, so that it appeared as if the ignited and elastic matter were discharged laterally; and the interior of the crater assumed the same appearance as before.

I shall now offer some observations on the theory of these phænomena. It appears almost demonstrable that none of the chemical causes anciently assigned for volcanic fires can be true. Amongst these, the combustion of mineral coal is one of the most current; but it seems wholly inadequate to account for the phænomena. However large a stratum of pit-coal, its combustion under the surface could never produce violent and extensive heat; for the production of carbonic acid gas, when there was no free circulation of air, must tend constantly to impede the process: and it is scarcely possible that carbonaceous matter, if such a cause existed, should not be found in the lava, and be disengaged with the saline or aqueous products from the bocca or craters. There are many instances in England of strata of mineral coal which have been long burning; but the results have been merely baked clay and schists, and it has produced no result similar to lava.

If the idea of Lemery were correct, that the action of sulphur on iron may be a cause of volcanic fires, sulphate of iron ought to be the great product of the volcano; which is known not to be the case; and the heat produced by the action of sulphur on the common metals, is quite inadequate to account for the appearances. When it is considered that volcanic fires occur and intermit with all the phænomena that indicate intense chemical action, it seems not unreasonable to refer them to chemical causes. But for phænomena upon such a scale, an immense mass of matter must be in activity, and the products of the volcano ought to give an idea of the nature of the substances primarily active. Now what are these products? Mixtures of the earths in an oxidated and fused state, and intensely ignited; water and saline substances, such as might be furnished by the sea and air, altered in such a manner as might be expected from the formation of fixed oxidated matter. But it may be said, if the oxidation of the metals of the earths be the causes of the phænomena, some of these substances ought occasionally to be found in the lava, or the combustion ought to be increased at the moment the materials passed into the atmosphere. But the reply to this objection is, that it is evident that the changes which occasion volcanic fires, take place in immense subterranean cavities; and that the access of air to the acting substances occurs long before they reach the exterior surface.

There is no question but that the ground under the solfaterra is hollow, and there is scarcely any reason to doubt of a subterraneous communication between this crater and that of Vesuvius: whenever Vesuvius is in an active state, the solfaterra is comparatively tranquil. I examined the bocca of the solfaterra on the 21st of February 1820, two days before the activity of Vesuvius was at its height: the columns of steam which usually arise in large quantities when Vesuvius is tranquil, were now scarcely visible, and a piece of paper thrown into the aperture did not rise again; so that there was every reason to suppose the existence of a descending current of air*. The subterraneous thunder heard at such great distances under Vesuvius, is almost a demonstration of the existence of great cavities below filled with aëriform matter: and the same excavations which in the active state of the volcano throw out during so great a length of time immense volumes of steam, must, there is every reason to believe, in its quiet state become filled with atmospheric air†.

To what extent subterraneous cavities may exist even in common rocks, is shown in the limestone caverns of Carniola, some of which contain many hundred thousand cubical feet of air; and in proportion as the depth of an excavation is greater, so is the air more fit for combustion.

The same circumstance which would give alloys of the metals of the earths the power of producing volcanic phænomena, namely, their extreme facility of oxidation, must likewise prevent them from ever being found in a pure combustible state in the products of volcanic eruptions; for before they reach the external surface, they must not only be exposed to the air in the subterranean cavities, but be propelled by steam; which must possess, under the circumstances, at least the same facility of oxidating them as air. Assuming the hypothesis of the

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* In 1814, in 1815, and in January 1819, when Vesuvius was comparatively tranquil, I observed the solfaterra in a very active state, throwing up large quantities of steam and some sulphuretted hydrogen.

† Vesuvius is a mountain admirably fitted, from its form and situation, for experiments on the effect of its attraction on the pendulum: and it would be easy in this way to determine the problem of its cavities. On Etna, the problem might be solved on a larger scale.

existence of such alloys of the metals of the earths as may burn into lava in the interior, the whole phænomena may be easily explained from the action of the water of the sea and air on those metals; nor is there any fact or any of the circumstances which I have mentioned in the preceding part of this paper, which cannot be easily explained according to that hypothesis. For almost all the volcanoes in the old world of considerable magnitude are near, or at no considerable distance from the sea: and if it be assumed that the first eruptions are produced by the action of sea water upon the metals of the earths, and that considerable cavities are left by the oxidated metals thrown out as lava, the results of their action are such as might be anticipated; for after the first eruptions, the oxidations which produce the subsequent ones may take place in the caverns below the surface; and when the sea is distant, as in the volcanoes of South America, they may be supplied with water from great subterranean lakes; as Humboldt states that some of them throw up quantities of fish.

On the hypothesis of a chemical cause for volcanic fires, and reasoning from known facts, there appears to me no other adequate source than the oxidation of the metals which form the bases of the earths and alkalies; but it must not be denied that considerations derived from thermometrical experiments on the temperature of mines and of sources of hot water, render it probable that the interior of the globe possesses a very high temperature: and the hypothesis of the nucleus of the globe being composed of fluid matter, offers a still more simple solution of the phænomena of volcanic fires than that which has been just developed.

Whatever opinion may be ultimately formed or adopted on this subject, I hope that these inquiries on the actual products of a volcano in eruption will not be without interest for the Royal Society.

XIV. *Rationale of the Difficulty of separating Plane Surfaces by a Blast, in certain Cases.* *By* R. Hare, *M.D. Professor of Chemistry in the University of Pennsylvania.*[*]

THE phænomenon above alluded to, is usually illustrated by means of two discs, into the centre of one of which, a tube is fastened, so that on blowing through the tube, the current is arrested by the other moveable disc. Under these circumstances, the moveable disc is not removed as would be naturally expected. Supposing the diameter of the discs to be

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[*] Communicated by the Author.

be to that of the orifice as 8 to 1, the area of the former to the latter must be as 64 to 1. Hence if the discs were to be separated (their surfaces remaining parallel) with a velocity as great as that of the blast, a column of air must meanwhile be interposed 64 times greater than that which would escape from the tube during the interim. Consequently, if all the air necessary to preserve the equilibrium be supplied from the tube, the discs must be separated with a velocity as much less than that of the blast, as the column, required between them, is greater than that yielded by the tube; and yet the air cannot be supplied from any other source, unless a deficit of pressure be created between the discs, unfavourable to their separation.

It follows, then, that under the circumstances in question, the discs cannot be made to move asunder with a velocity greater than 1-64th of that of the blast. Of course all the momentum of the aërial particles which constitute the current through the tube, will be expended on the moveable disc, and the thin ring of air which exists around the orifice between the discs; and since the moveable disc can only move with 1-64th of the velocity of the blast, the ring of air in the interstice must experience nearly all the momentum of the jet, and must be driven outwards; the blast following it in various currents radiating from the common centre of the tube and discs. The effect of such currents in producing an afflux of the adjoining portions of any fluid in which they may be excited, is well known, having been successfully illustrated by Venturi. (See Nicholson's Journal, quarto series, vol. ii. p. 172.) Accordingly the afflux of air towards the discs counteracts the small velocity which the blast would communicate, and thus prevents their separation, and may even cause them to approach each other, if previously situated a small distance apart.

This rationale commences with the assumption, that the discs will remain nearly parallel. That there cannot be much deviation from parallelism must be evident; since any obliquity will make the opening greater on one side than on the other; and the jet proceeding with most force towards the widest opening, will increase the afflux of air upon the outer surface of the moveable disc in the part where the current is strongest, and thus correct the obliquity.

XV. *Chemical Examination of the Oxides of Manganese. By* EDWARD TURNER, *M.D. F.R.S. Ed. Professor of Chemistry in the University of London, and Fellow of the Royal College of Physicians of Edinburgh.*

[Concluded from p. 35.]

PART II.

On the Composition of the Ores of Manganese described by Mr. Haidinger.

Method of Analysis.—PURE fragments of the ores were carefully selected, reduced to fine powder in a mortar of agate, and washed with distilled water. Some of the ores yielded nothing to the action of water; but from some of them, especially from those of Ihlefeld, minute quantities of the muriate and sulphate of lime, and sometimes of soda, were separated by the action of water. It is the accidental presence of the muriates which gives rise to the disengagement of chlorine when sulphuric acid is added to some of the native oxides of manganese, and which induced Mr. Macmullin to regard chloric acid as a constituent of these ores. For the correction of this error we are indebted to Mr. Richard Phillips*, with whose observation my own experiments correspond;—none of the native oxides yield a trace of chlorine on the addition of sulphuric acid, provided the muriates have been previously removed by washing.

The ores, before being submitted to analysis, were dried at 212° F., by which means they were brought to the same degree of dryness which they possessed before being washed. The water naturally contained in them was ascertained in every instance by heating a known quantity of the ore to redness, and collecting the water in a tube filled with fragments of the chloride of calcium.

The quantity of oxygen was in most cases ascertained both by bringing the ore to the state of red oxide by exposure to a white heat, and by converting it into the protoxide by means of heat and hydrogen gas. When performed with the precautions stated in the first part of this communication, either of these methods may be relied on with confidence; but the first is more convenient in general practice, because it requires less time and a more simple apparatus. The latter is sometimes very troublesome, owing to the difficulty with which some of the ores of manganese, the native peroxide for example, are reduced

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* Phil. Mag. and Annals, vol. i. p. 313.

reduced by hydrogen to the state of pure protoxide. I have in no instance estimated the quantity of oxygen by means of the deutoxide, the formation of this compound being in my opinion too uncertain to admit of any analytic process being founded upon it.

In searching for the presence of foreign matters I have employed the following processes. The water which was expelled from the ores by heat, was examined with test paper, but was always found quite free from alkaline or acid reaction. The absence of carbonates was ascertained by the entire want of effervescence on the addition of dilute nitric acid. Strong sulphuric acid did not cause the evolution of chlorine or any acid fumes.

On dissolving the ores in muriatic acid and evaporating the solution to perfect dryness, the residue, with the exception of a little siliceous matter and red oxide of manganese proceeding from slight decomposition of the chloride, was always completely redissolved by water. This circumstance demonstrates the absence of phosphoric and arsenic acids, which, if present, would have been left as the insoluble phosphate or arseniate of manganese. By well known methods I satisfied myself of the absence of sulphuric acid, alumina, and magnesia. In several of the ores the oxalate of ammonia detected a trace of lime. It is remarkable that every species, with one exception, contains baryta. In most of them, indeed, it is present only as an impurity; but in two of the ores, the uncleavable manganese-ore or black hematite, and the *manganèse oxidé noir barytifère* of Haüy, it is an essential ingredient of the mixture. In those species in which this earth exists as an impurity, it is not united with the sulphuric or carbonic acid; but is most probably combined with the peroxide of manganese.

From the frequency with which iron has been found accompanying the ores of manganese, I was led to expect its presence, and employed the ferrocyanate of potash and hydrosulphuret of ammonia as re-agents for its detection. The muriatic solution of the different species yielded a white precipitate with the ferrocyanate of potash, and the characteristic flesh-coloured sulphuret of manganese with the hydrosulphuret of ammonia. It hence follows that all the ores submitted to analysis, even the uncleavable manganese-ore, which has been placed among the ores of iron, are perfectly free from iron, as well as from copper, lead, and similar metallic substances.

Analysis of Manganite or the Prismatoidal Manganese-ore.—This ore, even when selected with the greatest care, yields to distilled water traces of the muriates and sulphates of lime and soda. It dissolves without residue in muriatic acid, and is free from siliceous earth, lime, baryta, and every other impurity. It is the purest native oxide of manganese which has fallen under my notice. Its powder has a uniform brown tint, and I have been unable to observe in it any tendency to pass into the peroxide by absorbing oxygen from the air. After exposure to the air for six months, during which it was frequently moistened with distilled water, it underwent no change of weight. Cold sulphuric acid acts very feebly on this oxide. M. Gmelin* of Heidelberg states that it is not dissolved at all by this acid in the cold, and I was at first of the same opinion: but by employing a considerable quantity of the oxide, and agitating the mixture frequently, the acid does acquire a red tint in the course of two or three days. In this respect manganite agrees with the peroxide; but differs from all the other species, which communicate a red colour to cold sulphuric acid with much greater facility.

When manganite is heated to redness it gives out 10·10 per cent of water; and the total loss from exposure to a white heat is 13·15 per cent. Deducting from the last number the amount of water, 3·05 remain as the loss in oxygen. The result of this analysis is therefore,

Red oxide..................	86·85
Oxygen......................	3·05
Water........................	10·10
	100·00

According to this analysis, manganite contains an oxide of manganese, 89·9 parts of which yield 3·05 of oxygen, on being converted into the red oxide. An equal quantity of pure deutoxide, in undergoing a similar change, should lose 2·997 of oxygen.

Exposed to a strong red heat and a current of hydrogen gas, 100 parts of manganite lost 19·09 parts in one experiment, and 19·07 in another. The mean is 19·08, and subtracting 10·10 as water, 8·98 remain as oxygen. According to this analysis the manganite is composed of

Protoxide..................	80·92
Oxygen	8·98
Water........................	10·10
	100·00

Now as 80·92 : 8·98 : : 36 : 3·995.

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* I regret that I have been unable to obtain a sight of that volume of the *Zeitschrift der Mineralogie*, which contains M. Gmelin's paper on the composition of the oxides of manganese. My knowledge of his labours is solely derived from M. Leonhard's *Handbuch der Oryktognosie*.

From

From the result of both analyses it is apparent that manganite, in relation to manganese and oxygen, is a deutoxide.

Also as 89·90 : 10·10 : : 40 : 4·494.

The fourth number is so near 4·5, half an equivalent of water, that we may safely regard manganite as a compound of 80 parts or two equivalents of the deutoxide of manganese, and 9 parts or one equivalent of water.

The material for the preceding analysis was taken from a very fine crystallized specimen from Ihlefeld. The result of Gmelin's analysis of the same variety is as follows:—Red oxide 87·1, oxygen 3·4, water 9·5. The water is here certainly underrated.

The grey oxide from Undenaes in West Gothland, analysed by Arfwedson, is a similar compound.

Analysis of the Brachytypous Manganese-ore or Braunite.—The colour of this ore, both in mass and in powder, is nearly black. With sulphuric acid it yields no distinct odour of chlorine. It dissolves in muriatic acid, leaving a trace of siliceous matter. The solution gives a precipitate of sulphate of baryta with sulphuric acid, but does not contain any other impurity. Of all the native oxides this is the most easily reduced to the state of protoxide by the action of hydrogen gas. The material for analysis formed part of a specimen from Elgersburg.

As a mean of two closely corresponding experiments, this oxide contains 0·949 per cent of water.

To ascertain the quantity of oxygen, 16·634 grains were exposed for half an hour to the action of hydrogen gas at a red heat. The residue weighed 14·837 grains, and had the light green tint of the protoxide. The total loss was 1·797 grains, or 10·80 per cent; and subtracting 0·949 for water, there remains 9·851 per cent as the loss in oxygen.

The baryta was precipitated by sulphuric acid from a solution in muriatic acid of 42·09 grains of the mineral. The precipitate after being heated to redness amounted to 1·44 grains, equivalent to 0·951 of a grain or 2·26 per cent of pure baryta. According to this analysis, 100 parts of the ore contain

Protoxide	86·94
Oxygen	9·851
Water	0·949
Baryta	2·260
Silica	a trace.
	100·000

Now 86·94 : 9·851 : : 36 : 4·079; and as the presence of water and baryta, from the small quantity of these substances, must be regarded rather as accidental than essential to the mixture, it follows that braunite is an anhydrous deutoxide of manganese. I apprehend the baryta must be in combination with deutoxide of manganese; since, were it united with peroxide, the loss in oxygen would exceed the quantity above stated.

I am not acquainted with any analysis of this mineral by other chemists.

Analysis of the Pyramidal Manganese-ore or Hausmannite.— Hausmannite, before being washed, yields a faint odour of chlorine by the action of sulphuric acid. When heated to redness it gives off 0·435 per cent of water; and at a white heat the loss is only 0·65 per cent, indicating 0·215 of oxygen. When dissolved in muriatic acid, a small quantity of silica is left, amounting to 0·337 per cent; and on adding sulphuric acid to the solution, a little sulphate of baryta subsides, indicating 0·111 per cent of the pure earth. Hausmannite is accordingly resolved by this analysis into

Red oxide	98·098
Oxygen	0·215
Water	0·435
Baryta	0·111
Silica	0·337
	100·000

This oxide is manifestly an anhydrous red oxide of manganese. The small quantity of oxygen lost at a white heat is probably owing to the admixture of a little deutoxide or peroxide, combined with the baryta.

From some preliminary experiments on hausmannite, M. Gmelin of Heidelberg* inferred that it is a pretty pure red oxide, an inference which entirely agrees with the result of the preceding analysis. This is the only chemical examination of hausmannite by other chemists, which I have met with. The material for my analysis was part of a specimen from Ihlefeld, for which I am indebted to the kindness of Professor Stromeyer.

Analysis of Pyrolusite, or the Prismatic Manganese-ore.— The following analysis was made with a compact columnar variety from Elgersburg, which has a specific gravity of 4·94, and the individuals of which have a parallel direction. With sulphuric acid it does not yield a trace of chlorine; and the only impurities which I could discover in it are silica and baryta, the former amounting to 0·513, and the latter to 0·532 per cent.

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* Leonhard's *Handbuch der Oryktognosia.*

The

The quantity of water was determined as usual by means of the chloride of calcium, and amounted to 1·12 per cent.

On exposing 23·746 grains of this oxide to a white heat, the loss proved to be 3·064 grains or 12·90 per cent. Subtracting 1·12 for water, there remain 11·78 as the loss of oxygen.

Accordingly, 100 parts of the pyrolusite were resolved into

Red oxide	84·055
Oxygen	11·78
Water	1·12
Baryta	0·532
Silica	0·513
	100·000

Now, omitting the water, baryta, and silica as accidental impurities, the remaining 97·835 parts lose 11·78 parts, or 12·04 per cent of oxygen in being converted into the red oxide. On the supposition that pyrolusite is composed of one equivalent of manganese and two equivalents of oxygen, it should lose in passing into the state of red oxide exactly 12·122 per cent of oxygen, a quantity which corresponds closely with the result of analysis. It is therefore an anhydrous peroxide of manganese.

I have analysed another columnar variety of pyrolusite, which has a density of 4·819, and of which the individuals radiate from a common centre. I brought it with me from Germany, and believed it to be from Ihlefeld, as the ticket indicated; but Mr. Haidinger, after carefully inspecting several large cabinets in Germany, has been unable to discover any similar specimen which is known to have been found in that place. Its locality therefore is doubtful.

This variety is less pure than the foregoing. Before being washed, it yields chlorine on the addition of sulphuric acid; and after the muriates have been removed by distilled water, the neutral solution in muriatic acid gives traces of lime with oxalate of potash. It contains silica and baryta nearly in the same proportion as the first variety.

The following is the result of my analysis:

Red oxide	85·617
Oxygen	11·599
Water	1·566
Silica	0·553
Baryta	0·665
Lime	a trace.
	100·000

Subtracting

Subtracting 2·784 as impurities, there remain 97·214 parts, which lose 11·599, or 11·931 per cent, of oxygen in being converted into the red oxide. It is therefore an anhydrous peroxide, most probably containing an admixture of some other oxide.

Analysis of Psilomelane, or the Uncleavable Manganese-ore.—This mineral when reduced to powder has a brownish-black colour. With sulphuric acid it does not emit any odour of chlorine. It dissolves completely in muriatic acid, excepting a small quantity of silica which amounts to 0·26 per cent; and the only substances which I could detect in the solution are baryta and the oxide of manganese. Though this ore has been placed by mineralogists among the oxides of iron, under the names of Black Hematite and Black Iron-ore, pure fragments of it do not contain a trace of that metal.

When heated to redness psilomelane gives out 6·216 per cent of water. The diminution in weight occasioned by exposure to a white heat is 13·58 per cent; and on subtracting 6·216 for water, there remains 7·364 as the loss in oxygen.

To ascertain the quantity of baryta 30·028 grains of the mineral were dissolved in muriatic acid, and the baryta precipitated by means of the sulphate of soda, a considerable excess of muriatic acid being allowed to remain in the liquid, to prevent any manganese from adhering to the precipitate. The sulphate of baryta, after exposure to a red heat, amounted to 7·434 grains, equivalent, according to the atomic numbers of Dr. Thomson, to 4·914 grains, or 16·365 per cent of pure baryta.

According to this analysis, 100 parts of psilomelane have yielded of

Red oxide............	69·795
Oxygen...............	7·364
Baryta	16·365
Silica.................	0·260
Water	6·216
	100·000

The precise atomic constitution of psilomelane is not made apparent by this analysis; and, indeed, the result is of such a nature as to leave no doubt of this mineral containing more than one oxide of manganese. For it follows, from the quantity of oxygen expelled by heat, that a considerable part of the manganese must be in the form of peroxide; but it is equally clear that the whole of it cannot be in that state, because 69·795 parts of red oxide require 9·627 instead of 7·364 parts of oxygen to constitute the peroxide. On perceiving this

this deficiency of oxygen, I at first suspected that the baryta might prevent the usual quantity of oxygen from being expelled from the peroxide by heat. Accordingly I ascertained the quantity of pure red oxide by the way of precipitation; but its amount corresponded closely with the number already stated. Psilomelane must therefore, I conceive, be a mixed mineral. I was at first disposed to regard it as a compound of baryta and peroxide of manganese, accidentally containing an admixture of some other oxide in a lower stage of oxidation; but the fact noticed by Mr. Haidinger of psilomelane being frequently and intimately associated with pyrolusite in the mineral kingdom, appears to justify the inference, that the uncleavable manganese-ore consists essentially of some compound, in proportions not yet ascertained, of baryta and the deutoxide of manganese, and that pyrolusite is the accidental ingredient. The propriety of this view is further shown by an analysis of the following ore from Romanèche, a mineral which is analogous to psilomelane in the proportion of its ingredients, and in which an admixture of pyrolusite may be detected by the eye.

Analysis of the Manganèse oxidé noir Barytifère *from Romanèche.*—The observations of Mr. Haidinger leave no doubt of this ore being a mixed mineral; and according to my analysis it is very analogous to psilomelane. The specific gravity of some of the purest fragments which I could select, is 4·365; and the density of psilomelane, according to Mr. Haidinger, is 4·145. The colour of both minerals is similar.

The black oxide of Romanèche yields a very faint odour of chlorine with sulphuric acid. When heated to redness it gives out 4·13 per cent of water. At a white heat it loses 11·39 per cent; and after subtracting 4·13 for water, there remain 7·26 as the loss in oxygen.

In order to ascertain the quantity of baryta, 32·13 grains were dissolved in muriatic acid; and after separating a small portion of silica, which amounted to 0·953 per cent, I precipitated the baryta by means of the sulphate of soda. The insoluble sulphate, after exposure to a red heat, weighed 8·113 grains, equivalent to 5·363 grains, or 16·69 per cent of pure baryta. 100 parts of the oxide are accordingly resolved into

Red oxide	70·967
Oxygen	7·260
Baryta	16·690
Silica	0·953
Water	4·130
	100·000

This

This mineral was analysed some years ago by Vauquelin and Dolomieu; but the numbers which they have mentioned, owing to the insufficient mode of analysis employed at that time, are not entitled to any confidence.—(*Journal des Mines* ix. 778.)

XVI. *General Solution of the Problem: to represent the Parts of a given Surface on another given Surface, so that the smallest Parts of the Representation shall be similar to the corresponding Parts of the Surface represented. By* C. F. GAUSS. *Answer to the Prize Question proposed by the Royal Society of Sciences at Copenhagen**.

Ab his via sternitur ad majora.

THE author of this paper believes that he must consider the repeated selection by the Royal Society of the question which forms the subjects of it, as a proof of the importance which the Royal Society attaches to it; and has thereby been induced to submit a solution found by him some considerable time since, as the lateness of the time at which he was informed of the prize question would otherwise have prevented him from sending an answer. He regrets that the latter circumstance has obliged him to limit his inquiry to the essential part only, besides hinting some obvious applications to the projection of maps and the higher branches of geodetics. Had it not been for the near approach of the term fixed by the Society, he would have followed up several inquiries, and have detailed numerous applications of the subject to geodetical operations; all which he must now reserve to himself for another moment and another place.

December 1822.

1. The nature of a curve surface is determined by an equation between the coordinates belonging to every point of the same x, y, z. In consequence of this equation, every one of these three variable quantities may be considered as a function of the two others. It is still more general to introduce two new variable quantities t, u, and to represent each of the quantities x, y, z as a function of t and u, by which at least generally speaking, determinate values of t and u always belong to every determinate point of the surface, and *vice versâ*.

2. Let X, Y, Z, T, U have the same signification for a second surface, which x, y, z, t, u had in reference to the first.

3. To *represent* the former surface on the second means to establish

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* From Prof. Schumacher's *Astronomische Abhandlungen*, No. 3.

establish a law by which a determinate point of the second surface is to correspond to every point of the first. This will have been effected if T and U have been made equal to two functions of t and u. These functions will cease to be arbitrary as soon as they are required to satisfy certain conditions. As X, Y, Z next become likewise functions of t and u, these functions must, therefore, besides satisfying the conditions required by the nature of the second surface, also fulfill those of the representation.

The problem of the Royal Society of Sciences prescribes that the representation shall be similar to the object represented in the smallest parts. It is, therefore, first required to find an analytical expression for this condition. Let us suppose that the following equations are the result of the differentiation of the functions of t and u expressing the values of x, y, z, X, Y, Z.

$$\begin{aligned} dx &= a\,dt + a'du \\ dy &= b\,dt + b'du \\ dz &= c\,dt + c'du \\ d\mathrm{X} &= \mathrm{A}\,dt + \mathrm{A}'du \\ d\mathrm{Y} &= \mathrm{B}\,dt + \mathrm{B}'du \\ d\mathrm{Z} &= \mathrm{C}\,dt + \mathrm{C}'du \end{aligned}$$

The condition prescribed requires first that all infinitely small lines proceeding from one point of the first surface and situate in it, shall be proportionate to the corresponding lines on the second surface; and next, that the former shall form between them the same angles as the latter.

Such a linear element on the first surface has this expression

$$\sqrt{\left((a^2+b^2+c^2)dt^2+2(aa'+bb'+cc')\,dt\,du+(a'^2+b'^2+c'^2)du^2\right)}$$

and the corresponding one on the second surface is

$$\sqrt{\left((\mathrm{A}^2+\mathrm{B}^2+\mathrm{C}^2)\,dt^2+2\,(\mathrm{AA}'+\mathrm{BB}'+\mathrm{CC}')dt\,du+(\mathrm{A}'^2+\mathrm{B}'^2+\mathrm{C}'^2)du^2\right)}.$$

If both are to be in a certain ratio independent of dt and du, the three quantities

$$a^2+b^2+c^2,\ aa'+bb'+cc',\ a'^2+b'^2+c'^2$$

must evidently be respectively proportional to the three quantities

$$\mathrm{A}^2+\mathrm{B}^2+\mathrm{C}^2,\ \mathrm{AA}'+\mathrm{BB}'+\mathrm{CC}',\ \mathrm{A}'^2+\mathrm{B}'^2+\mathrm{C}'^2.$$

If we suppose that the values t, u and $t+\delta t$, $u+\delta u$ correspond to the extreme points of a second element on the first surface, the cosine of the angle formed between the two elements on that surface, will be

$$\frac{(a\,dt+a'du)(a\delta t+a'\delta u)+(b\,dt+b'du)(b\delta t+b'\delta u)+(c\,dt+c'du)(c\delta t+c'\delta u)}{\sqrt{\left[(a\,dt+a'du)^2+(b\,dt+b'du)^2+(c\,dt+c'du)^2\right]\cdot\left[(a\delta t+a'\delta u)^2+(b\delta t+b'\delta u)^2+(c\delta t+c'\delta u)^2\right]}}$$

and we shall obtain an exactly similar expression for the cosine of the corresponding angle on the second surface by changing a, b, c, a', b', c' into A, B, C, A′, B′, C′. The two expressions become clearly equal if the above-mentioned proportionality takes place, and the second condition is already comprehended in the first, as a little reflection will easily show.

The analytical expression of the condition of our problem is, therefore, this:

$$\frac{A^2+B^2+C^2}{a^2+b^2+c^2} = \frac{AA'+B\,.\,B'+C\,.\,C'}{aa'+bb'+cc'} = \frac{A'A'+B'B'+C'C'}{a'^2+b'^2+c'^2}.$$

Let the value of these equal quantities, which must be a finite function of t and u, be $= m^2$. The quantity m is therefore the index of the ratio in which linear quantities on the first surface are increased or diminished in their representation on the second surface (according as m is greater or smaller than 1). This ratio will, generally speaking, be different in different places: in the particular case in which m is constant, there will be a perfect similarity also in the finite parts; and if m is besides $= 1$, there will be a perfect equality, and the one surface may be developed on the other. Putting for brevity

$$(a^2+b^2+c^2)\,dt^2+2(aa'+bb'+cc')\,dt.du+(a'^2+b'^2+c'^2)du^2=\omega$$

we remark that the differential equation $\omega=0$ admits of two integrations. Representing the trinomial ω as the product of two factors linear with respect to dt and du, either of the two may be $= 0$, which will give two different integrations. One of the integrations will be derived from the equation : $0 =$

$$(a^2+b^2+c^2)\,dt+\{aa'+bb'+cc'+i\surd[(a^2+b^2+c^2)(a'^2+b'^2+c'^2)-(aa'+bb'+cc'^2)]\}du$$

(where i is written for brevity instead of $\surd-1$, for it will be easily seen that the irrational part of the expression must become imaginary), the other integration will be the result of a similar equation, which will be obtained by putting $-i$ in place of i in the former. If the integral of the first equation be this

$$p+iq = \text{const.}$$

where p and q denote real functions of t and u, the other integral will be

$$p-iq = \text{const.}$$

It follows from this, that $(dp+idq)(dp-idq)$ or dp^2+dq^2 must be a factor of ω, or that

$$\omega = n\,(dp^2+dq^2)$$

where n is a finite function of t and u.

Let us now denote by Ω the trinomial into which dX^2+

dY^2+

dY^2+dZ^2 will be converted by substituting for dX, dY, and dZ their values expressed by T, U, dT and dU; and let us assume that in a similar manner, as before, the two integrals of the equation $\Omega=0$ are as follow:

$$P+iQ = \text{const.} \quad ; \quad P-iQ = \text{const. and}$$

$\Omega = N.(dP^2+dQ^2)$ where P, Q, N denote real functions of T and U.

These integrations may evidently be effected (without taking into consideration the general difficulties of integrating) before the solution of our principal problem.

Now, if for T, U such functions of t and u are substituted as will fulfill the condition of our principal problem, Ω will be changed into $m^2\omega$, and we shall have

$$\frac{(dP+i\,dQ).(dP-i\,dQ)}{(dp+i\,dq)\cdot(dp-i\,dq)} = \frac{m^2n}{N}.$$

But it will be easily seen that the numerator in the first part of this equation cannot be divisible by the denominator, except if either

$dP+idQ$ is divisible by $dp+idq$, and $dP-idQ$ by $dp-idq$,

or,

$dP+idQ$ is divisible by $dp-idq$, and $dP-idQ$ by $dp+idq$.

In the former case $dP+idQ$ will therefore vanish if $dp+idq=0$, or $P+iQ$ will be constant if $p+iq$ is supposed to be constant; that is to say, $P+iQ$ will be a function of $p+iq$ only, and in the same manner $P-iQ$ will be a function of $p-iq$. In the latter case $P+iQ$ will be a function of $p-iq$, and $P-iQ$ a function of $p+iq$. It is easy to perceive that the reverse of these positions likewise holds good, or that if for $P+iQ$ and $P-iQ$ functions of $p+iq$ or $p-iq$ (either respectively or inversely) are assumed the divisibility of Ω by ω, and consequently the above required proportionality will take place.

It will easily be conceived that if, for example, we suppose

$$P+iQ=f(p+iq),\ P-iQ=f'(pe-iq)$$

the nature of the function f' is already given by that of f. For if among the constant quantities which it involves, there are none but real quantities, the function f' must be identical with f; in order that real values of P and Q may correspond to real values of p and q: in the contrary case, f' will only be distinguished from f by having in the imaginary quantities which f involves $-i$ instead of $+i$.

We have next, $P=\frac{1}{2}f(p+iq)+\frac{1}{2}f'(p-iq)$

$$iQ=\tfrac{1}{2}f(p+iq)-\tfrac{1}{2}f'(p-iq),$$

or, which is the same, as the function f is assumed quite arbitrarily (involving at pleasure constant imaginary quantities), P is equal to the real, and iQ (or $-i$Q in the second solution) equal to the imaginary part of $f(p+iq)$, and by elimination T and U will be represented as functions of t and u. Thus the proposed problem is solved quite generally and completely.

6. If we represent any determinate function of $p+iq$ by $p'+iq'$ (where p' and q' are real functions of p and q), it will be easily seen that likewise the equations

$$p'+iq' = \text{const. and } p'-iq' = \text{const.}$$

will represent the integrals of the differential equation $\omega = 0$; indeed, these equations will respectively agree with the above

$$p+iq = \text{const. and } p-iq = \text{const.}$$

In like manner the integrals of the differential equation $\Omega=0$, viz.

$$\mathrm{P}'+i\mathrm{Q}' = \text{const. and } \mathrm{P}'-i\mathrm{Q}' = \text{const.}$$

will agree with the above,

$$\mathrm{P}+i\mathrm{Q} = \text{const. and } \mathrm{P}-i\mathrm{Q} = \text{const.}$$

if P$'+i$Q$'$ represents any determinate function of P$+i$Q (while P$'$ and Q$'$ are real functions of P and Q). Hence it is clear that in the general solution of our problem which we have given in the preceding article, p' and q' may be substituted for p and q, and P$'$ and Q$'$ for P and Q. Although this change does not add to the generality of the solution, yet in practice one form may be more applicable to one, and another to another purpose.

7. If the functions arising from the differentiation of the arbitrary function f and f' are denoted respectively by ϕ and ϕ', so that $d.f'v = \phi v.dv$ and $d.f'v = \phi' v.dv$. we shall have in conformity with our general solution

$$\frac{d\mathrm{P}+id\mathrm{Q}}{dp+idq} = \varphi(p+iq), \quad \frac{d\mathrm{P}-id\mathrm{Q}}{dp-idq} = \phi'(p-iq),$$

therefore,

$$\frac{m^2 n}{\mathrm{N}} = \phi(p+iq).\phi(p-iq).$$

The scale of linear dimensions is determined by

$$m = \sqrt{\left\{\frac{dp^2+dq^2}{\omega.} \cdot \frac{\Omega}{d\mathrm{P}^2+d\mathrm{Q}^2} \cdot \phi(p+iq).\phi'(p-iq)\right\}}.$$

8. We shall now illustrate our general solution by some examples by which the manner of applying it, as well as the nature of some circumstances which may come into consideration, may be best explained.

Let the two surfaces be in the first place planes, in which case we may put

$$x = t, \quad y = u, \quad z = 0$$
$$\mathrm{X} = \mathrm{T}, \mathrm{Y} = \mathrm{U}, \mathrm{Z} = 0.$$

The differential equation $\omega = dt^2 + du^2 = 0$ gives these two integrals

$$t + iu = \text{const.},\ t - iu = \text{const.}$$

and in like manner the two integrals of the equation $\Omega = dT^2 + dU^2 = 0$, are the following $T + iU = \text{const.}$, $T - iU = \text{const.}$ The two general solutions of the problem are accordingly

$$\text{I. } T + iU = f(t+iu),\ T - iU = f'(t-iu)$$
$$\text{II. } T + iU = f(t-iu),\ T - iU = f'(t+iu).$$

This result may be thus expressed: f signifying an arbitrary function, the real part of $f(x+iy)$ is to be taken for x, and the imaginary part divided by i for y or for $-y$.

If the functional characteristics ϕ, ϕ' are taken in the same signification which they have in article 7, and if we put

$$\phi(x+iy) = \xi + i\eta,\ \phi'(x-iy) = \xi - i\eta$$

where ξ and η will be clearly real functions of x and y, we have by the first solution

$$dX + i\,dY = (\xi + i\eta)(dx + i\,dy)$$
$$dX - i\,dY = (\xi - i\eta)(dx - i\,dy)$$

and consequently, $dX = \xi\,dx - \eta\,dy$
$dY = \eta\,dx + \xi\,dy$

If we now put $\xi = \sigma.\cos j \quad , \quad \eta = \sigma.\sin j$

$$dx = ds.\cos g,\quad dy = ds.\sin g$$
$$dX = dS.\cos G,\ dY = dS.\sin G,$$

so that ds is a linear element in the first plane, g its inclination to the line of abscissae, dS the corresponding linear element in the second plane, and G its inclination to the line of abscissae, the above equations give

$$dS.\cos G = \sigma.ds.\cos(g+j)$$
$$dS.\sin G = \sigma\,ds \quad \sin(g+j),$$ and consequently,

if we consider σ as positive, as we may do

$$dS = \sigma.ds \quad , \ G = g + j.$$

We see, therefore (in conformity to article 7), that σ is the index of the ratio of increase of the element ds in the representation ds, and is, as it ought to be, independent of g; and in the same way the angle j being independent of g, proves that all linear elements of the first plane proceeding from one point are represented by elements in the second plane which form to each other, and, as we may add, in the same direction, the same angles.

If we now choose for f a linear function, so that $fv = A + Bv$ where the constant coefficients are of the form $A = a + b.i$, $B =$

$B = c + e\,i$, we shall have $\varphi v = B = c + e\,i$, therefore $\sigma = \sqrt{(c^2 + e^2)}$, $j = \text{arc tang}\ \frac{e}{c}$.

The ratio of increase or the scale is consequently constant throughout, and the whole representation similar to the surface represented. For every other function f, it may be easily proved that the scale cannot be constant, and that the similarity can only take place in the smallest part. If the places are given which are to correspond in the representation to a determinate number of given points of the first plane, we may easily determine by the common method of interpolation the simplest algebraical function f, which will fulfill those conditions. If we denote the values of $x + i\,y$ for the given points by a, b, c, &c. and the corresponding values of $X + i\,Y$ by A, B, C, &c. then it will be necessary to put

$$f v = \frac{(v-b)(v-c)\ldots}{(a-b)(a-c)\ldots}\,A + \frac{(v-a)(v-c)\ldots}{(b-a)(b-c)\ldots}\,B + \frac{(v-a)(v-b)\ldots}{(c-a)(c-b)\ldots}\,C + \&c.$$

which is an algebraical function of v of a degree one unity lower than the number of given points. For two points, where the function becomes linear, a perfect resemblance will consequently take place.

An useful application may be made of this in geodetics, for converting a map founded on moderately good measurements, which in its minute detail is good, but on the whole somewhat distorted, into a better one, if the correct position of a number of points is known.

Going through the second solution in the same manner, it will be found that the only difference is, that the similarity is a reversed one; that all elements form indeed with each other the same angles as in the original, but in a contrary direction, so that that which is to the right in the one, is to the left in the other. But this difference is not an essential one, and vanishes if the side of the plane which was first considered as the upper one is made the lower one. This latter remark may be always applied whenever one of the surfaces is a plane; and we shall confine ourselves in the following examples of this kind to the first solution.

9. Let us now consider (as a second example) the representation of the surface of a perpendicular cone in a plane. As the equation of the former, we take

$$x^2 + y^2 - K^2 z^2 = 0$$

where we put $x = K t \,.\, \cos u$, $y = K t \,.\, \sin u$, $z = t$, and as before, $X = T$, $Y = U$, $Z = 0$.

The

The differential equation,

$\omega = (K^2+1)\,dt^2 + K^2 t^2 du^2 = 0$, gives the two integrals,

$$\log t \pm i\sqrt{\frac{K^2}{K^2+1}}\,.\,u = \text{const.}$$

We have, accordingly, the solution

$$X + iY = f\left(\log t + i\sqrt{\frac{K^2}{K^2+1}}\,u\right),$$

$$X - iY = f'\left(\log t + i\sqrt{\frac{K^2}{K^2+1}}\,.\,u\right);$$

that is to say, f denoting an arbitrary function, X is to be the real part of $f\left(\log t + i\sqrt{\frac{K^2}{K^2+1}}\,u\right)$, and Y the imaginary part, leaving out the factor i.

Let an exponential quantity be taken for f, or let $fv = he^v$ where h is constant and e the base of the hyperbolical logarithms, and the most simple representation will be

$$X = ht\,.\cos\sqrt{\frac{K^2}{K^2+1}}\,.\,u\,.\quad Y = ht\,.\sin\sqrt{\frac{K^2}{K^2+1}}\,.\,u.$$

The application of the formulæ of article 7, gives in this case

$$n = (K^2+1)\,t^2 \quad N = 1$$

and ϕv being $= \phi' v = he^v$,

$$\phi\left(\log t + i\sqrt{\frac{K^2}{K^2+1}}\,.\,u\right).\,\phi'\left(\log t - i\sqrt{\frac{K^2}{K^2+1}}\,.\,u\right) = h^2 t^2$$

consequently $m = \frac{h}{\sqrt{(K^2+1)}}$, and therefore constant. If now, besides, h is made $= \sqrt{(K^2+1)}$, the representation becomes a perfect development.

10. Let it next be required; to represent in a plane the surface of a sphere whose radius $= a$. We put here

$x = a\,.\cos t\,.\sin u, \quad y = a\,.\sin t\,.\sin u,$

$Z = a\,.\cos u$, by which we obtain

$\omega = a^2 \sin u^2\, dt^2 + a^2 du^2$. The differential equation $\omega = 0$ gives consequently

$$dt \mp i\,.\,\frac{du}{\sin u} = 0, \text{ and its integration}$$

$$t \pm i \log.\text{cotang}.\tfrac{1}{2}u = \text{const.}$$

If we denote therefore again by f an arbitrary function, X is to be put equal to the real, and iY to the imaginary part of $f(t + i \log \text{cotang} \tfrac{1}{2}u)$. We shall adduce some particular cases of this general solution. If we choose for f a linear function by putting $fv = kv$, we shall have $X = kt$, $Y = k \log \text{cotang} \tfrac{1}{2}u$.

This

This agrees evidently when applied to the earth with Mercator's projection, if we make t the geographical longitude, and $90°-a$ the latitude. For the scale of linear dimensions the formulæ of article 7 give $m = \frac{k}{a \sin u}$.

If we assume for f an imaginary exponential function, and in the first place the simplest of all, $fv = k\,e^{iv}$, we have $f(t + i \log \operatorname{cotang} \frac{1}{2} u) = k\,e^{\log \operatorname{tang} \frac{1}{2} u + it} = k \operatorname{tang} \frac{1}{2} u (\cos t + i \sin t)$ and $X = k \operatorname{tang} \frac{1}{2} u . \cos t$, $Y = k \operatorname{tang} \frac{1}{2} u . \sin t$ which is, as will be easily seen, the stereographical projection.

If we put more generally $fv = k e^{i\lambda v}$, we have

$$X = k \operatorname{tang} \tfrac{1}{2} u^{\lambda} . \cos \lambda t \quad , \quad Y = k \operatorname{tang} \tfrac{1}{2} u^{\lambda} . \sin \lambda t.$$

For the scale of linear dimensions in the representation, we obtain here $n = a^2 \sin u^2$, $N = 1$, $\phi k v = i \lambda k e^{i\lambda v}$, and hence

$$m = \frac{\lambda k \operatorname{tang} \frac{1}{2} u}{a \sin u}.$$

It is evident that the representation of all points for which u is the same, will form a circle, and the representation of those points for which t is constant, a straight line, as also that the different circles corresponding to the different values of u are concentric. This affords a very useful projection for maps, if a part only of a sphere is to be represented. It will then be best to choose λ in such a manner as to make the scale the same for the extreme values of u which will make it smallest towards the middle. If we suppose the extreme values of u to be $u°$ and u', we must put

$$\lambda = \frac{\log \sin u' - \log \sin u°}{\log \operatorname{tang} \frac{1}{2} u' - \log \operatorname{tang} \frac{1}{2} u°}.$$

The sheets Nos. 19—26 of Prof. Harding's Celestial Maps, are drawn agreeably to this projection.

11. The general solution of the example given in the preceding article, may be exhibited in another form, which deserves to be mentioned on account of its neatness.

In conformity to what has been proved in article 6, we have [$\operatorname{tang} \frac{1}{2} u (\cos t + i \sin t)$ being a function of $t + i \log \operatorname{cotang} \frac{1}{2} u$ and $\operatorname{tang} \frac{1}{2} u (\cos t + i \sin t) = \frac{\sin u . \cos t + i \sin u . \sin t}{i + \cos u} = \frac{x+iy}{a+z}$] for the general solution likewise these formulæ:

$X + iY = f \frac{x+iy}{a+z}$, $X - iY = f' \frac{x-iy}{a+z}$ that is, X must be made equal to the real, and iY to the imaginary part of $f' \frac{x+iy}{a+z}$

f' denoting

f' denoting an arbitrary function. It will be easily seen that instead of $f\frac{x+iy}{a+z}$, any arbitrary function of $\frac{y+iz}{a+x}$, or of $\frac{z+ix}{a+y}$, may be taken.

[To be continued.]

XVII. *Analysis of two new Mineral Substances, consisting of Bi-seleniuret of Zinc and Sulphuret of Mercury, found at Culebras in Mexico. By Professor* DEL RIO*.

EACH step of the traveller in this Republic discovers to him something new. Mr. Joseph Manuel Herrera, in an excursion to Culebras, near the mining district of El Doctor, found a mineral resembling cinnabar, accompanied by metallic quicksilver, in the limestone which overlies the red sandstone (*arenisca roxa*), and he gave me a few small specimens of this substance. Some considerable time afterwards Col. Robinson gave me an additional quantity, informing me at the same time that Dr. Magos had obtained two ounces and a half of quicksilver from sixteen ounces of the ore.

Under the blowpipe the red ore burns with a beautiful violet-coloured flame, accompanied by much smoke of a most offensive smell, resembling that of rotten cabbage: the residue is a grayish-white earthy matter.

Intimately admixed with the red mineral is another substance so strongly resembling light gray silver ore, that I acknowledge that I mistook it, at first, for this ore of silver. My only doubt on the subject arose from the consideration that gray silver ore and cinnabar are never found together. It differs, however, from gray silver in yielding a blacker powder when scraped, and which stains more than the powder of the latter. Under the blowpipe nearly the same phænomena are observed as when the red mineral is submitted to the same test. According to Mr. Chovell, the specific gravity of the gray substance is 5·56, after having been carefully cleared by washing from the calcareous spar of the matrix. That of the red substance, after having also been carefully separated from the spar, is 5·66; while the specific gravity of hepatic mercury exceeds 5·8.

The analysis of these minerals is very easy where great precision is not required. Nothing more is necessary than to put fifty grains of the ore in a small retort on the fire; mercury, selenium, and a small quantity of sulphur are imme-

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* Communicated by A. F. Mornay, Esq.

diately sublimed, and a sub-oxide of zinc remains at the bottom of the retort. That the metallic gray powder attached to the upper part of the retort is selenium, is proved by the red colour of the light transmitted through it, and by the high metallic lustre of the surface in contact with the glass. The residuum is shown to be sub-oxide of zinc by its solubility in acids, and by its being redissolved by an excess of potass, soda or ammonia, after having been precipitated by the alkali from an acid solution: also by its phosphorescence when fused by the blowpipe, by the white smoke which it emits and which attaches itself to the charcoal, and by the enamel which it forms with borax and microcosmic salt.

In order to determine the proportions of the component parts of the gray substance, I first treated it with concentrated sulphuric acid, which dissolved the mercury and some of the zinc; I then applied nitric acid, which dissolved the remainder of the zinc, and I finally employed nitro-muriatic acid to oxidate the selenium. By these operations 1·5 grain of sulphur, without any red tinge, and which I therefore suppose to be pure, was separated; and after the nitro-muriatic acid had been distilled off, selenic acid was sublimed: this was partly in acicular crystals, and partly in a dense white mass half fused and semi-transparent. There remained at the bottom of the retort the sulphate of lime formed by the sulphuric acid used in the first process, and the lime of the calcareous spar accidentally mixed with the mineral.

I think that it may be deduced from the foregoing experiments and others, that the gray mineral is composed of

Selenium	49
Zinc	24
Mercury	19
Sulphur	1·5
	93·5

which, with the addition of six grains of lime obtained, will amount to 99·5. But the lime merely accompanies the ore, and does not enter into its composition.

The gray mineral is therefore a bi-seleniuret of zinc united to a protosulphuret of mercury, the latter giving, in my opinion, the dark or gray colour to the mineral.

The red mineral will also be a bi-seleniuret of zinc, but the mercury will be in the state of a bi-sulphuret or cinnabar, which will give the red colour to the mineral.

These two minerals are therefore in my view, and according to Berzelius, two distinct genera, because they are expressed by two distinct formulæ, as is the case with orpiment and

and realgar; that is to say, that the gray mineral will be expressed by the formula $\ddot{Z}n\,\ddot{S}e^4+HgS$. The red mineral by the formula $\ddot{Z}n\,\ddot{S}e^4+HgS^2$.

Mexico, December 1, 1827. (Signed) A. Del Rio.

☞ On one occasion I distilled the mineral alone, and I poured spirit of wine into the receiver, when I observed at the bottom a drop of yellow oil, which in time tinged the alcohol of a beautiful yellow: on the addition of water, the colour disappeared without any precipitate being thrown down. I presume that this was the same substance noticed by Berzelius, as being formed on the admixture of selenic acid and anhydrous muriatic acid with selenium, in which case both these acids must exist in the mineral. I detected the muriatic by means of nitrate of silver; but no sensible precipitate of seleniate of silver was obtained by the addition of cold water to a boiling nitric solution, perhaps because the quantity was too small.

XVIII. *Observations on the Peruvian Andes, in reply to a Paper by* M. Coquebert de Montbret, *in the* Annales des Sciences Naturelles. *By* J. B. Pentland, *Esq.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

THE last Number of the *Annales des Sciences Naturelles,* (vol. xiii. p. 420) contains a paper by Mons. Coquebert de Montbret, entitled "*Note sur quelques Montagnes du Haut Pérou,*" purporting to be founded on a memorandum of some of my measurements of the Peruvian Andes, which I had communicated to that gentleman in February last.

The memorandum in question was drawn up, in the course of conversation, for Mons. de Montbret's private information; and I distinctly stated to him at the time that the results ought merely to be considered as approximative; since I had not the detailed notes of my observations at hand, and the calculations on which they were founded, required a careful revisal, before they were submitted to the public,—having been made in the midst of the fatigues and annoyances attendant on a tedious journey. I have therefore seen with regret, that a part of my observations has been rendered public in the unconnected and inaccurate manner in which they are brought forward in the paper in question: and I shall feel sincerely obliged by your giving an early insertion to this letter,

letter, in which I shall confine myself to the correction of some of the errors into which Mons. de Montbret has fallen, and to rebutting the conclusions drawn by this writer and Mons. Brué against the accuracy of my measurements.

The principal objection raised against the great elevation which I have attributed to certain peaks of the Peruvian Andes, situated between the 14th and 17th parallels of south latitude, consists in an assumption, that if the geographical position in which my astronomical observations have placed these mountains be correct, they must be easily seen from the coasts of the Pacific Ocean, and could not have hitherto escaped the attention of the navigators frequenting the ports of Peru situated in or near the same latitude.

To meet this inference, I take the liberty of annexing an extract from a letter, which, in my own justification, I have judged it necessary to address to Mons. Coquebert de Montbret, in reply to his observations:—

"The great chain of the Andes, between the 14th and 20th parallels of southern latitude, is divided into two longitudinal and parallel ridges, or *Cordilleras* (the name by which they are designated by the Creole population of Peru). These two cordilleras are separated by a very extensive interalpine valley, the mean elevation of which is 12,600 feet; its southern portion is traversed by the river Desaguadero, whilst its northern is occupied by the celebrated lake of Titicaca, on the shores and in the islands of which Peruvian civilization and the Empire of the Ingas had their origin.

"The western cordillera, or, as it is called, the Cordillera of the Coast, separates the valley of the Desaguadero (the Thibet of the new world), and the basin of the lake of Titicaca, from the shores of the Pacific. Many of its peaks exceed 20,000 feet in elevation, and in it are situated several active volcanoes; whilst the eastern cordillera, composed chiefly of transition and secondary rocks (grauwacke-slate and new-red-sandstone), separates the same valley from the extensive plains of Chiquitos and Moxos, and the confluents of the rivers Beni, Mamoré and Paraguay, from those streams which empty themselves into the lake of Titicaca, and into the river Desaguadero.

"The eastern cordillera of the Peruvian Andes is situated within the political limits of the Republic of Bolivia; and it presents, between the 14th and 17th degrees of latitude, an almost continuous ridge of snow-capped mountains, the mean elevation of which exceeds 19,000 feet. It is upon this snowy range of the eastern cordillera that rise the most elevated mountains hitherto determined throughont the entire extent of of the Andean chain. The Nevados of Illimani and of Sorata (those referred to in Mons. de Montbret's paper) surpassing in height the giants of the Columbian prolongation of the Andes, Chimborazo, Cayambé and Antisana,—and approaching near to the most elevated peaks of the Himalaya range.

"The mountain of Illimani is situated in the Bolivian province of La Paz, twenty leagues E.S.E. of the city of the same name. Like Chimborazo it forms the most southern limit of the snowy range to which it belongs; and according to my astronomical observations, (made at La Paz, and at the hamlet of Jotoral near to its northern base,) it is placed between 16° 35′ and 16° 40′ south latitude; and between the 67th and 68th degrees of west longitude, reckoned from the meridian of Greenwich. Its summit forms an elevated ridge, surmounted by four peaks, disposed on a line from north to south and parallel to the axis of the chain. The most northern of these eminences attains an elevation, according to my measurement, of 24,200 British feet, or 12,000 feet above the city of La Paz; but the southernmost peak appeared to me to be still more elevated, although it was impossible to ascertain the exact difference from my station. This stupendous mountain is composed of grauwacke and transition-slate, with frequent interstratifications of quartz-rock and flinty-slate; which in their mineralogical structure and geological relations entirely resemble those of the valleys of the Maurienne and Tarentaise in the Savoy Alps: and with these schistose rocks are associated large masses of porphyry, of sienite, and of true granite, in the form of veins and beds. The transition-slate is traversed by numerous veins of quartz, containing minute portions of gold and of auriferous pyrites; many of which veins were worked by the aboriginal Peruvians, at an elevation of 16,000 feet above the level of the sea, at a very remote period, prior to the arrival of their Europæan invaders.

"The most eastern point of the coast of the Pacific, on the same parallel of latitude with the mountain of Illimani, is situated between the roads of Quilca (latitude 16° 42′), and the headland or Morio of Arequipa (latitude 16° 30′ S.); and between the meridians of 72° 40′, and 73° 20′ W. of Greenwich,—adopting a mean of the observations of Captain Basil Hall, and of Alessandro Malespina. Illimani is consequently separated from the nearest point of the coast of Peru, by an horizontal distance equal to 5° 30′ of longitude, or to 310 nautical miles. This fact in itself is sufficient to show the impossibility of discovering from the coast of Peru, that mountain, or indeed any part of the eastern cordillera of the Andes (the axis of which, between the 14th and 17th degrees of latitude,

tude, is nearly parallel to the meridian),—even supposing the intervening space to be perfectly horizontal, and not interrupted, as I have already shown it to be, by the elevated mass of the western cordillera,—some of the peaks of which, as well as the trachytic dome which towers over the valley of Chuquibamba, N.N.W. of Arequipa, rise to an elevation exceeding 22,000 feet*."

I am therefore at a loss to imagine how two gentlemen, possessing the acknowledged acquirements of Messrs. Brué and de Montbret, could have raised such an objection to the accuracy of my observations as that conveyed in the paper of the latter; since a reference even to the old and inaccurate map of South America, by Olmedilla de la Cruz, or to the incorrect compilation of Alcedo, must have rendered evident to the merest tyro in geographical science, the physical impossibility of descrying an eminence no more than 24,200 British feet above the level of the ocean, from a distance which exceeds 100 nautical leagues.

On the northern prolongation of the eastern cordillera of the Bolivian Andes, and nearly in the centre of the snowy range above mentioned, rises, in latitude 15° 30′ S., the Nevado of Sorata, from the midst of a group of snow-capped pinnacles, some of which attain an elevation of 23,000 feet. The Nevado of Sorata is situated to the east of the large Indian village of the same name, and is elevated 25,200 feet above the level of the sea, or 12,450 feet above the waters of the lake of Titicaca:—as deduced from a trigonometrical measurement taken from the shores of the lake, and from a determination (made at a less distant station) of the height of that portion of the summit which is placed above the superior limit of perpetual snow;

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* The city of Arequipa, one of the handsomest in South America, is situated at the western base of the western cordillera, in the midst of a fertile valley, watered by the streams of the Arequipa and Inquocajo, which descend from the adjoining Andes. The valley of Arequipa is bounded on its northern and eastern sides, by three snow-capped mountains; that in the centre, the volcano of Arequipa, resembling in form, and being nearly equal in elevation to Cotopaxi: whilst towards the south and west the valley is separated from the shores of the Pacific Ocean, by a low range of trachytic eminences; and by an arid sandy desert which occupies an extent of fifty miles in breadth. The mean of my observations, as deduced from an extensive series of meridian altitudes of *Achernar*, *Canopus*, *α Arietis*, *Capella*, and *Saturn*, places the house of the British consulate at Arequipa in latitude 16° 23′ 58″; and in longitude 71° 20′ 0″ W. resulting from observations made with two good chronometers, and from several sets of lunar distances. The elevation of Arequipa above the level of the neighbouring ocean, is 7797 feet; being the mean of 170 barometrical observations, made during thirteen successive days with an excellent barometer by Fortin, and calculated according to the formula of Laplace.

a limit which, between the 15th and 17th degrees of south latitude, and on the sides of the Bolivian Andes, seldom descends below 17,100 feet above the sea.

The great mass of the eastern cordillera, situated north of the parallel of 17° S. is likewise formed of the transition rocks above enumerated; the sienitic or crystalline rocks becoming more abundant on its northern prolongation. The schistose rocks here also abound in auriferous veins; and through the deep dells which intersect them, descend the numerous auriferous torrents, which empty themselves into the river Beni and its confluents, and give to the tropical district bordering on the river of Tipuacio (in the province of Larecaja), the fairest claim to the title of the El Dorado of the new world,—from the great quantities of gold, which have been and are still collected from the alluvial deposits that form its banks.

I am, Gentlemen, yours, &c.

June 25, 1828. J. B. Pentland.

XIX. *On the Penetration of Water into stoppered and corked Bottles sunk to a great Depth in the Sea. By* J. de C. Sowerby, *Esq. F.L.S. &c.*

To Richard Taylor, Esq.

Dear Sir,

MANY papers having at different times appeared upon the popular paradox, a bottle filling with water when sunk to a great depth in the sea, however well it may have been corked and sealed, without any satisfactory explanation having been given, and seeing the subject resumed by Dr. Green, in your Philosophical Magazine for this month,—I am induced to send you my explanation of the phænomenon.

Dr. Green thinks that by proving (as others had done) that the water would not penetrate glass, he had reduced the question into very narrow limits; and that the water enters glass vessels through the "cork and all its coverings in consequence of the vast pressure of superincumbent water, in the same manner as blocks of wood are penetrated by mercury in the pneumatic experiment of the mercurial shower."

It may be concluded from recorded experiments, that well-fitted glass stoppers (by the bye, every chemist knows such are rarely to be obtained as will confine the vapour of nitric acid) will exclude the water; corks when properly protected will also prevent the water from entering. When mercury is made to pass through a block of wood by pneumatic pressure, it finds its way by the longitudinal tubes; such tubes do not

not exist in cork. My explanation is this; cork is elastic, and by the pressure of the sea is readily condensed, and consequently much diminished in bulk, first that part out of the bottle where the sides are not protected by the neck, and then gradually the remaining length until the cork, separated entirely from the glass, affords a free passage for the water, unless the sealing or wrapper be of such a tenacious and ductile nature as to adhere to the glass and the cork so as to fill up the space that would otherwise be left, and yet not yield completely to the pressure; if it be brittle, it either separates from the glass, or cracks, or both, allowing a free passage to the water. Even pitch when cooled in the deep water would be very brittle and crack or separate from the bottle readily, and it would resume its former ductility and appearance upon returning through the warm surface: this and similar considerations will show how a trifling difference in closing the bottles may produce considerable differences in the results of the experiments. I remain, yours truly,

2, Mead Place, Lambeth, July 12, 1828. J. DE C. SOWERBY.

XX. *Some further Remarks on* Messrs. Tiedemann *and* Gmelin's *Observations on the Acids of the Stomach.* *By* WM. PROUT, *M.D. F.R.S.*[*]

THE observations of Messrs. Tiedemann and Gmelin on my paper published in the last Number of the Philosophical Magazine and Annals, seem to me to be intelligible only on the two following assumptions. First, that the method employed was adopted at random and without any preliminary inquiry, and was intended to include every possible case; and secondly, that on the faith of this random method, *I denied generally and under all circumstances* the existence of every other acid except the muriatic acid, in the stomachs of animals. Now whether these assumptions can be fairly drawn from my paper, I, as an interested individual, can scarcely, perhaps, be admitted as competent to decide; but I can truly say at least, that I never intended that such inferences should be drawn, nor was aware that any thing had been stated to authorize them.

With respect to the first of these assumptions it may be said, that the nature of the gastric fluids, and especially the acid, had occasionally occupied my particular attention for many years; and that during the summer before my paper was published, I had set about the inquiry in earnest, and with the determi-

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[*] Communicated by the Author.

nation, if possible, of putting the matter at rest. With this view a number of animals were fed in various ways; that is to say, on substances both natural and unnatural to them, and the contents of their stomachs subjected to analysis. The examination was conducted in the most rigorous manner, and varied in every possible way that I could devise; and up to the period at which my paper was sent to the Royal Society, I completely satisfied myself, that in every instance the acid present was the muriatic acid and no other, at least in any appreciable quantity. Now it was in the knowledge thus previously acquired, and not at random, that the method proposed was founded; and among a variety that were tried, the one in question was ultimately chosen as comprehending every point that had then occurred to me. If it be objected that these preliminary experiments ought to have been given, I can only say, that I did not at the time think this necessary, nor do I now. The muriatic acid was not a new substance, nor one difficult to be identified; besides, such a preliminary inquiry seemed to be sufficiently indicated by the method proposed; for who would ever think of proposing a formal method of analysis, involving the *quantities* of substances, without determining beforehand what those substances were? Further, my paper was intended to be little more than a simple announcement of an important fact, which, before it could be established, I well knew must be corroborated by other experience than mine; and lastly, something must be ascribed to a sort of innate antipathy to long-winded dissertations, which is too apt to cause me to err on the side of brevity.

Messrs. T. and G. observe, that considering my method quite perfect, I infer from it the absence of all other acids, except that of the muriatic acid in the gastric fluids. To this I answer, that under the circumstances to which it was applied, I considered it then, and do still, as quite perfect: and as the residuum after combustion could not have been neutral if the acid had been of a destructible nature, because the quantity of potash required to saturate the free acid was more than sufficient to decompose the whole of the muriate of ammonia present,—the argument even in this point of view was strictly correct, though acknowledged to be imperfect if applied generally*. This argument was given, because it was the

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* Messrs. T. and G. will, I trust, give me credit when I assert that I was perfectly aware of all the chemical objections they have raised, and many more to the same effect; and never should have thought of applying the method in question in a new case when the nature of the acid was unknown, and particularly in the case of a destructible acid in conjunction with the muriate of ammonia. The fact was, that I detected free muriatic acid

the only one bearing on the point in question that was strictly deducible from the method employed; and more could not have been well said without destroying the unity of my design, and entering on details which, for the reasons above stated, I concluded would have been taken for granted.

With respect to the second assumption; namely, that I denied generally, and under all circumstances, the existence of every other acid in the stomachs of animals, except the muriatic acid,—I can only say, that nothing was further from my intention. On the contrary, I distinctly alluded to the "occasional presence of other acids in the stomach," taking it for granted that such an occurrence must sometimes happen. What I did assert, and what I again assert is, that in the cases related, and in all others in which a rigorous examination was instituted up to the period mentioned, no other acid did occur in any appreciable quantity; and I acknowledge that in consequence of this experience, I was induced to conclude that the presence of other acids was comparatively of rare occurrence, and my subsequent experience decidedly favours this conclusion. I have already said, that since my paper was read before the Royal Society, I have occasionally, by means precisely similar to those formerly employed, detected the presence of combustible acids in the stomach, and have expressed a belief that these acids were probably derived from the food; and in several of the instances, I have no doubt this was the case. I wish however by no means to be understood to deny that the stomach occasionally secretes a combustible acid in a free state*, though I think

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acid in a fluid ejected from the human stomach so long ago as 1820, but then thought that its presence was accidental, or that by some means or other I had deceived myself; and when I commenced the experiments in question, I was actually prejudiced in favour of a destructible acid, viz. the *lactic* acid of Berzelius (though the distinct nature of this acid always, I confess, appeared to me to be somewhat problematical). In consequence of this prejudice, therefore, the inquiry was conducted in a much more rigorous and elaborate manner than it probably otherwise would have been; and after a series of the most complete evidence that perhaps was ever brought to bear on a chemical point, I was obliged to conclude, is opposition to my preconceived notion that the acid was the muriatic and no other. On reflecting, however, on this most unexpected fact, I soon saw its importance, and that, in short, it was one of those leading facts that opens up an entire new field of inquiry. So satisfied indeed was I of this, that a work on the digestive functions, in which I had been long engaged, and which I had actually begun to print, was suppressed; and since that time I have been engaged in an entire new field of research, which I fear will yet occupy me for several years to come.

* Within the last few months I have seen a very remarkable case of disease, where the acetic acid seemed to be formed, not only by the stomach, but the salivary glands, &c. in great abundance. In this case the breath of the

I think it more frequently happens that some salt containing a combustible acid, *e.g.* the acetate of soda, is actually secreted; and that this, by being decomposed by the free muriatic acid, gives origin to the *apparent* presence of free acetic acid.

In conclusion, it may be observed that, during the long period that my attention has been turned to this interesting subject, a great many curious and most important facts have come to my knowledge: in some of these I have been anticipated by Messrs. T. and G.; while others appear to have escaped their observation, or probably did not occur to them. But when I make this statement, I wish it to be distinctly understood that I am very far from accusing these gentlemen of chemical ignorance, because they failed to point out what probably was not present in the substances they examined, or of charging them with denying, generally, the existence of every thing else that did not happen to fall within the limits of their own observation;—charges which these gentlemen, from not sufficiently attending to the general character of my brief announcement, have inadvertently brought against me under very similar circumstances.

XXI. *On the vitrified Fort of Dunnochgoil, in the Isle of Bute.*

By SAMUEL SHARPE, *Esq. F.G.S.*[*]

THE fort is on a rocky point at the south-west corner of the Isle of Bute, perhaps the point nearest to the Isle of Arran. It is at some distance from trees, habitations, and higher ground.

There remains now little more than the ground-plan, which may be traced by the vitrified foundations; but at one part the wall is more than a foot high, built of rough stones not much larger than bricks, and by vitrifaction formed into one solid mass, much like the slag of a furnace.

The parts can best be described by reference to the following figure.

From *q* there is a gradual ascent to the outer chamber *efgh*, which appears to have been surrounded on two sides

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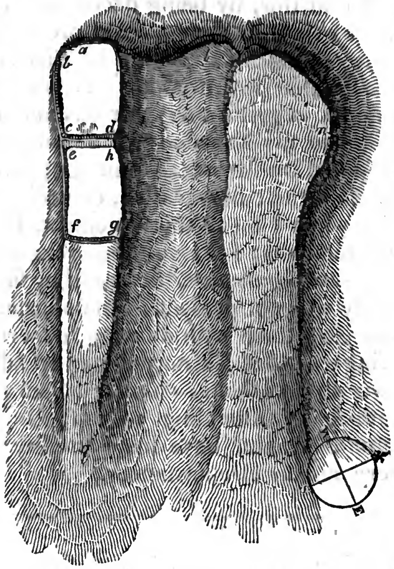
the patient smelt strongly of vinegar; the saliva and fluids occasionally ejected from the stomach contained also the same acid in abundance, as apparently did the perspirable fluid; for the whole body exhaled a strong odour somewhat like sour milk: during this time the urine was strongly alkalescent. In another anomalous case, I have seen the blood itself strongly acid; the acid was of a combustible nature, but from peculiar circumstances it was not satisfactorily proved to be vinegar, though this was probably the case.

[*] Communicated by the Author.

e f and *f g* by vitrified walls. Between the outer chamber and the inner one, *a b c d*, there is a slight descent, which may however formerly have been a ditch of some depth. This chamber was apparently fortified by vitrified walls, not only outwards on the sides *a b* and *b c*, but also on the side *c d* against the outer chamber.



The remains of the wall are mostly little more than foundations, but for part of the way between *b* and *c* it is more than a foot high.

I found no traces of art to prove that the neighbouring height *n* was any part of the fort, though it is made probable by the absence of all remains of wall on the side *a d h g*. The walls were probably only two or three feet thick, which, at least on three sides, was all that was necessary where the situation made them only accessible to missiles; and if there were originally any others besides those mentioned, they were probably not vitrified, as no traces of them are now apparent: the ground below is scattered with fragments of rock, some of which doubtless formed the walls.

The heights were estimated by guess, and the distances by pacing, and have no claims to exactness.

a b	perhaps 70 feet above the shore,	nearly perpendicular.
b c e f	ditto,	not so perpendicular.
l	15	a rather steep ascent.
n	40	
a d and *h g*	40	nearly perpendicular.

Between *d* and *h* the side is kept perpendicular by building, without vitrifaction or apparent cement. Each chamber is about 40 paces long, and 25 paces wide, the space between the chambers 3 paces, the gradual ascent from *q* above 100 paces.

The sides *b a b* and *b f q* are each about 100 yards from the sea; and near *b* are the traces of a landing-place on the beach, which

which however must be either modern or accidental, as they could hardly have withstood the waves for so many centuries.

I have nothing to add to the received opinion, that it must have been built before Roman arts and civilization (and in particular the use of mortar) travelled so far north.

Dr. Macculloch, after describing in the Geological Transactions, vol. ii. the Fort of Dun MacSniochan near Oban (which I had intended to visit, but being hindered, visited this in Bute instead), combats at length and successfully the opinion, that the vitrifaction was the effect of natural causes; but I think the opinion could never have been held by one who had seen this fort in Bute, where the traces of art are so evident and so undeniable.

The wall must have been first built, and then made compact and solid by vitrifaction, which must have required a considerable fire to be moved from place to place, as the work proceeded.

Samuel Sharpe.

XXII. *Method of solving adfected Quadratic Equations. By Mr.* Joseph Seers; *in a Letter to Mr.* Peter Nicholson*.

Dear Sir,

I BEG leave herein to submit to your inspection, &c. the method I discovered and mentioned to you, about two months ago, of solving adfected quadratic equations. I flatter myself it is quite new; and I think it inferior to none in present use. It is as follows:

Whatever be the original form of a quadratic equation, it must always be reduced to this formula of three terms; viz. $x^2 \pm px \pm q = 0$.

In this formula, it is to be observed that p is the sum of the root, and that q is their product. And having their sum, and substituting (d) for their difference, we have, by a well-known theorem, the two roots in this expression $\frac{\mp p \pm d}{2}$; in which expression the sign of p is always contrary to what it is in the above formula. Moreover, we have, as before observed, $\frac{p+d}{2} \times \frac{p-d}{2} = \pm q$. In which equation $d = \pm \sqrt{p^2 \mp 4q}$: here the sign of q is contrary to what it is in the formula. Hence, $\frac{\mp p \pm d}{2} = \frac{\mp p \pm \sqrt{p^2 \mp 4q}}{2}$: an expression containing the two roots of the given equation in terms of known quantities.

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* Communicated by Mr. P. Nicholson.

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Example:—Given $x^2-17x+35=0$. To find the values of x.

$$\text{Here } x = \frac{17\pm d}{2}.\ \text{Moreover, } \frac{17+d}{2}\times\frac{17-d}{2}=35.$$

$$\text{Hence, } 17^2-d^2=140\ .\ .\ .\ .\ .\ \text{or, } d^2=149.$$

$$\therefore d=\pm\sqrt{149}=\pm 12.206+\&c.$$

$$\therefore x=(17+12.206+\&c.)\div 2.\ \text{Or, } (17-12.206+\&c.)\div 2.$$
$$=14.603+\&c.,\ \text{or } 2.397+\&c.$$

I will not trouble you with any more examples, as there is no need. I remain, Dear Sir,

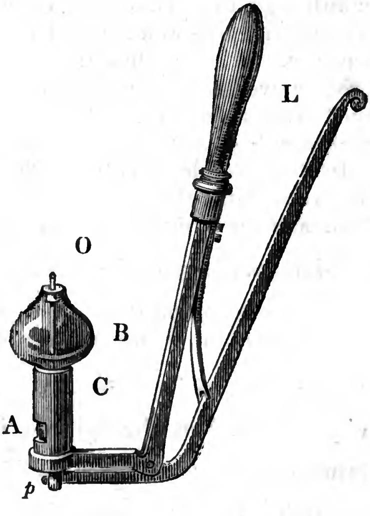
Your most obedient and much obliged servant,

Chelsea, June 20, 1828. JOSEPH SEERS.

XXIII. *Improved Eudiometrical Apparatus.* By R. HARE, M.D. *Professor of Chemistry in the University of Pennsylvania*[*].

I. *Piston Valve Volumeter.*

I HAVE contrived some instruments for taking volumes of gas at one time, precisely equal to those taken at another time. I call them volumeters, to avoid circumlocution. They are of two kinds, one calculated to be introduced into a bell glass, over water, or mercury; the other may be filled through an orifice, as is usual in the case of filling a common bottle over the pneumatic cistern. The annexed figure will convey a due conception of one of them, which having a piston, I call the piston valve volumeter.



The lever L is attached by a hinge to a piston *p*, which works inside of a chamber C. The rod of this piston extends beyond the packing through the axis of the bulb B to the orifice O in its apex, where it sustains a valve, by which this orifice is kept close, so long as the pressure

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[*] From the American Journal of Science, with corrections and additions by the Author.

pressure of the spring, acting on the lever at L, is not counteracted by the hand of the operator.

Suppose that while the bulb of this instrument, filled with water or mercury, is within a bell glass, containing a gas, the lever be pressed towards the handle, the valve is consequently drawn back so as to open the orifice of the apex of the bulb, and at the same time the piston descends below an aperture A in the chamber. The liquid in the bulb will now of course run out, and be replaced by gas, which is securely included, as soon as the pressure of the spring is allowed to push the piston beyond the lateral aperture in the chamber, and the valve into the orifice O, in the apex of the bulb.

The gas thus included may be transferred to any vessel, inverted over mercury or water, by depressing the orifice of the bulb below that of the vessel, and moving the lever L, so as to open the aperture A in the chamber, and the orifice of the bulb simultaneously.

The bulk of gas, included by the volumeter, will always be the same; but the quantity will be as the density of the gas into which it may be introduced. Hence in order to measure a gas accurately, the liquid, whether water, or mercury, over which it may be confined, should be of the same height within, as without. This is especially important, in the case of mercury, which being nearly fourteen times heavier than water, affects the density of a gas materially, even when its surface within the containing vessel does not deviate sensibly from the level of its surface without.

To remove this source of inaccuracy, I employ a small syphon gauge which communicates through a cock, in the neck of the bell, with the gas within. In this gauge any light liquid will answer, which is not absorbent of the gas. In the case of ammonia, liquid ammonia may be used; in the case of muriatic gas, the liquid acid.

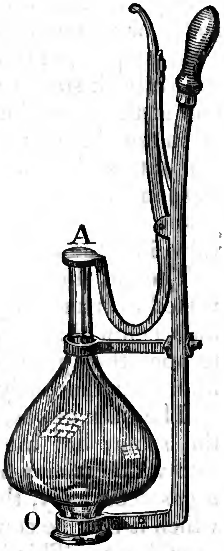
The density of the gas will be *in equilibrio* with that of the air, when the bell is supported at such a height as to cause the liquid in each tube of the gauge to be in the same level.

II. *Simple Valve Volumeter.*

Besides the lower orifice O, by which it is filled with gas, the volumeter which the next figure represents, has an orifice at its apex A, closed by a valve attached to a lever. This lever is subjected to a spring, so as to receive the pressure requisite to keep the upper orifice shut, when no effort is made to open it.

When this volumeter is plunged below the surface of the water

water of a pneumatic cistern, the air being allowed to escape, and the valve then to shut itself under the water, on lifting the vessel it comes up full of the liquid, and will remain so, if the lower orifice be ever so little below the surface of the water in the cistern. Thus situated, it may be filled with hydrogen, proceeding by a tube, from a self-regulating reservoir. If the apex A be then placed under any vessel, inverted duly in the usual way, the gas will pass into it as soon as the valve is lifted.



Volumes of atmospheric air are taken by the same instrument, simply by lowering it into the liquid of the cistern, placing the apex under the vessel into which it is to be transferred, and lifting the valve: or preferably by filling it with water, and emptying it in some place out of doors where the atmosphere may be supposed sufficiently pure, and afterwards transferring the air thus obtained, as above described, by opening the valve while the apex is within the vessel, in which the mixture is to be made. In this case, while carrying the volumeter forth and back, the orifice must be closed. This object is best effected by a piece of sheet metal, or pane of glass.

It is necessary that the water, the atmosphere, and the gases should be at the same temperature during this process.

III. *Sliding Rod Gas Measure.*

The construction of this instrument differs from that of my sliding rod eudiometers, in having a valve which is opened and shut by a spring and lever, acting upon a rod passing through a collar of leathers. By means of this valve, any gas, drawn into the receiver, is included so as to be free from the possibility of loss, during its transfer from one vessel to another. This instrument is much larger than the eudiometers for explosion, being intended to make mixtures of gas, in those cases where one is to be to the other, in a proportion which cannot be conveniently obtained by taking more or less volumes of the one than the other, by means of the volumeters: as for instance, suppose it were an object to analyse the air accord-

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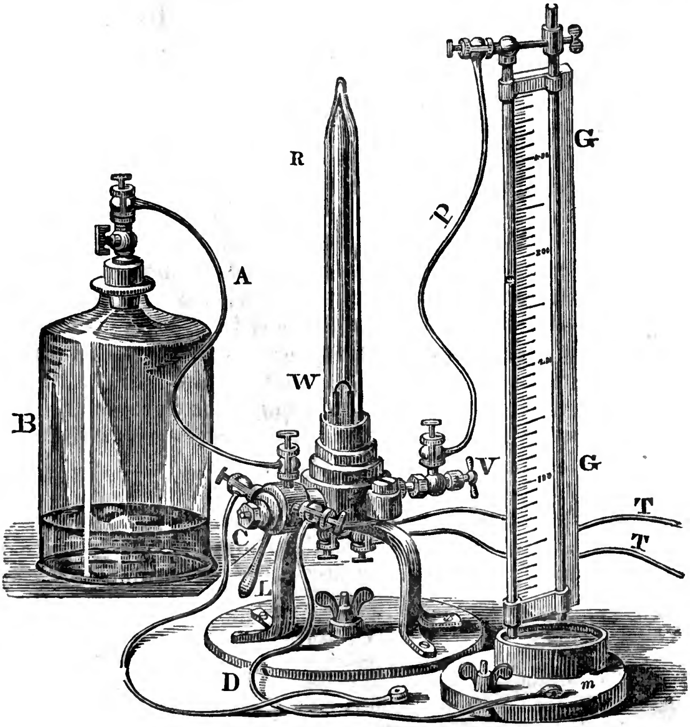
ing to Dr. Thomson's plan of taking 42 per cent of hydrogen. The only way of mixing the gases by a volumeter, in such a

ratio, would be to take the full of the volumeter, 21 times of hydro-

hydrogen, and 50 times of atmospheric air. By the large sliding-rod instrument, this object is effected at once by taking 42 measures of the one, and 100 measures of the other.

IV. *Barometer-Gauge Eudiometer.*

The following is an engraving of the barometer-gauge eudiometer for explosive mixtures. R is a glass receiver. Within the receiver near W is an arc of platina, by the ignition of which the gas is inflamed. C is a cock with three orifices, either of which may be made to communicate with the receiver, according to the position of the lever L. More than one of the orifices cannot be open at once, but all may at the same time be closed. The barometer-gauge GG is seen beside the receiver, with which it communicates through the pipe P, and the valve cock V, by means of which the communication between the gauge and receiver may be suspended at pleasure. The pipe A conveys to the receiver the gaseous mixture from the bell-glass B. By one of the pipes D, a communication



munication with the air-pump may be established. The other pipe is used when different kinds of gas are to be successively introduced, or when a portion of residual gas is to be drawn out for examination. T, T are rods, by means of which the platina wire communicates with the poles of a calorimotor, so as to be ignited, by being the medium of discharge, as often as the surfaces are excited by the acid. The calorimotor* employed is so constructed, as that the revolution of a wheel through a quarter of a circle, is sufficient to raise the vessel holding the acid until the galvanic plates are surrounded by it. At *m* is a wooden dish holding mercury for the gauge-tube.

It is well known to those who are familiar with pneumatics, that if a receiver communicate simultaneously with an air-pump and a barometer-gauge, the extent of the exhaustion will be indicated by the height of the mercury in the gauge-tube; so that if there be a scale of equal parts associated with the tube, the quantity of air taken from the receiver at any stage of the exhaustion will be to the quantity held by it when full, as the number opposite the upper extremity of the mercurial column, when the observation is made, to that to which it would extend if the receiver were thoroughly exhausted.

Hence, if on exhausting the vessel thoroughly the mercury rise 450 degrees, on admitting a gas freely, 450 parts of the gas would replace the air withdrawn; but if the entrance of the gas be restricted, so that a mercurial column is still sustained in the tube, the quantity of gas which has entered will be as much less than 450, as the mercury is above 0. Thus for instance, let the mercurial column sustained extend to 150 on the scale, 300 parts of gas will have entered, and if by explosion or any other means any number of parts of the gas, thus introduced, be condensed, the mercury must rise that number of degrees in the gauge†.

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* See Phil. Mag. vol. liv. p. 209.

† That portion of the bore of the tube which is not occupied by mercury, adds to the capacity which influences the gauge, and the portion of the gauge which is emptied of mercury varies in extent; but as the air which remains in the gauge is not subjected to the explosion, the extent of the condensation is uninfluenced by it.

A slight error may arise from the sinking of the mercury in the dish, as the quantity in this receptacle lessens by its rise in the tube; and *vice versâ* when subsidence ensues. This movement will be to the movement of the mercurial column in the tube, as the square of its diameter to the square of the diameter of the mercurial stratum in the dish; and the diameters of these being respectively as 20 to 1, it would be 1-400 of the whole height of the scale: this difference may be allowed for, or may be remedied, by raising or lowering the dish, by an appropriate screw, or employing a dish of a superficies so large, and a gauge-tube with a bore so small, as to render the effect of the rise, or subsidence of the mercury in the gauge, insignificant.

The receiver is a stout glass tube, which tapers from two inches, in diameter, internally, to one inch; being open at the larger end, at the smaller end closed. This form was adopted as combining strength, to resist explosions, with a capacity to hold larger quantities of gas than have heretofore been exploded in eudiometers. It must be evident that the larger the quantities of gas operated with, the less upon the whole will be the influence of any minute leakage, or error in measurement.

The tube is cemented at the larger end into a brass ferrule, which is screwed into a casting of the same metal, furnished with iron feet. Into the same casting, a brass plug screws, through which are inserted stout wires, one of them insulated, for producing galvanic ignition, in an arc of platina wire, as already described in the case of my other eudiometers *.

With the gauge-tube, is associated a scale divided into 450 equal parts. Instead of inhaling successively due portions of hydrogen and atmospheric air, as heretofore described, I have found it better to mix them previously in known volumes, by means of the volumeters, described in the preceding articles. Having by the aid of one of those instruments made a mixture of one part of hydrogen, with two of atmospheric air, it follows, that if 300 measures be taken by a sliding-rod eudiometer, or other adequate means, there will be a mixture, in the quantity so taken, of 200 parts of atmospheric air, and 100 of hydrogen. In case equal volumes of these aëriform fluids be mixed into one bell-glass, 200 measures would contain 100 of each. This mode of procuring such mixtures, is preferable from its saving trouble, and lessening the chances of error in the measurement; and because the gaseous fluids become more thoroughly blended,—a result which does not follow their admixture as immediately as might be expected.

Having prepared a mixture of two volumes of atmospheric air with one of hydrogen, and the receiver being exhausted as far as practicable, if any small quantity of the mixture be exploded in it, by exciting ignition in the platina wire W, all the oxygen will be condensed. The residuum, consisting of hydrogen and nitrogen, will not interfere with the result of any subsequent experiment, although the receiver should not be thoroughly exhausted. Under these circumstances, let the

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* One of the greatest difficulties which I encountered, was in the imperfection of stop-cocks, in the common form. This I obviated by two contrivances of my own; one invented about sixteen years ago, the other in the summer of 1825. Of these I shall publish a description, with engravings, as soon as I conveniently can.

exhaustion be carried to 400 degrees, and let 300 measures of the mixture enter, so as to depress the mercury in the gauge to 100 on the scale. An explosion being effected, the mercury in the gauge will rise at first to about 215 degrees, and after the gas shall have regained its previous temperature, will be found somewhat above 220 degrees.

Of course a deficit will have ensued of more than 120 parts, of which one-third, or a little more than 40 parts, will be the quantity of oxygen in 200 parts of the air, subjected to analysis.

In order to ascertain the influence of temperature, a thermometer is placed in the receiver, the state of which is noted before and after explosion; and the deficit is estimated either by allowing for the difference produced by the temperature, or awaiting the refrigeration until the mercury in the thermometer be at the same height as before the explosion.

From this account of the barometer-gauge eudiometer, and those previously given of the sliding-rod instruments*, it must be evident that I have contrived three methods of analysing the atmosphere, or other mixtures containing oxygen or hydrogen gas.

In the barometer-gauge instrument, the deficit is known by its effect upon the mercury in the gauge-tube; in one of the sliding-rod instruments, the deficit is compensated by water, and the quantity of this liquid which enters for this purpose, is known by the portion of the sliding rod which remains without, after excluding the residual gas. In the instrument with the sliding rod and gauge, the deficit is compensated by introducing the rod, the gauge enabling us to know when it has been introduced sufficiently; while the graduation shows the ratio of the gaseous matter condensed, to the quantity confined.

When the diversity of these methods is considered, it is pleasing to observe but little difference in the results obtained by them.

A great number of experiments performed by means of the barometer-gauge eudiometer, or those of the sliding-rod construction, over water and over mercury, gave 20 $\frac{66}{100}$ as the quantity of oxygen in 100 parts of the air. In twenty experiments the greatest discordancy did not amount to $\frac{1}{1000}$th part in 100 measures of air.

In lieu of the glass receiver a strong metallic vessel may be used, as for instance, one of the iron bottles employed to contain mercury. The igniting wire may be placed so as to be visible in a very stout glass tube projecting from the bottle.

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* See Phil. Mag. vol. liv. p, 209.

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But a glass tube is not necessary, as, without seeing the ignition, the explosion will be known to take place by the noise which it makes, and the movement of the mercury in the gauge.

[To be continued.]

XXIV. *Notices respecting New Books.*

An Appendix to the First Volume of an Introduction to Practical Astronomy. By the Rev. W. Pearson, LL.D. F.R.S. Treasurer of the Astronomical Society.

THE Rev. Dr. W. Pearson has just published an Appendix to his First Volume of An Introduction to Practical Astronomy, containing eleven sheets; in which he has shown that his series of XIV Tables, computed from constants of aberration and nutation approved by Zach, Delambre, Bessel, &c. will determine the corrections due to any other coefficients that may be deemed preferable, in the present improving state of practical astronomy; and without altering the mode of computation otherwise than by the introduction of one constant logarithmic factor in each operation, which converts one result into the other; and thus renders these tables *permanent* under all the changes of coefficients, which future observations may render necessary. The author has also taken occasion to correct some erroneous computations that had before escaped his notice; and has given an additional list of typographical errata. He has likewise added a catalogue of 520 zodiacal stars, including their subsidiary numbers, for facilitating the computation of their corrections; as well in longitude and latitude, as in right ascension and declination; all which stars are subsequently arranged in the order of right ascension, in a table of fourteen quarto pages, in such a manner, that it exhibits those stars in succession that are liable to suffer occultation at any given time, by having reference only to the moon's longitude and place of her node, as given in the Nautical Almanac: and what renders this classification extremely convenient, those stars that will suffer an occultation as observed in England, or in the same parallels of latitude, are distinguished from those that will be seen occulted on other parts of the globe.

We are authorized to state, which we have much pleasure in doing, that the second volume, describing the instruments used in practical astronomy, with the methods of adjusting and using them, is in a state of great forwardness, and will probably be ready for publication in the course of three months from the present time.

On the Curative Influence of the Southern Coast of England, especially that of Hastings: with Observations on Diseases in which a Residence on the Coast is most beneficial. By William Harwood, M.D. London, 1828; post 8vo, pp. 326.

This work is an interesting and useful combination of scientific and medical information, adapted to the use of invalids who are desirous of of benefiting by the invigorating breezes of our southern coasts, as well as to that of their medical advisers. It describes the peculiarities of climate, with respect especially to their influence on disease, which are presented on the southern coasts, and discusses, with considerable success, some of the causes of this influence. It comprises at the same time a general view of the various physical characteristics of the district to which it relates; such as is calculated to entertain the mind of the invalid who may consult it. To some of the observations on the effect of atmospheric variations on the human body, we do not feel disposed to subscribe; but the reasoning on this subject does not affect the general merits of the work. The contents of the work are arranged in the following order:

The varied nature of our coasts; causes tending to affect the temperature of coast-situations, more especially that of the southern coasts; the Hastings coast, its geological character, choice of situation it affords to invalids in elevation and in temperature, its other peculiarities, table of its temperature; on the air; influence of atmospherical variations on the constitution; on the effects of sea-air; on the water of the southern coast; general observations on bathing; on cold sea-bathing, its effects on the constitution, circumstances which render it inadmissible, precautions in its employment; warm sea-water bathing, its operation on the system; shower and vapour bathing, observations on indigestion and hypochondriasis; acute rheumatism; chronic rheumatism; gout; consumption; winter cough; asthma; hæmoptysis; diseases of the liver; the effects of mercurial medicines; the effects of loss of blood; other causes of debility; diseases of children; scrofula; rickets; marasmus; spasmodic diseases; hooping-cough; measles; diseases of the skin, &c.; notice concerning the chalybeate waters of the Hastings coast.

The Royal Society of Göttingen have published a new volume of their Transactions, entitled "Commentationes Societatis Göttingensis." It contains three papers by Professor Gauss:—1. Theoria residuorum biquadraticorum.—2. Supplementum theoriæ combinationis observationum minimis erroribus obnoxiæ.—3. Disquisitiones generales circa superficies curvas*.

Professor Gauss has likewise published (in German) his "Determination of the difference of latitude of the observatories at Göttingen and Altona," being the astronomical part of his measurement of an arc of the meridian.

The Berlin "Astronom. Jahrbuch for 1830," has been published for the first time by Prof. Encke, on an extended and improved plan. It contains, besides the ephemeris, four papers by Prof. Encke on the calculations of occultations of Stars; on Interpolation; on Sextants, and on Transits†.

The well-known eccentric Dr. Gruithuisen, now Professor of Astronomy at Munich, who has so frequently amused the public by his discovery of flat-roofed buildings, palm-groves, and macadamized roads

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* See Phil. Mag. and Annals, N. S. vol. iii. p. 331.

† See p. 141 of the present Number.

roads in the moon, has begun publishing a Journal, devoted to astronomy and geography, under the title "*Analecten fur Erd-und Kimmels Kunde.*"

The first paper is a minute description of every part of a zenith telescope, for the use of a Katachthonian observatory to be built sixteen German (seventy-four English) miles below the surface of the earth!!!

XXV. *Proceedings of Learned Societies.*

ASTRONOMICAL SOCIETY.

June 13.—PROF. STRUVE communicated the result of his observations and measurements of the apparent distance between the body and the ring of Saturn: from which it appears that he is decidedly of opinion that the body of Saturn is not in the centre of the ring. From a mean of 15 measurements, he makes the apparent distance on the left side equal to 11″·272, and on the right side equal to 11″·390: the difference is 0″·215. The probable error of these mean measurements he considers equal to 0″·024. M. Struve adds some slight corrections to his former measurements of the diameters, &c. of Jupiter, of Saturn, and of the Ring; which he has deduced from a more accurate determination of the value of his micrometer.

The next communication was from Mr. Prinsep of Benares, giving an account of *two* eclipses which he had observed at that place in the course of the preceding year. The *first* was a solar eclipse on April 26, 1827. The commencement was not observed; but during the course of the eclipse a number of micrometrical measurements were taken by means of the five horizontal wires of a Troughton's 18-inch circle: and he states the end of the eclipse to have taken place at $20^h\ 3^m\ 7^s,5$ mean time at Benares. Mr. Prinsep then adds, "At the period marked as the end of the eclipse, the sun's disc was clear of the moon: but, for 10 or 15 seconds later, I remarked, as it were, a stretching of the sun's edge toward the point which the moon had just quitted. This was apparently the effect of refraction by the moon's atmosphere." The end of this eclipse was also observed by Mr. Walter Ewer at Cawnpore, at $19^h\ 56^m\ 3^s,5$ mean time at that place. The *second* eclipse, alluded to by Mr. Prinsep, was of the Moon, on November 3, 1827. It was observed in the same manner as the solar eclipse above mentioned. The following is the result of his observations, stated in mean time:

		h	m	s
The edge became dull at		8	42	0
The edge invisible........................		8	44	18
The edge of the same colour as the sky ..		8	45	30
Decided shadow		8	46	1
A bright spot becomes invisible		8	52	26
Immersion of a small star		10	42	14,2
Moon's transit...............	1st limb	11	45	48,2
Do. do................	2nd limb	11	47	57,1
End of the eclipse		12	1	6

Mr. Walter Ewer observed the beginning of this eclipse at Cawnpore, $8^h\ 35^m\ 23^s$ mean solar time at that place: the difference of longitude

longitude is assumed equal to $-10^m\ 12^s$. Diagrams, illustrating the several phases of the eclipse, and apparently drawn up with considerable care, accompanied these communications.

Mr. Rumker of Paramatta, in New South Wales, communicated the result of several series of observations in which he had been engaged at the Observatory there. They contained, 1st. The determination of the solstice in December 1826, June 1827, and December 1827. In deducing the results, he notices the insufficiency of Delambre's formula for the *Reduction to the Meridian* in cases of great altitude: and suggests an alteration when the sun culminates near the zenith. 2nd. Observations on the inferior conjunction of Venus in December 1826. 3rd. Observations of moon-culminating stars during parts of the years 1826 and 1827. 4th. Places of some of the fixed stars in the southern hemisphere. 5th. A Catalogue of stars with which the great comet of 1825 was compared. 6th. Corrected observations of the place of the said comet. 7th. A determination of the latitude of the Observatory by reflection with the mural circle.

The next communication was from Mr. Curnin of Bombay, giving a more accurate account of his observations of moon-culminating stars at that Observatory, during the year 1825: from a mean of all which, compared with corresponding observations at Bushey Heath, and at Greenwich, he deduces the longitude of the Observatory equal to $4^h\ 51^m\ 9^s$ east from Greenwich.

Mr. Baily presented a short account of the two invariable pendulums, the one of iron and the other of copper, which he had caused to be made, agreeably to the order of the Council, and which are intrusted to the care of Captain Foster in his present voyage of experiment and observation, for the purpose of investigating the possible effects of the earth's magnetism in various geographical positions. The form and construction of these pendulums are somewhat different from those in general use; consisting merely of a plain, straight, uniform bar of metal: and, as he conceived that there is a considerable advantage in having each pendulum a *convertible* pendulum, he has placed *two* knife-edges on each bar. This property of convertibility, however, instead of being effected by a sliding or moveable weight, is produced by filing away one of the ends of the pendulum, until the number of vibrations on the two knife-edges are equal. The mode of making a pendulum of this kind he then describes in the following manner: Take a plain straight bar of metal, two inches wide, half an inch thick (or $\frac{3}{8}$ths of an inch if thought preferable) and *about* $62\frac{1}{2}$ inches long; at least it should not be shorter than this, prior to the first trial for the adjustment. At five inches from one end of the bar should be placed the apex of one of the knife-edges, which he calls A, and at the distance of 39·3 inches therefrom, should be placed the apex of the other knife-edge, which he calls B; each knife edge being firmly and properly secured in the usual manner. The distance of 39·3 inches is chosen, because the intervals of the coincidences are in such case about 15 mi-

nutes; but if an interval of about 10 minutes should be preferred, the distance should be about 39·4 inches: and so in proportion.

In order to adjust a pendulum of this kind, it must be placed on the agate planes, and the number of vibrations determined in the usual manner; beginning, for the sake of regularity, with the knife-edge A; then inverting the pendulum, and determining the number of vibrations with the knife-edge B. In these preliminary experiments it is not necessary to extend the observations beyond one coincidence; neither is it requisite to apply any other correction than for the arc of vibration, and for the temperature of the room, since all the other sources of error will be common to the two positions of the pendulum, and therefore may be rejected in these first trials. If it should be found (as will in fact be the case) that the knife-edge B makes a *less* number of vibrations in a day than the knife-edge A, we must file away the bar at the end B, until the two knife-edges are perfectly synchronous. The amount to be taken away can be ascertained by experiment only; and as we approximate towards the truth we must be more cautious in using the file, and more accurate in making the observations. In this last step of the process it is difficult in all cases to determine the exact quantity that has been filed away; and we may sometimes overdo it, so as to cause an inequality in the vibrations of an *opposite* kind, and thus render it necessary to *add* a small quantity to the end B. In order to meet this difficulty, Mr. Baily caused a small hole to be drilled at the end B, into which a screw was fitted; and by means of a small piece of sheet lead inserted underneath, the adjustment could be carried to any required degree of accuracy.

The principal advantages attending the placing of two knife-edges on one and the same bar, Mr. Baily states to be as follows: viz. 1st. That we are thereby possessed of two separate and independent pendulums; the results of which may be used separately or conjointly at pleasure: and each of which is a more complete check on the other than when formed of separate pieces of metal, that may probably be of different specific gravities, and of different expansive qualities. 2nd. That the knife-edges, being once rendered synchronous, will always remain so, into whatever part of the world the pendulum may be carried; and thus enable us, if it should be required, to determine the length of the simple pendulum at any point of the globe at which it may be swung, by merely measuring the distances between the knife edges. 3rd. That we are thus furnished with the means of ascertaining whether the pendulum has sustained any accidental injury; since such a fact would be *immediately* discoverable from the inequality in the number of vibrations between the two knife-edges. And, even in case of such an unforeseen misfortune occurring, the *ratio* between the two would from that moment remain the same in all parts of the world, and answer the same useful purpose of *comparison* during the remainder of the voyage. Whereas, in the pendulum as usually constructed, the effect of such an injury (if not suspected) might be attributed to the errors of observation: and indeed the fact itself could not be ascertained until the return of the observer to some place where the pendulum had been previously swung; leaving,

leaving, however, the precise *time* at which the accident happened still undetermined, and not only the observations themselves, during some indefinite period, the subject of doubt and suspicion, but probably the whole series of no utility or avail.

Mr. Baily considers that there are also some advantages attending the *form* of this pendulum. For, being uniform in its dimensions, without any protuberant bob or projecting tail-piece, it is not so liable to accident as the ordinary pendulum, where those parts present opportunities for injury. It is also capable of being packed in a more convenient case, and thus rendered more easy of transportation, when required as a travelling instrument. But he states that if we view it in the light of an instrument intended for the observatory, as a means of determining the length of the simple pendulum, where both knife-edges are necessary for the solution of the problem, the advantages will be more apparent. For, in the construction of the pendulum here proposed, none of the parts slide over one another: there are no shifting weights, no moveable screws: every thing is fixed and stationary, and consequently more peculiarly adapted for the determination of so nice and difficult a problem.

As these pendulums are formed without any tail-piece, it became necessary to adopt some other mode of determining the arc of vibration. This, Mr. Baily has effected by making the edge of the pendulum, which is perfectly straight, answer the purpose of the point in the tail-piece of the ordinary pendulum: and by this method he was also enabled to enlarge the divisions of the scale (which is a diagonal one), so that the hundredth part of a degree occupies the length of three-tenths of an inch, and consequently can be read off with the greatest ease.

[*The remainder of the Proceedings will be continued in our next Number.*]

ROYAL ACADEMY OF SCIENCES OF PARIS.

December 10.—The ordonnance of the king approving of the nomination of M. Savart was read.—M. Anatasi communicated a new plan for the towing of ships.—M. l'Abbé Lachèvre objected to a part of M. Damoiseau's report respecting his chronological tables.—M. Chevreul, in the name of a Commission, made a very favourable report respecting the memoir of MM. Dumas and Boullay, jun. On the formation of sulphuric æther.—MM. Duméril and Dupuytren gave an account of the interesting essays by Dr. Senn of Geneva, respecting the treatment of diseases of the larynx.—M. Geoffroy Saint-Hilaire read a memoir on a small kind of crocodile living in the Nile, its organization and habits, and the motives which occasioned its being anciently honoured with the appellation of the Sacred Crocodile.—M. Cauchy read a memoir on the development of functions and rational fractions.—The observations of Mons. Giroux of Buzareingue, on the reproduction of domestic birds, were read.

December 17.—M. Cassini, in the name of a Commission, made a favourable report respecting Mons. A. Brongniart's memoir On the spermatic granules of vegetables.—M. Chevreul gave an account of several notices of M. Sérullas relating to the bromides of arsenic, antimony,

mony, and bismuth.—M. Girard gave a verbal analysis of several works published in America on the occasion of the opening of the Hudson canal.—M. Cauchy read a memoir, intitled *Usage du calcul des résidus pour la transformation ou la sommation des séries.*—M. Bonnard read a memoir on the locality of the manganese of Romanèche.—M. Féburier read a memoir, intitled *Notice sur la Lune rousse, et sur quelques effets de sa lumière et de celle des autres astres sur les végétaux.*

December 24.—MM. Raspail and Saigey sent a Notice respecting the sizing of paper.—M. Buran transmitted several observations concerning M. Payen's memoir on a new borate of soda.—M. Cagniard-Latour sent a memoir relating to the elasticity and change of size which metallic wires undergo when they are stretched.—M. Chevallier forwarded a sealed packet relating to the extraction of indigo. —M. Tilloy, of Dijon, sent his work on currants.—M. Duméril read a letter from Bretonneau, On the blistering properties of some insects of the cantharides-family.—M. Moreau de Jonnès communicated a Notice respecting the recent employment of mercurial treatment, both internal and external, in Cephalonia, for the prevention of the first symptoms of the plague.—M. de Blainville, in the name of a Commission, made a report on the memoir of M. Jacobson, intitled *Observations sur le prétendu développement des œufs, des moulettes, et des anodontes dans leurs branchies.* The Section of Mineralogy and Geology presented the following list of candidates for the two vacant places of Correspondents. *Geology:* MM. Conybeare, of London; Buckland, of Oxford; MacCulloch, of London; Freisleben, of Freyberg; Charpentier, of Bex.—*Mineralogy:* MM. Mitscherlich, of Berlin; Gustavus Rose, of Berlin; Haidinger, of Edinburgh.

Jan. 7, 1828.—According to the rules, the Academy proceeded to the election of a Vice-President. M. Mirbel had a majority of votes.—Mr. Warden communicated a letter from Mr. Smith, who, towards the end of 1826, explored a country hitherto unknown, to the S.W. and E. of the Rocky Mountains.—M. Thomas Grillon announced his discovery of a new mechanical means for moving vessels. —M. Blainville read a notice respecting the difference of the males and females of a species of gelasin.—M. Gannal read a memoir On the inspiration of chlorine in consumption.—Mr. Ivory was elected a Corresponding Member in the Section of Geometry.—M. Becquerel read a memoir On the electrical properties of the tourmaline.—M. Duvau read a statistical essay On the department of Indre and Loire.

Jan. 14.—M. Biot read a memoir On double refraction. On this occasion a sealed packet deposited by him on the 7th of January 1822, was given up to him; it contained a paper intitled, *Détermination expérimentale des expressions des deux vitesses dans les phénomènes de la double réfraction.*— A secret committee from the Section of Chemistry presented the following list of candidates for the vacant place of Corresponding Member: MM. Arfwedson, of Stockholm; Henry Rose, of Berlin; Thomson, of Glasgow; Houtou Labillardière, of Rouen; Liebig, of Giessen; Brande, of London.

Jan. 22.—M. Arago communicated a letter from Mr. Dalton on the aurora borealis of the 29th of March 1826; and a memoir by Mr. Scoresby On the singular effects produced by lightning on the vessel called the New York. He also gave a verbal account of an important memoir by M. Savary On magnetizing by the electric spark. —M. Legendre added fresh details to those which had been previously given on the interesting analytical researches of M. Jacobi of Kœnigsberg.—M. Cauchy presented a memoir On the remainders of functions expressed by definite integrals.—M. Dupin read a notice respecting early instruction at Touraine.—Mr. Warden communicated a letter relating to some islands recently discovered by Captain Coffin, not far from the coast of Brazil.—M. Arfwedson received the greatest number of votes as a corresponding member of the Section of Chemistry.—The members elected by ballot to constitute Commissions for the adjudging of prizes this year, are; For the mathematical prize relating to the resistance of fluids: MM. Lacroix, Legendre, Poisson, Fourier, and Prony.—For the astronomical prize: MM. Arago, Mathieu, Lalande, Bouvard, and Damoiseau.—For the prize relating to statistics: MM. Coquebert, Fourier, Dupin, Andreossy, and Lacroix.

Jan. 28.—There were read, a letter addressed to M. Delessert, containing information respecting M. Bonpland; A letter from MM. Quoy and Gaimard, containing geological observations; A letter from M. Valz, of Nîmes, On the elements of the two last comets.—After a report by M. Navier, a memoir presented by M. Landormy, On the theory of flying, was not approved of; this was also the case with M. Joseph Anastasi's project for towing.—M. Quenot read a memoir On a wire suspension-bridge, constructed at Jarnac, over the Charente.—M. Geoffroy Saint-Hilaire read a memoir On two species of animals, named *Trochilos* and *Bdella* by Herodotus.—The members for the Commission to decide the medical prize are: MM. Magendie, Boyer, Dumeril, Portal, Blainville, Fréd. Cuvier, Chaptal, Dulong, and Gay-Lussac.—Those for the physical prize are: MM. Magendie, Mirbel, Desfontaines, Dumeril, and Cuvier. The Commission for the mechanical prize is composed of MM. Girard, Navier, Prony, Molard, and Dupin.

XXVI. *Intelligence and Miscellaneous Articles.*

NEW ASTRONOMICAL EPHEMERIS.

WE have to congratulate the public on the appearance of one of the most useful publications in practical astronomy that has ever yet been formed. It is an Ephemeris arranged in an entirely new manner, computed on an entirely new principle, and adapted to the present advanced state of that important science.

Our readers are aware that, for the last fifty years, the celebrated Bode conducted the Berlin Ephemeris with great credit to himself, and with great advantage to astronomy. This work, inferior to none on the subject, contained annually a vast variety of valuable information,

tion, which would probably have perished, had it not been for the interest and zeal that Bode took in every thing relating to astronomy. Notwithstanding the rapid strides which the science has made on the Continent, little or no alteration however was made in the usual columns of this annual publication during Bode's life-time; but on his death M. Encke, who has been appointed to succeed him, determined on re-modelling the work altogether, and on adapting it to the increased and increasing demands of the astronomer. With this view he has abandoned the plan of publishing the voluminous Appendix thereto, which has generally been filled with matter that more properly belongs to a periodical journal, and which will now be transferred to the pages of Professor Schumacher's very valuable *Astronomische Nachrichten*; whilst the monthly columns of the Ephemeris will be consequently enlarged without any additional expense to the reader. On the other hand, Professor Schumacher will in future discontinue his annual *Hülfstafeln*; which will henceforth form part of M. Encke's work above alluded to. This exchange will be highly advantageous to the practical astronomer, who will thus have, in one volume, all the daily information he requires for the use of his observatory. The present volume is for the year 1830.

One principal and great *improvement* in this Ephemeris is the introduction of *mean solar* time into all the computations, instead of *apparent* time, as hitherto adopted in other ephemerides. The latter is never referred to, except in the case of the sun *at the time of its culmination*. In every other instance, the places of the moon and planets (and even the *sun* itself) is computed to mean solar time reckoned from the apparent equinox.

The *arrangement* of the Ephemeris also is very much improved. The places of the sun and moon are, as usual, disposed in monthly columns: but the places of the planets, and the other subjects which compose the body of the Ephemeris, are arranged in their respective orders, each by itself; as will be better understood from the synopsis of the work which we are about to present to our readers.

The *computations* likewise are carried to a greater degree of minuteness than has hitherto been done in any other similar work; and are thus not only better adapted to the more refined wants of the modern astronomer, but also more convenient for interpolation.

On the whole it is a work which we are persuaded will find a place in every observatory. We have often expressed our opinion of the want of such an Ephemeris, having occasionally suggested improvements for our own national production "the *Nautical Almanac*:" and we know that for many years past repeated representations on the same subject have been made to the Board of Longitude, not only by private individuals, but also by the Royal Society; but all to little or no purpose. For, though a gleam of light had lately begun to flitter amongst that learned body (like the expiring flame of a lamp), and they consequently thought it right (unconscious however of their approaching dissolution) to listen at last to the increasing demands of the astronomer; yet they were so tardy in their production, and so sparing in their explanations, that the information they intended

intended to give was more speedily and better supplied from a *foreign* source.

The present, however, forms a new æra in the science; and something may now perhaps be done to place astronomy (as it ought to be) on a better footing in this country. And since œconomy is the order of the day, and has in fact been publicly declared to be one of the causes of the dissolution of the Board of Longitude, we would propose to follow up that system, by getting rid also of the whole of the expense incurred in forming the *Nautical Almanac*, and placing it in totally different hands. For, the computers of the Berlin Ephemeris would (no doubt) for a small additional sum, be very readily induced to adapt their calculations to the meridian of Greenwich: and any respectable booksellers, or other body of men in this country, if the copyright of such work were secured to them, would not only very readily defray that additional sum, and the expenses of printing, for the privilege thus conferred on them, but also employ an English computer to revise the calculations. The astronomer would thus be furnished with a work more fitted for his purpose, and the public be relieved of a considerable expense, which, after all, has hitherto produced only a secondary sort of Ephemeris*.

We come now, however, to a more minute account of the work in question, which is as follows. The ephemeris of the sun is for each month divided into two pages; one of which is devoted to *apparent* noon, and the other to *mean* noon. The former page contains, besides the days of the month and the days of the week, the mean time (to *two* places of decimals in the seconds), the right ascension of the sun (to *two* places of decimals), and its declination (to *one* place of decimals), together with the equation of time (to *two* places of decimals), and the logarithm of the double daily variation in the declination,—a quantity extremely useful in determining the time from altitudes of the sun. The latter page contains the right ascension of the meridian (to *two* places of decimals), the longitude of the sun (to *one* place of decimals), its latitude (to *two* places of decimals), the logarithm of the radius vector (to *seven* places of decimals), and the semi-diameter of the sun (to *two* places of decimals); together with not only the days of the month, but likewise the number of days elapsed from the commencement of the year.

The ephemeris of the moon is also divided into two parts; but as the computations are made for every twelve hours, each month occupies four pages. These contain the moon's longitude, latitude, right-ascension, declination, parallax, and semi-diameter, (each to *one* place

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* If the Nautical Almanac were made what it *ought* to be, and such as the situation of this country demands, we have no doubt but that its sale might be considerably increased. We know that the American booksellers (who *reprint* that work in the United States) correspond with the German astronomers for the supply of additional matter, to be inserted in the annual volumes. And what is the consequence? *One* bookseller alone (and there are *several* who reprint the work) sells upwards of twelve thousand copies! We believe the *total* sale of the Nautical Almanac, in *this* country, never amounted to seven thousand copies.

place of decimals,) for *mean* noon, and mean midnight. There is also given the mean time of the moon's upper and *lower* culmination, (to the *tenth* of a minute in time), as well as her right ascension and declination (to the tenth of a minute in space); together with the time of her rising and setting, the time of her changes, and the time when she is in perigee or apogee.

At the end of this joint ephemeris of the sun and moon, there is given for every *tenth* day of the year, the apparent obliquity of the ecliptic, the parallax of the sun, the aberration, and the equation of the equinoctial points (each to *two* places of decimals); together with the place of the moon's node (to the nearest *tenth* of a minute).

Then follows an ephemeris of each of the planets, including the four newly discovered ones. The places of Mercury and Venus are computed for mean time at *noon* for every *second* day, and the remaining planets for mean time at *midnight* for every *fourth* day of the year. The columns contain the heliocentric longitude and latitude of the seven principal planets (to one place of decimals in the seconds), the geocentric right ascension (to two places of decimals), and the geocentric declination (to one place of decimals); the radius vector, and the logarithm of the distance from the earth (each to seven places of decimals); together with the time of their rising, setting, and passing the meridian. The computations of the four newly discovered planets are not so minute, except at the time of their opposition; for which period a separate ephemeris is given of the position of the planet for *every day*.

We have next an ephemeris of the time of the eclipses of Jupiter's satellites (to one place of decimals); to which is subjoined (for *each* satellite) a table for computing with the greatest accuracy, not only the configurations at any moment, but also the position of the satellite with respect to Jupiter at the time of its immersion or emersion. At the end of these tables, we are presented with another ephemeris (computed for every fortieth day) of the apparent position and magnitude of Saturn's ring.

After this comes a table of the mean places (for 1830) of 45 principal stars; the right ascensions to *three* places of decimals, and the declinations to *two* places of decimals. From these are computed and given for every tenth day of the year, the apparent places of the same stars (to *two* places of decimals), with their differences. And we have also the apparent places, for *every* day in the year, of α and δ *Ursæ Minoris.* To the whole of which are annexed formulæ for determining the amount of the diurnal aberration. Following these is given a table of the constants A, B, C, D, for every tenth day of the year, for the purpose of determining the apparent places of any other stars. It should however be remarked, that these letters do not indicate precisely the same quantities as are so designated in the catalogue of the Astronomical Society: and it should also be noted that the numbers are adapted to *sidereal* time. There is however another table subjoined, for the use of those who are disposed to adopt *mean solar* time in these computations.

Next follows a particular account of all the solar and lunar eclipses that

that will happen in the course of the year; together with all the necessary elements for computing them. This is followed by three pages of the principal phænomena of the planets: such as the time of their perigee or apogee, their perihelion or aphelion, their greatest elongation, their greatest latitude, their conjunction and opposition, their passing the nodes, their greatest brilliancy, their proximity to the moon and occultation thereby, &c.

Then follows a list of moon-culminating stars, occupying seventeen pages; and (which is equally valuable,) a list of the occultations of all the stars down to the 7th magnitude inclusive, that will take place in the course of the year; wherein the mean time of the immersion and emersion of the star (to the nearest tenth of a minute) is given, as well as the angle from the vertex of the moon at which the phænomenon will take place. To this list is subjoined some auxiliary tables for computing the occultation more minutely, if required.

To the whole is annexed an Appendix, giving an account of the mode in which all the computations are made, and the tables from which they are derived. By this excellent plan, the observer can at any time verify any of the calculations, and detect any error which he may have cause to suspect. The names of the computers also are given, which must materially tend to insure the accuracy of the work.

Such is the substance of the publication now before us, which has just reached this country, and which does so much credit to its distinguished conductor. We hail it as the harbinger of a general improvement in the mode of arranging and forming the ephemerides of different nations. And although it is mortifying to reflect that this country cannot (or will not) maintain its pre-eminence in these and other scientific subjects, yet we are grateful for information wherever it can be found, and trust that we shall be able eventually to emulate the splendid example which has thus been set us. M. Encke, disdaining the trammels of former and less enlightened times, and relying on his own excellent judgement and abilities, has nobly and boldly struck out a new path for himself, which we have no doubt will soon be followed by every nation pretending to encourage the science of astronomy.

We propose to give, in a subsequent Number of our Journal, a translation of the Appendix above alluded to, which will enable the English reader to make use of this most excellent Ephemeris; since a very minute account is there given of the mode in which the different tabular values are formed. There will then be nothing left for explanation but the *headings* of the different columns; which are in most cases so much like the English names, that little difficulty will occur in understanding them.

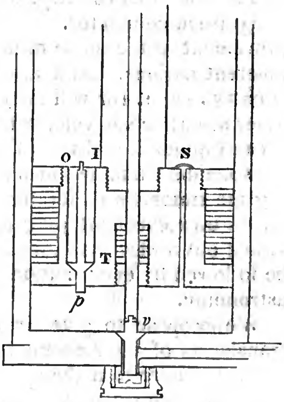
IMPROVED AIR-PUMP. BY MR. JOHN DUNN, OPTICIAN, EDINBURGH.

In the course of my business, having often heard it regretted that the cost of apparatus prevented many gentlemen from engaging in philosophical pursuits, I have made it my study to simplify the construction

struction of those which I have been employed to make, wherever this could be done without impairing the accuracy of their performance.

One of my first efforts was directed to that most valuable instrument the air-pump, which I shall endeavour to show I have improved so very materially, as to be able to furnish one capable of effecting as complete an exhaustion as the most perfect form of the instrument hitherto devised, and, at the same time, nearly as simple and as cheap as its most imperfect form. I mentioned my views on the subject to several gentlemen qualified to judge of their correctness, and soon had an opportunity of putting them to the test of experiment. I received an order to make one for Mr. Lees, lecturer on mechanical philosophy in the School of Arts here, on condition that he was to be permitted to return it, if, on trial, it was not found capable of executing all that I had led him to expect. This pump, through the kindness of Mr. Lees, in whose possession it has been for the last eighteen months, was exhibited to the Society for the Improvement of the Useful Arts, on the 19th of December 1827 *.

Believing the only useful part of Cuthbertson's improvement of the air-pump to be the contrivance for opening the valves at the bottoms of the barrels, mechanically, I was of opinion a pump would perform nearly, or altogether as well, divested of all the other peculiarities of his instrument, and possessing the decided advantages of being cheaper and much more easily kept in order.



The Figure is a section of one of the barrels of my pump, in which I employ metallic valves *v v'* at the bottom of the barrels, and waxed silk ones S S' in the pistons, laying aside Cuthbertson's metallic valves in the pistons, removing all his apparatus from the top of the barrels, and *leaving the pistons exposed to the atmosphere*, as I consider all those contrivances to be unnecessary, although it has been uniformly held essential to a good air-pump, since the time of Smeaton's invention, that the pressure of the atmosphere should be taken off the piston-valves; and my reason for doing so is, that the air will be always so compressed in the barrels, by the descent of the pistons, as of itself to have sufficient elastic force to open the silk valves in the pistons, the capacity of the barrels being each several thousand times greater than the space between the two valves, when the piston is at the bottom. In fact, by making the under side of the piston and the bottom of the barrel fit each other, which, with the assistance of the oil

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* The instrument had been previously submitted to the examination of Dr. Turner, one of the Secretaries of the Society of Arts, who reported that he had minutely examined it, and was perfectly satisfied with its performance. On his representation to the Council of the London University, I have since received an order to make one for the chemical class of that Institution.

oil employed in the barrels may be done perfectly, there will be no space left but the small hole in the piston leading to its valve.

For illustration, let us suppose the stroke to be 12 inches, and the diameter of the barrels $2\frac{1}{2}$ inches, or 25 tenths (as is the case in Mr. Lees' pump), the diameter of the hole *e* one-tenth of an inch, and its length 1 inch, then, circles being to each other as the squares of their diameters, we have $1 \times 1 = 1$ for the capacity of the hole, and $25 \times 25 \times 12 = 7500$ for the capacity of the barrels; and consequently air, which in the receiver was 7000 times rarer than the atmosphere, would have sufficient elastic force to open the valve in the piston; but as this is a degree of rarefaction far beyond what has ever been attained, or even expected, it follows that any greater nicety of construction here is unnecessary.

The above plan may, however, be objected to, on account of its still leaving *something* to depend on the elastic force of the air which, should any one consider desirable to be removed, can be done by adopting metallic valves I I′* with projecting points *p′ p′*, to strike against the bottom of the barrels, having the spaces O′ T′, O T, filled with oil, to exclude the external air during their shutting, instead of the oiled silk ones S S′; but even this small addition I consider wholly unnecessary.—*Edin. New Phil. Journ.*

GALLATES OF QUINA AND CINCHONIA.

M. Platania forms these compounds in the following way: Pour an infusion of galls into a hot solution of sulphate of quina, wash the precipitate with cold water upon a filter, and dry it at 100° of Fahr. Afterwards dissolve it in warm alcohol; pour off the solution and evaporate it, then add cold water to it, which precipitates pure gallate of quina.

Another process consists in pouring gallic acid into sulphate of quina, and merely washing the precipitate with cold water; and it may also be formed by directly combining the acid and base each separately dissolved in alcohol. Gallate of quina is very white and light; its sp. gr. is 0·816 at 60° Fahr. Its vapour is astringent, and very slightly bitter; it is soluble in alcohol and æther, but almost insoluble in water. It is composed of nearly

Gallic acid..........	14·87
Quina..............	85·13
	100·00

The gallate of cinchonia is obtained by dropping gallic acid into a solution of cinchonia; the gallate precipitates, and is to be redissolved in water and suffered to cool; the liquid becomes opalescent, and deposits granular transparent crystals.—*Hensman's Repertoire de Chimie, &c.* Jan. 1828.

PREPARATION AND PROPERTIES OF ALUMINUM.

On these subjects the following statements are made by M. Woehler.

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* The accented letters refer to a suppressed figure of the other barrel of the pump.

ler. The method of preparing aluminum is founded upon the inoxidability of this metal by water. When an attempt is made to heat chloride of aluminum with potassium in a tube, the action is so strong and the extrication of heat is so considerable, that the apparatus is instantly broken. I therefore employed a small platina crucible, the cover of which was kept on by a wire of the same metal. At the moment of reduction, the crucible became intensely red-hot, both within and without, although it was but slightly heated; the metal of the crucible was not sensibly acted upon. The operation may also be effected in a porcelain crucible with a cover attached. Some small pieces of potassium of about the size of a pea, and not more than ten at once, are placed in the crucible, and upon them are put an equal number of pieces of chloride of aluminum of the same size; the crucible is to be heated with the spirit-lamp, at first gently, and afterwards more strongly, and until the spontaneous incandescence of the matter ceases. Excess of potassium is to be avoided; for after it was oxidized, it would dissolve a portion of the aluminum. The reduced mass is generally completely fused, and is of a blackish-gray colour. When all is cold, the crucible is to be thrown into a large vessel of water; a gray powder is soon deposited, which, when looked at in the sunshine, appears to be entirely composed of small metallic plates; the powder is to be washed with cold water and then dried: it is the metal of alumina.

Aluminum somewhat resembles platina in powder. I discovered some scaly coherent particles, which had the colour and splendour of tin. Under the burnisher it readily assumes the appearance of this metal; rubbed in an agate mortar, it seems to be a little compressible, and unites into larger scales, with a metallic lustre; and it leaves in the mortar traces of a metallic appearance. When heated in the air, until it is ignited, it inflames and burns with great rapidity; the product is the white oxide of aluminum in a hard mass. Reduced to powder and blown upon in the flame of a candle, each particle suddenly becomes an inflamed point, the splendour of which is not less than that of the sparks of iron burning in oxygen gas. In pure oxygen gas aluminum burns with so dazzling a light, that the eyes can scarcely bear it; the heat generated is so considerable, that the oxide produced is partly fused. The particles which have been fused are yellowish, and as hard as corundum; they do not merely scratch, but they cut glass. In order that aluminum may burn in oxygen gas it must be heated to redness.

Aluminum is not oxidized by water, and this fluid may spontaneously evaporate from the metal without its being in the least tarnished; when however the water is nearly at its boiling point, the metal is slowly oxidized, and hydrogen is liberated.

The sulphuric and nitric acids when cold do not act upon aluminum; when heated, concentrated sulphuric acid readily dissolves it, and without the evolution of sulphurous acid; the sulphuric solution did not by evaporation give the smallest crystal of alum.

Aluminum introduced into a solution of caustic potash, even when weak, dissolves readily, and with the evolution of hydrogen; the solution

lution is perfectly clear; the same solution takes place in ammonia; and it is surprising to observe how much of this earth the ammonia is capable of uniting with: the evolution of hydrogen is similar to that with potash. When aluminum is heated to dull redness, and exposed to a current of chlorine, it inflames and is converted into chloride, which sublimes as fast as it is formed.—*Ibid.*

CHLORIDE AND OTHER COMPOUNDS OF ALUMINUM.

M. Woehler obtains chloride of aluminum, for the purpose of procuring the metal from it, by the following process: alumina precipitated by excess of carbonate of potash, was well washed and dried, and then made into a thick paste with powdered charcoal, sugar and oil; this paste was then heated in a covered crucible until all the organic matter was destroyed. By these means any substance is mixed very intimately with carbon: the product while it was hot, was put into and made to fill a porcelain tube, which was placed in a furnace of an oblong form. One end of the tube was connected with another tube containing fused chloride of calcium, and this with an apparatus for the evolution of chlorine; the other end of the tube opened into a small tubulated receiver, provided with a conducting tube. When the apparatus was full of chlorine, the tube and its contents were made red-hot. The chloride of aluminum was readily formed; a small portion was carried over with oxide of carbon, which fumed strongly on coming into contact with the air. The chlorine was long retained by the mass of matter. The receiver contained chloride of aluminum in the state of powder. After an hour and a half the chloride obstructed the end of the tube (though an inch in diameter) which passed into the receiver; this caused the stoppage of the process.

On taking the apparatus to pieces, it was found that all that part of the tube which passed through the furnace was filled with chloride of aluminum, and it weighed more than an ounce. It consisted partly of an aggregation of long crystals, and partly of a firm mass, which was readily detached from the tube, and was of a pale yellowish-green colour, semitransparent, and of a lamellated and distinctly crystalline texture; but no crystal could be found sufficiently regular to admit of its form being ascertained. When brought into contact with the air, it fumed feebly, gave a smell of muriatic acid, and soon became a transparent fluid. When thrown into water, it dissolved with strong hissing, accompanied with so much heat, that the fluid, when the quantity is small, boils rapidly: according to M. Oersted, the temperature is not much higher than that of boiling water. Its fusing and vaporizing points seem to be the same. Chloride of aluminum may be preserved without any alteration in naptha; when heated with this oil it liquefies, and sinks to the bottom of the vessel, in the form of a reddish-brown liquid, upon which potassium exerts no action. Chloride of boron may be obtained by passing chlorine over calcined borax heated to redness.

Sulphuret of Aluminum.—When sulphur is suffered to drop upon aluminum

aluminum in a state of vivid ignition, the mixture becomes strongly incandescent, and a black frit is formed: it is semimetallic in appearance, and when polished is of a shining iron-black colour. When exposed to the air, this frit emits a smell of sulphuretted hydrogen, swells, and falls into a grayish-white powder; when applied to the tongue, it occasions a hot penetrating sensation; when thrown into water, it is converted into a gray powder of alumina, accompanied with a rapid disengagement of sulphuretted hydrogen. Sulphate of alumina when heated to redness in contact with hydrogen, loses its acid, but the earth is not reduced.

Sulphuretted Hydrogen and Aluminum.—When chloride of aluminum is sublimed in a small retort, and a strong current of sulphuretted hydrogen gas is at the same time made to enter its neck, it is absorbed; and a very white sublimate is formed, partly in the state of pearly transparent scaly crystals, and partly in that of a brittle mass. The residuum of sulphuretted hydrogen was displaced from the apparatus by simple hydrogen. In the cold, this gas is not absorbed by the chloride of aluminum. In contact with the air, the sublimed matter moistens rapidly, sulphuretted hydrogen is disengaged, and chloride of aluminum remains in solution. When sublimed in a tube, it evaporates with the evolution of sulphuretted hydrogen equal to from 30 to 40 times its volume, which however cannot be the whole of the gas, because the combination is formed at a high temperature. When put into water, the sublimate is decomposed with the same violence as the pure chloride; much sulphuretted hydrogen is disengaged, and the solution is rendered turbid by the precipitation of sulphur. Pass a small piece of the compound into a tube full of mercury, and afterwards some water; a great volume of gas is evolved with great rapidity, which is completely absorbed by solution of acetate of lead, with the precipitation of sulphuret; when thrown into solution of ammonia, alumina is precipitated. No action takes place between the compound of sulphuretted hydrogen and aluminum with muriatic acid gas.

Phosphuret of Aluminum.—Aluminum heated to redness in the vapour of phosphorus, combines with it with vivid inflammation; the product is a blackish-gray pulverulent substance, which under the burnisher assumes a deep gray metallic lustre, and exhales a smell of phosphuretted hydrogen; when thrown into water, it occasions the evolution of phosphuretted hydrogen, which is not spontaneously inflammable. In the cold, the disengagement of this gas is not so rapid as that of sulphuretted hydrogen, but it is quickened by heat.

Seleniuret of Aluminum.—Selenium when mixed with the metal of alumina, and heated to redness, combines with it, producing strong inflammation. The seleniuret thus obtained is a black powder, which being rubbed becomes of a dull metallic aspect. When exposed to the air it continually exhales a smell of seleniuretted hydrogen; in water the disengagement of this gas is very rapid, and the water is quickly reddened by a portion of precipitated selenium.

Arseniuret of Aluminum.—Arsenic reduced to powder and heated to redness with aluminum, combines with it; the inflammation is less vivid than with the preceding combustibles. The compound is a powder of a deep gray colour, which by rubbing acquires a dull metallic appearance, and when exposed to the air it exhales a faint smell of arseniuretted hydrogen; when cold, the disengagement is slow, but it is much accelerated by heat.

Telluret of Aluminum.—When the powder of tellurium was put into a tube with aluminum, much heat was excited, and the mixture was thrown with explosion out of the tube; this inconvenience is avoided by not powdering the tellurium. The product is a metalline, brittle, black frit, which when exposed to the air emits an intolerable odour of telluretted hydrogen; and when thrown into water it evolves the same gas with rapidity: the water at first becomes of a red colour, afterwards brown, and eventually opake, on account of the interposed reduced tellurium: the telluret of aluminum appears to decompose in water with much greater facility than the sulphuret of the same metal.—*Ibid.*

NATIVE IODIDE OF MERCURY.

M. Del Rio has already mentioned that he has discovered iodide of silver in America, and he has mentioned its locality. He has since discovered another iodide; and he is of opinion that the metal in combination with it is mercury. It perfectly resembles dark-coloured cinnabar, except that its colour is deeper and its streak paler; it is however certain, that it accompanies an earthy iodide, which M. Del Rio believes to be the metal of magnesia mineralized by iodine.—*Ibid.*

CORYDALIN,—A NEW VEGETABLE ALKALI.

According to M. Wackenroder, this alkali is contained in the root of the fumitory (not the common fumitory, *fumaria officinalis,* but the *fumaria cava,* and *corydalis tuberosa* of Decandolle). The dry root is to be coarsely powdered and digested for some days in water; filter the infusion, and precipitate with excess of potash; dry the precipitate and treat it with boiling alcohol, until it ceases to dissolve anything. It sometimes happens that during the cooling of the alcohol, crystals of corydalin are deposited. The solution is to be evaporated to dryness, and the residuum is to be dissolved in weak sulphuric acid; this solution is then to be decomposed by an alkali either caustic or carbonated. A white deposit is formed, which by drying becomes of a light gray colour.

Dry corydalin soils the fingers very much; it is insipid and inodorous. It is soluble in alcohol; and this solution when hot and saturated deposits colourless prismatic crystals of a line in length. By slow spontaneous evaporation, fine laminæ are formed. The solution acts as an alkali upon vegetable blue colours. At a temperature below that of boiling water, it melts into a deep green-coloured fluid, which, when solidified, has a crystalline texture, and is transparent in thin laminæ. At a higher temperature it yields water and ammonia,

ammonia, and is converted into a transparent brown mass. Æther dissolves corydalin with the same facility as alcohol; caustic potash dissolves it in considerable quantity.

This alkali forms extremely bitter salts with acids; sulphuric acid forms two different salts; one which crystallizes is obtained when the acid is digested with excess of base; the solution is to be filtered and evaporated: the product is very slightly soluble in water. When a small quantity of sulphuric acid is added to a solution of corydalin in alcohol, so as not to saturate the base perfectly, a portion of crystalline matter is deposited; and there remains a stratum of a greenish transparent substance, which is unalterable by exposure to the air, and readily soluble in water: the solution reddens litmus paper slightly; an excess of acid renders it purple, and eventually blackens it. Nitric acid when diluted and cold dissolves and forms a colourless solution with corydalin; but when heated it becomes of a red colour, which, when the solution is concentrated, becomes of a blood-red colour. This action is so strong, that by the aid of heat the smallest quantity of corydalin may be discovered in a fluid. Muriatic acid forms with this alkali an uncrystallizable salt; acetic acid is still more difficult of combination with it than sulphuric acid; but it forms a crystalline salt, which may be redissolved a second time in water and crystallized. Tannin is one of the most sensible tests of corydalin, as for all other vegetable bases. The precipitate is white when the solution is dilute, and grayish-yellow if concentrated.—*Ibid.*

ACTION OF ALKALIES AND THEIR CARBONATES, &C. ON IODIDES.

M. Berthemot, having made numerous experiments on the action of alkalies, and some metals on the iodides, concludes:—That the earthy oxides and their carbonates do not act upon iodide of mercury; —that potash, soda, barytes and strontia, decompose iodide of mercury by the intervention of water or alcohol, and there result oxide of mercury and tri-iodo-hydrargyrate of potash, which on the cooling of the liquors, successively deposit iodide of mercury, and bi-iodo-hydrargyrate of potash;—that lime produces the same phænomena, with this difference however, that the action occurs only by the intervention of alcohol;—that the soluble carbonates of the alkaline oxides also decompose iodide of mercury, and yield analogous products, but only with the intervention of alcohol;—that the insoluble carbonates of the alkaline oxides do not act upon iodide of mercury, either by the intervention of water or alcohol;—that the protoxide of mercury decomposes the iodide of potassium, forming potash, and metallic mercury, or protiodide of mercury and iodo-hydrargyrate of potash;—that the remaining alkaline iodides have a similar action, except that of calcium, which does not appear susceptible of it;—that peroxide of mercury decomposes the alkaline iodides, forming an alkaline oxide and bi-iodo-hydrargyrate.—*Journal de Pharmacie, April* 1828.

CITRIC ACID FROM GOOSEBERRIES.

M. Tilloy, by the annexed process, has prepared citric acid from gooseberries,

gooseberries, so as to be able to obtain it for 12 francs, 96 centimes the kilogramme; whereas the price of citric acid in France is from 29 to 30 francs for the same weight.

The gooseberries are to be bruised and fermented; the alcohol is to be separated by distillation; the residuum is to be pressed to extract the whole of the liquid. To this liquor, while hot, carbonate of lime is to be added as long as effervescence takes place: after standing, the citrate of lime is to be collected and suffered to drain; it is to be repeatedly washed and then pressed. The citrate of lime thus obtained, being still coloured and mixed with malate of lime, is to be mixed with water to the consistence of a thin syrup, and is then, while hot, decomposed with sulphuric acid, diluted with twice its weight of water. The liquor resulting from this operation, is a mixture of sulphuric (malic ?) and citric acid, and is to be again treated with carbonate of lime. The precipitate, when collected on a filter, is to be plentifully washed, pressed, and again mixed with sulphuric acid; the clear liquor, containing the acid, is to be decolorized by animal charcoal, and evaporated. When it is sufficiently concentrated, it is suffered to deposit, and the clear liquor poured off is put into stoves heated from 20° to 25° Centig. Coloured crystals are thus obtained, which are to be drained, slightly washed, and recrystallized.—*Ibid.*

SOLANINE.

M. Pelletier could not obtain solanine from the *solana* of Europe, but he procured it from the *solanum mammosum* of the Antilles.—*Ibid. May* 1828.

BLUE COLOUR BY THE ACTION OF MURIATIC ACID UPON ALBUMEN.

Various unsuccessful experiments appear to have been made to produce this blue colour; first observed, we believe, by M. Caventou. According to M. Robiquet, the more acid employed, the more readily is the blue colour produced, to a certain extent. He finds that seven or eight parts of acid, to one part of albumen, yield the most intense blue, even at a low temperature; but its development is favoured by a temperature of 25° to 30° Centig.—*Ibid.*

BOTRYOGENE, OR NATIVE RED IRON-VITRIOL OF FAHLUN.

Berzelius gave an analysis of this salt some time since; of its physical properties very little was however then known. Mr. Haidinger, having been furnished with specimens by Berzelius, and M. Pohlheimer of Fahlun, has given an account of its crystalline form and qualities in Brewster's Journal for July last.

It occurs in the great copper-mine at Fahlun in Sweden. The regular forms of botryogene belong to the hemiprismatic system of Mohs; they are in general pretty distinct, but too imperfectly formed to permit any thing more than an approximation to the real angles within ten minutes of a degree. The lustre of botryogene is vitreous. It is translucent. Its colour is a deep hyacinth-red; which, however, in compound massive varieties, passes into ochre-yellow, which is likewise the colour of the streak. It is sectile, and becomes a little shining

shining in the streak, and its hardness is a little inferior to that of alum. Its specific gravity is 2·039. It is slowly soluble in water, and does not, therefore, possess so powerful an astringent taste as common sulphate of iron. The crystals are not above two lines in length, and are usually aggregated in reniform and botryoidal shapes, consisting of globules with a crystalline surface; the trivial name alludes to the tendency of the salt to produce such imitative shapes.

When exposed to a moist atmosphere, it becomes covered with a dirty yellowish powder, but remains unchanged in a dry atmosphere: before the blowpipe it intumesces, and gives off water in a glass tube, leaving a reddish yellow earth behind, which according to the flame employed may be changed into protoxide or peroxide of iron. With salt of phosphorus it yields a red glass, which loses its colour on cooling. Boiling water dissolves part of it, leaving a yellow ochre, which therefore is an integral portion of the mixture. The solution, nitric acid being added to it, may be precipitated by muriate of barytes, but not by nitrate of silver. Ammonia, with which the salt is digested in a stoppered bottle, takes away all the acid, and leaves the iron in the shape of a slightly greenish black powder. The iron therefore is contained in the salt, not as a pure oxide, but as a compound of the protoxide and peroxide, which is black when pure, and produces red solutions.

The following are the results of three analyses:

	I.	II.	III.
Persulphate of iron, with excess of base,	6·77	6·85	48·3
Bisulphate of the protoxide and peroxide of iron	35·85	39·92	
Sulphate of magnesia	26·88	17·10	20·8
Sulphate of lime	2·22	6·71	0·0
Water and loss	28·28	31·42	30·9

The second analysis is most correct as to the water. Berzelius considers all the substances mixed with salt of iron as foreign to the salt, and uncombined with it.

ERINITE,—A NEW MINERAL SPECIES.

This substance is arseniate of copper, contained in Mr. Allan's cabinet. Mr. Haidinger makes the following observations on it. "Though not presenting determinable crystals, the appearance of the specimens in Mr. Allan's cabinet, the only ones which I remember to have ever met with, are highly crystalline. The individuals are arranged in concentric coats with rough surfaces, produced by the termination of exceedingly small crystals, the layers often not firmly cohering, so that they may be easily separated from each other. These layers themselves are very compact; they show an uneven, or sometimes imperfect conchoidal fracture, and traces of cleavage. The cleavage probably takes place parallel to the broad faces of rectangular four-sided plates, into which the individual terminates. I have, in several instances, observed something like them by means of a compound microscope, but always very indistinctly. These plates form crest-like aggregations. A circumstance which greatly increases the difficulty of observing the regular forms, is the complete absence of of lustre, the surface of the concentric layers being quite dull, while there is only a slight degree of resinous lustre on the fracture.

The colour of erinite is a beautiful emerald-green, slightly inclining to grass-green; the streak, likewise green, is a little paler, and approaches to apple-green. It is slightly translucent on the edges. The substance of erinite is brittle; its hardness I found = 4·5 . . . 5·0 of the scale of Mohs; its specific gravity = 4·043.

According to the locality attached to the specimens in Mr. Allan's cabinet, they are natives of the county of Limerick in Ireland. For the name of Erinite, which is here proposed for this mineral, the mineralogical public is indebted to Mr. Allan. It unites, what is rarely the case with mineralogical names, the comparatively trite and prosaical allusion to the native country, with the poetical recollection of the characteristic verdure of the "*Emerald Isle.*"

Erinite is associated with two of the species containing arsenic acid and copper, described by Count Bournon; the common arseniate of copper (prismatic olive-malachite of Mohs), and the dark blue arseniate, both of them crystallized and disposed between the concentric layers of erinite. Dr. Turner gives the following as an approximation of the analysis of erinite:—

Oxide of copper	59·44
Alumina	1·77
Arsenic acid	33·78
Water	5·01
	100·00

Brewster's Journal, July 1828.

ALTERATION OF CRYSTALLINE STATE IN SOLIDS.

M. Mitscherlich finds that when sulphate of magnesia or sulphate of zinc is slowly heated in alcohol, and the heat be gradually increased to boiling, the crystals lose their transparency by degrees; and when broken they are found to consist of a great number of new crystals entirely different from those of the salt employed, owing to the change in the position of the atoms, by internal motion, without the occurrence of solution. *Ann. de Chim.* xxxvi. p. 206.

DECOMPOSITION OF AMMONIA BY METALS.

M. Savart found that 141·91 grains of thin copper wire became 142·382 grains, or acquired an increase of 0·472 in weight, when used for four hours to decompose ammonia: as the wire was in a slight degree oxidized, the experiment was repeated; and when every precaution was employed, the increase amounted to $\frac{1}{275}$, and 0·105 of an unknown substance was absorbed by the copper, and its specific gravity was diminished from 8·8659 to 7·7919.

Iron also increases in weight, and diminishes in specific gravity by similar treatment, and will strike fire with flint like ordinary steel.

Ibid. xxxvii. p. 326.

IODIDES OF CARBON.

Whilst experimenting for a peculiar purpose, M. Mitscherlich mingled the alcoholic solutions of iodine and soda. "There was formed imme-

immediately," he observes, "the compound obtained by Serullas. But Serullas, to whom we are indebted for a great many interesting experiments on this compound, says, that there is formed simultaneously, iodate of soda, iodide of sodium, and hydriodide of carbon; but I have not found the slightest trace of iodate of soda. On decomposing the substance obtained by Serullas by means of copper, iron, and mercury, I obtained no hydrogen, nor any other kind of gas, but only a combination of iodine and carbon. We should therefore consider this substance as a compound of carbon and iodine formed in the following manner:—When the two alcoholic solutions are mixed, the iodine combines with the sodium; and the oxygen set free, unites to the hydrogen of the alcohol to form water; whilst the carbon of the alcohol (the latter being considered as a compound of water and olefiant gas) combines with another portion of the iodine to produce the iodide of carbon.

"This iodide of carbon, distilled with corrosive sublimate, yields a liquid analogous to that which Serullas obtained by employing dry chloride of phosphorus. It is also a compound of carbon and iodine; so that we now know two combinations of iodine and carbon, and one with carburetted hydrogen, discovered by Faraday, which is distinguished from the two others by its chemical properties and crystalline form."

The experiments of M. Mitscherlich, by showing the true nature of M. Serullas' compound, remove the difficulty of supposing that two hydriodides of carbon could exist of exactly the same composition, but different in properties.

Ann. de Chim. xxxvii. p. 85. *Roy. Inst. Journal, July* 1828.

SOLAR SPOTS.

The large solar spot, whose appearance we described under our last monthly meteorological report, came round on the sun's eastern limb in the night of the 12th instant, as we supposed it would, and was well-defined by the 14th, when the nucleus had assumed the shape of a pear: on the 17th it was bell-shaped, and on the 19th, when nearest to the sun's centre, the umbra and nucleus were nearly circular, with a few indentations on the edge of the latter, and but little apparent diminution in the size of either since the 27th of May. At 7 A.M. on the 23rd it was, as nearly as could be ascertained from a drawing, in the same position on the sun's disc as on the 27th ultimo; and on the 25th at sunset it was very near his lower limb in a very contracted state, resembling a line without any perceptible umbra, and went off on his posterior side again in the night, making a complete revolution in both cases in 27 days, and thus travelling, when the necessary correction is made for the earth's annual motion in the ecliptic during the period of its revolution, at the rate of 1454 miles per hour, which is to the velocity of a point on the earth's equator as 7 to 5 nearly. Early in the morning of the 19th, this spot was within 9 degrees of the sun's equator, or its declination was 9 degrees North. Its largest diameter, from a mean of several admeasurements, was $1\frac{1}{2}$ diameter of the

the earth, or about 12000 miles. Although it had undergone considerable changes in respect to figure, yet it appeared strong enough to last another revolution, by which means more favourable opportunities may offer to obtain the number of hours (if any) in addition to the first observed 27 days of its revolution. It appears from a drawing of the positions of this spot, and another large one that accompanied it, whose declination was about 19 degrees South, that in their daily progress across the sun's disc they moved in slightly parallel curved lines from East to West, and went off nearly at the same time; therefore they will probably appear on the sun's eastern limb at noon of the 9th of July. Since the 27th of May, considerable variations and alterations have taken place in the positions and number of the solar spots; some have entirely disappeared, while new ones have appeared on other parts of the sun's disc.

LIST OF NEW PATENTS.

To S. Pratt, of New Bond-street, camp equipage maker, for improvements on elastic beds, cushions, seats, pads, and other articles of that kind.—Dated the 25th of June 1828.—6 months allowed to enrol specification.

To J. Baring, of Broad-street Buildings, merchant, for a new and improved mode of making machines for cutting fur from skins for the use of hatters. Communicated from abroad.—3rd of July.—6 months.

To J. Johnston Isaac, of Star-street, Edgeware Road, Middlesex, for improvements in propelling vessels, boats, &c.—5th of July.—6 months.

To T. Revis, of Kennington-street, Walworth, Surrey, for an improved method of lifting weights.—10th of July.—6 months.

To J. Hawks, of Weymouth-street, Portland Place, iron manufacturer, for an improvement in the construction of ships' cable and hawser chains.—10th of July.—6 months.

To J. H. A. Gunther, of Camden Town, Middlesex, for improvements on piano-fortes.—10th of July.—2 months.

To Captain W. Muller, of Doughty-street, Bedford-row, for an instrument or apparatus for teaching mathematical geography, astronomy, and other sciences; and for resolving problems in navigation, spherics, and other sciences.—10th of July.—6 months.

To B. Rider, of Redcross-street, Southwark, for his improvements in the manufacture of hats.—17th of July.—6 months.

To J. Jones, of Amlwch, Anglesea, for his improvement in certain parts of the process of smelting copper ore.—17th of July.—6 months.

⁂ Mr. Herapath informs us that he has perused a copy of the paper written in his defence signed *Veritas*, and requests us to state to our readers, in a form more permanent than a notice on our wrapper, that he cannot consider it as intemperate, nor acquiesce in our reasons for not inserting it; and that he conceives the majority of our readers would coincide with him in this opinion. He adds that he is ready to reply to every point advanced in the papers signed $\alpha\,\beta$, and F.R.S., the names of the writers are commnuicated to him to use in public.

We

We must therefore repeat in our justification that we object to continue a controversy, when it is degenerating from a philosophical inquiry into a personal dispute. We should not have inserted Mr. H.'s last letter, had we observed that, instead of giving any reply to the objections brought by α β, and F.R.S. against his charge of failure in Lagrange's method, he had passed them by in silence, and aimed at taking up ne ground. We submit, however, that the fair course of discussion absolutely requires that he should dispose of the objections, either by admitting their validity, or by refuting them, before he can have a claim further to occupy our pages on this subject. With his suggestion respecting the names of his opponents we cannot comply: nor are names of any consequence in such discussions. As to the letter of *Veritas*, it does not appear to contain any thing by which knowledge may be advanced, or our readers interested.—Ed.

METEOROLOGICAL OBSERVATIONS FOR JUNE 1828.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·33 June 26. Wind S.—Min. 29·35 June 18. Wind N.E.
Range of the index 0·98.
Mean barometrical pressure for the month .... 29·982
Spaces described by the rising and falling of the mercury........... 4·610
Greatest variation in 24 hours 0·550.—Number of changes 18.
Therm. Max. 81° June 28. Wind S.E.—Min. 48° June 6. Wind N.W.
Range 33°.—Mean temp. of exter. air 63°·63. For 30 days with ☉ in ♊ 62·10
Max. var. in 24 hours 24°·00—Mean temp. of spring water at 8 A.M. 52°·44

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the evening of the 22nd.............. 86°
Greatest dryness of the air in the afternoon of the 8th............... 40
Range of the index.. 46
Mean at 2 P.M. 51°·2—Mean at 8 A.M. 57°·7—Mean at 8 P.M. 63·7
—— of three observations each day at 8, 2, and 8 o'clock......... 57·5
Evaporation for the month 4·65 inches.
Rain near ground 1·98 inches.
Prevailing wind, S.W.

Summary of the Weather.

A clear sky, 5; fine, with various modifications of clouds, 17; an overcast sky without rain, 4; rain, 4.—Total 30 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus
25	16	29	0	29	23	14

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
2	3	2½	4	3	8	2½	5	30

General Observations.—The first part of this month was alternately wet and dry, but from the 20th to the end, more favourable weather could not have happened for hay-making, which was performed generally in Hampshire with expedition, and the crops got in, in excellent condition. Early in the morning of the 5th a storm passed over to the eastward, with lightning and thunder: showers of rain and hail with distant thunder also occurred in the afternoon of the 6th. In the evening of the 7th a parhelion appeared in a *cirrostratus* cloud on the south side of the sun. From between two and

and three till nearly six o'clock in the morning of the 15th, the weather was very awful here; the lightning, which was chiefly forked, flashed vividly at short intervals; its colour was dark-red; it continued a long time in the zenith, and the explosions were so near, that the rushing of the adjacent air into the displacement to restore its equilibrium, shook the foundations of the houses. There were two winds at the same time; viz. a strong gale next the earth from due North, surmounted by a slow moving current from S.E. as ascertained by the black thunder-clouds which the latter wind carried with it: by the inosculation of these winds, and clouds of unequal temperatures from nearly opposite points of the compass, the lightning was generated, and was awfully grand for upwards of two hours. No damage was done by the storm in this neighbourhood, but it was severely felt in the upper part of the country. The same morning between four and five o'clock, just before the heavy rain came on, a beautiful double rainbow appeared in a large *nimbus* to the westward; the arc of the exterior bow extended from about S.S.W. to W.N.W. The electric fluid which accompanied the recent thunder-storms in this county was very powerful, having killed several men and horses.

On the 20th, about 5 o'clock in the afternoon, an anthelion appeared in the eastern prime vertical, opposite to and 120 degrees distant from the sun. This rare phænomenon presented itself in a light brown *cumulostratus* cloud, from which it was distinguished by its circular silvery colour, which repeatedly contracted and expanded according to the effulgence of the sun. It continued in sight nearly two minutes, by which time the cloud had moved off too far to the north-east to exhibit the sun by reflection.

The 28th and 29th were hot sunny days, the thermometer in the shade in the afternoons being at 80° and 81°, and in the sun's rays at 106°.

The mean temperature of the external air this month is 2½ degrees higher than the mean of June for the last twelve years.

The atmospheric and meteoric *phænomena* that have come within our observations this month, are one anthelion, one parhelion, four solar halos, two double rainbows, lightning and thunder on four different days; and eight gales of wind, or days on which they have prevailed; namely, one from the North, one from the North-east, one from the East, three from the South-west, and two from the West.

REMARKS.

London. — June 1—3. Very fine. 4. Rainy. 5. Cold and cloudy. 6. Sultry: with thunder. 7. Clear and fair. 8. Fine: showery at night. 9—11. Very fine. 12. Sultry, and warm. 13—15. Very fine. 16. Drizzly. 17. Sultry, and warm. 18. Showery in the morning: fine. 19. Cloudy, and warm. 20. Very fine. 21. Wet morning: fine. 22. Drizzly: fine. 23—30. Very fine and warm.

Boston.—June 1. Cloudy. 2—4. Fine: rain A.M. 5. Cloudy: rain A.M. hail-storm 1 P.M. rain at night. 6, 7. Cloudy. 8. Cloudy: rain A.M. 9. Fine. 10—13. Cloudy. 14. Fine. 15. Cloudy. 16. Fine. 17. Cloudy: rain A.M. 18. Fine: rain A.M. and P.M. 19, 20. Fine. 21. Rain: thunder and lightning with rain P.M. 22. Fine: rain P.M. 23. Cloudy: rain P.M. 24—27. Fine. 28—30. Cloudy.

Penzance.—June 1. Fair: rain. 2. Clear. 3, 4. Rain: showers. 5. Clear: showers. 6. Fair: showers. 7. Fair. 8. Fair: clear. 9, 10. Clear. 11. Clear: fair. 12. Fair: at times clear. 13. Fair: clear. 14. Clear: cloudy: lightning. 15. Misty. 16. Misty: showers. 17. Rain. 18. Rain: fair. 19. Fair: showers. 20. Fair. 21. Clear: showers at night. 22. Clear. 23. Fair: clear. 24, 25. Clear. 26. Fair: clear. 27—29. Clear. 30. Fair.

Meteorological Observations made at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1828.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston 8½ A.M.	London.		Penzance.		Gosport.		Bost. 8½ A.M.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.										
June 1	30·073	30·047	30·15	30·12	30·06	30·02	29·45	69	52	63	53	69	55	62·5	SW.	W.	SW.	W.	...	...	...	0·055	...
2	29·966	29·924	30·08	30·00	29·94	29·92	29·33	67	49	61	50	66	52	59	SW.	NW.	W.	W.	...	...	0·145	·030	0·06
3	29·991	29·919	30·05	30·00	29·99	29·96	29·44	65	54	61	51	69	55	58	SW.	W.	SW.	W.	0·45	...	0·100	·230	...
☾ 4	29·537	29·477	29·75	29·54	29·63	29·48	29·12	65	50	58	51	62	49	58	W.	NW.	SW.	W.	...	·76	0·475	·255	·14
5	29·543	29·323	29·73	29·55	29·55	29·38	28·85	62	45	60	50	66	50	55	SW.	NW.	W.	W.	...	·03	0·175	·070	·08
6	29·802	29·626	30·00	29·83	29·78	29·64	29·15	65	49	57	51	66	48	54·5	W.	NW.	SW.	W.	·35	·01	0·050	·070	·22
7	30·137	30·001	30·20	30·14	30·11	30·00	29·53	61	44	58	49	64	52	55	W.	N.	NW.	W.	...	...	...	...	...
8	30·206	30·186	30·25	30·25	30·18	30·17	29·70	64	47	63	48	70	55	58	W.	N.	NW.	W.	...	·07	...	...	...
9	30·252	30·132	30·26	30·25	30·20	30·20	29·75	70	47	62	52	74	51	58·5	NW.	N.	N.	NW.	·35	...	...	...	·30
10	30·266	30·249	30·30	30·28	30·26	30·24	29·72	70	55	61	51	75	56	61·5	W.	N.	NW.	NW.	...	...	...	...	...
11	30·247	30·219	30·30	30·28	30·23	30·20	29·66	73	56	62	51	75	55	61	W.	N.	NW.	NW.	...	...	...	...	...
● 12	30·245	30·233	30·25	30·20	30·22	30·20	29·70	65	47	66	54	67	55	62	NW.	N.	N.	NW.	·60	...	...	...	...
13	30·251	30·235	30·15	30·12	30·20	30·16	29·75	77	48	67	55	76	54	61·5	E.	SE.	E.	calm	...	...	...	...	...
14	30·233	30·185	30·10	30·04	30·17	30·08	29·75	72	54	69	55	72	56	67	NE.	SE.	SE.	calm	...	...	...	·350	...
15	30·086	30·032	30·04	30·00	30·01	29·97	29·67	73	58	65	57	73	60	57·5	NE.	SW.	SE.	E.	·45	·06	...	·150	...
16	30·010	29·852	29·95	29·73	29·92	29·77	29·53	71	59	66	56	75	59	64·5	E.	NE.	NE.	E.	...	·01	...	...	...
17	29·541	29·517	29·50	29·25	29·52	29·49	29·12	71	55	64	56	71	58	63	NW.	N.	NE.	E.	...	...	0·215	·280	·16
18	29·721	29·503	29·75	29·45	29·72	29·35	28·97	72	55	62	56	70	58	66	W.	NW.	SW.	E.	·30	·05	0·555	·020	·07
19	29·974	29·947	29·86	29·85	29·94	29·90	29·32	72	54	66	56	76	58	65	SW.	SW.	S.	W.	...	·02	0·025	·005	·29
☽ 20	29·976	29·968	29·86	29·86	29·96	29·94	29·40	73	58	68	56	76	57	67	SW.	SW.	S.	NW.	...	·21	0·075	·465	...
21	29·904	29·867	29·88	29·86	29·86	29·84	29·32	70	55	67	56	70	56	61·5	SW.	W.	SW.	NW.	·25	·68	...	...	·33
22	29·972	29·920	30·00	29·95	29·93	29·90	29·34	72	48	65	57	73	53	64	SW.	NW.	SW.	W.	...	·04	0·140	...	·35
23	30·182	30·081	30·15	30·12	30·10	30·06	29·53	73	52	67	56	68	53	60	W.	NW.	N.	W.	...	...	...	...	·05
24	30·308	30·268	30·25	30·25	30·26	30·24	29·78	75	53	68	53	76	54	63	W.	W.	SE.	W.	·40	...	...	...	...
25	30·301	30·271	30·26	30·24	30·28	30·28	29·68	81	53	68	53	71	54	69	SE.	N.	SW.	calm	...	...	...	...	...
26	30·337	30·305	30·30	30·30	30·33	30·26	29·71	85	54	71	58	74	57	69	E.	SE.	S.	calm	...	...	...	...	...
○ 27	30·168	30·130	30·18	30·10	30·21	30·10	29·60	83	57	74	58	74	62	73	E.	SE.	SE.	calm	·80	...	...	...	...
28	30·045	29·975	30·07	30·00	30·02	29·92	29·46	79	56	75	59	81	62	69·5	E.	SE.	NE.	calm	...	...	...	...	...
29	30·013	29·924	29·95	29·90	29·91	29·90	29·40	81	49	74	62	80	60	65	NE.	SE.	E.	E.	...	...	...	...	...
30	29·959	29·929	29·90	29·90	29·97	29·93	29·37	84	58	74	62	76	59	66	SE.	S.	SE.	NE.	·70	...	...	...	...
Aver.:	30·041	29·974	30·30	29·25	30·33	29·35	29·47	72	52	75	48	81	48	62·4					4·65	1·94	1·955	1·980	2·05

THE
PHILOSOPHICAL MAGAZINE
AND
ANNALS OF PHILOSOPHY.

[NEW SERIES.]

SEPTEMBER 1828.

XXVII. *A brief Account of Microscopical Observations made in the Months of June, July, and August,* 1827, *on the Particles contained in the Pollen of Plants; and on the general Existence of active Molecules in Organic and Inorganic Bodies. By* ROBERT BROWN, *F.R.S., Hon. M.R.S.E. & R.I. Acad., V.P.L.S., Corresponding Member of the Royal Institutes of France and of the Netherlands, &c. &c.*

[We have been favoured by the Author with permission to insert the following paper, which has just been printed for private distribution.—ED.]

THE observations, of which it is my object to give a summary in the following pages, have all been made with a simple microscope, and indeed with one and the same lens, the focal length of which is about $\frac{1}{32}$nd of an inch[*].

The examination of the unimpregnated vegetable Ovulum, an account of which was published early in 1826[†], led me to attend more minutely than I had before done to the structure of the Pollen, and to inquire into its mode of action on the Pistillum in Phænogamous plants.

In the Essay referred-to, it was shown that the apex of the

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[*] This double convex Lens, which has been several years in my possession, I obtained from Mr. Bancks, optician, in the Strand. After I had made considerable progress in the inquiry, I explained the nature of my subject to Mr. Dollond, who obligingly made for me a simple pocket microscope, having very delicate adjustment, and furnished with excellent lenses, two of which are of much higher power than that above mentioned. To these I have often had recourse, and with great advantage, in investigating several minute points. But to give greater consistency to my statements, and to bring the subject as much as possible within the reach of general observation, I continued to employ throughout the whole of the inquiry the same lens with which it was commenced.

[†] In the Botanical Appendix to Captain King's Voyages to Australia, vol. ii. p. 534. *et seq.*

nucleus of the Ovulum, the point which is universally the seat of the future Embryo, was very generally brought into contact with the terminations of the probable channels of fecundation; these being either the surface of the placenta, the extremity of the descending processes of the style, or more rarely, a part of the surface of the umbilical cord. It also appeared, however, from some of the facts noticed in the same Essay, that there were cases in which the Particles contained in the grains of pollen could hardly be conveyed to that point of the ovulum through the vessels or cellular tissue of the ovarium; and the knowledge of these cases, as well as of the structure and economy of the antheræ in *Asclepiadeæ*, had led me to doubt the correctness of observations made by Stiles and Gleichen upwards of sixty years ago, as well as of some very recent statements, respecting the mode of action of the pollen in the process of impregnation.

It was not until late in the autumn of 1826 that I could attend to this subject; and the season was too far advanced to enable me to pursue the investigation. Finding, however, in one of the few plants then examined, the figure of the particles contained in the grains of pollen clearly discernible, and that figure not spherical but oblong, I expected, with some confidence, to meet with plants in other respects more favourable to the inquiry, in which these particles, from peculiarity of form, might be traced through their whole course: and thus, perhaps, the question determined whether they in any case reach the apex of the ovulum, or whether their direct action is limited to other parts of the female organ.

My inquiry on this point was commenced in June 1827, and the first plant examined proved in some respects remarkably well adapted to the object in view.

This plant was *Clarckia pulchella*, of which the grains of pollen, taken from antheræ full grown, but before bursting, were filled with particles or granules of unusually large size, varying from nearly $\frac{1}{4000}$th to about $\frac{1}{5000}$th of an inch in length, and of a figure between cylindrical and oblong, perhaps slightly flattened, and having rounded and equal extremities. While examining the form of these particles immersed in water, I observed many of them very evidently in motion; their motion consisting not only of a change of place in the fluid, manifested by alterations in their relative positions, but also not unfrequently of a change of form in the particle itself; a contraction or curvature taking place repeatedly about the middle of one side, accompanied by a corresponding swelling or convexity on the opposite side of the particle. In a few instances the particle was seen to turn on its longer axis. These motions were such as to satisfy me, after frequently repeated ob-

servation,

servation, that they arose neither from currents in the fluid, nor from its gradual evaporation, but belonged to the particle itself.

Grains of pollen of the same plant taken from antheræ immediately after bursting, contained similar subcylindrical particles, in reduced numbers however, and mixed with other particles, at least as numerous, of much smaller size, apparently spherical, and in rapid oscillatory motion.

These smaller particles, or Molecules as I shall term them, when first seen, I considered to be some of the cylindrical particles swimming vertically in the fluid. But frequent and careful examination lessened my confidence in this supposition; and on continuing to observe them until the water had entirely evaporated, both the cylindrical particles and spherical molecules were found on the stage of the microscope.

In extending my observations to many other plants of the same natural family, namely *Onagrariæ*, the same general form and similar motions of particles were ascertained to exist, especially in the various species of *Œnothera*, which I examined. I found also in their grains of pollen taken from the antheræ immediately after bursting, a manifest reduction in the proportion of the cylindrical or oblong particles, and a corresponding increase in that of the molecules, in a less remarkable degree, however, than in *Clarckia*.

This appearance, or rather the great increase in the number of the molecules, and the reduction in that of the cylindrical particles, before the grain of pollen could possibly have come in contact with the stigma,—were perplexing circumstances in this stage of the inquiry, and certainly not favourable to the supposition of the cylindrical particles acting directly on the ovulum; an opinion which I was inclined to adopt when I first saw them in motion. These circumstances, however, induced me to multiply my observations, and I accordingly examined numerous species of many of the more important and remarkable families of the two great primary divisions of Phænogamous plants.

In all these plants particles were found, which in the different families or genera varied in form from oblong to spherical, having manifest motions similar to those already described; except that the change of form in the oval and oblong particles was generally less obvious than in *Onagrariæ*, and in the spherical particle was in no degree observable*.

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* In *Lolium perenne*, however, which I have more recently examined, though the particle was oval and of smaller size than in *Onagrariæ*, this change of form was at least as remarkable, consisting in an equal contraction in the middle of each side, so as to divide it into two nearly orbicular portions.

In a great proportion of these plants I also remarked the same reduction of the larger particles, and a corresponding increase of the molecules after the bursting of the antheræ: the molecule, of apparently uniform size and form, being then always present; and in some cases indeed, no other particles were observed, either in this or in any earlier stage of the secreting organ.

In many plants belonging to several different families, but especially to *Gramineæ*, the membrane of the grain of pollen is so transparent that the motion of the larger particles within the entire grain was distinctly visible; and it was manifest also at the more transparent angles, and in some cases even in the body of the grain in *Onagrariæ*.

In *Asclepiadeæ*, strictly so called, the mass of pollen filling each cell of the anthera is in no stage separable into distinct grains; but within, its tessellated or cellular membrane is filled with spherical particles, commonly of two sizes. Both these kinds of particles when immersed in water are generally seen in vivid motion; but the apparent motions of the larger particle might in these cases perhaps be caused by the rapid oscillation of the more numerous molecules. The mass of pollen in this tribe of plants never bursts, but merely connects itself by a determinate point, which is not unfrequently semitransparent, to a process of nearly similar consistence, derived from the gland of the corresponding angle of the stigma.

In *Periploceæ*, and in a few *Apocineæ*, the pollen, which in these plants is separable into compound grains filled with spherical moving particles, is applied to processes of the stigma, analogous to those of *Asclepiadeæ*. A similar economy exists in *Orchideæ*, in which the pollen-masses are always, at least in the early stage, granular; the grains, whether simple or compound, containing minute, nearly spherical particles, but the whole mass being, with very few exceptions, connected by a determinate point of its surface with the stigma, or a glandular process of that organ.

Having found motion in the particles of the pollen of all the living plants which I had examined, I was led next to inquire whether this property continued after the death of the plant, and for what length of time it was retained.

In plants, either dried or immersed in spirit for a few days only, the particles of pollen of both kinds were found in motion equally evident with that observed in the living plant; specimens of several plants, some of which had been dried and preserved in an herbarium for upwards of twenty years, and others not less than a century, still exhibited the molecules or smaller spherical particles in considerable numbers,

bers, and in evident motion, along with a few of the larger particles, whose motions were much less manifest, and in some cases not observable*.

In this stage of the investigation having found, as I believed, a peculiar character in the motions of the particles of pollen in water, it occurred to me to appeal to this peculiarity as a test in certain families of Cryptogamous plants, namely Mosses, and the genus *Equisetum*, in which the existence of sexual organs had not been universally admitted.

In the supposed stamina of both these families, namely, in the cylindrical antheræ or pollen of Mosses, and on the surface of the four spathulate bodies surrounding the naked ovulum, as it may be considered, of *Equisetum*, I found minute spherical particles, apparently of the same size with the molecule described in *Onagrariæ*, and having equally vivid motion on immersion in water; and this motion was still observable in specimens both of Mosses and of *Equiseta*, which had been dried upwards of one hundred years.

The very unexpected fact of seeming vitality retained by these minute particles so long after the death of the plant, would not perhaps have materially lessened my confidence in the supposed peculiarity. But I at the same time observed, that on bruising the ovula or seeds of *Equisetum*, which at first happened accidentally, I so greatly increased the number of moving particles, that the source of the added quantity could not be doubted. I found also that on bruising first the floral leaves of Mosses, and then all other parts of those plants, that I readily obtained similar particles, not in equal quantity indeed, but equally in motion. My supposed test of the male organ was therefore necessarily abandoned.

Reflecting on all the facts with which I had now become acquainted, I was disposed to believe that the minute spherical particles or Molecules of apparently uniform size, first seen in the advanced state of the pollen of *Onagrariæ*, and most other Phænogamous plants,—then in the antheræ of Mosses and on

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* While this sheet was passing through the press I have examined the pollen of several flowers which have been immersed in weak spirit about eleven months, particularly of *Viola tricolor*, *Zizania aquatica*, and *Zea Mais;* and in all these plants the peculiar particles of the pollen, which are oval or short oblong, though somewhat reduced in number, retain their form perfectly, and exhibit evident motion, though I think not so vivid as in those belonging to the living plant. In *Viola tricolor*, in which, as well as in other species of the same natural section of the genus, the pollen has a very remarkable form, the grain on immersion in nitric acid still discharged its contents by its four angles, though with less force than in the recent plant.

the surface of the bodies regarded as the stamina of *Equisetum*,—and lastly in bruised portions of other parts of the same plants, were in reality the supposed constituent or elementary molecules of organic bodies, first so considered by Buffon and Needham, then by Wrisberg with greater precision, soon after and still more particularly by Müller, and, very recently by Dr. Milne Edwards, who has revived the doctrine and supported it with much interesting detail. I now therefore expected to find these molecules in all organic bodies: and accordingly on examining the various animal and vegetable tissues, whether living or dead, they were always found to exist; and merely by bruising these substances in water, I never failed to disengage the molecules in sufficient numbers to ascertain their apparent identity in size, form, and motion, with the smaller particles of the grains of pollen.

I examined also various products of organic bodies, particularly the gum-resins, and substances of vegetable origin, extending my inquiry even to pit-coal; and in all these bodies Molecules were found in abundance. I remark here also, partly as a caution to those who may hereafter engage in the same inquiry, that the dust or soot deposited on all bodies in such quantity, especially in London, is entirely composed of these molecules.

One of the substances examined, was a specimen of fossil wood, found in Wiltshire oolite, in a state to burn with flame; and as I found these molecules abundantly, and in motion in this specimen, I supposed that their existence, though in smaller quantity, might be ascertained in mineralized vegetable remains. With this view a minute portion of silicified wood, which exhibited the structure of *Coniferæ*, was bruised, and spherical particles, or molecules in all respects like those so frequently mentioned, were readily obtained from it; in such quantity, however, that the whole substance of the petrifaction seemed to be formed of them. But hence I inferred that these molecules were not limited to organic bodies, nor even to their products.

To establish the correctness of the inference, and to ascertain to what extent the molecules existed in mineral bodies, became the next object of inquiry. The first substance examined was a minute fragment of window-glass, from which, when merely bruised on the stage of the microscope, I readily and copiously obtained molecules agreeing in size, form, and motion with those which I had already seen.

I then proceeded to examine, and with similar results, such minerals as I either had at hand or could readily obtain, including several of the simple earths and metals, with many of their combinations.

Rocks of all ages, including those in which organic remains have never been found, yielded the molecules in abundance. Their existence was ascertained in each of the constituent minerals of granite, a fragment of the Sphinx being one of the specimens examined.

To mention all the mineral substances in which I have found these molecules, would be tedious; and I shall confine myself in this summary to an enumeration of a few of the most remarkable. These were both of aqueous and igneous origin, as travertine, stalactites, lava, obsidian, pumice, volcanic ashes, and meteorites from various localities*. Of metals I may mention manganese, nickel, plumbago, bismuth, antimony, and arsenic. In a word, in every mineral which I could reduce to a powder, sufficiently fine to be temporarily suspended in water, I found these molecules more or less copiously; and in some cases, more particularly in siliceous crystals, the whole body submitted to examination appeared to be composed of them.

In many of the substances examined, especially those of a fibrous structure, as asbestus, actinolite, tremolite, zeolite, and even steatite, along with the spherical molecules, other corpuscules were found, like short fibres somewhat moniliform, whose transverse diameter appeared not to exceed that of the molecule, of which they seemed to be primary combinations. These fibrils, when of such length as to be probably composed of not more than four or five molecules, and still more evidently when formed of two or three only, were generally in motion, at least as vivid as that of the simple molecule itself; and which from the fibril often changing its position in the fluid, and from its occasional bending, might be said to be somewhat vermicular.

In other bodies which did not exhibit these fibrils, oval particles of a size about equal to two molecules, and which were also conjectured to be primary combinations of these, were not unfrequently met with, and in motion generally more vivid than that of the simple molecule; their motion consisting in turning usually on their longer axis, and then often appearing to be flattened. Such oval particles were found to be numerous and extremely active in white arsenic.

As mineral bodies which had been fused contained the

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* I have since found the molecules in the sand-tubes, formed by lightning, from Drig in Cumberland.

moving molecules as abundantly as those of alluvial deposits, I was desirous of ascertaining whether the mobility of the particles existing in organic bodies was in any degree affected by the application of intense heat to the containing substance. With this view small portions of wood, both living and dead, linen, paper, cotton, wool, silk, hair, and muscular fibres, were exposed to the flame of a candle or burned in platina-forceps, heated by the blowpipe; and in all these bodies so heated, quenched in water, and immediately submitted to examination, the molecules were found, and in as evident motion as those obtained from the same substances before burning.

In some of the vegetable bodies burned in this manner, in addition to the simple molecules, primary combinations of these were observed, consisting of fibrils having transverse contractions, corresponding in number, as I conjectured, with that of the molecules composing them; and those fibrils, when not consisting of a greater number than four or five molecules, exhibited motion resembling in kind and vivacity that of the mineral fibrils already described, while longer fibrils of the same apparent diameter were at rest.

The substance found to yield these active fibrils in the largest proportion and in the most vivid motion, was the mucous coat interposed between the skin and muscles of the haddock, especially after coagulation by heat.

The fine powder produced on the under surface of the fronds of several Ferns, particularly of *Acrostichum calomelanos*, and the species nearly related to it, was found to be entirely composed of simple molecules and their primary fibre-like compounds, both of them being evidently in motion.

There are three points of great importance which I was anxious to ascertain respecting these molecules, namely, their form, whether they are of uniform size, and their absolute magnitude. I am not, however, entirely satisfied with what I have been able to determine on any of these points.

As to form, I have stated the molecule to be spherical, and this I have done with some confidence; the apparent exceptions which occurred admitting, as it seems to me, of being explained by supposing such particles to be compounds. This supposition in some of the cases is indeed hardly reconcileable with their apparent size, and requires for its support the further admission, that, in combination, the figure of the molecule may be altered. In the particles formerly considered as primary combinations of molecules, a certain change of form must also be allowed; and even the simple molecule itself has sometimes appeared to me when in motion to have been slightly modified in this respect.

My manner of estimating the absolute magnitude and uniformity in size of the molecules, found in the various bodies submitted to examination, was by placing them on a micrometer divided to five thousandths of an inch, the lines of which were very distinct; or more rarely on one divided to ten thousandths, with fainter lines, not readily visible without the application of plumbago, as employed by Dr. Wollaston, but which in my subject was inadmissible.

The results so obtained can only be regarded as approximations, on which perhaps, for an obvious reason, much reliance will not be placed. From the number and degree of accordance of my observations, however, I am upon the whole disposed to believe the simple molecule to be of uniform size, though as existing in various substances and examined in circumstances more or less favourable, it is necessary to state that its diameter appeared to vary from $\frac{1}{15,000}$th to $\frac{1}{20,000}$th of an inch*.

I shall not at present enter into additional details, nor shall I hazard any conjectures whatever respecting these molecules, which appear to be of such general existence in inorganic as well as in organic bodies; and it is only further necessary to mention the principal substances from which I have not been able to obtain them. These are oil, resin, wax, and sulphur; such of the metals as I could not reduce to that minute state of division necessary for their separation; and finally, bodies soluble in water.

In returning to the subject with which my investigation commenced, and which was indeed the only object I originally had in view, I had still to examine into the probable mode of action of the larger or peculiar particles of the pollen, which, though in many cases diminished in number before the grain could possibly have been applied to the stigma, and particularly in *Clarckia*, the plant first examined, were yet in many other plants found in less diminished proportion, and might in nearly all cases be supposed to exist in sufficient quantity to form the essential agents in the process of fecundation.

I was now therefore to inquire, whether their action was confined to the external organ, or whether it were possible to

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* While this sheet was passing through the press, Mr. Dollond, at my request, obligingly examined the supposed pollen of *Equisetum virgatum* with his compound achromatic microscope, having in its focus a glass divided into 10,000ths of an inch, upon which the object was placed; and although the greater number of particles or molecules seen were about $\frac{1}{20,000}$th, yet the smallest did not exceed $\frac{1}{30,000}$th of an inch.

follow them to the nucleus of the ovulum itself. My endeavours, however, to trace them through the tissue of the style, in plants well suited for this investigation, both from the size and form of the particles, and the development of the female parts, particularly *Onagrariæ*, was not attended with success; and neither in this nor in any other tribe examined, have I ever been able to find them in any part of the female organ, except the stigma. Even in those families in which I have supposed the ovulum to be naked, namely, *Cycadeæ* and *Coniferæ*, I am inclined to think that the direct action of these particles, or of the pollen containing them, is exerted rather on the orifice of the proper membrane than on the apex of the included nucleus; an opinion which is in part founded on the partial withering confined to one side of the orifice of that membrane in the larch,—an appearance which I have remarked for several years.

To observers not aware of the existence of the elementary active molecules, so easily separated by pressure from all vegetable tissues, and which are disengaged and become more or less manifest in the incipient decay of semitransparent parts, it would not be difficult to trace granules through the whole length of the style: and as these granules are not always visible in the early and entire state of the organ, they would naturally be supposed to be derived from the pollen, in those cases at least in which its contained particles are not remarkably different in size and form from the molecule.

It is necessary also to observe, that in many, perhaps I might say in most plants, in addition to the molecules separable from the stigma and style before the application of the pollen, other granules of greater size are obtained by pressure, which in some cases closely resemble the particles of the pollen in the same plants, and in a few cases even exceed them in size: these particles may be considered as primary combinations of the molecules, analogous to those already noticed in mineral bodies and in various organic tissues.

From the account formerly given of *Asclepiadeæ*, *Periploceæ*, and *Orchideæ*, and particularly from what was observed of *Asclepiadeæ*, it is difficult to imagine, in this family at least, that there can be an actual transmission of particles from the mass of pollen, which does not burst, through the processes of the stigma; and even in these processes I have never been able to observe them, though they are in general sufficiently transparent to show the particles were they present. But if this be a correct statement of the structure of the sexual organs in *Asclepiadeæ*, the question respecting this family would no longer be, whether the particles in the pollen were

were transmitted through the stigma and style to the ovula, but rather whether even actual contact of these particles with the surface of the stigma were necessary to impregnation.

Finally, it may be remarked that those cases already adverted to, in which the apex of the nucleus of the ovulum, the supposed point of impregnation, is never brought into contact with the probable channels of fecundation, are more unfavourable to the opinion of the transmission of the particles of the pollen to the ovulum, than to that which considers the direct action of these particles as confined to the external parts of the female organ.

The observations, of which I have now given a brief account, were made in the months of June, July and August, 1827. Those relating merely to the form and motion of the peculiar particles of the pollen were stated, and several of the objects shown, during these months, to many of my friends, particularly to Messrs. Bauer and Bicheno, Dr. Bostock, Dr. Fitton, Mr. E. Forster, Dr. Henderson, Sir Everard Home, Captain Home, Dr. Horsfield, Mr. Kœnig, M. Lagasca, Mr. Lindley, Dr. Maton, Mr. Menzies, Dr. Prout, Mr. Renouard, Dr. Roget, Mr. Stokes, and Dr. Wollaston; and the general existence of the active molecules in inorganic as well as organic bodies, their apparent indestructibility by heat, and several of the facts respecting the primary combinations of the molecules, were communicated to Dr. Wollaston and Mr. Stokes in the last week of August.

None of these gentlemen are here appealed to for the correctness of any of the statements made; my sole object in citing them being to prove from the period and general extent of the communication, that my observations were made within the dates given in the title of the present summary.

The facts ascertained respecting the motion of the particles of the pollen, were never considered by me as wholly original; this motion having, as I knew, been obscurely seen by Needham, and distinctly by Gleichen, who not only observed the motion of the particles in water after the bursting of the pollen, but in several cases remarked their change of place within the entire grain. He has not, however, given any satisfactory account either of the forms or of the motions of these particles, and in some cases appears to have confounded them with the elementary molecule, whose existence he was not aware of.

Before I engaged in the inquiry in 1827, I was acquainted only with the abstract given by M. Adolphe Brongniart himself, of a very elaborate and valuable memoir, entitled "*Recherches sur le Génération et le Développement de l'Embryon dans les Végétaux Phanerogames,*" which he had then read before

before the Academy of Sciences of Paris, and has since published in the *Annales des Sciences Naturelles.*

Neither in the abstract referred to, nor in the body of the memoir, which M. Brongniart has with great candour given in its original state, are there any observations, appearing of importance even to the author himself, on the motion or form of the particles; and the attempt to trace these particles to the ovulum, with so imperfect a knowledge of their distinguishing characters, could hardly be expected to prove satisfactory. Late in the autumn of 1827, however, M. Brongniart having at his command a microscope constructed by Amici, the celebrated professor of Modena, he was enabled to ascertain many important facts on both these points, the result of which he has given in the notes annexed to his memoir. On the general accuracy of his observations on the motions, form, and size of the granules, as he terms the particles, I place great reliance. But in attempting to trace these particles through their whole course, he has overlooked two points of the greatest importance in the investigation.

For, in the first place, he was evidently unacquainted with the fact, that the active spherical molecules generally exist in the grain of pollen along with its proper particles; nor does it appear from any part of his memoir that he was aware of the existence of molecules having spontaneous or inherent motion, and distinct from the peculiar particles of the pollen, though he has doubtless seen them, and in some cases, as it seems to me, described them as those particles.

Secondly, he has been satisfied with the external appearance of the parts in coming to his conclusion, that no particles capable of motion exist in the style or stigma before impregnation.

That both simple molecules and larger particles of different form, and equally capable of motion, do exist in these parts, before the application of the pollen to the stigma can possibly take place, in many of the plants submitted by him to examination, may easily be ascertained; particularly in *Antirrhinum majus*, of which he has given a figure in a more advanced state, representing these molecules or particles, which he supposes to have been derived from the grains of pollen, adhering to the stigma.

There are some other points respecting the grains of pollen and their contained particles in which I also differ from M. Brongniart, namely, in his supposition that the particles are not formed in the grain itself, but in the cavity of the anthera; in his assertion respecting the presence of pores on the surface of the grain in its early state, through which the particles formed in the anthera, pass into its cavity; and lastly, on the existence of a membrane forming the coat of his *boyau* or mass of cylindrical form ejected from the grain of pollen.

I reserve, however, my observations on these and several other topics connected with the subject of the present inquiry for the more detailed account, which it is my intention to give.

July 30, 1828.

[The examination of the unimpregnated vegetable Ovulum, mentioned at the beginning of this Paper, will be found in Phil. Mag. vol. lxvii. p. 352.]

XXVIII. *On a New Micrometer, principally intended for the Construction of a more complete Map of the Heavens.* By M. Steinheil.

[With an Engraving.]

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I HAVE lately received, through the kindness of Professor Schumacher, one of Fraunhofer's 42-inch refracting telescopes, with an object-glass of three inches diameter. This instrument is a most excellent one, and far exceeds any telescope of the same size that I have ever seen. Attached to it, there is one of M. Steinheil's new micrometers; the first, I believe, that has ever reached this country. As a description of this invention may be interesting to many of your readers, I beg leave to send you the following translation (from No. 117 of Professor Schumacher's *Astronomische Nachrichten*), with which Dr. Tiarks has favoured me.

I am, Gentlemen, your obedient servant,

July 15, 1828. Francis Baily.

The comparison of a celestial map with the heavens, for the purpose of inserting therein the stars of inferior magnitude, is subject to peculiar difficulties, as is well known to every one who has undertaken this task. The method described by Professor Bessel in No. 93 of the *Astr. Nachr.* is indeed exceedingly simple, and on that account much to be commended; but it is in one respect not quite satisfactory. For the differences of right ascension and declination with respect to the standard stars which determine the position of the stars to be inserted, can only be estimated by means of the cross wires; which is the more uncertain and unsatisfactory the greater those differences become. A method therefore by which these coordinates could be measured, appears to me to be a very desirable object: and would have the additional advantage of doing away with the necessity of laying down the stars by candle-light, an operation at once tedious and hurtful to the eyes, as the observations may in the present case be reduced

duced at our leisure, and the stars afterwards inserted among the others in their proper places.

Amongst the micrometers hitherto used, none answers this purpose; for those in which the field of view is illuminated, weaken the effect of the telescope too much; and if illuminated lines are employed, either these, or the faint stars when approaching near them, will disappear. This led me to the idea that the difficulty might be removed, if it were possible to illuminate at pleasure thin divided cross bars in the dark field of view.

The beautiful discovery of Professor Gauss (*Astr. Nachr.* No. 43), that the diaphragm of a telescope may be seen by means of another, fixed in its axis, afforded me the means of effecting my object. With this view I fastened upon the object-glass of the telescope a second smaller object-glass, and then fixed in its focus a micrometer plate, so entirely perforated as to have nothing left but the above-mentioned cross bars. Parallel rays issuing both from the micrometer bars and a very distant object, situated in the optical axis of the telescope, will reach the large object-glass; and the images of both these objects will necessarily appear clearly over each other in the field of the telescope.

In order to render the image of the micrometer visible on the dark ground of the heavens, the light, which I used for noting down my observations, was found sufficient without any other apparatus, and I was enabled to vary the brightness of the image, by changing the position of the light with respect to the optical axis of the telescope. On trying this method, however, it did not quite answer my expectation; for it was still difficult to determine the position of very faint points of light, because they still disappeared in the vicinity of the bars, when illuminated ever so faintly. The very faint stars, therefore, which a telescope shows in the dark part of the field of view, will absolutely not bear any light in their vicinity. If their position with regard to other observed stars is to be ascertained, it is necessary to make them coincide with a dark object whose position with regard to the micrometer is known. For this purpose it will be sufficient (as Plate I. fig. A and A′ show) to fasten in the eye-glass thick cross wires, or to give to the diaphragm a square form instead of a round one; by which means greater distances may be measured, even in case one could not distinguish either the cross wires, or the bounds of the field of view, from the dark appearance of the heavens.

We may, however, determine the coincidence of the stars (as in a circular micrometer) from their disappearance. If the star that is to be observed has been thus noted, the telescope is is moved until a brighter observed star passes the illuminated micrometer; and the difference is then read off. It is clear that this method is to be applied to very small stars only, as it requires more time than the direct observation on the illuminated bars.

Although we have thus described the essential parts of the construction and use of this micrometer, we hope that those who are engaged in revising the maps of the heavens will still be pleased to see a detailed description of its adaptation to a Fraunhofer's sweeper; that being the instrument intended by Professor Bessel for the revision of the maps. In determining the construction of such an instrument, we must take care,

1°. That the small object-glass should intercept as little of the light coming to the larger object-glass as possible; and yet should present a sufficiently clear image of the micrometer plane. I have found by trial, that the limits of the measure of brightness of the same should be $0'''{\cdot}3$ and $0'''{\cdot}8$ Paris lines:

2°. That the micrometer plane should be entirely covered by the small object-glass in regard to the object-glass of the eye-piece:

3°. That the micrometer plane should extend over the whole field of view.

Besides these conditions, there are restrictions arising from the mechanical execution of the small micrometer plane, the intensity of the light for its illumination, &c. &c.; so that after the limits, between which the dimensions must be selected, have been found by calculation, practice only will lead to the most advantageous combination. In this manner I found, if the dimensions of the telescope are as follow,—viz.

Focal length of the object-glass	288	Paris lines.
Aperture	34	do.
Diameter of the object- (*Collective*-) glass of the eye-piece	20	do.
Field of view	4°	
Magnifying power	15	times,—

that the following construction of the micrometer is the most advantageous: viz.

Focal length of the micrometer object-glass	$74'''$
Aperture	9
Diameter of the object-glass with frames	11·4
External or greatest diameter of the micrometer plane	6·5
Interior or smallest	5·0
One division of the micrometer plane	0·1

Fig. 1. represents the micrometer as adapted and fitted to the telescope.

The micrometer plane (*a*) consists of a small plate of silver (a piece (a piece of very smooth ivory would be preferable), on which a rectangular net-work has been cut by means of a dividing engine, and which is then filed out so that nothing remains but the small bars represented in the figure. These bars, of the breadth of a division of the micrometer, must contract in breadth towards the back part, in order to appear clearly defined in every position of the eye. The divisions are cut pretty deep, in order to be easily seen by a small portion of light. The reading off is facilitated by a dot placed at every fifth division.

This plane, as well as the arm that supports it, must be blackened (without polish), in order to prevent all reflection of light. The arm (*b*) which carries the micrometer is a drawn tube of brass, as it must be stiff and light. It is held in a socket (*c*), which is screwed to the ring (*d*). The small object-glass, which has its flint lens turned towards the micrometer plane, is fastened by its support (*e*) to the socket (*c*). The support (*e*) must be blackened, and should be broad enough to prevent any reflection of light (*a'*) from coming into the field of view.

In making the adjustments, which must precede the use of the instrument, some advantages have presented themselves to me, which I shall here describe, in order to save others the trouble of finding them out.

First, the eye-piece is to be so placed, that the perfect distinctness of the image be not in the centre of the field, but at an equal distance from the border and the centre. For this position the parallax of the cross wires in the eye-glass is first to be destroyed, and they are to be placed parallel to the motion of the axis of the telescope.

The micrometer must next be fastened to the telescope, and the micrometer plane must be placed parallel to the small object-glass (for which operation a distant object may be used), and the arm (*b*) must be slid backward and forward, until the parallax between the cross wires of the eye-piece and the bars of the micrometer plane is destroyed.

In order to adjust approximately the position of the cross wires, with regard to the micrometer plane, as is shown in fig. A, it should be observed, that the image of the cross wires may be distinctly seen in the same plane with the micrometer plane if the eye is placed in the optical axis behind the micrometer. Keeping this image in view, we may turn the arm (*b*) together with the connecting ring (*d*) about their axes, and change the position of (*a'*) until the cross wires are respectively parallel to and bisect the micrometer bars. The errors which may then still remain may be easily corrected by repeating the same operation

operation while looking into the telescope. The degree of force used in clamping the screws will cause a slight alteration in the position of the two images, which may be subsequently remedied in a similar manner.

That the telescope should have an equatorial motion, and be provided with an apparatus for minute changes of the axis, is clear from the preceding description.

I shall now add some observations as originally noted down, together with their comparison with meridian observations, in order to give some idea of the degree of accuracy which may be attained by single readings off.

Position in 1800. Star compared.		
Name.	α	δ
δ Orionis	$5^h\ 21^m\ 47^s,6$	$-0^\circ\ 27',5$

Above — ; Below + ; Right + ; Left — ; 1 Division = 2′·866.

Observation 1827.						Reduction to 1800.			
$\Delta\delta$	Direction.	$\Delta\alpha$	Correction.	Direction.	Magnitude.	δ'	Merid. Obser.	α'	Merid. Obser.
6,3	B	12,9	—	R	8	$-0^\circ\ 9',5$	0′,0	$5^h\ 24^m\ 15^s,5$	−0″,2
4,0	B	1,6	6″,4	R	8,9	−0 16,0	0 ,0	24 44 ,6	−1 ,5
1,0	B	16,45	—	R	8,9	−0 24,6	−0 ,2	24 56 ,1	−0 ,0
18,5	A	22,4	—	R	2	−1 20,6	+0 ,2	26 4 ,3	−0 ,5
17,8	A	8,3	—	R	7	−1 18,5	−0 ,1	23 22 ,8	−0 ,2
15,2	A	11,0	—	R	7	−1 11,2	+0 ,1	23 53 ,7	+0 ,9
16,65	A	11,5	—	L	6,7	−1 15,4	−0 ,3	19 35 ,8	+0 ,2
10,6	A	11,9	—	L	7	−0 57,9	−0 ,3	19 31 ,1	−0 ,3
7,8	A	—	3	R	9	−0 35,3	+0 ,2	21 50 ,6	+0 ,9
1,5	A	3,3	—	L	9	−0 13,8	+0 ,2	23 37 ,4	+0 ,6

The telescope used is one by Fraunhofer, of 34‴ aperture, 42″ focal length, and magnifying 23 times: observations with a sweeper would be somewhat more uncertain *.

As the scale which has been adopted in the maps, does not well admit of greater accuracy than 0′,5 in the position of the stars, no sensible error can arise from this method of observing, even with a sweeper. By the former methods, errors amount-

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* [I do not understand the notation here introduced; but I presume it means 34 Paris lines (= 3 English inches), and 42 Paris inches (= 45 English inches): at least, these are the dimensions of my telescope.—F. B.]

ing to two or three minutes are unavoidable, even with the greatest attention.

Addition.—It may be desirable to mention, that the micrometer-apparatus here described may be made use of also as an achromatic microscope, if the object to be viewed is brought into the focus of the small object-glass instead of the micrometer-plane. But it will be necessary, for the purpose of illuminating it and of rendering it more commodious, to give to the whole a more convenient construction. The small object-glass might (as shown in fig. 2.) be screwed into a tube which could be clamped to the telescope, and should in such case have two incisions in the focus of the small object-glass, in order to receive the frame holding the object which is to be viewed. Although this object may not be perfectly in the focus, its image may be rendered distinct by changing the position of the eye-glass in the telescope. The ring, represented in the figure, will serve to support the telescope and microscope.

The power of this microscope is, independently of its absolute size, the more considerable, the greater the ratio of the aperture of the second object-glass to its focal length. It would, therefore, be more advantageous to use object-glasses composed of more than two lenses. Perfect object-glasses of four lenses would, as far as spherical aberration is concerned, admit of almost a double aperture, and, as the loss of light by refraction and reflection is very small, their effect would be nearly double. The image would likewise gain in distinctness, as it would be possible to destroy the chromatic aberration for rays incident at a distance from the axis.

I am now engaged in calculating such object-glasses, and M. Merz (the director of the establishment of Ützschneider and Fraunhofer) having promised the execution of them, I hope to be able at some future period to communicate the result of my labours.

If we are satisfied with a double lens, the effect of this microscope is somewhat less than that of Fraunhofer's; because, in the latter the object may be brought nearer to the object-glass than its focal distance. The advantage which it may, however, claim over it, is the absolutely greater focal distance of the object-glass of the microscope, in consequence of which the whole of an object of some thickness may be viewed with distinctness at the same time. It seems to deserve the attention of travellers, on account of the ease with which every one can thus convert his telescope into a microscope. Different eye-glasses would, of course, change the field of view and the magnifying power of such a microscope.

I must

I must apologize for having mentioned a subject which is not astronomical, on account of its intimate connexion with the preceding part of this paper.

STEINHEIL.

XXIX. *Comparison of a Formula representing the Velocity of Sound, with* Capt. Parry *and* Lieut. Foster's *Experiments on that Subject at Port Bowen; with some Remarks on the Ellipticity of the Earth. By* WM. GALBRAITH, *Esq. A.M.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN the first volume of the New Series of the Phil. Mag., p. 337, I have given two formulæ to determine the velocity of sound. It would be more convenient, however, to adapt that for the temperature by Fahrenheit's thermometer to zero of that scale, and it becomes

$$V=(102{\cdot}4225+0{\cdot}1103t)\left(1+\frac{f}{5\frac{1}{3}p-2f}\right)(10{\cdot}2739-0{\cdot}0138\cos 2\lambda)$$
$$+\,\omega\cos\varphi.$$

This gives the velocity in English feet, when the English barometer and Fahrenheit's thermometer are used.

By a comparison of this formula adapted to the centigrade thermometer, I found an almost perfect accordance with Dr. Moll's experiments. I also found that the effect of wind on the 27th of June 1823 was about 19 feet,—half the difference between the velocities, as determined from each extremity of the base. Indeed there can be little doubt that the velocity of sound is affected by that of the wind at the time. Dr. Gregory of Woolwich, in a series of experiments on sound detailed in the first volume of the Transactions of the Cambridge Philosophical Society*, expressly states that the wind increases or diminishes the velocity of sound according as it blows in the same or in an opposite direction;—a conclusion which might almost *à priori* have been anticipated. The only difficulty is, to adapt the formula to the actual state of the atmosphere with regard to moisture. The expansion of the *dry air* with which Messrs. Dulong and Petit operated, was 0·375 from the freezing point to the boiling point of water. It is a little greater, however, in *moist air*, such as exists in an ordinary state of the atmosphere. Laplace in that case assumed 0·4, and from a mean of a great number of experiments on air, sound, &c. I found 0·4112, that adopted in the above formula.

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* See Phil. Mag. vol. lxiii. p. 401.—EDIT.

Now

Now this is very nearly true in the usual state of the atmosphere, but in extreme cases of dryness and moisture it must vary a little from this, so that I have not been able to discover the exact quantity of variation. From such comparisons as I have been able to make, it seems, however, in its present state, to be pretty accurate. As I have already, in the volume referred to, shown its agreement with Professor Moll's experiments, I shall now compare it with those made by Captains Parry and Foster at Port Bowen; and as they had no anemometer to determine the velocity of the wind, I shall make a probable estimation of its effects, from Smeaton's table in the 51st volume of the Philosophical Transactions, as nearly as I can, from the account of the weather given along with the observations, and the angle between the direction of the wind and sound estimated to the nearest point, that being the degree of accuracy attainable only from the *data*, page 86, Appendix to the Third Voyage.

Experiments made at Port Bowen, in Latitude 73° 14′ *N. The extent of the measured Base was* 12892·89 *feet, and the bearings of the Gun S.* 71° 48′ *E.*

1824.	Bar. in Inches	Temp.	Wind.		Weather.	No. of Guns fired.	Interval in Seconds between Flash and Report.			Exp. Velocity per sec.
							P.	F.	Mean.	
Nov. 24	29·841	— 7°	E.S.E.	light	overcast	5	12^{s}·3525	12^{s}·4300	12^{s}·3912	1040·49
Dec. 8	29·561	— 9	N.N.E.	squally	very clear	6	12 ·3310	12 ·5266	12 ·4288	1037·34
1825.										
Jan. 10	30·268	—37	E.S.E.	light	clear	4	12 ·5889	12 ·4700	12 ·5290	1029·04
Feb. 7	29·647	—24·5	N.E.	light	very clear	6	12 ·6390	12 ·6167	12 ·6278	1020·99
17	29·598	—18	calm	...	overcast	6	12 ·3720	12 ·4400	12 ·4060	1039·25
21	29·735	—37·5	calm	...	overcast	6	12 ·8167	12 ·7067	12 ·7617	1010·28
Mar. 2	30·398	—38·5	easterly	light	a little overcast	6	12 ·6400	12 ·7800	12 ·7100	1014·39
22	30·258	—21·5	wester^{ly}	light	very clear and fine	6	12 .4000	12 ·7167	12 ·5583	1026·64
June 3	30·118	+33·5	easterly	light	very clear	6	11 ·7333	11 ·7440	11 ·7387	1098·32
4	30·102	+35	S.E.	strong, squally	clear	6	11 ·5889	11 ·4733	11 ·5311	1118·10

Now, by applying the above formula, in which t is the temperature by Fahrenheit's thermometer, f the elastic force of aqueous vapour, p the barometric pressure, λ the latitude, ω the velocity of the wind, and ϕ the angle between the wind and sound. Above 0° Fahr. I have taken f according to the temperature marked, which cannot cause any great error.

1824.

1824.	Exp. Velocity in feet.	Contained Angle.	Calculated Velocity.	Estimated Effect of Wind.	Final Velocity.	Difference.
Nov. 24	1040·49	4° 18′	1045·51	+ 4·0	1049·5	+ 9·0
Dec. 8	1037·34	85 42	1043·24	+ 4·0	1047·2	+ 9·9
1825.						
Jan. 10	1029·04	4 18	1011·48	+ 4·0	1015·5	−13·5
Feb. 7	1020·99	63 12	1025·66	+ 2·0	1027·7	+ 6·7
17	1039·25	......	1033·03	......	1033·0	− 5·7
21	1010·28	......	1010·91	......	1010·9	+ 0·6
Mar. 2	1014·39	18 12	1009·78	+ 4·0	1013·8	− 0·6
22	1026·64	161 48	1029·06	− 4·0	1025·1	− 1·5
June 3	1098·32	18 12	1092·82	+ 4·0	1096·8	− 1·5
4	1118·10	16 48	1094·60	+25·0	1119·6	+ 1·5
		Mean error of the whole . . .				+ 4·9
		Of a single set				+ 0·5

In most of the above experiments, the experimental and calculated velocities approximate very closely. There is, no doubt, some uncertainty in the estimated effect of the wind, though it is believed it cannot be great. Perhaps it is a little too great in the first two experiments. I cannot reconcile the third very well by any probable supposition. The only one on which the effect of the wind is considerable, is the last, when it was *strong and squally, and blowing nearly in the direction of the sound.* Upon the whole, the comparison appears satisfactory, though it would have been less objectionable had the velocity of the wind been ascertained by experiment, and its direction more accurately observed.

I may add, that since my last communication on experiments by the pendulum, I have reconsidered the whole; and upon rejecting those evidently affected with *some cause not well explained,* I have found the following formula:

$$P = 39{\cdot}01326 + 0{\cdot}20686 \sin^2 (\lambda - \theta) \; \ldots\ldots\ldots \; (A)$$

In which P is the length of the pendulum, λ the observed latitude, and θ the reduction of the latitude.

Also $\varepsilon = 0{\cdot}00330 = \frac{1}{303}$ very nearly;

And P at London by computation from formula (A) is 39·13937, while I have found it from Captain Kater's experiments to be 39·13938, almost exactly the same. P at Paris, by the same formula is 39·12982, or 0·00053 greater than by experiment. And these two instances show the great accuracy of the formula.

The

The most probable ellipticity by the pendulum-experiments appears to be, from my calculations, ...	0·00330
The same, from my comparison of degrees ...	0·00322
Mr. Ivory's investigations give from arcs	0·00324
Laplace adopted	0·00326
Mean of the whole	0·00327

It is probable that Mr. Ivory's ellipticity, or 0·00324, is the most accurate of the whole, and may safely be adopted as that to which it will ultimately converge, since it satisfies all the most accurate arcs hitherto measured with extreme precision.

But the most extraordinary circumstance attending all these comparisons is their discrepancy from those of Mr. Professor Airy, of Cambridge, who finds from Captain Sabine's pendulum-experiments 0·003474; and still more so the result of his comparison of arcs, which is 0·003589! *these arcs being the very same as those which Mr. Ivory and I have employed.* To what cause then must this discordance be attributed? Can it be supposed that the Professor has committed an error either in his investigations, or in his calculations, or in both? In such an important investigation it would be most desirable to see the whole scrutinized with great care, and this scrutiny would come with a better grace from the Professor himself than from any other individual. I am, Gentlemen, yours, &c.

Edinburgh, June 18, 1828. William Galbraith.

XXX. *On the Reduction of Circummeridian Altitudes of the Sun*[*].

PROFESSOR GAUSS's ingenious method of effecting the usual reduction of circummeridian altitudes of the sun not having yet been noticed in any English work, the following deduction of the same will perhaps deserve a place in the Philosophical Magazine. Let

$\varphi =$ the latitude of the place of observation.
$\delta =$ the sun's declination at noon.
$\Delta\delta =$ the change of the sun's declination in 24 hours at noon expressed in seconds.
$-t =$ the number of seconds any observation was taken before noon.
$+t =$ the number of seconds any observation was taken after noon.
$O =$ the observed altitude of the sun for the time t.
$M =$ the meridian altitude of the sun.

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[*] Communicated by the Author.

We

We shall then have for every observation the following equation:

$$O + a t^2 - b t = M$$

where $a = \frac{15^2 . \sin 1''}{2} . \frac{\cos \varphi . \cos \delta}{\sin (\varphi - \delta)}$; $b = \frac{\Delta \delta}{86400}$.

Let $\frac{b}{2a} = \tau$ seconds; and we shall have $O + a(t - \tau)^2 = M + a\tau^2$, where the part on the right is the same for every observation, τ being independent of t. This equation shows that the greatest, O, will belong to $t - \tau = 0$, or $t = \tau$, and will exceed the meridian-altitude M by $a\tau^2 \left[= \frac{b\tau}{2}\right]$, or that τ seconds after noon the sun will attain his highest altitude $M + a\tau^2$, to which every observed altitude may be reduced by the addition of the single term $a(t - \tau)^2$; $t - \tau$ will evidently be the number of seconds elapsing between the observation and the moment of the sun's highest altitude. This moment is found by this equation: $\tau \left(= \frac{b}{2a}\right) = \frac{\Delta \delta . \sin (\varphi - \delta) . N}{100 . \cos \varphi . \cos \delta}$, log. N = 0·0257289, and τ is positive in the ascending, and negative in the descending signs. Prof. Schumacher publishes annually a table of the values of τ for every tenth day of the year, and every degree of latitude from 36° to 60°. It is unnecessary to add, that the quantities $a(t - \tau)^2$ for every observation, and the constant quantity $a\tau^2$, are calculated by the assistance of the well-known tables of Delambre, Dr. Young, and others.

We entirely avoid, therefore, by this method, the calculation of the term $b\,t$, or the change of declination for every observation. M. Von Heiligenstein, who has explained this method in Prof. Schumacher's *Astr. Nachrichten*, No. 134, has neglected the quantity $a\tau^2$, which indeed never amounts to $0''.25$; but it is clear that this is not correct, and that where great accuracy is required it certainly ought to be taken into consideration.

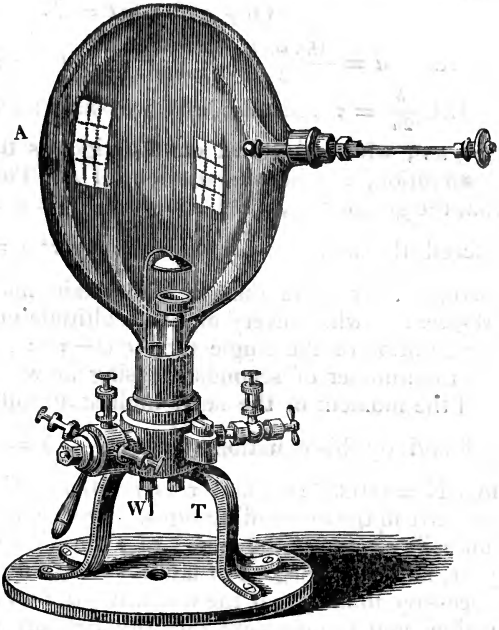
J. L. T.

XXXI. *Improved Eudiometrical Apparatus.* *By* R. Hare, *M.D. Professor of Chemistry in the University of Pennsylvania.*

[Concluded from page 134.]

Of the Barometer-Gauge Eudiometer by Phosphorus.

A HOLLOW glass spheroid A, of which the vertical diameter is 11 inches, the horizonal diameter 9 inches, is cemented into a brass socket which screws into the same place as as the socket of the receiver of the eudiometer above described. In lieu of the igniting wires employed in that instrument, a cup containing phosphorus is supported by and closes the upper end of a tube T. This tube is soldered into the axis of a brass plug, screwed in at the bottom of the brass casting, which at top receives the socket of the spheroid. The phosphorus being ignited by means of a hot iron passed up through the tube, the oxygen of the air included in the spheroid is condensed, and the *deficit* ascertained by the gauge.



It will be recollected that the gauge of the barometer-gauge eudiometer is graduated into 450 degrees. It is expedient to commence this experiment with the mercury at 50 degrees, which leaves 400 parts in the spheroid, and allows room for the expansion which takes place in the beginning of the process.

I have made several experiments with this apparatus, and find the results to harmonize with each other, and with those obtained by my other instruments.

Upon the wire W, which passes through the stuffing box into the cavity of the spheroid, a copper hood is supported, which is just large enough to cover the cap containing the phosphorus. By this contrivance the phosphorus may be secluded from the air, until its exposure becomes desirable.

On one side of the spheroid a thermometer may be observed, which is so fastened by means of a stuffing-box, as that the bulb is within, while the stem is without, and may be easily inspected. A small sliding band enables the operator to mark the

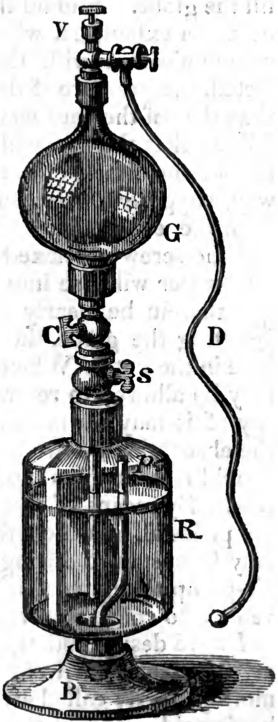
the place to which the thermometrical liquid reaches before the ignition of the phosphorus, and of course enables him, by awaiting its return to the same position, to know when the heat arising from the combustion has escaped so as to permit the bulk of the residual air to be fairly measured.

Of the Carbonicometer or Gasilotor;

An Apparatus for withdrawing a known Portion of residual Gas from the Receiver of the Barometer-Gauge Eudiometer, in order to cause the Absorption of Carbonic Acid by Agitation with Lime-water.

A mixture of oxygen with carbonic oxide, or carburetted hydrogen, may be exploded in the barometer-gauge eudiometer. Any ensuing *deficit* will be seen by the effect upon the gauge.

The quantity of carbonic acid produced, may be ascertained by means of the instrument described in the following article.



p is a pipe which causes a communication between the upper part of the receiver R, and the cavity under the hollow pedestal B. The lower orifice of this pipe, where it enters the cavity of the pedestal, is covered by a valve opening downwards. The receiver is surmounted by a brass cap, into which, as well as into the socket in the pedestal, it is cemented air-tight. In the axis of the receiver, and descending nearly to the bottom, may be seen a tube, which is soldered into a perforation communicating with the bore of the cock C, so as to establish a communication between the receiver and the globe G.

The globe is surmounted by a valve-cock V, furnished with a gallows and screw, so that a leaden pipe D, terminated by a brass knob duly perforated, may be joined to it, air-tight, without difficulty. Hence if the pipe be annexed at the other end to the cock of the barometer-gauge eudiometer,

meter, a communication between the inside of the receiver of this instrument and the globe G, may be easily opened or suspended at pleasure.

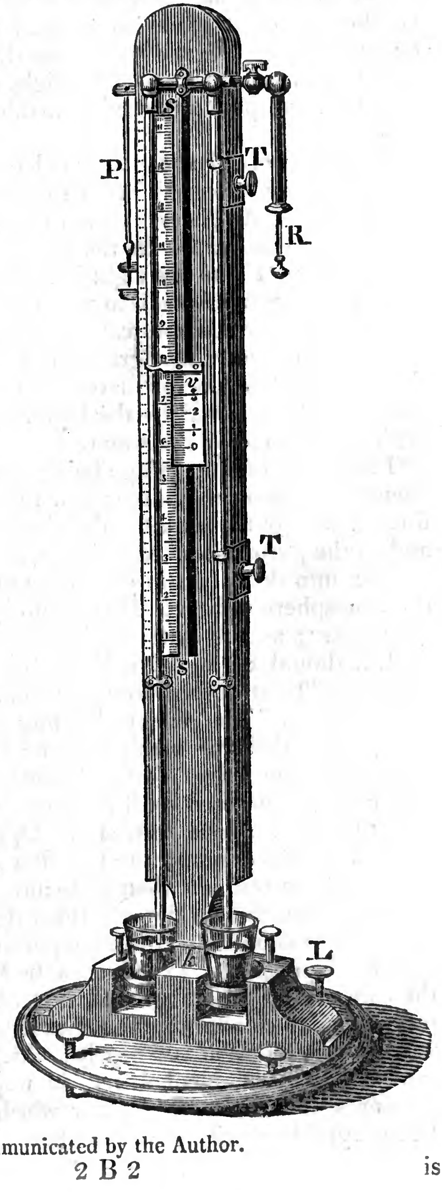
The screw S serves to open or close a perforation which communicates with the cavity of the receiver.

Suppose the receiver R to be occupied by lime-water as represented in the figure. Place the pedestal B over the hole in the air-pump plate, which the rim of the pedestal is ground to fit. On working the pump, the air of the receiver above the lime-water is drawn out through the valve at the bottom of the pipe *p*. Of course the air in the globe follows it through the pipe, which leads from it into the receiver. Having exhausted the globe and receiver, if the screw S be so loosened as to allow the atmosphere to enter the receiver, and press upon the surface of the lime-water while the globe remains exhausted, the lime-water will of course rise into and fill the globe. Should the receiver under these circumstances be again exhausted, while by means of the flexible pipe D a communication with the barometer-gauge eudiometer is effected, the pressure of the gas in the eudiometer being greater than that of the rare medium of the exhausted receiver R,—it follows that this gas will press into the globe and cause a portion of the lime-water to descend into the receiver. In this way, suppose 100 measures, by the barometer-gauge, taken from the eudiometer. The valve-cock may then be closed, and the screw S relaxed so as to admit the atmosphere. The lime-water will rise into the globe until the pressure of the gas therein be nearly equal to that of the atmosphere. By agitating the globe, the carbonic acid will combine with the lime in the water. When this object is effected, the residual gas may be allowed to re-enter the eudiometer, where the quantity of it may be measured, and consequently the extent of the absorption known. It is not necessary that the apparatus should remain upon the air-pump plate during the whole process. By means of the valve which covers the perforation in the pedestal, in which the pipe P is inserted, the exhaustion may be sustained during the removal of the receiver from the air-pump to any part of the laboratory where it may be convenient to connect it with the eudiometer.

I have designated this instrument as a carbonicometer in my text-book, to avoid circumlocution. It may however be more properly called a washer of gas, than a measurer of carbonic acid. Hence the term gasilotor would be more appropriate. The employment of new names may appear pedantic to some readers, but is really necessary, in order to avoid tedious, and, at times, almost unintelligible circumlocution.

XXXII. *Of the Litrameter.* *By* R. Hare, *M.D. Professor of Chemistry in the University of Pennsylvania*[*].

LITRAMETER is a name derived from "*meter*," and the Greek λιτϱα (weight), and is given to one of the instruments which I have contrived for ascertaining specific gravities. The litrameter owes its efficiency to the principle, that when columns of different liquids are elevated by the same pressure, their heights must be inversely as their gravities.



Two glass tubes, of the size and bore usually employed in barometers, are made to communicate internally with each other, and with a syringe R, by means of a brass tube and two sockets of the same metal, into which they are severally inserted. The brass tube terminates in a cock, to which the syringe is screwed.

The tubes are placed vertically, in grooves, against an upright strip of wood, tenoned into a pedestal of the same material. Parallel to one of the grooves, in which the tubes are situated, a strip of brass SS is fastened; and graduated so that each degree may be about equal to 1·110 of the whole height of the tubes. The brass plate

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[*] Communicated by the Author.

is long enough to admit of about 70 degrees. Close to this scale, a vernier *v* is made to slide, so that the divisions of the scale are susceptible of subdivision into tenths, and the whole height of the tubes into about 1100 parts, or degrees.

On the left of the tube, there is another strip of brass, with another set of numbers so situated as to divide each of the degrees in the scale above mentioned into two: so that, agreeably to this enumeration, the height of the tubes is, with the aid of a corresponding vernier, divided into 2200 parts or degrees.

A small strip of sheet-tin *k* is let into a notch in the wood, supporting the tubes, in order to indicate the commencement of the scale. At distances from this of 1000 parts, and 2000 parts (commensurate with those of the scale), there are two other indices TT to the right-hand tube. Let a small vessel containing water be made to receive the lower end of the tube by the side of which the scale is situated, and a similar vessel of any other fluid, whose gravity is sought, be made to receive the lower end of the other tube; so that the end of the one tube may be covered by the liquid in question, and the end of the other tube by the water.

The piston of the syringe being previously pushed into the chamber as far as possible, is now to be moved in the opposite direction. By these means the air is rarefied in the chamber and in the glass tubes, and consequently it allows the liquids to rise into the tubes, in obedience to the greater pressure of the atmosphere without. If the liquid to be assayed be heavier than water; as, for instance, let it be concentrated sulphuric acid, it should be raised a little above the first index, at the distance of 1000 degrees from the common level of the orifices of the tubes. The vessels holding the liquids being then lowered, so that the result may be uninfluenced by any inequality in the height of the liquids in them, the column of acid must be lowered until its upper surface coincide exactly with the index of one thousand. Opposite the upper surface of the column of water, the two first numbers of the specific gravity of the acid will then be found; and by duly adjusting and inspecting the vernier, the third figure will be ascertained. The liquids should be at the temperature of 60°.

If the liquid under examination be lighter than water, as in the case of nearly pure alcohol, it must be raised to the upper index. The column of water measured by the scale of 1000, will then be found at 800 nearly; which shows that one thousand measures of alcohol are, in weight, equivalent to 800 measures of water—or, in other words, 800 is ascertained to be the specific gravity of the alcohol.

The

The plummet P, and the screws at L, enable the operator to detect and rectify any deviation from perpendicularity in the instrument.

XXXIII. *On Measurements on the Earth's Surface perpendicular to the Meridian.* *By* J. Ivory, *Esq. M.A. F.R.S.*[*]

AFTER so many laborious researches undertaken to determine the figure of the earth, the opinions of philosophers upon that point are still very unsettled. In proof of this it will be sufficient to cite what is advanced in the latest memoir on this subject, in which it is said that the compression $\frac{1}{300}$ is adopted, because it is the mean between $\frac{1}{310}$ and $\frac{1}{289}$, the limits between which the ellipticity is generally supposed to be comprised[†]. There is at least great prudence in this procedure; for at the same time that the particular ellipticity is pitched upon which is nearly the best fitted to reconcile all the phænomena with the measurements of the Survey, there is no risk incurred that the truth, when it can no longer be disputed, will fall beyond the boundaries mentioned. In the Numbers of this Journal for May and June last, the elliptical elements of the earth are deduced from the five most esteemed measurements of meridional arcs in our possession; and it is fully proved that the elements found represent the five distances on the meridian with great accuracy. As far as our present knowledge extends, we are therefore entitled to infer that the terrestrial meridians are equal ellipses of a known excentricity, and the earth itself an elliptical spheroid having a known compression at the poles.

Till additional surveys shall enable us to establish the foregoing conclusion, or to correct it, if it be erroneous, we may inquire what light will be thrown on the question by measurements perpendicular to the meridian. In this Journal for July last, I have shown that, in the English Survey, the operations at Beachy Head and Dunnose, for finding the length of a degree perpendicular to the meridian, lead to a result that accords exactly with the same spheroid deduced from the meridional arcs. My present intention is to examine some more instances of the same kind; and I shall begin with putting the formula I used for computing the difference of longitude into a form more convenient for calculation.

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[*] Communicated by the Author.

[†] Phil. Trans. 1828, p. 132.

Referring

Referring to this Journal, July last, pp. 8 and 9, for the explanation of the symbols employed, I shall now put

$$\text{Sin}\,\frac{\beta}{2} = \frac{\gamma}{2a}$$

$$\text{Sin}\,\frac{\delta}{2} = \frac{1}{2}\sqrt{(p-u)^2+(q-t)^2}:$$

and it is obvious that $\sin\frac{\delta}{2}$ is no other than half the chord of the elliptical meridian comprehended between the latitudes of the two stations, which may be computed to any required degree of exactness. If now we substitute these values in the equation at the top of p. 9, we shall get,

$$\text{Sin}^2\frac{\beta}{2} - \sin^2\frac{\delta}{2} = pu\sin^2\frac{\omega}{2};$$

and hence,

$$\text{Sin}\,\frac{\omega}{2} = \sqrt{\frac{\sin\frac{\beta+\delta}{2}\sin\frac{\beta-\delta}{2}}{\cos\lambda\cos\lambda'}} \times \left(1 - \frac{\varepsilon}{2}\sin^2\lambda - \frac{\varepsilon'}{2}\sin^2\lambda'\right).$$

or, in logarithms,

$$\text{Log}\sin\frac{\omega}{2} = \tfrac{1}{2}\log\left(\frac{\sin\frac{\beta+\delta}{2}\sin\frac{\beta-\delta}{2}}{\cos\lambda\cos\lambda'}\right) - \frac{M\varepsilon}{2} \times$$

$$(\sin^2\lambda + \sin^2\lambda'). \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(A)}$$

This formula, when $\varepsilon = 0$, coincides with the usual rule for finding an angle of a spherical triangle when the three sides are given, β being the base, and δ the difference of the sides. If we observe that small arcs of the elliptical meridian and of the equator, which are equal in length, have very nearly equal chords, we shall readily obtain this formula for finding δ which is very convenient in practice, viz.

$$\delta = (\lambda-\lambda').\left\{1 - \varepsilon\left(\frac{1}{2} + \frac{3}{2}\cos(\lambda+\lambda')\right)\right\} \quad \text{(a)}$$

I shall now add another formula for finding the difference of longitude when there is given, the azimuth at one station, and the latitude of the other, together with the length of the chord between them. Let m denote the azimuth at the first station, that is, the angle between the meridian and the second station; λ', the latitude of the second station; and γ, the length of the chord: further put R for the radius of a sphere the surface of which passes through the two stations, and touches the horizon of the first: then the difference of longitude ω, will

will be found by this formula, which is exact and easily demonstrated by the most simple geometry, viz.

$$\text{Sin}\ \omega = \frac{\gamma}{a} \cdot \frac{\sin m}{\cos \lambda'} \sqrt{1 - \frac{\gamma^2}{4\text{R}^2}} \times \sqrt{1 - 2\varepsilon \ \sin^2 \lambda'} .$$

Now it is obvious that R will always be very nearly equal to a; and since γ is always a small part of R, or of a, we may take $\frac{\gamma^2}{4a^2}$ as equivalent to $\frac{\gamma^2}{4\text{R}^2}$. But if we make $\sin \frac{\beta}{2} = \frac{\gamma}{2a}$; then $\cos \frac{\beta}{2} = \sqrt{1 - \frac{\gamma^2}{4a^2}}$; and $\frac{\gamma}{a} \sqrt{1 - \frac{\gamma^2}{4a^2}} = 2 \sin \frac{\beta}{2} \cos \frac{\beta}{2} = \sin \beta$: and thus we obtain,

$$\text{Sin}\ \omega = \frac{\sin \beta \sin m}{\cos \lambda'} \sqrt{1 - 2\varepsilon \sin^2 \lambda'},$$

or, in logarithms,

$$\text{Log} \sin \omega = \log \left(\frac{\sin \beta \sin m}{\cos \lambda'} \right) - \text{M}\varepsilon \sin^2 \lambda'. \qquad \text{(B)}$$

In illustration of these rules I am tempted to apply them for finding the difference of longitude between the observatories at Greenwich and Paris. In the new survey the length of the arc drawn from Dover perpendicular to the meridian of Greenwich, is 50634 fathoms*. I consider the foot of this arc as the first station in the formula (B), and Dover as the second station. Hence, $m = 90°$; $\lambda' = 50° \ 7' \ 45''{\cdot}6$. As the given distance is not a chord, but an arc on the earth's surface, we shall find β by reducing the given length, taken as an arc of the earth's equator, to degrees: therefore $\beta = \frac{50634}{60856} \times 3600''$ $= 49' \ 53''{\cdot}3$. The formula (B) will now give us the longitude of Dover equal to

$$1° \ 19' \ 23''{\cdot}78.$$

As we have no azimuth either at Dover or Dunkirk, we must apply the formula (A). The two latitudes are,

Dover………… $\lambda = 51° \ 7' \ 45''{\cdot}6$
Dunkirk……… $\lambda' = 51 \quad 2 \quad 8 \cdot 5$.

General Roy makes the distance from Dover to Dunkirk equal to 244916 feet†, or 40822 imperial fathoms. According to the mode of calculation in the Survey, this length is not a chord, but an arc on the earth's surface; and hence $\beta = \frac{40822}{60856} \times 3600''$ $= 40' \ 14''{\cdot}87$. The formula (a) gives $\delta = 5' \ 36''{\cdot}91$. We have therefore, by the formula (A), the difference of longitude between Dover and Dunkirk equal to

$$1° \ 3' \ 19''{\cdot}10.$$

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* Phil. Trans. 1828, p. 180.

† Trig. Survey, vol. i. p. 147.

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The sum of the two results is the longitude of Dunkirk, 2° 22′ 42″·88: and as the meridian of Paris is 2′ 22″ west of the meridian of Dunkirk*, we get the difference of longitude of the two observations, equal to,

In degrees.	In time.
2° 20′ 20″·88	9^m 21^s·39
By experiment, P. T. 1826,	9 21 ·46
Defect...	0·07

In order to confirm the result obtained at Beachy Head, I shall add a similar instance taken from the New Survey. At the station of Fairlight†, the angle between the meridian and Blancnez, was found 85° 36′ 36″·73 $= m$; the latitude of Blancnez is 50° 55′ 29″·36 $= \lambda'$. The arc on the earth's surface between the two stations is 42117·6 fathoms; and hence $\beta = \frac{42117\cdot6}{60856} \times 3600'' = 41' \, 31''\cdot51$. The formula (B) will now give us the difference of longitude of the two stations equal to 1° 5′ 33″·42. According to the Survey, the length of the perpendicular arc at Blancnez is 41998·66 fathoms; and the amplitude of this arc, computed from the difference of longitude, is 41′ 19″·58; and hence, by proportion, the perpendicular degree is 60976 fathoms. Now, at the latitude of Blancnez, a perpendicular degree on the surface of the spheroid is 60974·5 fathoms.

It appears that the perpendicular degrees at Beachy Head and at Blancnez on the French coast, agree very exactly with the elliptical spheroid deduced from the meridional arcs. The coincidence of the curvature of the earth's surface with the same spheroid in this region, may likewise be inferred from the calculation of the difference of longitude between Greenwich and Paris, which brings out a result so near the quantity obtained by direct observation. Let us next inquire how the case will stand at a very distant part of the globe. Colonel Lambton has made in India a measurement precisely similar to that at Beachy Head and Dunnose in the British Survey. The particulars of this measurement at the two stations are as follows‡:

Curnatighur.	Carangooly.
Azimuth, 92° 49′ 15″·93 $= m$,	Azimuth, 87° 0′ 7″·54
Latitude, 12 34 38 ·85,	Latitude, 12 32 12 ·27 $= \lambda'$

	Feet.	Fathoms.
Rectilineal distance	291189·3	= 48531·5
Perpendicular arc at Carangooly,	290841	= 48473·5

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* *Conn. des Tems.* † Phil. Trans. p. 186.

‡ Asiatic Researches, vol. viii.

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As in this instance we have the rectilineal distance of the stations, or the chord γ between them, we must find β by the formula $\sin\frac{\beta}{2} = \frac{\gamma}{2a} = \frac{\gamma}{2p\Delta}$; whence $\beta = 47' \, 50''\cdot94$. With this value of β, and the values of m and λ' noted above, the difference of longitude will be found, by the formula (B), equal to 48′ 57″·05. From this we get 47′ 47″·03, for the amplitude of the perpendicular arc at Carangooly, and 60866 fathoms, for the perpendicular degree, very little different from 60865·2, the length on the surface of the spheroid at the latitude of Carangooly.

But if the measurements made in England and India are all represented by the same spheroid, Why should not the case be the same in France? We have a great tendency to infer uniformity in the works of Nature, which principle is in reality the foundation of every physical inquiry. And if the public were put in possession of the extensive operations that have been executed in France and the north of Italy, for determining an arc of the mean parallel, there can be little doubt that we should be able to prove that all the degrees of the parallel are equal, and agree in their length with the dimensions of the spheroid we have been considering. But at present we cannot draw our arguments from so rich a source, and we shall be content with examining a single instance taken from the great meridional measurement of France.

The length of an arc drawn perpendicular to the meridian of Dunkirk from *La Rogière*, in latitude 44° 34′ 36″·6 is, according to the survey, 27534·6 toises *. This length is a deduction from actual measurement, and is independent of any hypothesis about the figure of the earth. The arc is 29345·2 fathoms; and, by proceeding as in the example of Dover, we get $\beta = 28' \, 55''\cdot95$, and the difference of longitude =40′ 33″·21. In order to find the amplitude of the arc, we must know the latitude of the point where it cuts the meridian. Now, according to the survey, the small arc of the meridian, between the foot of the perpendicular and the parallel of La Rogière, is = 114·3 toises = 121·7 fathoms, making 7″·2 of difference of latitude. The latitude of the foot of the perpendicular is therefore, 44° 34′ 43″·8; whence we get the amplitude = 28′ 53″·18, and the length of the perpendicular degree = 60953 fathoms, exactly the same as on the surface of the spheroid at the latitude 44° 34′ 43″·8.

In this last instance, as well as in all the others, the degree perpendicular to the meridian measured on the earth's surface,

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* *Base Metrique*, vol. iii. p. 268.

is very consistent with the dimensions of the spheroid deduced from the meridional arcs. Now *La Rogière* is only 1° 9′ south of the parallel on which the measurements have been made in France and Italy; and it is well known that the result of these operations requires a compression considerably different from what we have investigated. Here there is a difficulty of some moment, which it would be interesting to discuss, but which the length of this article precludes us from entering upon at present.

August 8, 1828. J. IVORY.

XXXIV. *The Tables of* Oltmanns *for calculating Heights by the Barometer, rendered applicable to English Barometers and Measures.* *By* H. T. DE LA BECHE, *Esq. F.R.S.*[*]

THE French Board of Longitude have given these Tables in their *Annuaire* for the last two or three years, and state that they appear to them "the most convenient of all those hitherto published, for facilitating the calculation of heights." After this eulogium it would be useless for me to add any thing in favour of their merits, the chief of which consists in their great simplicity.

Being calculated for the metrical barometer, these tables were useless to persons employing that graduated according to English inches and their decimal parts. To render them applicable to our barometers, I have prefixed a table (A), in which the equivalent of every millimetre of the metrical barometer is given in English inches and the hundredth parts of inches, which is sufficiently close for all practical purposes.

To reduce the metres used in these tables into English feet, I have appended a table (F), where the number of English feet corresponding to any number of metres up to 10,000 will be immediately obtained.

Abstraction being made of table A prefixed, and table F appended, the march of operations is as follows:

Let h be the height of the barometer at the lower station expressed in millimetres; h' that of the higher station; T and T′ the temperature of the barometer at the different stations according to the centigrade thermometer, t and t' that of the air.

We search in table B for the number which corresponds to h; let us call it a: we likewise search in the same table for that which corresponds to h'; let this be named b: let us call

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[*] Communicated by Mr. De la Beche.

c, the generally very small number which, in table C, faces $T-T'$; the approximate height will be $a-b-c$. (If $T-T'$ is negative, it should be written $a-b+c$.) In order to apply the correction necessary for the strata of air, it will suffice to multiply the thousandth part of the approximate height by the double sum $2\,(t+t')$ of the detached thermometers; the correction will be either positive or negative, according as $t+t'$ is itself either positive or negative.

The second and last correction, that for the latitude and the diminution of weight, is obtained by taking, in table D, the number which corresponds vertically to the latitude, and horizontally to the approximate height: this correction, which can never exceed 28 metres, is always added.

In those very rare cases where the lower station is itself considerably elevated above the sea, it will be necessary to apply a small correction to be found in table E.

In order to understand the calculation of a height by means of these tables, and those prefixed and appended, let us suppose that in latitude =44° we had at the level of the sea, the barometer =30·04 English inches, temperature of the instrument =22°·5 centigrade, and of the air =22°. At the top of a mountain, the barometer =26·57 English inches, temperature of the instrument =17·5, and of the air =17°.

In order to obtain the equivalents of the English inches in millimetres, search in table A; where the number of millimetres corresponding to 30·04 inches observed at the sea will be 763, and that of 26·57 observed on the mountain will be 675. Having obtained these equivalents, the calculation proceeds:

	Mill.	Metres.	
Barometer at sea level ...... =	763 =	6182·0	Table B.
Barometer on the mountain =	675 =	5206·1	
		975·9	
Diff. of attached thermometers = 5° =		7·4	Table C.
Apparent height....................		968·5	
Double the sum of the detached thermometers multiplied by the thousandth part of 968·5		75·5	
		1044·	
Correction for latitude		3·1	Table D.
Height of the mountain...............		1047·1	
Height in English feet............		3435	Table F.

TABLE A.

Inches.	Milli.	Inches.	Milli.	Inches.	Milli.
14·56	370	16·22	412	17·87	454
14·60	371	16·26	413	17·91	455
14·64	372	16·29	414	17·95	456
14·68	373	16·33	415	17·99	457
14·72	374	16·37	416	18·03	458
14·76	375	16·41	417	18·07	459
14·80	376	16·45	418	18·11	460
14·84	377	16·49	419	18·15	461
14·88	378	16·53	420	18·19	462
14·92	379	16·57	421	18·22	463
14·96	380	16·61	422	18·26	464
15·00	381	16·65	423	18·30	465
15·04	382	16·69	424	18·34	466
15·07	383	16·73	425	18·38	467
15·11	384	16·77	426	18·42	468
15·15	385	16·81	427	18·46	469
15·19	386	16·85	428	18·50	470
15·23	387	16·89	429	18·54	471
15·27	388	16·93	430	18·58	472
15·31	389	16·97	431	18·62	473
15·35	390	17·00	432	18·66	474
15·39	391	17·04	433	18·70	475
15·43	392	17·08	434	18·74	476
15·47	393	17·12	435	18·77	477
15·51	394	17·16	436	18·81	478
15·55	395	17·20	437	18·85	479
15·59	396	17·24	438	18·89	480
15·63	397	17·28	439	18·93	481
15·67	398	17·32	440	18·97	482
15·71	399	17·36	441	19·01	483
15·75	400	17·40	442	19·05	484
15·78	401	17·44	443	19·09	485
15·82	402	17·48	444	19·13	486
15·86	403	17·52	445	19·17	487
15·90	404	17·55	446	19·21	488
15·94	405	17·59	447	19·25	489
15·98	406	17·63	448	19·29	490
16·02	407	17·67	449	19·33	491
16·06	408	17·71	450	19·37	492
16·10	409	17·75	451	19·41	493
16·14	410	17·79	452	19·44	494
16·18	411	17·83	453	19·48	495

TABLE A. (*continued.*)

Inches.	Milli.	Inches.	Milli.	Inches.	Milli.
19·52	496	21·18	538	22·83	580
19·56	497	21·22	539	22·87	581
19·60	498	21·26	540	22·91	582
19·64	499	21·30	541	22·95	583
19·68	500	21·33	542	22·99	584
19·72	501	21·37	543	23·03	585
19·76	502	21·41	544	23·07	586
19·80	503	21·45	545	23·11	587
19·84	504	21·49	546	23·15	588
19·88	505	21·53	547	23·19	589
19·92	506	21·57	548	23·23	590
19·96	507	21·61	549	23·26	591
20·00	508	21·65	550	23·30	592
20·04	509	21·69	551	23·34	593
20·08	510	21·73	552	23·38	594
20·11	511	21·77	553	23·42	595
20·15	512	21·81	554	23·46	596
20·19	513	21·85	555	23·50	597
20·23	514	21·88	556	23·54	598
20·27	515	21·92	557	23·58	599
20·31	516	21·96	558	23·62	600
20·35	517	22·00	559	23·66	601
20·39	518	22·04	560	23·70	602
20·43	519	22·08	561	23·74	603
20·47	520	22·12	562	23·78	604
20·51	521	22·16	563	23·82	605
20·55	522	22·20	564	23·85	606
20·59	523	22·24	565	23·89	607
20·63	524	22·28	566	23·93	608
20·66	525	22·32	567	23·97	609
20·70	526	22·36	568	24·01	610
20·74	527	22·40	569	24·05	611
20·78	528	22·44	570	24·09	612
20·82	529	22·48	571	24·13	613
20·86	530	22·52	572	24·17	614
20·90	531	22·55	573	24·21	615
20·94	532	22·59	574	24·25	616
20·98	533	22·63	575	24·29	617
20·02	534	22·67	576	24·33	618
21·06	535	22·71	577	24·37	619
21·10	536	22·75	578	24·41	620
21·14	537	22·79	579	24·45	621

TABLE A. (*continued.*)

Inches.	Milli.	Inches.	Milli.	Inches.	Milli.
24·48	622	26·14	664	27·79	706
24·52	623	26·18	665	27·83	707
24·56	624	26·22	666	27·87	708
24·60	625	26·25	667	27·91	709
24·64	626	26·29	668	27·95	710
24·68	627	26·33	669	27·99	711
24·72	628	26·37	670	28·03	712
24·76	629	26·41	671	28·07	713
24·80	630	26·45	672	28·11	714
24·84	631	26·49	673	28·14	715
24·88	632	26·53	674	28·18	716
24·92	633	26·57	675	28·22	717
24·96	634	26·61	676	28·26	718
25·00	635	26·65	677	28·30	719
25·03	636	26·69	678	28·34	720
25·07	637	26·73	679	28·38	721
25·11	638	26·77	680	28·42	722
25·15	639	26·81	681	28·46	723
25·19	640	26·85	682	28·50	724
25·23	641	26·88	683	28·54	725
25·27	642	26·92	684	28·58	726
25·31	643	26·96	685	28·62	727
25·35	644	27·00	686	28·66	728
25·39	645	27·04	687	28·70	729
25·43	646	27·08	688	28·74	730
25·47	647	27·12	689	28·78	731
25·51	648	27·16	690	28·82	732
25·55	649	27·20	691	28·85	733
25·59	650	27·24	692	28·89	734
25·63	651	27·28	693	28·93	735
25·67	652	27·32	694	28·97	736
25·70	653	27·36	695	29·01	737
25·74	654	27·40	696	29·05	738
25·78	655	27·44	697	29·09	739
25·82	656	27·48	698	29·13	740
25·86	657	27·52	699	29·17	741
25·90	658	27·56	700	29·21	742
25·94	659	27·60	701	29·25	743
25·98	660	27·63	702	29·29	744
26·02	661	27·67	703	29·33	745
26·06	662	27·71	704	29·36	746
26·10	663	27·75	705	29·40	747

TABLE A. (*continued.*)

Inches.	Milli.	Inches.	Milli.	Inches.	Milli.
29·44	748	30·00	762	30·55	776
29·48	749	30·04	763	30·59	777
29·52	750	30·07	764	30·63	778
29·56	751	30·11	765	30·66	779
29·60	752	30·15	766	30·70	780
29·64	753	30·19	767	30·74	781
29·68	754	30·23	768	30·78	782
29·72	755	30·27	769	30·82	783
29·76	756	30·31	770	30·86	784
29·80	757	30·35	771	30·90	785
29·84	758	30·39	772	30·94	786
29·88	759	30·43	773	30·98	787
29·92	760	30·47	774	31·02	788
29·96	761	30·51	775	31·06	789

TABLE B.

Milli.	Metres.	Milli.	Metres.	Milli.	Metres.
370	418·5	394	919·0	418	1389·9
371	440·0	395	939·2	419	1408·9
372	461·5	396	959·3	420	1427·9
373	482·9	397	979·4	421	1446·8
374	504·2	398	999·5	422	1465·7
375	525·4	399	1019·5	423	1484·6
376	546·6	400	1039·4	424	1503·4
377	567·8	401	1059·3	425	1522·2
378	588·9	402	1079·1	426	1540·8
379	609·9	403	1098·9	427	1559·5
380	630·9	404	1118·6	428	1578·2
381	651·8	405	1138·3	429	1596·8
382	672·7	406	1157·9	430	1615·3
383	693·5	407	1177·5	431	1633·8
384	714·3	408	1197·1	432	1652·2
385	735·0	409	1216·6	433	1670·6
386	755·6	410	1236·0	434	1689·0
387	776·2	411	1255·4	435	1707·3
388	796·8	412	1274·8	436	1725·6
389	817·3	413	1294·1	437	1743·8
390	837·8	414	1313·3	438	1762·1
391	858·2	415	1332·5	439	1780·3
392	878·5	416	1351·7	440	1798·4
393	898·8	417	1370·8	441	1816·5

Table B. (*continued.*)

Milli.	Metres.	Milli.	Metres.	Milli.	Metres.
442	1834·5	484	2557·3	526	3220·0
443	1852·5	485	2573·7	527	3235·1
444	1870·4	486	2590·2	528	3250·2
445	1888·3	487	2506·6	529	3265·3
446	1906·2	488	2622·9	530	3280·3
447	1924·0	489	2639·2	531	3295·3
448	1941·8	490	2655·4	532	3310·3
449	1959·6	491	2671·6	533	3325·3
450	1977·3	492	2687·9	534	3340·2
451	1994·9	493	2704·1	535	3355·1
452	2012·6	494	2720·2	536	3370·0
453	2030·2	495	2736·3	537	3384·8
454	2047·8	496	2752·3	538	3399·6
455	2065·3	497	2768·3	539	3414·4
456	2082·8	498	2784·4	540	3429·2
457	2100·2	499	2800·4	541	3443·9
458	2117·6	500	2816·3	542	3458·6
459	2135·0	501	2832·2	543	3473·3
460	2152·3	502	2848·1	544	3487·9
461	2169·6	503	2864·0	545	3502·5
462	2186·9	504	2879·8	546	3517·2
463	2204·1	505	2895·6	547	3531·8
464	2221·3	506	2911·3	548	3546·3
465	2238·4	507	2927·0	549	3560·8
466	2255·5	508	2942·7	550	3575·3
467	2272·6	509	2958·4	551	3589·8
468	2280·6	510	2974·0	552	3604·2
469	2306·6	511	2989·6	553	3618·6
470	2323·6	512	3005·2	554	3633·0
471	2340·5	513	3020·7	555	3647·4
472	2357·4	514	3036·2	556	3661·7
473	2374·2	515	3051·7	557	3676·0
474	2391·1	516	3067·2	558	3690·3
475	2407·9	517	3082·6	559	3704·6
476	2424·6	518	3097·9	560	3718·8
477	2441·3	519	3113·3	561	3733·0
478	2458·0	520	3128·6	562	3747·2
479	2474·6	521	3143·9	563	3761·3
480	2491·3	522	3159·2	564	3775·4
481	2507·9	523	3174·4	565	3789·5
482	2524·3	524	3189·7	566	3803·6
483	2540·8	525	3204·9	567	3817·7

TABLE B. (*continued.*)

Milli.	Metres.	Milli.	Metres.	Milli.	Metres.
568	3831·7	611	4412·8	654	4954·4
569	3845·7	612	4425·9	655	4966·6
570	3859·7	613	4438·9	656	4978·7
571	3873·7	614	4451·9	657	4990·9
572	3887·6	615	4464·8	658	5003·0
573	3901·5	616	4477·7	659	5015·1
574	3915·4	617	4490·7	660	5027·2
575	3929·3	618	4503·6	661	5039·2
576	3943·1	619	4516·4	662	5051·2
577	3956·9	620	4529·3	663	5063·3
578	3970·7	621	4542·1	664	5075·3
579	3984·5	622	4554·9	665	5087·2
580	3998·2	623	4567·7	666	5099·2
581	4011·9	624	4580·5	667	5111·2
582	4025·6	625	4593·2	668	5123·1
583	4039·3	626	4606·0	669	5135·0
584	4052·9	627	4618·7	670	5146·9
585	4066·6	628	4631·4	671	5158·8
586	4080·2	629	4644·0	672	5170·6
587	4093·8	630	4656·7	673	5182·5
588	4107·3	631	4669·3	674	5194·3
589	4120·8	632	4682·0	675	5206·1
590	4134·3	633	4694·5	676	5217·9
591	4147·8	634	4707·1	677	5229·7
592	4161·3	635	4719·7	678	5241·4
593	4174·7	636	4732·2	679	5253·2
594	4188·1	637	4744·7	680	5264·9
595	4201·5	638	4757·2	681	5276·6
596	4214·9	639	4769·7	682	5288·3
597	4228·2	640	4782·1	683	5300·0
598	4241·6	641	4794·6	684	5311·6
599	4254·9	642	4807·0	685	5323·2
600	4268·2	643	4819·4	686	5334·8
601	4281·4	644	4831·7	687	5346·4
602	4294·7	645	4844·1	688	5358·0
603	4307·9	646	4856·4	689	5369·6
604	4321·1	647	4868·7	690	5381·1
605	4334·3	648	4881·0	691	5392·7
606	4347·4	649	4893·3	692	5404·2
607	4360·5	650	4905·6	693	5415·7
608	4373·7	651	4917·8	694	5427·2
609	4386·7	652	4930·0	695	5438·7
610	4399·8	653	4942·2	696	5450·1

TABLE B. (*continued.*)

Milli.	Metres.	Milli.	Metres.	Milli.	Metres.
697	5461·5	729	5819·0	761	6161·1
698	5472·9	730	5829·9	762	6171·5
699	5484·3	731	5840·8	763	6182·0
700	5495·7	732	5851·7	764	6192·4
701	5507·1	733	5862·5	765	6202·8
702	5518·4	734	5873·4	766	6213·2
703	5529·8	735	5884·2	767	6223·6
704	5541·1	736	5895·1	768	6234·0
705	5552·4	737	5905·9	769	6244·4
706	5563·7	738	5916·7	770	6254·7
707	5575·0	739	5927·5	771	6265·0
708	5586·2	740	5938·2	772	6275·4
709	5597·5	741	5949·0	773	6285·7
710	5608·7	742	5959·7	774	6296·0
711	5619·9	743	5970·4	775	6306·2
712	5631·1	744	5981·2	776	6316·5
713	5642·2	745	5991·9	777	6326·7
714	5653·4	746	6002·5	778	6337·0
715	5664·6	747	6013·2	779	6347·2
716	5675·7	748	6023·8	780	6357·4
717	5686·8	749	6034·4	781	6367·6
718	5697·9	750	6045·1	782	6377·8
719	5709·0	751	6055·7	783	6388·0
720	5720·1	752	6066·3	784	6398·2
721	5731·1	753	6076·9	785	6408·3
722	5742·1	754	6087·5	786	6418·5
723	5753·1	755	6098·0	787	6428·6
724	5764·2	756	6108·6	788	6438·7
725	5775·1	757	6119·1	789	6448·8
726	5786·1	758	6129·6	790	6458·9
727	5797·1	759	6140·1		
728	5808·0	760	6150·6		

TABLE C.

Deg.	Metre.	Deg.	Metre.	Deg.	Metre.	Deg.	Metre.
0·2	0·3	1·4	2·1	2·6	3·8	3·8	5·6
0·4	0·6	1·6	2·3	2·8	4·1	4·0	5·9
0·6	0·9	1·8	2·6	3·0	4·4	4·2	6·2
0·8	1·2	2·0	2·9	3·2	4·7	4·4	6·5
1·0	1·5	2·2	3·2	3·4	5·0	4·6	6·8
1·2	1·8	2·4	3·5	3·6	5·3	4·8	7·1

TABLE C. (*continued.*)

Deg.	Metre.	Deg.	Metre.	Deg.	Metre.	Deg.	Metre.
5·0	7·4	8·8	12·9	12·6	18·5	16·4	24·1
5·2	7·6	9·0	13·2	12·8	18·8	16·6	24·4
5·4	7·9	9·2	13·5	13·0	19·1	16·8	24·7
5·6	8·2	9·4	13·8	13·2	19·4	17·0	25·0
5·8	8·5	9·6	14·1	13·4	19·7	17·2	25·3
6·0	8·8	9·8	14·4	13·6	20·0	17·4	25·6
6·2	9·1	10·0	14·7	13·8	20·3	17·6	25·9
6·4	9·4	10·2	15·0	14·0	20·6	17·8	26·2
6·6	9·7	10·4	15·3	14·2	20·9	18·0	26·5
6·8	10·0	10·6	15·6	14·4	21·2	18·2	26·8
7·0	10·3	10·8	15·9	14·6	21·5	18·4	27·1
7·2	10·6	11·0	16·2	14·8	21·8	18·6	27·4
7·4	10·9	11·2	16·5	15·0	22·1	18·8	27·7
7·6	11·2	11·4	16·8	15·2	22·4	19·0	28·0
7·8	11·5	11·6	17·1	15·4	22·7	19·2	28·2
8·0	11·8	11·8	17·4	15·6	22·9	19·4	28·5
8·2	12·1	12·0	17·6	15·8	23·2	19·6	28·8
8·4	12·4	12·2	17·9	16·0	23·5	19·8	29·1
8·6	12·6	12·4	18·2	16·2	23·8		

TABLE D.

Approx. Height.	0°	5°	10°	15°	20°	25°
	m.	m.	m.	m.	m.	m.
200	1·2	1·2	1·2	1·0	1·0	1·0
400	2·4	2·4	2·4	2·2	2 0	2·0
600	3·4	3·4	3·4	3·2	3·0	2·8
800	4·5	4·5	4·5	4·3	4·1	3·8
1000	5·7	5·7	5·7	5·3	5·1	4·8
1200	7·0	7·0	6·8	6·4	6·0	5·8
1400	8·2	8·2	8·0	7·6	7·1	6·7
1600	9·2	9·2	9·0	8·8	8·2	7·6
1800	10·4	10·4	10·2	9·8	9·4	8·6
2000	11·6	11·5	11·3	11·0	10·4	9·6
2200	12·8	12·6	12·6	12·1	11·4	10·6
2400	14·0	14·0	13·8	13·3	12·5	11·6
2600	15·2	15·2	15·0	14·4	13·6	12·6
2800	16·6	16·5	16·4	15·6	14·8	13·6
3000	17·9	17·7	17·6	16·8	15·8	14·6
3200	19·1	18·9	18·7	18·0	17·0	15·7
3400	20·5	20·3	20·1	19·3	18·4	16·9

Table D. (*continued.*)

Approx. Height.	0°	5°	10°	15°	20°	25°
	m.	m.	m.	m.	m.	m.
3600	21·8	21·7	21·4	20·4	19·6	18·0
3800	23·1	22·9	22·6	21·6	20·6	19·1
4000	24·6	24·4	24·0	22·9	21·9	20·3
4200	25·9	25·7	25·3	24·3	23·0	21·6
4400	27·5	27·3	26·8	25·8	24·3	23·0
4600	28·9	28·7	28·2	27·1	25·6	24·3
4800	30·4	30·2	29·6	28·4	27·0	25·5
5000	31·8	31·6	30·9	29·8	28·4	26·7
5200	33·0	32·8	32·1	31·0	29·7	28·0
5400	34·3	34·1	33·5	32·4	30·8	29·2
5600	35·7	35·5	34·8	33·7	32·1	30·2
5800	37·1	36·9	36·1	35·0	33·2	31·3
6000	38·5	38·3	37·5	36·3	34·3	32·3

Approx. Height.	30°	35°	40°	45°	50°	55°
	m.	m.	m.	m.	m.	m.
200	0·8	0·8	0·6	0·6	0·6	0·4
400	1·8	1·7	1·4	1·2	1·0	0·8
600	2·6	2·4	2·0	1·8	1·6	1·2
800	3·5	3·1	2·8	2·4	2·0	1·7
1000	4·3	3·8	3·4	3·1	2·6	2·2
1200	5·1	4·6	4·2	3·6	3·1	2·6
1400	6·1	5·4	4·8	4·2	3·6	3·0
1600	7·0	6·2	5.6	4·8	4·1	3·4
1800	8·0	7·0	6·3	5·4	4·6	3·8
2000	8·8	7·8	7·0	6·0	5·1	4·2
2200	9·7	8·6	7·6	6·6	5·6	4·6
2400	10·6	9·4	8·4	7·2	6·1	5·1
2600	11·6	10·5	9·2	8·0	6·8	5·6
2800	12·6	11·4	10·0	8·8	7·4	6·2
3000	13·6	12·2	10·8	9·4	8·0	6·6
3200	14·6	13·1	11·5	10·1	8·6	7·0
3400	15·7	14·1	12·4	10·9	9·2	7·7
3600	16·7	15·0	13·4	11·6	9·8	8·2
3800	17·7	15·9	14·3	12·4	10·5	8·7
4000	18·7	17·0	15·1	13·1	11·2	9·4
4200	19·9	18·0	15·9	14·0	12·0	10·1
4400	21·1	19·1	16·9	15·0	12·9	10·8
4600	22·3	20·3	18·0	15·9	13·6	11·5
4800	23·4	21·3	19·0	16·7	14·3	12·1

TABLE D. (*continued.*)

Approx. Height.	30°	35°	40°	45°	50°	55°
	m.	m.	m.	m.	m.	m.
5000	24·6	22·3	19·9	17·4	15·0	12·7
5200	25·7	23·3	20·8	18·2	15·7	13·3
5400	26·7	24·3	21·7	19·1	16·4	13·9
5600	27·8	25·3	22·6	19·9	17·2	14·5
5800	28·9	26·3	23·6	20·7	17·8	15·1
6000	30·0	27·3	24·6	21·5	18·5	15·7

TABLE E.

h	Metres.	*h*	Metres.
400	1·71	600	0·63
450	1·39	650	0·42
500	1·11	700	0·22
550	0·86	750	0·03

Let, for example, the height of the barometer at the lower station be = 600 millimetres; the difference of level = 1500 metres, we have 1000: 0·63 = 1500: 0·95, and the difference of the level corrected = 15·009 metres. This correction is always added.

TABLE F.

Reduction of Metres into English Feet and Inches.

Metres.	Feet.	Inches.	Metres.	Feet.	Inches.
1	3	3·370	60	196	10·217
2	6	6·740	70	229	7·920
3	9	10·111	80	262	5·623
4	13	1·481	90	295	3·326
5	16	4·851	100	328	1·029
6	19	8·222	200	656	2·058
7	22	11·592	300	984	3·087
8	26	2·963	400	1312	4·116
9	29	6·333	500	1640	5·145
10	32	9·702	600	1968	6·174
20	65	7·405	700	2296	7·203
30	98	5·108	800	2624	8·232
40	131	2·811	900	2952	9·261
50	164	0·514	1000	3280	10·290

Table F. (*continued.*)

Metres.	Feet.	Inches.	Metres.	Feet.	Inches.
2000	6561	8·58	7000	22966	0·03
3000	9842	6·87	8000	26246	10·32
4000	13123	5·16	9000	29527	8·61
5000	16404	3·45	10000	32808	6·90
6000	19685	1·74			

Reduction of Decimetres, Centimetres, and Millimetres, to English Inches.

Dec.	Inches.	Cent.	Inches.	Milli.	Inches.
1	3·937	1	0·393	1	0·039
2	7·874	2	0·787	2	0·078
3	11·811	3	1·181	3	0·118
4	15·748	4	1·574	4	0·157
5	19·685	5	1·968	5	0·196
6	23·622	6	2·362	6	0·236
7	27·559	7	2·755	7	0·275
8	31·496	8	3·149	8	0·314
9	35·433	9	3·543	9	0·354
10	39·370	10	3·937	10	0·393

XXXV. *General Solution of the Problem: to represent the Parts of a given Surface on another given Surface, so that the smallest Parts of the Representation shall be similar to the corresponding Parts of the Surface represented. By* C. F. Gauss. *Answer to the Prize Question proposed by the Royal Society of Sciences at Copenhagen.*

[Concluded from p. 113.]

12. As a fourth example, we will consider the representation of the surface of an ellipsoid of revolution in a plane. Let a and b be the two principal semiaxes of the ellipsoid, so that we may put $x = a \cos t \sin u$, $y = a \sin t \sin u$, $z = b \cos u$. We shall then have

$$\omega = a^2 \sin u^2 \, d t^2 + (a^2 \cos u^2 + b^2 \sin u^2) \, d u^2$$

and the differential formula $\omega = 0$ gives, if we put for brevity $\surd\left(1 - \frac{b^2}{a^2}\right) = \varepsilon$ (b being supposed $< a$),

$$0 = d t \mp i \, d u \surd(\text{cotang}\, u^2 + 1 - \varepsilon^2).$$

Putting

Putting now $\surd(1-\varepsilon^2)\,.\,\text{tang}\,u = \text{tang}\,\omega$ (when applied to the terrestrial spheroid $90-\omega$ will be the geographical latitude and t the longitude), the equation will assume this form:

$$0 = dt \mp i\,d\omega\,.\,\frac{1-\varepsilon^2}{(1-\varepsilon^2\cos\omega^2)\sin\omega},$$

the integration of which gives

$$\text{const.} = t \pm i \log\left\{\text{cotang}\,\tfrac{1}{2}\,\omega\,.\left(\frac{1-\varepsilon\cos\omega}{1+\varepsilon\cos\omega}\right)^{\frac{1}{2}\varepsilon}\right\}.$$

Consequently f denoting an arbitrary function, we have to take for X the real, and for i Y the imaginary part of

$$f\left(t+i\log\left\{\text{cotang}\,\tfrac{1}{2}\,\omega\,.\left(\frac{1-\varepsilon\cos\omega}{1+\varepsilon\cos\omega}\right)^{\frac{1}{2}\varepsilon}\right\}\right).$$

If a linear function is chosen for f, putting $f v = k v$, we shall have

$$\text{X} = kt,\ \ \text{Y} = k\log\text{cotang}\,\tfrac{1}{2}\,\omega - \tfrac{1}{2}\,k\,\varepsilon\log\frac{1+\varepsilon\cos\omega}{1-\varepsilon\cos\omega},$$

which is a projection analogous to that of Mercator.

If on the contrary an imaginary exponential function is taken for f, we have

$$\text{X} = k\,\text{tang}\,\tfrac{1}{2}\,\omega^{\lambda}\left(\frac{1+\varepsilon\cos\omega}{1-\varepsilon\cos\omega}\right\}^{\frac{1}{2}\varepsilon\lambda}.\cos\lambda t,$$

$$\text{Y} = k\,\text{tang}\,\tfrac{1}{2}\,\omega^{\lambda}\left(\frac{1+\varepsilon\cos\omega}{1-\varepsilon\cos\omega}\right\}^{\frac{1}{2}\varepsilon\lambda}\sin\lambda t,$$

which putting $\lambda = 1$ will give a projection analogous to the stereographical, and generally one which is very proper for representing a portion of the earth's surface if the ellipticity is to be taken into consideration.

The formulæ for the other case in which $b > a$ may be immediately derived from the preceding ones; the same notation being retained, ε will become imaginary, but $\left(\frac{1+\varepsilon\cos\omega}{1-\varepsilon\cos\omega}\right)^{\frac{1}{2}\varepsilon}$ will again become real. But for the sake of completeness we will separately develope the formulæ for this case, and first put $\surd\left(\frac{b^2}{a^2}-1\right) = \eta$. We then determine ω by the equation $\surd(1+\eta^2)\,.\,\text{tang}\,u = \text{tang}\,\omega$, and the differential equation $0 = dt \mp i\,d\omega\,.\,\frac{1+\eta^2}{(1+\eta^2\cos\omega^2)\sin\omega}$ has for its integral, the following:

Const. $= t \pm i\,(\log\text{cotang}\,\tfrac{1}{2}\,\omega + \eta\,.\,\text{arc tang}\,\eta\,.\cos\omega)$ so that X will be the real and iY the imaginary part of

$$f\left(t+i\log\left(\text{cotang}\,\tfrac{1}{2}\,\omega+\eta\,.\,\text{arc tang}\,\eta\,.\cos\omega\right)\right)$$

From

From this expression may be immediately derived the formulæ for this case corresponding to those above given for the particular suppositions made for the function f.

In the first supposition we shall have to take

$$X = kt,\ Y = k \log \operatorname{cotang} \tfrac{1}{2}\omega + \eta k \operatorname{arc\,tang} \eta \,.\, \cos\omega$$

In the second case

$$X = k \operatorname{tang} \tfrac{1}{2}\omega^{\lambda} \,.\, e^{-\eta\lambda \operatorname{arc\,tang} \eta \,.\, \cos\omega} \,.\, \cos\lambda t$$

$$Y = k \operatorname{tang} \tfrac{1}{2}\omega^{\lambda} \,.\, e^{-\eta\lambda \operatorname{arc\,tang} \eta \,.\, \cos\omega} \,.\, \sin\lambda t.$$

13. Lastly, we will consider the general representation of the surface of an ellipsoid of revolution on the surface of a sphere. For the latter we will retain the solution of the preceding article, and put the radius of the sphere = A, and $X = A \cos T \,.\, \sin U$, $Y = A \sin T \,.\, \sin U$, $Z = A \,.\, \cos U$.

Applying the general solution of art. 5. we shall find, f denoting an arbitrary function, that T must be made equal to the real, and $i \log \operatorname{cotang} \frac{1}{2} U$ to the imaginary part of

$$f\left(t + i \log \left\{ \operatorname{cotang} \tfrac{1}{2}\omega \,.\, \left(\frac{1-\varepsilon\cos\omega}{1+\varepsilon\cos\omega}\right)^{\frac{1}{2}\varepsilon} \right\}\right)^{*}.$$

The supposition $fv = v$ will give the simplest solution, by which will be

$$T = t,\ \operatorname{tang} \tfrac{1}{2} U = \operatorname{tang} \tfrac{1}{2}\omega \,.\, \left(\frac{1+\varepsilon\cos\omega}{1-\varepsilon\cos\omega}\right)^{\frac{1}{2}\varepsilon}$$

This presents a transformation exceedingly useful in higher geodetics; on the application of which we can, however, give in this place only a few short hints. If we regard as corresponding points on the surface of the ellipsoid and the sphere those which have the same longitude, and whose latitudes 90° − U, 90° − ω respectively are connected together by the above-given equation, we shall have for a system of comparatively small triangles (as those which can serve for real measurement must always be) which are formed by shortest lines on the surface of a spheroid, a corresponding system of triangles on the surface of the sphere whose angles are *exactly* equal to the corresponding ones on the spheroid, and the sides of which deviate so little from arcs of greatest circles, that in most cases where the very extreme of accuracy is not required, they may be supposed to coincide with them; and even where such extreme accuracy is required, the deviation from parts of

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[*] We pass over the second solution of art. 5. which is distinguished from the above by a substitution of −T for +T only, and which would give a reversed representation; and we pass likewise over the case of an oblong spheroid, which, agreeably to the treatment of the analogous case in the preceding article, results immediately from that of the oblate spheroid.

greatest circles may be calculated with any accuracy that may be necessary by simple formulæ. It is therefore possible to calculate the whole system, one side of a triangle having first been duly transferred to the spherical surface, by the angles, entirely as if the whole were on the sphere itself, with the modification just indicated, if necessary; for all points of the system the values of T and U may be determined, and we may go back from the latter to the corresponding values of ω (in the simplest manner by an auxiliary table of very easy construction). A triangulation never embracing more than a very moderate portion of the surface of the earth, the above-mentioned purpose may be still more perfectly accomplished if we generalize the preceding solution by putting $fv = v +$ const. instead of $fv = v$. Clearly nothing would be gained by this supposition, if a real value were assigned to the const. as T and t would then only differ by this constant quantity; and consequently, the points from which the longitudes are counted would only be different. But the result is very different, if we assign to the constant quantity an imaginary value. If we put it $= i \log k$, we have

$$\mathrm{T} = t,\ \operatorname{tang} \tfrac{1}{2} \mathrm{U} = k \operatorname{tang} \tfrac{1}{2} \omega \,.\left(\frac{1+\varepsilon \cos \omega}{1-\varepsilon \cos \omega}\right)^{\frac{1}{2}\varepsilon}$$

In order to decide on the appropriate value of k, it is necessary first to determine the scale of the representation.

In conformity to the notation of articles 5 and 6, we have

$$n = a^2 \sin u^2, \quad \mathrm{N} = \mathrm{A}^2 \sin \mathrm{U}^2, \quad \varphi v = 1$$

hence $$m = \frac{\mathrm{A} \sin \mathrm{U}}{a \,.\, \sin u} = \frac{\mathrm{A} \sin \mathrm{U}}{a \sin \omega} .\ \sqrt{(1-\varepsilon^2 \cos \omega^2)} =$$

$$\frac{\mathrm{A}}{a} \,.\, \frac{k\,(1-\varepsilon^2 \cos \omega^2)^{\frac{1}{2}+\frac{1}{2}\varepsilon}}{\cos \frac{1}{2}\omega^2\,(1-\varepsilon \cos \omega)^{\varepsilon} + k^2 \sin \frac{1}{2}\omega^2\,(1+\varepsilon \cos \omega)^{\varepsilon}},$$

The scale, therefore, depends on the latitude only. The smallest possible deviation from perfect similarity is obtained by such a determination of k as will give equal values of m for the extreme latitudes, by which the value of m for the mean latitude will be nearly a maximum or a minimum. If we denote the extreme values of ω by ω° and ω', we obtain in this manner

$$k = \sqrt{\frac{\dfrac{\cos \frac{1}{2}\omega^{\circ 2}\,(1-\varepsilon \cos \omega^{\circ})^{\varepsilon}}{(1-\varepsilon^2 \cos \omega^{\circ 2})^{\frac{1}{2}+\frac{1}{2}\varepsilon}} - \dfrac{\cos \frac{1}{2}\omega'^{2}\,(1-\varepsilon \cos \omega')^{\varepsilon}}{(1-\varepsilon^2 \cos \omega'^{2})^{\frac{1}{2}+\frac{1}{2}\varepsilon}}}{\dfrac{\sin \frac{1}{2}\omega'^{2}\,(1+\varepsilon \cos \omega')^{\varepsilon}}{(1-\varepsilon^2 \cos \omega'^{2})^{\frac{1}{2}+\frac{1}{2}\varepsilon}} - \dfrac{\sin \frac{1}{2}\omega^{\circ 2}\,(1+\varepsilon \cos \omega^{\circ})^{\varepsilon}}{(1-\varepsilon^2 \cos \omega^{\circ 2})^{\frac{1}{2}+\frac{1}{2}\varepsilon}}}}$$

In order to ascertain for which latitude m has its greatest or smallest value, we have

$$\frac{dm}{m} = \text{cotang}\, U . dU - \text{cotang}\, \omega . d\omega + \frac{\varepsilon^2 \cos\omega . \sin\omega . d\omega}{1-\varepsilon^2\cos\omega^2}$$

$$\frac{dU}{\sin U} = \frac{d\omega}{\sin\omega} - \frac{\varepsilon^2 \sin\omega . d\omega}{1-\varepsilon^2\cos\omega^2} = \frac{(1-\varepsilon^2)\, d\omega}{(1-\varepsilon^2\cos\omega^2)\sin\omega}$$

and hence, $$\frac{dm}{m} = \frac{(1-\varepsilon^2)\, d\omega}{\sin\omega\,(1-\varepsilon^2\cos\omega^2} . (\cos U - \cos\omega).$$

It is clear from this that m obtains its greatest or smallest value when $U = \omega$; if we denote this value of ω by W, we shall have

$$k = \left(\frac{1-\varepsilon\cos W}{1+\varepsilon\cos W}\right)^{\frac{1}{2}\varepsilon}, \text{ or, } \cos W = \frac{1-k^{\frac{2}{\varepsilon}}}{\varepsilon(1+k^{\frac{2}{\varepsilon}})}$$ by which W may be determined if k is calculated by the above formula. In practice, however, the perfect equality of the values of m for the extreme latitudes will be of little moment, and it will be sufficient to take for $90 - W$ nearly the middle latitude, and to derive k from it. The general connexion between U and ω is given by this equation

$$\text{tang}\, \tfrac{1}{2} U = \text{tang}\, \tfrac{1}{2}\omega . \left\{\frac{(1-\varepsilon\cos W)(1+\varepsilon\cos\omega)}{(1+\varepsilon\cos W)(1-\varepsilon\cos\omega)}\right\}^{\frac{1}{2}\varepsilon}$$

For a real numerical calculation it is, however, more advantageous to apply series which may receive different forms, but the development of which we shall not here stop to investigate.

As it will be easily seen that for $\omega < W$, will be $U > \omega$, therefore, $\cos U - \cos\omega$, and consequently likewise $\frac{dm}{d\omega}$ negative, and that for $\omega > W$ we have $U < \omega$, and consequently $\frac{dm}{d\omega}$ positive, it is evident, that for $\omega = U = W$ the value of m is always a minimum and $= \frac{A}{a}\sqrt{(1-\varepsilon^2\cos W^2)}$. If the radius of the sphere A is therefore assumed $= \frac{a}{\sqrt{(1-\varepsilon^2\cos W^2)}}$, the representation of infinitely small parts of the ellipsoid in latitude $90 - W$ is not only similar, but also equal to the original, but in other latitudes larger.

The logarithms of m may be developed with advantage in a series of ascending powers of $\cos U - \cos W$, the first terms of which will be sufficient for practice, and are as follow:

$$\text{Log hyp.}\, m = \log\left\{\frac{A}{a}\sqrt{(1-\varepsilon^2\cos W^2)}\right\} + \frac{\varepsilon^2}{2(1-\varepsilon^2)} . (\cos U - \cos W)^2 - \frac{2\varepsilon^4\cos W}{3(1-\varepsilon^2)^2}(\cos U - \cos W)^3 \ldots\ldots$$

If

If, for example, the kingdom of Denmark between the limits of latitude 53° and 58° is transferred in this manner to the surface of a sphere, and W is made $= 34° \, 30'$, the representation will, for the ellipticity $\frac{1}{303}$, have its linear dimensions near the extreme latitudes increased by only $\frac{1}{330000}$. We must content ourselves in this place with having given only a short description of this one method of employing the transfer of figures in higher geodetics, and must reserve a more detailed explanation for another place.

14. It now remains to take into more close consideration a circumstance which presents itself in our general solution. We have shown in article 5, that there are always two solutions; as $P + iQ$ must either be a function of $p + iq$, and $P - iQ$ a function of $p - iq$, or $P + iQ$ a function of $p - iq$, and $P - iQ$ a function of $p - iq$. We will now prove that in the one solution the parts of the representation have a similar position as in the original; whereas in the other they have a reversed position, and we will at the same time give a criterion by which this may be ascertained *à priori*.

We observe in the first place, that the distinction between a perfect and a reversed similarity can only come into consideration if we make a distinction between the two sides of a surface by regarding the one as the upper, and the other as the lower one. As this is something arbitrary in itself, the two solutions are not essentially different, and a reversed similarity becomes a perfect one as soon as the side of one surface which was regarded as the lower one is considered as the upper one. This distinction could therefore not present itself in our solution, as the surfaces were only determined by the coordinates of their points. If this circumstance is to be taken into consideration, the nature of the surfaces must first be established in a manner which shall involve this circumstance. With this view we will assume that the nature of the first surface is determined by the equation $\psi = 0$, where ψ is a given uniform function of x, y, z. In all points of the surface the value of ψ will, therefore, vanish; and in all points of space not belonging to the surface, it will not vanish. In a transition through the surface, ψ will therefore, at least generally speaking, pass from a positive value to a negative one; while a transition in a contrary direction will change the negative values of ψ into positive ones, or on one side of the surface the values of ψ will be positive, on the other negative. Let us regard the former as the upper, the latter as the lower side. The same may be assumed with regard to the second surface, which is determined by the equation $\Psi = 0$, where Ψ

is a given uniform function of the coordinates X, Y, Z. Let us suppose that we obtain by differentiation

$$d\psi = e\,dx + g\,dy + h\,dz$$
$$d\Psi = \mathrm{E}\,d\mathrm{X} + \mathrm{G}\,d\mathrm{Y} + \mathrm{H}\,d\mathrm{Z}.$$

where e, g, h will be functions of x, y, z, and E, G, H functions of X, Y, Z.

The considerations by which we must reach the end here proposed being, although by no means difficult, yet of rather an uncommon kind, we shall endeavour to give to them the greatest possible perspicuity. Between the two corresponding representations on the surfaces whose equations are $\psi = 0$, and $\Psi = 0$, we will assume six intermediate representations or planes, so that eight representations will come under consideration; viz.

	Considering as corresponding the points whose co-ordinates are respectively =
1. The original on the surface, the equation of which is $\psi = 0$	$x, y, z.$
2. The representation in the plane...........	$x, y, 0.$
3. ——————————...........	$t, u, 0.$
4. ——————————...........	$p, q, 0.$
5. ——————————...........	P, Q, 0.
6. ——————————...........	T, U, 0.
7. ——————————...........	X, Y, 0.
8. The representation on the surface, the equation of which is $\Psi = 0$	X, Y, Z.

We will now compare these different representations merely with regard to the relative *position* of the infinitely small linear elements, without any regard to the relative magnitude, and we shall consider two representations as similarly situated, if of two elements proceeding from the same point, the one to the right, in one representation has its corresponding element in the other, likewise to the right; in the contrary case, we shall call them reversed. In the plane from No. 2 to No. 7, that side on which are the positive values of the third coordinate is considered as the upper one, but in the cases of the first and last surfaces the distinction between upper and lower side depends only on the positive and negative values of ψ and Ψ as has been before explained.

Now it is in the first place clear, that for each place of the first surface where, x and y remaining the same, a positive increment of z carries to the upper side, the representation 2 will be similarly situated with the representation 1; this will evidently

evidently happen whenever h is positive, and the contrary will take place when h is negative; in which case the representations will have reversed positions.

In the same manner the representations in 7 and 8 will be similarly or reversedly situated, according as H is positive or negative.

In order to compare together the representations in 2 and 3, let in the first, ds be the length of an infinitely small line from the point whose co-ordinates are x, y, to another whose co-ordinates are $x+dx$, $y+dy$, and let l be its inclination to the line of abscissæ increasing in the same direction in which we turn from the axis of the x to that of the y, therefore $dx = ds \cos l$, $dy = ds \, . \, \sin l$. In the representation 3, let $d\sigma$ be the length of the line corresponding to ds, and its inclination to the line of abscissæ in the same sense as before, λ so that $dt = d\sigma \, . \cos\lambda$, $du = d\sigma \, . \sin\lambda$. We have, therefore, in the notation of the 4th article,

$$ds \, . \cos l = d\sigma \, (a \cos\lambda + a' \sin\lambda)$$
$$ds \, . \sin l = d\sigma \, (b \cos\lambda + b' \sin\lambda), \text{ consequently}$$
$$\operatorname{tang} l = \frac{b \, . \cos\lambda + b' \sin\lambda}{a \, . \cos\lambda + a' \sin\lambda}.$$

If x and y are now considered as constant, and l, λ as variable quantities, the differentiation gives

$$\frac{dl}{d\lambda} = \frac{ab' - a'b}{(a\cos\lambda + a'\sin\lambda)^2 + (b\cos\lambda + b'\sin\lambda)^2} = (ab' - a'b) \, . \, \frac{d\sigma^2}{ds^2}.$$

It is therefore evident that, according as $ab' - ba'$ is positive or negative, l and λ will increase at the same time, or their variations will have contrary signs; and that in the first case the representations 2 and 3 will be similarly situated, in the other they will be reversed.

Combining this result with the one found above, we perceive that the representations in 1 and 3 will be similarly situated or reversed, according as $\frac{ab' - ba'}{h}$ is positive or negative. As on the surface, whose equation is $\psi = 0$, we have $e\,dx + g\,dy + h\,dz = 0$, therefore, likewise $(ea + gb + hc)\,dt + (ea' + gb' + hc')\,du = 0$; whatever ratio for dt and du may be chosen, the following quantities must be identically zero,

$$ea + gb + hc = 0, \quad ea' + gb' + hc' = 0$$

from which it follows that e, g, h must be respectively proportional to the quantities $bc' - cb'$, $ca' - ac'$, $ab' - ba'$, therefore

$$\frac{bc' - cb'}{e} = \frac{ca' - ac'}{g} = \frac{ab' - ba'}{h}$$

any one of these three expressions, or if we multiply by the quantity

quantity $e^2+g^2+h^2$ which is necessarily positive, the symmetrical quantity resulting from that multiplication, $abc'+gca'+hab'-ecb'-gac'-hba'$, may be applied as a criterion of a similar or reversed position of the parts in the representations 1 and 3.

In the same manner the similar or reversed position of the parts in the representations 6 and 8 may be proved to depend on the positive or negative value of the quantity $\frac{\text{BC}'-\text{CB}'}{\text{E}} = \frac{\text{CA}'-\text{AC}'}{\text{G}} = \frac{\text{AB}'-\text{BA}'}{\text{H}}$, or the symmetrical quantity

$$\text{EBC}'+\text{GCA}'+\text{HAB}'-\text{ECB}'-\text{GAC}'-\text{HBA}'.$$

The comparison of the representations in 3 and 4 depends on similar principles as that of 2 and 3, and the similar or reversed position of the parts depends on the positive or negative sign of the quantity $\left(\frac{dp}{dt}\right).\left(\frac{dq}{du}\right)-\left(\frac{dp}{du}\right).\left(\frac{dq}{dt}\right)$, and in like manner the positive or negative sign of

$$\left(\frac{d\text{P}}{d\text{T}}\right).\left(\frac{d\text{Q}}{d\text{U}}\right)-\left(\frac{d\text{P}}{d\text{U}}\right).\left(\frac{d\text{Q}}{d\text{T}}\right)$$

will determine the similar or reversed position of parts in the representations 5 and 6.

With regard to the comparison of the representations 4 and 5, we may refer to the analysis of the 8th article, from which it will be clear that these will be similar or reversed in their smallest parts, according as the first or second solution is adopted, that is, according as either, we have made

$$\text{P}+i\text{Q}=fp+iq, \text{ and } \text{P}-i\text{Q}=f'(p-iq), \text{ or}$$
$$\text{P}+i\text{Q}=f(p-iq), \text{ and } \text{P}-i\text{Q}=f'(p+iq).$$

From all that precedes, we now draw the conclusion that if the representation on the surface, whose equation is $\Psi=0$, is to be in the smallest parts, not only similar, but likewise similarly situated to the original in the surface, whose equation is $\psi=0$, we must regard the number of negative quantities which will be found among these four quantities

$$\frac{ab-ba'}{h},\ \left(\frac{dp}{dt}\right)\left(\frac{dq}{du}\right)-\left(\frac{dp}{du}\right).\left(\frac{dq}{dt}\right),\ \left(\frac{d\text{P}}{d\text{T}}\right)\left(\frac{d\text{Q}}{d\text{U}}\right)-\left(\frac{d\text{P}}{d\text{U}}\right)\left(\frac{d\text{Q}}{d\text{T}}\right),\ \frac{\text{AB}-\text{BA}'}{\text{H}};$$

if there is none, or an even number of them, the first solution must be taken; but if there is one, or if there are three negative quantities among them, the second solution must be adopted. By a contrary choice a reversed similarity will always take place.

It may besides be demonstrated that if we designate the above

above four quantities respectively by r, s, S, R, we shall always have $\frac{r\sqrt{(e^2+g^2+h^2)}}{s} = \pm n$, $\frac{R\sqrt{(E^2+G^2+H^2)}}{S} = \pm N$, n and N having the signification of article 5: we pass, however, over the demonstration of this theorem, which it is not difficult to find, as it is not further necessary for our purpose.

XXXVI. *On the Influence of the Air in determining the Crystallization of Saline Solutions.* *By* THOMAS GRAHAM, *Esq. A.M. F.R.S. E.*[*]

THE phænomenon referred to has long been known, and popularly exhibited in the case of Glauber's salt, without any adequate explanation. A phial or flask is filled with a boiling saturated solution of sulphate of soda or Glauber's salt, and its mouth immediately stopped by a cork, or a piece of bladder is tied tightly over it, while still hot. The solution, thus protected from the atmosphere, generally cools without crystallizing, although it contains a great excess of salt, and continues entirely liquid for hours and even days. But upon withdrawing the stopper, or puncturing the bladder, and admitting air to the solution, it is immediately resolved into a spongy crystalline mass, with the evolution of much heat. The crystallization was attributed to the pressure of the atmosphere suddenly admitted, till it was shown that the same phænomenon occurred, when air was admitted to a solution already subject to the atmospheric pressure. Recourse was likewise had to the supposed agency of solid particles floating in the air, and brought by means of it into contact with the solution; or it was supposed that the contact of gaseous molecules themselves might determine crystallization, as well as solid particles. But although the phænomenon has been the subject of much speculation among chemists, it is generally allowed that no satisfactory explanation of it has yet been proposed.

In experimenting upon this subject, it was found that hot concentrated solutions, in phials or other receivers, might be inverted over mercury in the pneumatic trough, and still remain liquid on cooling; and thus the causes which determine crystallization were more readily examined. For this purpose, it was absolutely necessary that the mercury in the trough should be previously heated to 110° or 120°; for otherwise that part of the solution in contact with the mercury cooled so rapidly, as to determine crystallization in the lower part of

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[*] From the Transactions of the Royal Society of Edinburgh; but revised by the Author for the Phil. Mag. and Annals.

the receiver long before the upper part had fallen to the temperature of the atmosphere. In such cases, crystallization beginning on the surface of the mercury, advanced slowly and regularly through the solution. Above, there always remained a portion of the solution too weak to crystallize, being impoverished by the dense formation of crystals below. It was also necessary to clean the lower and external part of the receivers, when placed in the trough, from any adhering solution, as a communication of saline matter was sometimes formed between the solution in the receiver and the atmosphere without. When these precautions were attended to, saline solutions over mercury remained as long without crystallizing as when separated from the atmosphere in the usual mode.

Solutions which completely filled the receivers when placed in the trough, allowed a portion of mercury to enter, by contracting materially as they cooled. A bubble of air could thus be thrown up, without expelling any of the solution from the receiver, and the crystallization determined, without exposing the solution directly to the atmosphere.

The first observation made was, that solutions of sulphate of soda sometimes did not crystallize at all upon the introduction of a bubble of air, or at least for a considerable time. This irregularity was chiefly observed in solutions formed at temperatures not exceeding 150° or 170°, although water dissolves more of the sulphate of soda at these inferior temperatures than at a boiling heat. Brisk ebullition for a few seconds, however, rendered the solution upon cooling amenable to the usual influence of the air. In all successful cases, crystallization commenced in the upper part of the receiver around the bubble of air, but pervaded the whole solution in a very few seconds. A light glass bead was thrown up into a solution without disturbing it.

It occurred to me, that, since the effect of air could not be accounted for on mechanical principles, it might arise from a certain *chemical* action upon the solution. Water always holds in solution a certain portion of air at the temperature of the atmosphere, which it parts with upon boiling. Cooled in a close vessel after boiling, and then exposed to the atmosphere, it reabsorbs its usual proportion of air with great avidity. Now, this absorbed air appears to affect in a minute degree the power of water to dissolve other bodies; at least a considerable part of it is extricated upon the solution of salts. When a bubble of air is thrown up into a solution of sulphate of soda, which has previously been boiled and deprived of all its air, a small quantity of air will certainly be absorbed by the

the solution around the bubble. A slight reduction in the solvent power of the menstruum will ensue at the spot where the air is dissolved. But the menstruum is greatly overloaded with saline matter, and ready to deposit; the slightest diminution of its solvent power may therefore decide the precipitation or crystallization of the unnatural excess of saline matter. The absorption of air may in this way commence and determine the precipitation of the excess of sulphate of soda in solution.

Here, too, we have an explanation of the fact just mentioned, that solutions of sulphate of soda which have *not* been boiled, are less affected by exposure to the air than well-boiled solutions; for the former still retain the most of their air, and do not absorb air so eagerly on exposure as solutions which have been boiled.

But the theory was most powerfully confirmed by an experimental examination of the influence of other gases, besides atmospheric air, in determining crystallization. *Their influence was found to be precisely proportionate to the degree in which they are absorbed or dissolved by water and the saline solutions.*

To a solution of sulphate of soda over mercury, which had not been affected by a bubble of atmospheric air, a bubble of carbonic acid gas was added. Crystallization was instantly determined around the bubble, and thence through the whole mass. Water is capable of dissolving its own volume of carbonic acid gas, and a solution of sulphate of soda as strong as could be employed was found by Saussure to absorb more than half its volume.

In a solution of sulphate of soda, which was rather weak, both common air and carbonic acid gas failed to destroy the equilibrium; but a small bubble of ammoniacal gas instantly determined crystallization.

When gases are employed which water dissolves abundantly, such as ammoniacal and sulphurous acid gases, the crystallization proceeds most vigorously. It is not deferred till the bubble of gas reaches the top of the receiver, as always happens with common air, and frequently with carbonic acid gas, but the track of the bubble becomes the common axis of innumerable crystalline planes, upon which it appears to be borne upwards; and sometimes before the ascent is completed, the bubble is entangled and arrested by crystalline arrangements which precede it.

The number of gases which are less soluble in water than atmospheric air is not considerable; but of these, hydrogen gas was found to be decidedly least influential in determining crystallization.

Minute quantities of foreign liquids soluble in water likewise disposed the saline solution to immediate crystallization, as might be expected, and none with greater effect than alcohol. It is known that alcohol can precipitate sulphate of soda from its aqueous solutions. The soluble gases I suppose to possess a similar property.

These facts appear to warrant the conclusion, that air determines the crystallization of supersaturated saline solutions, by dissolving in the water, and thereby giving a shock to the feeble power by which the excess of salt is held in solution.

⁂ Since the foregoing observations were printed, the author has perceived that M. Gay-Lussac, in his paper on crystallization, (*Ann. de Chim.* tom. lxxxvii.) had distinctly thrown out the same theory as a conjecture, although the circumstance is not noticed by any systematic chemical writer. But as M. Gay-Lussac brings forward no experimental illustration of the theory, and indeed adduces one experiment as unfavourable to it, the experimental confirmation of the theory is novel, and was certainly required.

XXXVII. *Method of avoiding certain sources of inaccuracy in the use of* Kater's *Horizontal Floating Collimator.* *By* J. Nixon, *Esq.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN making use of the *horizontal* floating collimator of Capt. Kater, in order to determine the error of collimation of the telescope of a mural circle, it is necessary to place the collimator first to the north and afterwards to the south of the circle. In addition to the consequent probable source of error, as pointed out by Capt. Kater, may we not enumerate the following?

1. In passing from the north, through the zenith to the south, the telescope describes an arc, which, from its magnitude, may give rise to a sensible error in the graduation. 2. The telescope, unless quite uniform in its parts, may have its flexure varied in consequence of being inverted in position; in which event, the error of collimation will not be the same with the telescope pointed to the north as when directed towards the south. 3. When the north and south sides of the observatory are not uniform in temperature, is it not possible that the difference may vitiate the observations?

All these sources of inaccuracy and doubt may be avoided, and the observations completed with the telescope of the circle

cle in one direction, by the addition of a telescope fixed on a support at such a distance from the circle that the collimator may be conveniently placed between, and in a line with, the two telescopes. To find the error of collimation with the telescope of the circle directed towards the north, proceed as follows:

1. The line of collimation of the telescope of the collimator being very nearly horizontal, place the instrument, with its telescope looking to the south, to the north of the mural circle. 2. Make the line of collimation of the telescope of the circle, (pointing northwards,) parallel to that of the telescope of the collimator, and read off the (minute) angle of elevation or depression. 3. Turn the collimator half round in azimuth, when its telescope (pointing northwards) should be in a line with the *fixed* telescope placed to the north of the collimator. Make the line of collimation of the fixed telescope, pointing southwards, parallel to that of the telescope of the collimator. 4. Remove the collimator, and measure by the micrometer of the fixed telescope the vertical angle formed by the intersection of its line of collimation by that of the telescope of the circle; half of which angle is the correct horizontal inclination of the line of collimation of the telescope of the circle*.

Having thus determined the northern error of collimation, we may subsequently ascertain, after the same method, the southern one; and on comparing these errors with that given by the *vertical* collimator with the telescope pointed towards the zenith, we obtain the horizontal flexure of the telescope for both directions. I am, Gentlemen, yours, &c.

Leeds, Aug. 2, 1828. JOHN NIXON.

XXXVIII. *Description of a new Kind of* Pear-Encrinite *found in England.* *By* JOHN EDW. GRAY, *Esq. F.G.S. &c.*†

ENCRINITES (*Apiocrinites*) PRATTII, n.

Specific Character:—COLUMN formed of round joints adhering by radiating surfaces.? of which the 4 or 5 top ones gradually enlarge at the apex, and sustain the pelvis, &c.

Icon. n. Inhab. Lias, summit of Lansdown, near Bath. *J. S. Pratt, Esq.* Mus. Brit.

This species appears to be intermediate between *A. rotundus* and *A. ellipticus* of Miller, and for the sake of comparison I have given the specific character after his method.

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* This angle will be an elevation, or a depression, according as the line of collimation of the fixed telescope points above, or below that of the telescope of the circle.

† Communicated by the Author.

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The column is thin, composed of short cylindrical joints, but the articulating surfaces are not distinctly seen in the specimen under examination; the enlarged apex is reversed conical, formed of 5 joints, the basal one is very small, and thin; the second, third and fourth, each gradually larger and thicker: the fifth is nearly of the same height, but rather larger in diameter, and the upper part is divided into 5 articulating surfaces, each marked with five radiating grooves, and finely crenated on the margin. The pelvic plate small, wedge-shaped; the outer edge is pentangular, outer sides very short. The first and second set of costals are broad and nearly equal; the scapulars are as thick as the costals in the centre, and shelving on each side; the arms, two from each scapular, compressed, each furnished with a double series of thin jointed filiform tentacula, the first joints of the arm are similar to the first costals, and the joints of the appendages are thin and compressed, similar to those in the arms of *Comatula.*

In the above description I have adopted the name of the parts used by Miller. For the knowledge of this species I am indebted to the kindness of Mr. J. S. Pratt of Bath, by whom it was found. The specimen is placed in the collection of the British Museum. And I have ventured to name the species after that gentleman, although he disclaims being the first discoverer of it: but I consider that he is justly deserving of the honour, as being the first person who enabled it to be made public, and presented a specimen for the purposes of science to the National Collection.

XXXIX. *Notices respecting New Books.*

A Popular Sketch of Electro-Magnetism, or Electro-Dynamics; with Plates of the most improved apparatus for illustrating the principal phænomena of the science; and outlines of the parent sciences Electricity and Magnetism.—By FRANCIS WATKINS, *Curator of Philosophical Instruments in the University of London.* London, 8vo. pp. 83. Three plates.

THIS work, we believe, is the first attempt that has been made to give a popular, and at the same time a comprehensive view of the new science of electro-magnetism. The notices of this science given in some of our elementary works on natural philosophy and chemistry, are necessarily brief and partial; and Professor Cumming's translation of Demontferrand's *Manuel d'Electricité Dynamique,* is adapted chiefly to the use of those who are accustomed to mathematical expressions. The writer of this "Popular Sketch" therefore, deserves commendation for having thus endeavoured to make this beautiful and interesting department of knowledge, a branch

branch of *popular* science. The prefatory outlines of electricity and magnetism are drawn up in a satisfactory manner; and the Sketch of Electro-Magnetism itself, gives a clear and connected detail of the principal observations and results of experiment, of which the science at present consists, with an account of the various experiments themselves, and directions for their performance. At the close of the work is given a description of a series of apparatus for exhibiting the most striking phænomena of electro-magnetism, illustrated by three engravings in outline, by Turrell.

There can be no doubt but that a second edition of this useful little work will be called for; and when such is the case, we hope it will be carefully revised prior to republication; for there are some inaccuracies in construction and language, and also in the occasional allusions to the objects of chemistry and other sciences connected with the subjects it explains, which, although they do not interfere with the main utility of the work, are yet likely to mislead the student in several minor, but still important points. We think, also, that it would be preferable to incorporate the description of the electro-magnetical instruments with the body of the work, giving each instrument in its proper place, as illustrating a certain part of the science; and in this case, engravings on wood inserted in the pages should be substituted for the plates, as uniting greater facility of reference, with equally satisfactory representation of the apparatus. These remarks are made entirely with the view to the future *improvement* of what we consider a very useful contribution to scientific literature; and we hope the sale of the work will be such as to encourage the writer to proceed in his endeavours to render the study of electro-magnetism accessible to every class of inquirers into the phænomena of Nature. It possesses one merit in particular, in which elementary works are too often deficient,—that of citing original and first-rate authorities on the subjects of which it treats, instead of referring only to compendiums and compilations. Every person, already possessing some elementary notions of experimental philosophy, may obtain from the perusal of Mr. Watkins's treatise, and the performance of the experiments described in it, a good general knowledge of electro-magnetic phænomena, and become prepared for the study of the works in which their intimate nature is investigated.

We must not, however, conclude this notice, without adverting to Mr. Watkins's remarks on the experiments of Professor Morichini and Mrs. Somerville, in which steel, in various forms, exposed to the more refrangible rays of the solar spectrum, acquired magnetic polarity. Mr. Watkins observes, ". . . . it is known that many of our most expert manipulators in experiments on natural philosophy, have failed in repeating those of Morichini and Mrs. Somerville. Hence we are led to infer, that the needles operated upon by Morichini and Mrs. Somerville, possessed magnetic properties previous to their being acted upon by the solar ray; and that that magnetism escaped the notice of the experimenters when tested by them at the commencement of the operation." With the details of Morichini's ni's experiments, we do not happen to be acquainted, nor do we know by whom they have been repeated in this country, except Mrs. Somerville. But we think the precision with which that lady has described her own researches, evinces,—even if it does not altogether preclude the idea that the needles &c. employed by her were previously devoid of magnetism,—that the more refrangible rays have a power of *increasing*, if not of imparting, magnetism; and that white light does not possess, this power *. The fact of the increase of magnetism in steel by exposure to certain varieties of coloured light, is nearly as important with respect to the solar influence in the production or regulation of terrestrial magnetism, as that of its being *induced* by the same means would be, if certainly proved.

[B.]

XL. *Proceedings of Learned Societies.*

GEOLOGICAL SOCIETY.

May 16.—DECIMUS BURTON, Esq. of Spring Gardens; and Major T. Perronet Thompson, of the 65th Regiment, were elected Fellows of this Society.

The reading was begun of a Paper entitled, "On the Old Conglomerates, and other secondary deposits on the north coasts of Scotland;" by the Rev. Adam Sedgwick, Woodwardian Professor, Cambridge, V.P.G.S., &c. and R. I. Murchison, Esq. For. Sec. G.S. and F.R.S.

June 6.—M. H. Ducrotay de Blainville, Member of the Institute of France, and of many other learned and scientific Societies, was elected a Foreign Member of this Society; and Richard Taylor, Esq. Sec. L.S. of Middleton Square; Charles Larkin Francis, Esq. of Nine Elms, Surrey; and Jeffry Wyattville, Esq. R.A., of Lower Brook Street,—were elected Fellows of this Society.

The reading of the Paper of Professor Sedgwick, and R. I. Murchison, Esq., begun at the last Meeting, was concluded.

§ 1. *Introduction.*—The authors here give a brief sketch of the general structure of Scotland, to the north of the Forth and the Clyde. They consider the country to be composed of two entirely distinct classes of deposits—primary and secondary; but with the primary deposits are associated many mountain-masses of crystalline rock, which appear to have been protruded since the deposition of the newest of the secondary series; and hence arises great, and sometimes insuperable, difficulty, in passing from one class of deposits to the other. The lowest of the secondary strata are chiefly composed of red-sandstone and red-conglomerate: and from a general review of this part of the subject, the authors conclude, that the conglomerate system on the N.E. coast of the Highlands is identical with that on the N.W. coast; and that both the systems are of the same epoch with the great masses of conglomerate which commence at Stonehaven, and range along the southern flank of the Grampian chain.

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* See Phil. Trans. for 1826: or Phil. Mag. vol. lxviii. p. 168.

§ 2. *Range of the old-red-conglomerates through Caithness, and on the shores of the Murray Firth, &c.*—These rocks are stated to appear in several unconnected masses on the north coast, between Cape Wrath and Port Skerry; and from the latter place they range into the interior, and rise into a mountain-chain (the highest parts reaching the elevation of 3500 feet), which is continued to the granite of the Ord of Caithness. Their range parallel to the shores of the Murray Firth, is also given with many details. They are stated to be developed upon an enormous scale, and sometimes to form two distinct chains of broken mountains, resting unconformably upon the primary strata. On the south-eastern shores of the Murray Firth they gradually thin off; and finally disappear near Cullen bay, in Banfshire.

§ 3. *On the general structure of Caithness.*—After an account of the external appearance of the county, the authors describe in great detail two coast-sections. The first, commencing with the old conglomerates of Port Skerry, which rest immediately upon the granite, exhibits the successive deposits in ascending order, and terminates with the newer red-sandstone on the shores of the Pentland Firth. The second section exhibited on the east coast, commences with the newer red-sandstone, and passing through all the intermediate deposits, finally exposes the old conglomerate system in a part of the coast between Borridale and the Ord. From a general review of the phænomena exhibited in these two sections, as well as from other details derived from the interior of the county, the authors conclude that the secondary deposits may be divided into three great natural groups:—

1. The old conglomerates,—which contain some subordinate masses of red-sandstone, red marle, and calcareo-siliceous flagstone; and which, through the intervention of the red-sandstone, sometimes graduate into the next system.

2. A great formation, occupying all the lower regions of the county, and composed of alternating beds of sandstone, siliceous and calcareo-siliceous schist and flagstone, dark foliated bituminous limestone, pyritous shale, &c.; the siliceous beds giving the type to the lower part of the formation, and the calcareo-bituminous beds to the intermediate part. This formation again becomes more siliceous and arenaceous in the upper portion, and so appears to graduate into the next superior division.

3. A great formation of red, brown, and variegated sandstone, which composes lofty precipices on the south shores of the Pentland Firth. It reappears on the other side of the Firth in the lofty red cliffs of the Orkneys, and there also reposes upon a calcareo-bituminous schist.

§ 4. *Fossil fish of the secondary deposits of Caithness, &c.*—These seem to be contained almost exclusively in the calcareo-bituminous schist, which is subordinate to the middle group of § 3. They do not appear to be confined to any particular part of it, but were found in various localities, some in the lowest and others in the highest part of the series; and in many places scales and imperfect impressions exist in the greatest abundance. Some imperfect specimens were examined during a preceding year by the Baron Cuvier, who found that they all exhibited a pointed tail (with the rays exclusively on the lower side,—as in the fish of the copper-slate of Thuringia), and notwithstanding the great imperfection of the specimens, he concluded that they were of the order *Malacopterygii abdominales,* and analogous to the bony pike. Since that time much more perfect specimens have been procured, which have been examined by Mr. Pentland; who has not only been enabled to confirm the conjectures of Baron Cuvier, but has ascertained two new genera, each containing two species. The first genus (*Dipterus*) has a double dorsal fin, and the other fins are nearly in the same position as in the *Esocii.*—One of the species (*Dipterus macrolepidon*) is remarkable for the size of its scales, which sometimes exceed half an inch in diameter. The second genus is nearly allied to *Amia* and *Lepisosteus.* The body is covered with hard quadrangular scales, disposed in oblique rows. In all the species the peculiar formation of the tail, before alluded-to, is the same.

Along with the fish were found the remains of a *Testudo,* nearly allied to *Trionyx,* and one specimen of a vegetable impression: but not a single fossil shell or zoophyte has yet been discovered in any part of the county. It adds to the interest of this singular assemblage of organic remains, that they all resemble the inhabitants of fresh water.

§ 5. *Secondary deposits on the shores of the Murray Firth.*—Several transverse sections through these deposits are described in great detail; and from a comparative view of the phænomena exhibited in a section from the conglomerate mountains in East Ross to the north Sutor of Cromarty, and from thence to Tarbet Ness, it appears that these secondary deposits admit of three natural divisions, like those described in Caithness. The conglomerates in both counties are the same. The formations in the lower region of East Ross contain subordinate beds of calcareo-bituminous schist; and though fossils are much more rare than in Caithness, yet a few examples of fish-scales, and a fragment of a *Testudo* resembling a *Trionyx,* have been found between the north Sutor and Tarbet Ness.—Lastly, the highest beds of the whole series near Tarbet Ness, may be compared with the newer red-sandstone of the Pentland Firth.

The transverse sections exhibited near the south shores of the Murray Firth, differ considerably in their details from what has been described. The bituminous schists seem to be in some measure replaced by beds of concretionary limestone, resembling the cornstone of Herefordshire: and these beds are surmounted by a great formation of white sandstone, nearly resembling the sandstone associated with the coal measures between the old and new-red-conglomerates in the Isle of Arran.

§ 6. *Red-sandstone and conglomerate series on the N.W. coast of Sutherland and Ross-shire.*—These extend almost without interruption from Cape Wrath to Applecross; and the authors (after stating a few facts in addition to the details already given by Dr. MacCulloch) assert that, through the intervention of the patches of conglomerate on the north coast of Scotland, they are most intimately connected with the conglomerates which extend from Port Skerry to the Ord of Caithness.

ness. The two systems appear also to be identical in their general character and relations. There are some difficulties arising out of the peculiar modifications of the quartz-rock, which sometimes cannot be distinguished, mineralogically, from that of the unconformable red-sandstone and conglomerate series. The authors have, however, no hesitation in classing the great red-sandstone series, which extends from Applecross to Cape Wrath, with the older portions of the secondary deposits of Caithness and Sutherland.

§ 7. *Conclusion.*—The deposits previously described are here compared with the corresponding formations of England.—1. The old-red-conglomerates are, from their mineralogical character and position, identified with the old-red-sandstone of English geologists.—2. The great central deposit, containing the ichthyolites, does not appear to be perfectly identical with any formation hitherto described. It seems in some measure to occupy the place of the coal-formation. Many parts of it resemble grauwacke in mineralogical character; and from its enormous development, it can hardly be compared with the copper-slate of Germany. Again, none of the fish of Caithness are identical with the fish of the copper-slate. The upper part of the Caithness schist might however, in accordance with the Arran section, be compared with the copper-slate; in which case the red-sandstone of the Pentland Firth might be considered as the representative of the new-red-sandstone of England. There is however a break in the series, and it is perhaps impossible to determine where the interruption takes place.—3. The red-sandstone on the shores of the Pentland Firth most nearly resembles the red-sandstone of Arran, which is interposed between the coal measures and the conglomerates of the new-red-sandstone.

A paper was read by the Rev. Dr. Buckland, on the *Cycadeoideæ*, a new family of fossil plants, specimens of which occur silicified in the Free-stone quarries of the Isle of Portland.

These fossils have as yet been noticed only in the Isle of Portland; their existence has long been known to many persons, and to the author, who acknowledges the assistance of Mr. Brown and Mr. Loddiges, in assigning to them their place in the vegetable kingdom, where they stand near the living Genera *Zamia* and *Cycas*.

Their external form approaches to that of the fruit of a pine-apple, and is still more like the trunk of a living *Zamia*, varying from five to fifteen inches in height, and from eight to fifteen inches in width. The stems are nearly cylindrical, and terminate downwards in a broad flat bottom, without any indication of roots: they have no true bark, but are inclosed in a thick case, composed of the permanent bases of decayed leaves, having a structure like that of the bases of the leaves of the recent *Zamia*; they are terminated externally by lozenge-shaped impressions, or scars, of which a continuous series winds spirally, like the scales on a fir-cone, round the whole exterior of the plant.

As yet no leaves have been found adherent to any of these fossils, but at the upper end there is a cavity, from which the crown and last leaves appear to have been removed, before the petrifaction of the stems.

The author describes and gives engravings of two species of these fossils, with comparative sections of the recent *Zamia* and *Cycas*.

1. In the larger species, which he calls *Cycadeoidea megalophylla*, the bases of the leaves are two inches long, and have nearly the form and size of those of the *Zamia horrida*. The trunk is short, and has a deep central cavity, like the interior of a bird's nest,—in which a number of siliceous plates intersect one another, and form an irregular plexus, unlike any vegetable structure, but resembling the coarse cellular appearance that is common in fossil wood. Nearer the circumference there appear distinct organic radiations, disposed in an insulated circle,—like that in the trunk of a recent *Zamia*, but differing, in that it is much broader, and placed nearer the circumference of the stem. The larger plates of this circle are made up of smaller plates, almost invisible to the naked eye. Between this radiating circle and the outer case or leaf stalks, is a narrow band, composed of a minutely cellular, and nearly amorphous substance, but analogous in structure and position to a much broader band that is exterior to the radiating circle of the recent *Zamia*.

2. In the second and smaller species (*Cycadeoidea microphylla*), the bases of the leaves are about an inch in length, but small and numerous, much like those of the *Xanthorrhœa*, or Gum Plant, of New South Wales. The trunk is more elongated, and the cavity at the summit less deep, whilst the transverse section exhibits the same irregular net-work at the centre, but near the circumference has two concentric circles composed of radiating plates; and exterior to each of these a narrow ring devoid of plates,—analogous to the two laminated circles within two cellular circles in a recent *Cycas*.

In external and internal structure, these plants approach more closely to the existing family of *Cycadeæ* than to any other; and they supply, from the fossil world, a link to fill the distant void which separates the *Cycadeæ* from the nearest existing family, the *Coniferæ*. Their occurrence in the Portland oolite adds another to the many facts which indicate the climate of these regions, during the period of the oolitic formations, to have been similar to that of our tropics.

A letter to the President was read, from Gideon Mantell, Esq. F.G.S. &c. inclosing a list of the fossils of the county of Sussex.

This list, which is taken principally from specimens in the author's own collection, enumerates the fossils, first, of the alluvial and diluvial deposits; and, successively, those of the London clay, the plastic clay, chalk, chalk-marle, firestone, gault, Shanklin sand, and Hastings deposits, including the Ashburnham beds.

Subjoined is a comparative table; one of the most remarkable features of which, is the preponderance of the number of species in the marine formations over those of the beds assumed to be of fresh-water origin, in a ratio of not less than six to one; the testaceous mollusca forming two-thirds of the whole, while in the fresh-water strata, the proportion is reversed. Thus the marine deposits contain upwards of two hundred and forty species of shells, and the two fresh-water formations but twenty-two species. In the other classes and orders, equally striking differences are observable.

On the other hand the marine formations are destitute of the characteristic fossils of the fresh-water formations, viz. birds, terrestrial and fresh-water reptiles, shells and vegetables. The author, in short, concludes that a comparison of the living inhabitants of our lakes and rivers, with those of the ocean, would not offer more striking discrepancies.

MEDICO-BOTANICAL SOCIETY.

The last general meeting of the eighth session of this Society was holden on Friday, the 11th of July, at its Apartments, 32 Sackville-street, Piccadilly; Sir James M'Grigor, M.D. F.R.S. K.C.T.S. President, in the chair.

The following gentlemen were elected to be Professors during the ensuing session: Professor of Botany, John Frost, Esq., F.R.S. E.; Professor of Toxicology, George Gabriel Sigmond, M.D .F.S.A. F.L.S.; Professor of Materia Medica, John Whiting, M.D.

A paper entitled "Remarks on the doubtful identity of *Bonplandia trifoliata*, of Willdenow, and Humboldt and Bonpland, and the Angostura, or Carony bark tree," in a letter addressed by Dr. John Hancock to the President and Fellows of the Society,—was read.

Dr. Hancock, who, during the year 1816, resided for several months in the districts in which grows the plant yielding the bark known in pharmaceutic language by the name of *Cortex Angosturæ* vel *Cuspariæ*, on directing his attention to this subject, discovered several material discrepancies between the tree he observed, and the description of a tree said to produce the drug, and of which Baron Alexander Humboldt, in other respects such an accurate observer, sent specimens obtained from Carony to Professor Willdenow, of Berlin; who, though there already existed a genus of that name, called it *Bonplandia*, in honour of Baron Humboldt's companion. This name was subsequently adopted by Humboldt and Bonpland in their splendid work on Æquinoctial plants, though the former had previously given it the appellation of *Cusparia febrifuga*. The opinion formed by Dr. Hancock was confirmed, on being informed by a gentleman of the name of Don Jose Tereas, with whom the travellers above-mentioned lodged, that they did not visit the missions of Carony, but sent down an Indian, who returned with a sample of the leaves of the tree in question, but, much to their disappointment, without flowers. The generic character having also become very doubtful to Dr. Hancock, he carefully examined its congeners, and found it agree in so many points with the genus *Galipea* of Aublet, that he considered it to be a species thereof, and in this opinion he has lately been confirmed by the arrangement of Professor DeCandolle, who has classed the *Cusparia febrifuga*, which, no doubt, is nearly allied to Dr. Hancock's plant, under the head *Galipea*. The paper then gave a detailed description of its botanical characters; which, with a figure of the plant, and a notice of its great efficacy in several diseases, especially in the malignant fevers, dysenteries, and dropsies prevalent in Angostura, in 1816 and 1817, will be published in the next Number of the Society's Transactions;

Transactions; together with a comparative statement of the differences existing between *Bonplandia trifoliata* (Willd.), vel *Cusparia febrifuga* (Humb. and DeC.), vel *Galipea Cusparia* (DeC.), and the real Angostura-bark tree; the most striking of which is, that instead of being a large and majestic forest tree, as described in The *Plantæ Æquinoctiales Orbis Novi*, the authors of which, no doubt, thought the tree found by them in the neighbourhood of Santa Fé de Cumana and Nueva Barcelona, was the same as that of which they obtained leaves in Angostura;—it is a tree, or almost shrub, of not more than from twelve to fifteen, and at the most twenty feet, in height, and four or five inches in diameter. The Doctor concludes by proposing that the plant described by him should be named *Galipea officinalis*.

The paper was accompanied by fine native specimens of the bark, leaves, flowers, capsules, and seeds of the plant. The thanks of the Meeting were ordered to Dr. Hancock for this very interesting communication.

XLI. *Intelligence and Miscellaneous Articles.*

TUBES FORMED BY LIGHTNING.

SOME very long tubes, supposed to be formed by the action of lightning, having lately been presented to the Academy of Sciences by Dr. Fiedler; MM. Hachette, Savart and Beudant, attempted to form similar tubes by the action of the electrical machine. The battery was discharged through powdered glass placed in a hole made in a brick: tubes were obtained perfectly similar to those which occur in nature, and which are attributed to lightning, except that they are of dimensions proportional to the means employed in forming them.

In one experiment made upon powdered glass, a tube of about twenty-five millim. in length was obtained; its external diameter, which decreased irregularly from one extremity to the other, is from three millim. to one millim. and a half, and the interior diameter half a millim.

In another experiment, powdered glass was mixed with common salt, and a tube of thirty millim. in length was formed, equally regular both within and without. The mean external diameter is four millim. and a half, and the internal diameter two millim. Two other experiments yielded smaller and less perfect tubes. Experiments made with powdered felspar and quartz did not succeed. It is remarked that the artificial as well as the natural tubes have a brownish layer on the interior; a circumstance which the authors of the experiments find it difficult to explain, unless it depends upon the oxidation of a small quantity of iron.—*Ann. de Chim.* March 1828.

ARTIFICIAL ULTRAMARINE.

M. Guimet, of Toulouse, has succeeded in forming this fine colour: it appears that M. Gmelin has also discovered a process

cess for forming it, and which is given as follows in the *Annales de Chimie* for April last. In giving it, it is to be observed that M. Guimet expresses a doubt whether it will yield the colour at a sufficiently cheap rate; but M. Gmelin asserts that it succeeds infallibly:—Prepare hydrate of silica and hydrate of alumina; the former is obtained by fusing well-powdered quartz with four times its weight of carbonate of potash, dissolving the fused mass in water, and precipitating by muriatic acid; hydrate of alumina is procured by precipitating a solution of alum with ammonia. These two earths are to be carefully washed with distilled water. After this, the quantity of dry earth remaining is to be ascertained, by heating to redness a certain quantity of the moist precipitates. The hydrate of silica which I employed in my experiments, contained in 100 parts 56, and the hydrate of alumina 3·24 parts of anhydrous earth.

Dissolve afterwards, with the assistance of heat, as much of this hydrate of silica as a solution of caustic soda is capable of taking up, and determine the quantity dissolved. Take then for 72 parts of the latter (anhydrous silica), a quantity of hydrate of alumina, which contains 70 of anhydrous alumina; it is to be added to the solution of silica, and the mixture is to be evaporated, with constant stirring, until a moist powder only remains.

This combination of silica, alumina and soda, is the base of the ultramarine, which is to be coloured by sulphuret of sodium; and this is effected in the following manner:—Put into a Hessian crucible, provided with a good cover, a mixture of two parts of sulphur, and one part of anhydrous carbonate of soda; it is to be gradually heated, until at a moderate red heat the mass is well-fused: this mixture is then to be projected, in very small quantities at a time, into the middle of the fused mass; as soon as the effervescence, occasioned by the vapour of water, ceases, a fresh portion is to be thrown in. Having kept the crucible moderately red-hot for an hour, it is to be taken from the fire and suffered to cool.—It now contains ultramarine, mixed with sulphuret in excess, which is to be separated by water. If there be sulphur in excess, it is to be expelled by a moderate heat. If the whole of the ultramarine be not equally coloured, the finer parts may be separated, after having reduced them to a very fine powder, by washing with water.—*Ibid.* April 1828.

MELLITIC ACID.

M. Woehler makes the following statement as to the means of obtaining this acid. I boil the mellite (mellitate of alumina) reduced to fine powder with subcarbonate of ammonia, and crystallize the resulting mellitate of ammonia. This salt is dissolved and precipitated by acetate of lead, and the precipitate is decomposed by sulphuretted hydrogen. Filter and evaporate to the consistence of a syrup; crystallization occurs with difficulty, but a white mass is obtained. This is to be dissolved in cold alcohol, and the solution by spontaneous evaporation, yields groups of stelliform crystals; these crystals have a strong acid taste, are unalterable in the air, and

and dissolve readily in water and alcohol. This acid may be subjected to a high temperature without being decomposed; it does not fuse, but is eventually converted into another acid, which is volatilized, and a coaly residuum. No empyreumatic oil is formed, nor does it even give any smell of burning. Neither sulphuric nor nitric acid acts upon this acid. The substance which Vauquelin supposed to be pure acid, was supermellitate of potash.—*Hensman's Repertoire de Chimie*, Feb. 1828.

ACTION OF ACIDS ON PALLADIUM. BY M. FISCHER OF BRESLAU.

It is well known that palladium is dissolved by cold nitric acid, without the evolution of either nitrous gas or subnitrous acid. This is also the case with mercury, which dissolves in cold colourless concentrated nitric acid. Cold sulphuric acid does not act upon palladium; with the assistance of heat, the acid dissolves it with the evolution of sulphurous acid: the solution is of a reddish yellow, and when it is saturated, it deposits a red powder on cooling; this powder is the neutral sulphate; it is readily soluble in water, to which it imparts a yellow colour. On the undissolved palladium there remains another powder, which is of a deeper colour; this is slightly soluble in water, and is the subsulphate. Cold muriatic acid dissolves palladium, and without the evolution of hydrogen. There is no doubt but that the oxidation of the metal is effected by the oxygen of the air; it does not occur with hot muriatic acid, which is sufficient to prove, that it cannot be derived from any other cause: the vapour which the heat raises preserves the fluid from the contact of the air, and prevents the metal from being oxidized. It is not quite impossible that the solution of the metal in the acid may be effected by the double affinity of the chlorine for the metal, and the hydrogen for the oxygen of the air. More than one extraordinary result, which it is not easy to credit, is effected by this double action; and among others the oxidation of iron by water, the bleaching of linen on meadows, and the dehydrogenation of water by the leaves of plants in the sunshine, are similar phænomena. I had previously observed the solubility of silver in the same acid, owing to a similar cause: the solution of both these metals, necessarily occurs but slowly; it is however sufficiently rapid to be rendered apparent by reagents within twenty-four hours. With respect to the solution of silver, it is sufficient to add water to it to precipitate the *luna cornea*. Muriatic acid therefore dissolves metals which cannot separate the chlorine, and which cannot therefore be the medium through which the decomposition of water is effected. Muriatic acid, as I have satisfied myself by experiment, dissolves in the same manner, and at common temperatures, almost all other metals. Platinum itself saturates aqua regia, upon which it acts in the contact of the air when cold, but the operation goes on very slowly. I ought to mention that in this last experiment I employ a very weak acid.

Phosphoric acid, assisted by long boiling, oxidizes and dissolves palladium, but on cooling, the phosphorous acid which is formed, decomposes

decomposes the salt and reduces the oxide, the metal of which floats on the fluid in the form of a brilliant metallic pellicle.

The solutions of palladium, whether in nitric or in muriatic acid, or in aqua regia, require only a slight excess of acid to possess rather a yellowish brown colour, than a reddish one, with a styptic and metallic taste; they mix with water in all proportions without becoming turbid; when neutral, or with only a slight excess of acid, they are decomposed by water into sub- and super-salts.—*Ibid.*

PREPARATION OF CONIA, THE ALKALI OF THE CONIUM MACULATUM. BY M. BRANDES.

The best method of obtaining this alkali is to digest the fresh herb in alcohol during some days, afterwards evaporating the filtered alcohol, agitating the residuum with water, and treating this mixture either with alumina, magnesia, or oxide of lead; the whole is to be evaporated to dryness, and the residuum obtained treated with a mixture of alcohol and æther, which, when again evaporated, leaves the *conia*. This substance, which was discovered and also named by M. Peschier, possesses very marked alkaline properties. According to M. Giseke, the aqueous solution forms, with the tincture of iodine, an abundant reddish precipitate; it renders tincture of galls slightly brown, precipitates muriate of zinc and nitrate of mercury of a dirty yellow; renders carbonate of potash and soda slightly turbid; gives a brown colour to muriate of platina; and produces a white precipitate with the nitrates of silver and barytes, the acetates of barytes and lead, muriate of lime and lime-water.

Half a grain of conia is sufficient to kill a rabbit; the symptoms which occur resemble those produced by strychnia.—*Ibid.*

ON PYROPHORUS.

M. Gay-Lussac, in forming this substance, used calcined lamp-black instead of honey or flour, usually employed. Potash-alum heated with this form of carbon, gave at first carbonic acid and sulphurous gas, and nearly in equal volumes; afterwards carbonic acid was obtained nearly pure, and at last it was mixed with oxide of carbon, and this eventually prevailed. The pyrophorus so formed burnt readily. M. Gay-Lussac is of opinion that carbon is not necessary to the combustion: he made a mixture of nearly 75 parts of alum, and 3·33 of lamp-black, or 1 atom of the former and 3·5 atoms of the latter; and this mixture, when calcined, at nearly a white heat, gave a reddish-brown product, containing no traces of carbon, but it burnt very readily, and left a grayish-white residuum. Alum is not essential to the preparation. Sulphate of magnesia produces the same effect; sulphuret of potassium alone does not, however, inflame spontaneously in mass; and it occurred to M. Gay-Lussac, that alumina or magnesia acted merely by dividing the sulphuret; that this was the case was proved by substituting charcoal for them, and though the compound obtained, by using 27·3 of sulphate of potash, or 1 atom and 7·5 of lamp-black, or 4 atoms agglutinated

agglutinated and did not inflame; yet, on using double the quantity of lamp-black, the pyrophorus obtained was extremely pulverulent, and was astonishingly inflammable, so much so as to be almost dangerous.

This pyrophorus yields no sulphurous acid during combustion; when put into water, it gives no hydrogen, showing that there is no uncombined potassium; and when the solution is treated with an acid, sulphuretted hydrogen is evolved, and sulphur precipitated. Unlike common pyrophorus, it does not require moist air for its combustion: the charcoal does not appear to be in a state of combination, for the aqueous solution of the pyrophorus is not distinguishable from that of sulphuret of potassium, made without charcoal; and this latter substance is so readily deposited in the vessel, as not to indicate that state of minute division which is characteristic of previous combination.

The new pyrophorus, compared with the common, appears to owe its greater inflammability to several causes: to its more minutely divided state, the absence of inactive earthy matter, and also to the smaller proportion of sulphur. Sulphate of soda, used in equivalent proportion, produces nearly the same effect as sulphate of potash; but sulphate of barytes did not at all answer. M. Gay-Lussac is of opinion that the action of potassium depends essentially upon the great combustibility of sulphuret of potassium, and its action upon water and air: alumina and magnesia appear only to divide the combustible matter; but charcoal being itself combustible, is not passive in the phænomena; the combustion having once commenced, it supports it. A very high temperature did not appear to alter the inflammability of the pyrophorus, provided that, during the cooling, the air was carefully excluded.—*Ann. de Chim.* April 1828.

Note.—Although we are by no means disposed to undervalue the facts contained in the above statement, yet it will appear from the following quotation from Dr. Thomson's System of Chemistry, vol. ii. p. 541, that one of the principal of them does not possess all the novelty which the author appears to suppose belongs to it. "Scheele proved that alum deprived of potash is incapable of forming pyrophorus, and that sulphate of potash may be substituted for alum."

R. P.

EFFECT OF EBULLITION UPON CUPREOUS SALTS.

It has been stated by Celin and Taillifert, that when blue or green carbonate of copper is boiled in water, it retains its carbonic acid, although it becomes black and anhydrous. On repeating these experiments, M. Gay-Lussac found that the black powder is mere anhydrous oxide of copper, and does not retain any carbonic acid. If the boiling be stopped as soon as the carbonate becomes black, then the product effervesces on the addition of acids; this is derived from the presence of some remaining carbonic acid. Acetate of copper suffers similar decomposition by the same process.

BORURET OF IRON.

M. Lassaigne gives the following directions for preparing this compound:—Prepare a sub-borate of iron by precipitating persulphate of iron by borax; wash and dry the precipitate, form it into a paste with water, and mould it into a small cylinder; when dry, place this cylinder within a porcelain-tube, heat it red-hot, and pass pure dry hydrogen over it. Boruret of iron is formed; it acts slightly upon the magnetic needle, and consists of 77·43 of iron, and 22·57 of boron, or of one atom of each nearly.—*Institution Journal,* July 1828.

VARIETIES OF BORAX.

M. Payen gives the following as the results of his analysis of crystallized boracic acid, anhydrous, prismatic, and octohedral borax,—oxygen being 10.

Crystallized Boracic Acid.

One atom acid	44
Three atoms water	33·73
	77·73

	Anhydrous Borax.		Prismatic Borax.		Octohedral Borax.	
Boracic acid	2 atoms	88	2 atoms	88	2 atoms	88
Soda	1 atom	39·09	1 atom	39·09	1 atom	39·09
Water			10 atoms	112·43	5 atoms	56·217
		127·09		239·52		183·307

Ibid.

FIGURE OF THE CELLS OF THE HONEYCOMB.

We are indebted to our correspondent M. Fayolle, for directing our attention to a paper on this subject by the celebrated Maclaurin, in the Philosophical Transactions for 1743. It appears from the notice which M. Fayolle has communicated to us, that Fontanelle, the Secretary of the *Academie des Sciences,* in concluding the account of Kœnig's paper read before that learned body in 1739, as mentioned by Mr. Sharpe in his paper on the subject, at p. 20 of our present volume, makes the following remark:—"La grande merveille est que la détermination de ces angles passe de beaucoup les forces de la geómétrie commune, et n'appartient qu'aux nouvelles methodes fondées sur la théorie de l'infini."

Maclaurin observes in the memoir in question, "Mr. de Reaumur has informed us (*Mém. sur les Insectes,* tom. v.), that Mr. Kœnig having, at his desire, sought what should be the quantity to be given to this angle, in order to employ the least wax possible in a cell of the same capacity; that gentleman had found, by a higher geometry than was known to the ancients, by the method of infinitesimals, that the angle in question ought in this case to be of 109° 26′. And we shall now make it appear, from the principles of common geometry, that the most advantageous angle for these *rhombuses* is indeed, on that account also, the same which results from the supposed equality of the three plane angles that form the above-mentioned solid ones." He then proceeds to demonstrate, by a method purely geometrical, that "the angle of the *rhombus* of the best form is that of 109° 28′ 16″;" precisely the result obtained by Mr. Sharpe by the use of the fluctional theorem *de maximis et minimis.*

MR. BUCHAN'S EXPERIMENTS ON THE AMALGAMATION OF SILVER-ORES.

Some very interesting experiments have lately been made upon the process of amalgamating the ores of silver in Mexico, by Mr. Buchan, at the Haciendas of Real del Monte. Considerable obscurity has prevailed as to the mode in which the decomposition of the various substances is brought about, and the silver detached from its combination with sulphur, so as to be in a state to be acted upon by the quicksilver.

Descriptions of the mode of conducting the operations of amalgamating in Mexico, will be found in the works of Humboldt; in the Selections relating to Mexico, by Taylor; and in Capt. Lyon's Journal.

The ores are mingled at first with a mixture of muriate of soda, calcined copper, and iron pyrites, called *magistral;* the mass in a short time heats, and decomposition goes on; after which, quicksilver is incorporated with it. If the heat generated be greater than experience has shown to be favourable to the proper effect, it is checked by the addition of lime.

The use of the magistral has not been hitherto clearly explained: from the mode in which it is prepared, it may be supposed to consist, as Humboldt states, of the sulphates of iron and copper; and the property of heating the mass has been attributed to these salts.

Mr. Buchan has found that the magistral contains a certain quantity of free sulphuric acid, and that it is esteemed good very much in proportion to this quantity. He has also exposed ores to amalgamation, substituting dilute acid for the magistral; and the effect, as far as the process had been conducted, was similar to that produced by the usual mode.

It is possible that the oxides in the magistral, particularly that of iron, may have important uses in the later stages of the operation; but as the magistral, in some of the mining districts in Mexico, is obtained at great expense only, it is probable that its use may be superseded with advantage, when further experiments have been made; and, at any rate, the researches of Mr. Buchan will probably throw much light on this obscure subject, which may lead to important results.

ACCOUNT OF A CHEAP AND EASILY-CONSTRUCTED BAROMETER FOR MEASURING ALTITUDES, &c. BY MR. J. OTLEY.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

Observing in a late Number of the Philosophical Magazine*, a proposal by Mr. Nixon for determining the heights and dip of strata by barometric observations, I take the liberty of offering a description of an instrument I have lately constructed, which, I think, particularly

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* See Phil. Mag. and Annals, N. S. vol. iii. p. 11.

ticularly applicable to that purpose, as well as to the measurement of any elevation where a barometer can be employed.

I procured a straight barometer-tube thirty-three inches in length, and also a bottle one inch in diameter, and the same in depth. In one side of this bottle, near the top, I bored a small hole; and having filled the tube with mercury, and the bottle rather more than half full, I inserted and cemented the tube into the neck of the bottle, with its open end a little below the middle; so that in every position the opening was covered with mercury.

I then fitted the whole into a casing of wood, the tube, for twenty-five inches of its length, being imbedded level with the surface; the upper end opposite the scale, for the length of eight inches, being fully exposed. The divisions of the scale denoting inches and tenths, are reduced a little, to compensate for the variation of the surface of the mercury in the cistern. For a vernier, I took a very thin piece of silver, the length of eleven divisions of the scale, and breadth something more than half the circumference of the tube; this divided into ten parts by lines quite across, except a small space for the figures, and bent so as to embrace the tube with a gentle elastic pressure, is made to slide as freely as required: the lines of the scale being reflected from the surface of the silver, afford great assistance in observing the coincidence, dividing the inch very accurately into an hundred parts; and a figure in the third place of decimals may be estimated by the eye. The lower part of the case being secured by a piece of thin brass plate, with a bottom projecting in front beyond the diameter of the bottle, I fit a wooden cover, the whole length of the instrument, with two pins to pass into corresponding holes in the bottom-plate: a bit of soft leather is placed so as to press on the mouth of the hole in the bottle, and the case being made a little taper, is easily kept close by a slight hoop of leather.

This barometer, with a moderate degree of precaution, is sufficiently portable, and very ready in use; it requires no other preparation for an observation than merely to hang it perpendicularly, and take off the cover: the air having immediate access to the surface of the mercury in the cistern, renders it more satisfactory than those in which it has to pass through the pores of the wood, and where the surface of the mercury cannot be seen; and less troublesome in use, with less risk of error, than others, in which it has to be adjusted by a screw for every observation.

If a due proportion is attained in the divisions of the scale, and proper attention paid in taking a mean observation at each station, to obviate the effects of the friction unavoidable in small tubes, I am convinced that it will be found as accurate as any barometer of the same dimensions, although of a far more elaborate and expensive construction.

Keswick, Aug. 7th, 1828. I am, &c. J. OTLEY.

NUMMULITES IN THE GREEN-SAND FORMATION.

In a note inserted in the third volume of the *Mémoires de la Société*

Société Linnéenne de Normandie, M. Elie de Beaumont, describing the environs of Martigues (Bouches du Rhône), mentions the occurrence of nummulites, in rocks which he refers to the green-sand formation, and states that the same strata contain, besides Hippurites, gryphites, terebratulæ, &c. the *Cucullea carinata*, a fossil whose analogue also is found in the ferruginous and green-sands of Saint-Ils, near Castellane (Basses Alpes), the barns of Bellevue, near Uchaux (Vaucluse), at Brousseval, near Vassy (Haute Marne), and at the mountain of St. Catharine, near Rouen: they also contain a trochus, or Pleurotoma, and a Melania, or Phasianella, whose analogues exist in the green-sand of England and Normandy. Following up these strata, he found at Gignac, gryphites, Cuculleæ, and Spatangus, known to belong to the green-sand; and near Pennes, on the road to Marseille, Milliolites, Spatangus, Cucullea, Trigonia, Pecten (*Pecten quinque-costatus*), equally known to belong to the green-sand.

Mr. De la Beche, in a late examination of the environs of Nice and of the neighbouring coast, also found an abundance of nummulites in rocks which he refers to the green-sand; in this case they are sometimes mixed in the same beds with gryphites, and constitute a subordinate portion of a formation in which are discovered *Ostrea carinata*, turrilites, inoceramus, ammonites, nautili, terebratula, dolium, echinites, &c.

This nummulitic green-sand, which *cannot* be referred to any member of the tertiary series, the calcaire grossier for instance, though this latter contains both nummulites and green grains, is a rock very extensively distributed over the Alps; of the calcareous portion of which it constitutes a considerable part, forming the summits of many lofty mountains.

FOSSIL HERBIVOROUS REPTILES.

In a late communication from Dr. Jæger of Stutgard, to Mr. Mantell of Lewes, the learned Professor states that he has discovered in the *Keuper-sandstein* the remains of two species, if not genera, of herbivorous reptiles: the one having lateral teeth of a cylindrical, and the other of a cubical form; the latter possessing lateral eminences somewhat similar to the teeth of the Iguanodon. Dr. J. expresses his intention of publishing figures and descriptions of these interesting remains in the course of the year.

SOLAR SPOTS.

The two large solar spots described in the last Number of the Phil. Mag. and Annals, came on the sun's eastern limb again between the hours of 7 and 10 A.M. on the 10th of July, with the same contracted and linear appearance as when they went off early in the morning of the 26th of June. At sunset on the 10th of July, they were a little more defined, and somewhat enlarged in the central part of the black lines which formed their nuclei, but no umbra yet appeared round either of them. At noon of the 12th, the nuclei and umbræ of these spots were elliptical. In the evening of the 16th, the upper-per spot showed its nearest position to the sun's centre, with very nearly the same solar latitude as before given, and was quite circular, but not so large as it was last month by one-third of its diameter. At this time the lower spot had become irregular in shape, and was divided into two in one umbra; on the 18th into three, and on the 19th into four distinct spots in the same umbra, with little variation in its shape or size, but which on the 21st had become more faint, and the small spots decreased. At noon of the 22nd, the spots had approached near the sun's western limb in the usual contracted state, and at 7 P.M. they were, as nearly as could possibly be ascertained from a correct drawing, in the same position on the sun's disc as at noon on the 25th of June, making the time of their revolution 27 days and 7 hours.

The spot which had divided went off in the morning of the 23rd, and the upper one slid behind the sun's western limb at 2 P.M. the same day, forming a little indentation thereon about a quarter of an hour. The upper spot, which has been on the sun's disc since the 20th of May, is diminished in size, and growing faint; and the lower one, which has been on more than forty days, is more faint; therefore it is doubtful whether they will last another revolution: but should they continue on so long, an opportunity may be afforded of ascertaining the precise time of their revolution with still greater accuracy, as it is only by repeated revolutions of the same spot or spots, that this circumstance can be correctly known, in consequence of the many difficulties and obstacles that generally occur in making observations of this sort.

LIST OF NEW PATENTS.

To A. Bernhard, of Finsbury-square, for his method of raising water.—Dated the 24th of July 1828.—6 months allowed to enrol specification.

To R. Wornum, of Wigmore-street, for improvements on upright piano-fortes.—24th of July.—2 months.

To J. C. Daniell, of Lumphey Stoke, Wiltshire, for certain improvements applicable to the manufacturing and preparing of woollen cloth.—5th of August.—6 months.

To J. L. Higgins, of Oxford-street, Esq. for his improvements on wheel carriages.—11th of August.—6 months.

To W. Mencke, of Park Place, Peckham, Surrey, for his improvements in preparing materials for, and in the making, bricks.—11th of August.—6 months.

To L. R. Fitzmaurice, of Jamaica Place, Commercial Road, Middlesex, for his improvements on ship- and other pumps.—11th of August.—6 months.

To W. Grisenthwaite, of Nottingham, Esq., for a new process for making sulphate of magnesia, common called Epsom Salts.—11th of August.—6 months.

To H. Maxwell, of Pall Mall, for an improvement in spring spur-sockets.—13th of August.—2 months.

To T. Stirling, of the Commercial Road, Lambeth, for improvements on filtering apparatus.—16th of August.—6 months.

To B. M. Payne, of the Strand, scale-maker, for improvements on weighing-machines.—18th of August.—6 months.

To E. Barnard, of Nailsworth, near Minchinhampton, Gloucester, for improvements in weaving and preparing cloth.—19th of August. —6 months.

To P. Foxwell, W. Clark, and B. Clark, all of Dye House Mill, Minchinhampton, Gloucester, for improvements in machinery for shearing and finishing woollen and other cloths.—19th of August.—6 months.

To W. Sharp, of Manchester, for improvements in machines for spinning or roving of cloth, silk, wool, &c.—19th of August.—6 months.

METEOROLOGICAL OBSERVATIONS FOR JULY 1828.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·03 July 31. Wind W.—Min. 29·24 July 20. Wind S.E.
Range of the index 0·79.
Mean barometrical pressure for the month .... 29·711
Spaces described by the rising and falling of the mercury............ 4·220
Greatest variation in 24 hours 0·430.—Number of changes 30.
Therm. Max. 82° July 3. Wind S.W.—Min. 47° July 29. Wind N.W.
Range 35°.—Mean temp. of exter. air 65°·55. For 31 days with ☉ in ♋ 66·37
Max. var. in 24 hours 25°·00—Mean temp. of spring water at 8 A.M. 54°·15

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the evening of the 21st .... 92°
Greatest dryness of the air in the afternoon of the 29th.............. 41
Range of the index.. 51
Mean at 2 P.M. 53°·5 —Mean at 8 A.M. 61°·1—Mean at 8 P.M. 67·2
—— of three observations each day at 8, 2, and 8 o'clock......... 60·6
Evaporation for the month 3·70 inches.
Rain near ground 3·405 inches.
Prevailing wind, S.W.

Summary of the Weather.

A clear sky, 2½; fine, with various modifications of clouds, 15; an overcast sky without rain, 8½; rain, 5.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus
26	17	30	0	27	27	26

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
2	0	½	4	2½	12	5	5	31

General Observations.—This month has presented a series of showery and windy weather, which was often attended with lightning and thunder; but it was very fine at intervals, and favourable to the growing corn, fruits, and grass-lands. In the North of England the rain has often been very heavy.

The wheat in this neighbourhood formed into ears the first week in June, and the harvest commenced the last week in July. It is generally short in ear, but thick and clean, and likely to produce average crops, notwithstanding the winter floods and a cold spring. The barley and oats have a promising appearance for larger crops, and will soon be fit to cut.

At

At half-past 8 o'clock in the evening of the 3rd instant, the clouds assumed a black electrical aspect, and the lightning and thunder gradually came on as they united by means of crossing currents of wind from S.W. by W. and S.E. From that time till sunrise the following morning, when the S.E. wind ceased to blow, the lightning was almost incessant, the flashes frequently amounting to 12 or 15 in a minute, and the streams of electric fluid presented themselves in almost every geometrical form, accompanied with light showers of rain at intervals. So much lightning from the passing clouds has not been observed here at any time since the night of the 28th of July 1814, when it was nearly similar in appearance for the same space of time. In the nights of the 7th and 8th we had vivid sheet lightning, and lightning and thunder in the afternoon of the 14th, which were produced by means of two winds crossing at right angles, and the consequent inosculation of the clouds. From the 26th of June to the 18th of July, the summer cockchafers were very numerous during the evening twilight: and for two or three years past a great number of the species of the *Melolontha solstitialis* has also appeared in the evenings of June and July, and are considerably smaller than those that generally come in May.

The mean temperature of the external air this month is about one degree and a half higher than the mean of July for the last twelve years.

The atmospheric and meteoric *phænomena* that have come within our observations this month, are one lunar and nine solar halos, one meteor, one rainbow, lightning and thunder on three different days; and eight gales of wind, namely, one from the South-east, two from the South-west, three from the West, and two from the North-west.

REMARKS.

London. — July 1. Very fine. 2. Overcast in morning; fine. 3. Very fine; sultry with heavy thunder storm at night. 4. Cloudy and warm. 5. Very fine. 6. Cloudy with showers. 7. Fine. 8. Sultry with thunder, and slight rain at night. 9. Showery: heavy rain at night. 10. Showery morning: fine. 11. Cloudy. 12. Heavy rain. 13. Showery. 14. Sultry with much thunder. 15. Showery. 16, 17. Fine. 18, 19. Showery. 20. Rainy, with thunder. 21. Fine morning: rain at night. 22. Showery. 23. Showery, with thunder. 24. Cloudy, with showers. 25. Fine morning: showery. 26. Cloudy, with showers. 27. Showery. 28. Very fine. 29. Showery. 30. Fine. 31. Very fine.

Boston. — July 1—4. Cloudy. 5—7. Fine. 8, 9. Rain. 10. Stormy. 11. Fine. 12. Rain. 13. Stormy and rain. 14. Fine: rain A.M. and P.M. 15. Rain. 16. Cloudy. 17. Rain. 18. Cloudy: thunder and lightning, with rain P.M. 19. Cloudy. 20. Cloudy: rain P.M. 21. Cloudy. 22—24. Fine. 25. Rain: heavy rain. 26. Cloudy. 27. Rain. 28. Fine: rain at night. 29. Fine: thunder, hail, and rain, P.M. 30. Rain. 31. Cloudy.

"The quantity of rain fallen in the last month exceeds that of any other month from the commencement of my observations in August 1823, by three inches and eighty-four hundredths. The greatest fall of rain, except as above, that I ever noticed was in September 1826. The rain-gauge in that month indicated a fall of 4·18.—The average height of the Barometer is only 29·15."—S. V.

Penzance.—July 1. Fair: rain. 2. Fair: showers. 3. Rain. 4, 5. Fair. 6. Clear. 7. Fair: rain. 8. Fair. 9. Rain: fair. 10. Fair. 11. Fair: rain. 12. Clear. 13. Clear: showers. 14. Fair: showers. 15. Showers. 16. Fair: showers. 17. Fair: rain. 18. Fair: showers. 19, 20. Clear: showers. 21. Fair: showers. 22. Fair. 23. Misty rain. 24. Rain. 25, 26. Fair: showers. 27. Fair: clear. 28—30. Clear. 31. Fair.

Meteorological Observations made at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1828.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost. 8½ A.M.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.										
July 1	29·927	29·901	29·90	29·86	29·90	29·90	29·27	74	62	68	60	77	63	68·5	SW.	SW.	SW.	W.	...	...	0·225	0·015	...
2	29·901	29·866	29·84	29·84	29·90	29·86	29·21	76	62	70	60	79	63	69	SW.	SW.	SW.	W.	...	...	·140	·010	...
3	29·902	29·849	29·84	29·80	29·90	29·86	29·18	84	64	68	62	82	64	70	S.	SW.	SW.	W.	0·35	0·78	·330	·080	...
☾ 4	29·860	29·827	29·76	29·75	29·86	29·83	29·07	79	62	70	64	76	64	72·5	SW.	W.	SW.	W.	...	...	·160	...	...
5	29·871	29·853	29·76	29·76	29·87	29·82	29·15	77	56	70	59	73	59	68·5	SW.	W.	SW.	W.	...	...	...	...	...
6	29·879	29·875	29·85	29·85	29·87	29·87	29·17	74	55	71	57	72	58	68	SW.	NW.	SW.	W.	·65	·06	...	...	...
7	29·887	29·796	29·75	29·68	29·84	29·73	29·25	77	58	68	60	77	61	67	SE.	SE.	SE.	W.	...	...	...	·010	...
8	29·697	29·578	29·65	29·65	29·66	29·58	29·13	82	61	70	58	77	62	66·5	E.	SE.	SE.	E.	...	·08	·320	·040	0·19
9	29·642	29·512	29·75	29·70	29·60	29·52	28·96	69	54	65	58	78	58	62	S.	N.	W.	NE.	·40	·57	·700	·380	·03
10	29·921	29·745	29·95	29·90	29·90	29·70	29·10	76	56	67	57	75	62	57	SW.	NW.	W.	NW.	...	·02	...	·005	1·23
11	29·981	29·848	29·95	29·85	29·96	29·82	29·40	72	58	65	57	78	59	67·5	S.	W.	SW.	W.	...	·18	·510	·290	...
● 12	29·519	29·483	29·75	29·75	29·54	29·53	29·00	65	54	65	54	72	55	62·5	S.	NW.	NW.	calm	·25	·75	...	·020	·56
13	29·539	29·459	29·75	29·75	29·55	29·53	28·65	65	51	64	55	70	56	57	SW.	NW.	W.	W.	...	·04	...	...	1·78
14	29·531	29·501	29·74	29·65	29·55	29·51	28·95	69	50	64	53	72	52	59	SW.	NW.	SW.	W.	...	...	·180	·280	·03
15	29·596	29·487	29·70	29·65	29·52	29·46	28·92	72	47	66	54	72	52	57	SW.	NW.	SW.	NE.	·25	·05	·130	·140	·78
16	29·788	29·753	29·80	29·75	29·77	29·72	29·22	76	56	65	53	77	60	64	SW.	SW.	N.	NE.	...	...	...	·070	·26
17	29·761	29·610	29·75	29·70	29·73	29·70	29·15	74	59	67	55	73	63	61·5	SW.	SE.	SW.	SE.	...	...	·330	·010	0·03
18	29·576	29·545	29·48	29·45	29·55	29·51	29·03	72	56	68	59	76	58	65	S.	SW.	SE.	S.	·30	·09	·165	...	·12
19	29·620	29·553	29·50	29·50	29·57	29·51	28·94	70	52	68	54	69	59	63	S.	SW.	SW.	SW.	...	·03	·190	·090	·17
☽ 20	29·398	29·298	29·35	29·30	29·40	29·24	28·87	68	54	68	55	75	58	63	W.	SW.	SE.	S.	...	·47	·300	·330	·04
21	29·521	29·438	29·60	29·50	29·52	29·49	28·91	71	50	67	56	72	53	60·5	NW.	SW.	S.	S.	·30	·43	...	·740	·43
22	29·654	29·568	29·75	29·65	29·63	29·50	28·95	72	54	68	56	69	55	62	W.	W.	W.	W.	...	·08	·200	·140	·28
23	29·701	29·683	29·75	29·74	29·70	29·67	29·10	74	57	67	57	70	59	66	W.	SW.	SW.	W.	...	·33	·200	·470	·03
24	29·644	29·592	29·70	29·65	29·60	29·54	29·10	72	58	67	57	74	60	64	SW.	SW.	S.	NW.	·20	·12	·090	·240	...
25	29·636	29·569	29·64	29·56	29·62	29·54	28·95	72	54	66	57	73	58	62	W.	W.	W.	NW.	...	·07	·120	...	1·33
○ 26	29·763	29·719	29·74	29·72	29·73	29·70	29·18	70	51	65	57	74	52	60·5	W.	W.	SW.	E.	...	·10	·260	·015	·04
27	29·905	29·804	29·95	29·84	29·84	29·76	29·22	67	52	65	52	72	54	58	NW.	NE.	NW.	NW.	·45	·08	...	...	·43
28	30·017	29·943	30·05	30·04	30·00	29·94	29·50	72	51	64	54	70	53	59	N.	NE.	N.	N.	...	...	...	...	·06
29	29·895	29·873	30·05	30·04	29·91	29·86	29·40	70	43	62	53	70	47	57·5	NW.	N.	NW.	NW.	...	·05	...	·030	·11
30	29·947	29·882	30·04	30·04	29·96	29·93	29·40	64	45	62	50	67	48	52	W.	N.	NW.	NW.	...	...	...	...	·09
31	30·012	29·958	30·05	30·03	30·03	29·98	29·54	74	53	67	51	71	57	56	NW.	W.	NW.	calm	·55	...	...	...	...
Aver.:	30·017	29·298	30·05	29·30	30·03	29·24	29·15	84	43	71	50	82	47	62·7					3·70	4·38	4·550	3·405	8·02

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

OCTOBER 1828.

XLII. *On the Method employed in the Trigonometrical Survey for finding the Length of a Degree perpendicular to the Meridian.* By J. Ivory, *Esq. M.A. F.R.S.*[*]

IN the first volume of the Trigonometrical Survey, a method is given for finding the difference of longitude of two stations lying nearly in the same parallel of latitude, without assuming that the earth has any particular figure, and supposing only that it is nearly a sphere[†]. An important part of the Survey depends upon this method; and, although its accuracy has heretofore been called in question, yet we see from the late volumes of the Phil. Trans. that it is now deemed sufficiently exact and unexceptionable in its principle. It is however remarkable, that this method has never succeeded in practice, or rather, has in every case led to results evidently wide of the truth. This failure it is usual to ascribe to errors in the observed azimuths; but we may reasonably doubt whether this be the sole cause of deficiency, when we observe that the difference of longitude of the two stations, computed by other modes of solution unquestionable in point of accuracy, is always found to depend on the compression of the spheroid. The method of which we are speaking, was first published in the Phil. Trans. for 1790 and 1795; it is therefore time to subject to a strict examination a process which, although it has never been of any utility, is still employed in practice; and as I have thrown out some doubts about the grounds of it in this Journal for May last, I deem it incumbent on me to ascertain fully its real character.

Let λ and m denote the latitude and azimuth at the first station; λ' and m' the same things at the second station;

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[*] Communicated by the Author.

[†] Trigonometrical Survey, vol. i. pp. 154, 293.

γ the rectilineal distance of the two stations, or the chord between them; ω the difference of longitude; a the equatorial semidiameter, and e the excentricity of the elliptical meridians. Further, let ϕ stand for the angle of depression of the chord below the horizon of the first station: then $\gamma \sin \phi$ will be the perpendicular drawn from the second station upon the horizon of the first; and the distance of this perpendicular from the plane of the meridian of the first station, to which plane it is parallel, will be equal to $\gamma \cos \varphi \sin m$, because the azimuth m is the angle which the projection of the chord upon the horizon makes with the meridian. Now let x be the distance of the second station from the polar axis of the spheroid: then, ω being the angle between the two meridians, it is obvious that the distance of the second station from the plane of the meridian of the first, will be equal to $x \sin \omega$; and in consequence of what was before proved, we shall have this equation,

$$x \sin \omega = \gamma \cos \varphi \sin m.$$

Next let R be the radius of a sphere which passes through both the stations, and touches the horizon of the first: then,

$$\text{Sin } \phi = \frac{\gamma}{2\text{R}}, \ \cos \varphi = \sqrt{1 - \frac{\gamma^2}{4\text{R}^2}}.$$

If we conceive a plane to bisect the chord γ at right angles, this plane will cut off from the normal to the earth's surface at the first station, a part equal to the line R. Therefore R, like the radii of curvature of the spheroid, will always be little different from a, the semidiameter of the equator; and since γ is always a small part of R, or of a, we may substitute a for R in the expression of $\cos \varphi$, without danger of introducing a sensible error in any case that can occur in practice. We have likewise, from the nature of the elliptical spheroid, $x = \frac{a \cos \lambda'}{\sqrt{1-e^2 \sin^2 \lambda'}}$; and thus we get,

$$\frac{\cos \lambda' \sin \omega}{\sqrt{1-e^2 \sin^2 \lambda'}} = \frac{\gamma}{a} \sqrt{1 - \frac{\gamma^2}{4a^2}} \times \sin m.$$

Now, put $\sin \frac{\beta}{2} = \frac{\gamma}{2a}$; then,

$$\frac{\gamma}{a} \sqrt{1 - \frac{\gamma^2}{4a^2}} = 2 \sin \frac{\beta}{2} \cos \frac{\beta}{2} = \sin \beta;$$

and the last formula will become,

$$\frac{\cos \lambda' \sin \omega}{\sqrt{1-e^2 \sin^2 \lambda'}} = \sin \beta \sin m.$$

The like reasoning applied to the second station will furnish another similar equation.

Thus

Thus we finally obtain,

$$\left.\begin{aligned}\text{Cos}\ \psi' &= \frac{\cos\lambda'}{\sqrt{1-e^2\sin^2\lambda'}}, \quad \cos\psi'\sin\omega = \sin\beta\sin m,\\ \text{Cos}\ \psi &= \frac{\cos\lambda}{\sqrt{1-e^2\sin^2\lambda}}, \quad \cos\psi\sin\omega = \sin\beta\sin m'.\end{aligned}\right\}\ (x)$$

Suppose now that a spherical triangle is constructed of which the base is equal to the arc β, and the two sides to the arcs $90-\psi$ and $90-\psi'$: I say, that the angle of this triangle opposite to the base β is not sensibly different from ω, the difference of longitude, when the two latitudes are nearly equal; and is exactly equal to it when the two latitudes are equal. In order to prove this, it is to be observed that $a\cos\psi$, $a\cos\psi'$, are the respective distances of the two stations from the polar axis of the spheroid; and $a\sin\psi\sqrt{1-e^2}$, $a\sin\psi'\sqrt{1-e^2}$, are their distances from the plane of the equator. Wherefore, because ω is the angle between the two meridians, we have this expression for the square of the chord, viz.

$$\frac{\gamma^2}{a^2} = (\cos\psi - \cos\psi'\cos\omega)^2 + \cos^2\psi'\sin^2\omega + (1-e^2)(\sin\psi - \sin\psi')^2;$$

or, which is the same thing,

$$\frac{\gamma^2}{a^2} = 2-2(\cos\psi\cos\psi'\cos\omega+\sin\psi\sin\psi')-e^2(\sin\psi-\sin\psi')^2:$$

but $\frac{\gamma^2}{a^2} = 4\sin^2\frac{\beta}{2} = 2(1-\cos\beta)$; and, hence,

$$\cos\beta = \cos\psi\cos\psi'\cos\omega+\sin\psi\sin\psi'+\frac{e^2}{2}(\sin\psi-\sin\psi')^2.$$

Now, from this equation and the relation that is known to subsist between an angle of a spherical triangle and the three sides, it follows that ω may be reckoned equal to the angle of the triangle opposite to the base β, whenever the latitudes are so nearly equal that the term multiplied by e^2, has no sensible value; and when the latitudes are exactly equal, the equality affirmed is rigorously true. But for the greater precision let us inquire, what variation the term multiplied by e^2 will produce in the arc β. For this purpose suppose that β becomes $\beta+\delta\beta$, then,

$$\text{Cos}\ (\beta+\delta\beta) = \cos\psi\cos\psi'\cos\omega+\sin\psi\sin\psi',$$

$$\delta\beta = \frac{e(\sin\lambda-\sin\lambda')}{\sin 1''}.\times\frac{a(\sin\lambda-\sin\lambda')}{\gamma},$$

the true latitudes being written for ψ and ψ', and $\frac{\gamma}{a}$ for $\sin\beta$, in the expression of the small variation. In the instance of Beachy Head and Dunnose, we shall find $\delta\beta = 0''{\cdot}11$, a quantity

tity far below the errors of observation. In this instance, and in all those where this method has been actually used, or where it can be supposed to apply, we may conclude that the angle of the spherical triangle opposite to the base β, is equal to ω, the difference of longitude of the two stations. But in every spherical triangle, the sines of the angles are proportional to the sines of the opposite sides; and hence, on account of the equations (x), we learn that m is the angle of the same triangle opposite to the side $90-\psi'$, and m' the angle opposite to the side $90-\psi$.

Having obtained a knowledge of all the parts of the spherical triangle, if we apply to it one of the analogies of Napier, we shall get,

$$\text{Tan}\ \frac{\omega}{2} = \frac{\cos\frac{\psi-\psi'}{2}}{\sin\frac{\psi+\psi'}{2}} \times \text{cotan}\ \frac{m+m'}{2}.$$

Now this formula is different from the method in the Trigonometrical Survey in no other respect, except that the arcs ψ and ψ', which are what are called the reduced latitudes, come in place of the true latitudes λ and λ'. But as the reduced latitudes depend upon the excentricity of the spheroid, it follows that the difference of longitude is no more independent of the figure of the earth in this mode of computation, than in any other. Because the difference of latitude is very small, we may write $\cos\frac{\lambda-\lambda'}{2}$, or even the radius of the tables, instead of $\cos\frac{\psi-\psi'}{2}$: and I have found, by reducing properly and putting $\varepsilon = \frac{e^2}{2}$,

$$\text{Sin}\ \frac{\psi+\psi'}{2} = \sin\frac{\lambda+\lambda'}{2} \times \left(1-\varepsilon\cos^2\frac{\lambda+\lambda'}{2}\right).$$

The foregoing expression will now become

$$\text{Tan}\ \frac{\omega}{2} = \frac{\cos\frac{\lambda-\lambda'}{2}}{\sin\frac{\lambda+\lambda'}{2}} \times \text{cotan}\ \frac{m+m'}{2} \times \left(1+\varepsilon\cos^2\frac{\lambda+\lambda'}{2}\right);$$

or, in logarithms,

$$\text{Log tan}\,.\ \frac{\omega}{2} = \log\left(\frac{\cos\frac{\lambda-\lambda'}{2}}{\sin\frac{\lambda+\lambda'}{2}} \times \text{cotan}\ \frac{m+m'}{2}\right) + M\varepsilon\cos^2\frac{\lambda+\lambda'}{2}.$$

This, then, is the formula by which we must compute the difference of longitude on a spheroid of which ε is the compression; and if we make $\varepsilon = 0$, it will coincide with the method in in the Trigonometrical Survey, and will give the difference of longitude on a sphere.

But even the correct expression of the difference of longitude, which we have here investigated, has a disadvantage that makes it improper to be applied in practice; namely, the result is always affected with the sum of the errors of the two azimuths, which is likewise heightened by the divisor of the formula. In the instance of Beachy Head and Dunnose, we have

$$\lambda = 50° 44' 21'', \qquad m = 96° 55' 58''$$
$$\lambda' = 50\ 37\ \ 5 \qquad m' = 81\ 56\ 53:$$

and with these data, the difference of longitude will be found equal to,

$$1° 26' 54''\cdot76.$$

Now I have computed the three following values of the same difference of longitude from independent data; one, by the formula (A) at p. 190 of the last Number of this Journal, which is independent of the azimuths; and two, by employing the formula (B) at p. 191, combining the azimuth at one station with the latitude of the other, the result not being sensibly affected in this mode of computation by any probable error in the azimuth; viz.

$$\begin{array}{lll} 1° & 27' & 5''\cdot62 \\ 1 & 27 & 5\cdot63 \\ 1 & 27 & 5\cdot61 \end{array}$$

It appears therefore that the result obtained by the formula investigated in this article is in defect about 11'', which can only arise from an error of about 9'' in the sum of the azimuths.

J. Ivory.

XLIII. *Some Remarks on an Article in the* Bulletin des Sciences Mathematiques Physiques et Chimiques, *for March* 1828. *By* J. Ivory, *Esq. A.M. F.R.S. &c.*[*]

IN the *Bulletin des Sciences Mathematiques Physiques et Chimiques* for March last, there is an article relating to the papers inserted in this Journal, which treat of the attraction of spheroids and the figure of equilibrium of a homogeneous planet in a fluid state. The remarks of the author on the opinions I have ventured to advance on these subjects, seem to call for some notice from me, which I shall study to make as brief as possible.

With regard to the attraction of spheroids, the usual ground of the dispute is shifted. The controversy has hitherto been confined to the law of attraction that prevails in nature; namely,

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[*] Communicated by the Author.

when the exponent of the attractive force is -2; but on the present occasion, the author brings forward the case when the exponent of the attractive force is negative and greater than 2. I have no inclination to enter the lists on this new ground; and I am persuaded that whoever will read attentively what is written in the *Bulletin*, will not blame Laplace for departing from the great generality aimed at in the third book of the *Mécanique Céleste*, and in his later writings confining his theory to the single case of an attraction inversely proportional to the square of the distance.

In p. 155, the author proceeds to animadvert on what he calls my new principle of Hydrostatics, which he says has not yet been refuted by any geometer "*d'une manière vraiment scientifique.*" Great was my astonishment on perusing what the author has written, to find that it does not affect in any respect what I have published concerning the equilibrium of a planet in a fluid state. This part of the *Bulletin* is mostly taken up with two demonstrations of the general equation of the level surfaces, or the surfaces of equal pressure, in a fluid mass *in equilibrio*. Now I have nothing to object to these demonstrations. Applied to the case of a homogeneous planet, the meaning of the equation is this: The equilibrium of the planet requires that it be possible to divide the whole fluid mass into any number of strata separated by surfaces of equal pressure, which, beginning at a point within the planet, extend to the outer surface, and are included one within another*. My solution of the problem is so far from being inconsistent with the general equation, or with the equivalent property of the level surfaces, that it is the only general method that has yet been found for rendering the existence of these surfaces demonstrative and certain †.

In the usual theory, and particularly in the theory delivered in the *Mécanique Céleste*, it is affirmed that the perpendicularity of gravity to the outer surface is all that is necessary to insure the existence of the interior level surfaces, their gradual decreasing, and final concurrence in a point. But of this no sufficient demonstration is given; and I contend that none can be deduced from the single principle of equilibrium assumed. I have done nothing more than add a condition which is wanting, without which the problem cannot be solved.

In reference to some of the author's remarks, it is to be observed,

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* See Clairaut, *Figure de la Terre*, Part. i. § xxi.

† In prop. 4th, p. 166 of this Journal for September 1827, it is shown in what manner the general equation of the level surfaces is fulfilled in my solution: and it is proved that, without the condition I have added, the same equation could not be fulfilled, and there would be no equilibrium.

served, that in the investigation published in this Journal for September 1827, there is no mention made of strata infinitely thin, nor of the addition or subtraction of such strata.

After all, the question is not about this or that principle of Hydrostatics, nor this or that theory. The real question is, Whether the investigation I have published, more especially in this Journal as above cited, is, or is not, rigorous and exact; and whether I have been able to deduce, from the supposition that there is an equilibrium, the conditions without which it cannot subsist, and which are sufficient to determine the figure of the fluid. The proper way of answering this question is to examine the solution itself. And as this is the fairest way of deciding the matter, so it is the shortest and the easiest: for the whole investigation is divided into distinct propositions, which hardly occupy three pages of this Journal; and it involves no nice nor intricate point of analysis, which is often introduced because the true principles of the problem have been viewed in an improper light. One thing at least is certain, that M. Poisson has not succeeded in detecting any flaw in my reasoning; and the animadversions of the present critic leave the matter just where it was.

I shall immediately set about reviewing all that I have written on this subject, in order to correct any inaccuracies that may have escaped me, and to clear up any obscurities that may have occurred in taking a new view of a difficult subject. I hope to be able to guard my theory against the objections and attacks to which it has hitherto been liable, in a short work which I will address to the Royal Society; thinking that, amidst the more interesting and fashionable objects that occupy their attention, that learned body will not entirely proscribe a capital part of the philosophy of Newton, which is still very imperfect, notwithstanding the researches of so many philosophers. I have also another reason for making this destination of my work: the Royal Society, as the public promoters of science, have imposed upon them the duty of securing to every one the discoveries he may make.

But the author of the critique in the *Bulletin* is not content with animadverting on what I have done; he is obliging enough to carry his attention to what he supposes I am doing. I assure him, however, that he has been misinformed about the nature of my present occupations, and that he entirely misconceives my views of the equilibrium of a planet of variable density. This problem I have solved long ago; and the result of my investigation has already appeared in this Journal for July 1826. My analysis is not indeed published; because it is too bulky for the pages of this Journal, in which I have been led, from very peculiar circumstances, to communicate what I write to the public. But in the work I have announced, I will treat this subject fully; and my critic will then see how far he is mistaken in supposing that I wished to introduce the consideration of particles attracting at very small distances.

J. IVORY.

XLIV. *On the Construction and Arrangement of the New Berlin Astronomical Ephemeris. By Professor* ENCKE*.

WE observe the bodies of our solar system not from the central point of their motions, but from a point on the surface of the earth which has a double motion about this central point. It would therefore be desirable to learn by the ephemerides the position of the heavenly bodies with respect to three points;—the centres of the sun, and the earth, and the place on the terrestrial surface for which the ephemerides are calculated. The peculiar modifications however, applicable to every body in our system, are such as to leave no more than two points for each of them, for which the more accurate data are requisite. For the planets which are more distant, and which are less regularly observed throughout the whole year, the reduction from the centre of the earth to a definite point of its surface is so simple, that nothing is required to facilitate the calculation; and for the sun and the moon, the relations to the centre of the whole system disappear, being implied with regard to the former, and unnecessary for the latter, whose course is referred only to the earth. In every opening of the book the two pages present, accordingly, for every body of our solar system the polar coordinates with respect to two points; for the moon and the sun, those relating to the centre of the earth and the place on the earth (Berlin) (with respect to the latter point the distances, however, have been omitted, as unnecessary); for the planets and the satellites of Jupiter, the heliocentric and geocentric places, or that which will supply their places. The coordinates which immediately involve the results of the observations are referred to the equator, the others to the ecliptic. The small planets make the only exception to this. The time which is everywhere applied, except where it is expressly mentioned, is mean time. The beginning of the day has been taken at noon, and the hours are counted to 24; so that hours below 12 are those of the afternoon, and the hours above 12 diminished by 12^h are the hours

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* From the New Berlin Ephemeris: being a translation of a portion of the Appendix to that work, as promised in our Number for August, p. 145. —EDIT.

hours of the forenoon of the civil day following the one corresponding to the given hours of the astronomical day. All longitudes, latitudes, right ascensions and declinations, refer to the true or apparent equinox, and the true or apparent position of the different planets, for which Mr. Bessel's determinations of the nutation and obliquity of the ecliptic have been throughout applied. All data have been calculated from the tables without neglecting any one correction, and have been given exactly as resulting from the tables. A main object of these ephemerides has been to save to the astronomer the trouble of the tedious immediate calculations from the tables.

The almanac contains, besides the chronological part and the explanation of the signs, four principal sections; viz. 1. Ephemerides of the sun and moon. 2. Ephemerides of the planets and their satellites. 3. Positions of the stars. 4. Phænomena and objects of observations.

For the sun and the moon every month has six pages, which for the facility of reference have been separately marked with Roman figures, I—VI. The first page contains the data necessary in solar observations. Their epoch is, therefore, the apparent noon at Berlin. After the first two columns, the days of the month and of the week, follows the mean time at the moment of the apparent noon, usually called the equation of time; next, the right ascension of the sun, or the sidereal time at the apparent noon; then the declination accompanied by the column, log. μ (agreeably to Gauss's notation, in the manner of Professor Schumacher's auxiliary tables), which is the log. of the change of declination in 48 hours expressed in seconds of a degree from the preceding noon to the following one, or very nearly the change of declination for 48 hours appertaining to the noon opposite to which it stands in the ephemeris. Lastly, the sidereal time is given which the sun employs in passing over the wire of a transit. The opposite page II. contains the data for the sun which are employed in calculations of the planets. Their epoch is, therefore, the mean noon. The columns of days of the month and of the week are followed by the sidereal time at the moment of the mean noon, which is requisite for reducing an observation made by sidereal time to mean time. Next follow the longitude, latitude and radius vector of the sun. In the former, the aberration has not been applied, so that the given numbers must be immediately used, without any correction, in converting geocentric places into heliocentric ones, and *vice versâ.* Lastly, the semidiameter of the sun is given, which is used in observations of declination.

These data have been derived from the solar tables of Carlini, improved by Mr. Bessel's corrections, which he has had the kindness to communicate to me. The columns of the time of transit and semidiameter of the sun are taken from Bessel's tables. The calculations have been most rigorously executed, and the latitude has been duly taken into consideration in the right ascensions and declinations. We may therefore hope, that, should even new tables of the sun be published before 1830, the calculated positions will not greatly deviate from the true ones.

The following four pages III—VI. contain the positions of the moon. The odd ones III. and V. contain the longitude and latitude, and the right ascension and declination, of the moon for every mean noon and midnight at Berlin. The present arrangement of these columns, in which the data for noon are not separated from those for midnight, as was hitherto usually done, appeared to be more convenient for taking the differences. On the opposite pages IV. and VI. are contained in the first place for the same epochs the horizontal equatorial parallax of the moon which supplies the place of the distance, and the diameter as seen from the centre of the earth. Next follow the three columns which refer to the moment of the moon's culmination at Berlin; viz. the mean time of the moon's superior or inferior culmination, with the right ascension and declination corresponding to that moment, likewise referred to the centre of the earth. The upper and lower culminations are distinguished by the letters O and U.

The two last columns give the times of the sun and moon's rising and setting, designated by the letters A and U. Below the odd pages III. and V. are placed the changes of the moon by mean time; below the even ones, the times of perigee and apogee.

The columns contained on the even pages are intended to facilitate the calculation of the apparent place affected by parallax; this will be treated of more in detail in another place. For this reason the apparently misplaced times of the sun's setting have been here inserted. Those times have besides for astronomers no other essential importance, except as far as the visibility of other heavenly bodies is dependent on them. The moments of the sun and moon's setting are, as always where there is no particular mention, given in mean time.

All the calculations for the moon have been deduced from Burckhardt's tables, from which the later ones of Damoiseau do not appear ever to deviate considerably. The accuracy of the tables of Burckhardt having been much confirmed of late years (in the opinion of a very competent judge), they have as yet been preferred to the others founded more on theory.

For the careful execution of this portion of the work, I am indebted

indebted to the persevering industry of Messrs. Herter, Wolfers, and Deinhardt, who have divided between them the calculation of all the longitudes and latitudes, as well as right ascensions and declinations, immediately from the tables. This being the first considerable astronomical calculation executed by any of these gentlemen, no pains have been spared to discover and to correct all errors by taking the first four differences. Wherever a correction of 0″·5 would bring out more regular differences, the whole calculation has been revised. In a few such cases it was necessary to retain the calculated numbers unchanged; and this quantity may therefore be considered as the maximum of error. Errors of 0″·3, and less, could not be avoided, on account of the great number of equations. The parallax and semidiameter have been put to the same test. The manner of calculating the other columns will be given in another place. This section is concluded by a table in which the apparent obliquity of the ecliptic, the true parallax of the sun, the aberration of the sun's longitude, the equation of the equinoctial points, and the longitude of the moon's node, have been placed together for every tenth day. The aberration is to be added algebraically with the sign given to it to the values contained on page II., in order to obtain the real longitude of the sun, as it will be observed. The sign of the equation of the equinoctial points denotes that the mean equinox is in this year behind the true equinox, or that all mean longitudes are greater than the true ones. The moon's node is given according to Burckhardt.

Next follow the ephemerides of the planets and satellites. For the older planets the page on the left contains the heliocentric places, together with the columns of rising and setting; while that on the right contains the geocentric places, with the passages over the meridian in mean time, the former referred to the ecliptic, the latter to the equator, the right ascension being given in time. For Mercury and Venus the places have been calculated for every other day, and the mean noon at Berlin; for the others they are calculated for every fourth day, and the mean midnight at Berlin.

The calculations for Mercury have been undertaken by Mr. Herter. One of the corrections of the tables of M. Lindenau, first noticed by Professor Schumacher, which refers to the radius vector, has been inadvertently omitted. This trifling neglect affects, however, the last figures only of the radius vector, and seems to lie within the limits of uncertainty of even Lindenau's tables. The fourth differences have likewise been taken in this case, but their magnitudes were in some parts such as to afford no certain criterion of the absolute correctness

ness of the calculation. The places of Mercury might, should it be wished, in future be given for every day of the year.

The calculations for Venus, and the greater part of those for Jupiter and Saturn, have been performed by Mr. Wolfers. For Venus and Mars, the tables of M. Lindenau; for Jupiter, Saturn, and Uranus, the latest tables of Bouvard,—have been used.

The time of passage over the meridian is meant only approximately; the astronomical use of it being supplied by the right ascension in time, which is likewise given. Calling θ the sidereal time at the moment for which the right ascension α has been calculated, the time given in the column, headed "Planet on the Meridian," is

For the superior planets..... $\alpha - \theta$
For the inferior planets...... $12^h + \alpha - \theta$

A corrective factor $= \frac{\text{mean solar day}}{\text{planetary day}}$ ought to have been applied to $\alpha - \theta$; but this factor would not have produced any great change, and if required, its effect may easily be calculated. From the time of passage over the meridian and the declination on that day, the times of rising and setting have been calculated, which are therefore not to be considered as rigorously correct. The times of rising and setting of the heavenly bodies have in general been calculated with due regard to refraction, for which purpose Bessel's horizontal refraction of 36′ has been adopted. For the moon the mean parallax of 57′ has besides been taken into account. The other heavenly bodies are, therefore, in those moments 36′ below, and the moon 21′, above the plane passing through the centre of the earth, and parallel to the horizon.

The four new planets make an exception; for there the geocentric place only is given, together with the auxiliary columns. The form in which their perturbations are calculated, is such that the accurate determination of their places would require more extensive calculations than the possible use renders necessary. In the same manner the determination of their heliocentric places would have caused a change in the form of calculation, which is in no proportion to the possible use which might be made of them. For this reason the elements for the time of the opposition have been rigorously deduced, and then have been retained for the whole year. For each planet, however, more accurate daily positions have been given for the 28 days, within which the moment of opposition is contained.

The perturbations of Pallas, Juno, and Vesta, have been calculated as far as the year 1830. For the first, the elements of Gauss

Gauss have been used; for the second, those of Nicolai; for the third, mine; which will appear in another place. For these three planets the errors will hardly amount to a minute. The planet Ceres, however, whose elements have not been further investigated since M. Gauss last corrected his Elements in the year 1809 (Elements, xiii.), and whose perturbations have not been completely developed, may deviate more considerably. In accordance with the last oppositions, the epoch of mean longitude has for the present been diminished by 14′ for the year 1830. It is to be hoped that this correction will likewise have nearly approximated it to its true position.

All data for the planets have been given, without any regard to aberration and parallax. On account of the former, the given places do not belong, with respect to the actual observations, to the moments 0^h and 12^h, but (calling the geocentric distance of any planet Δ) to those moments (viz. 0^h or 12^h) $+ 493''\cdot 2.\ \Delta$ (time).

With regard to the satellites of Jupiter, which then follow, it was customary to give, besides the eclipses which supply the place of the heliocentric place, a graphical representation of their geocentric position with respect to Jupiter for a certain definite moment. But as their position is thus only obtained for a single moment of time, it has appeared to me that the advantage of an ocular graphical representation is overbalanced by the concomitant want of being deprived of the means of deducing the geocentric position for any other given time. I have therefore preferred giving the time of the superior geocentric conjunction, together with the corresponding ratio of the axes of the apparent ellipsis of the orbit of the satellite, accompanied by the tables of reduction; by means of which, from the time elapsed since the last preceding conjunction, the geocentric coordinates of the satellite, with respect to the centre of Jupiter, may be derived.

It is to be observed that these results have been founded, both as regards the derivation of the superior geocentric conjunction from the heliocentric conjunction and the time of revolution, on which the tables of reduction are founded, on the hypotheses of the mean heliocentric synodic time of revolution of the satellite, and of the perfectly circular form of their orbits, while the true synodic geocentric revolution ought to have been taken. They may, however, should more accurate measurements render it necessary, be corrected without any great trouble. The difference will always be small, and quite insignificant as to inspection.

By this arrangement the observer of eclipses is, at the same time, enabled accurately to determine the place of emersion, on on which account the coordinates for those moments have not been added.

The occultations of the first two satellites are on the page on the left; those visible in Berlin are distinguished by an asterisk (*). On the right hand are contained the times of the superior geocentric conjunction with the corresponding ratio of the axis $\frac{a}{b}$, where a denotes the great, and b the small semi-axis. The sign − signifies that the satellite has in the superior conjunction a southern jovicentric latitude, or that we see the southern part of the plane of the satellite's orbit. The sign + would accordingly denote the visibility of the northern part of it. At the end of the column for each satellite will be found the tables of reduction belonging to it.

Their use may be learnt by the following example. Let it be required to find the position of the two satellites for April 14th, $15^{\mathrm{h}}\ 14'{\cdot}2$; then the next preceding geocentric conjunctions are to be taken together with the value of $\frac{a}{b}$ for the given time.

Sat. I.	April 14.	$13^{\mathrm{h}}\ 53'{\cdot}5$	−63·7
II.	—— 13.	9 57·1	−63·7

These deducted from the given time present the arguments for the tables of reduction

Sat. I.	$0^{\mathrm{d}}\ 1^{\mathrm{h}}\ 20'{\cdot}7$
II.	1 5 17·1

For these we take from the tables

Sat. I.	$x = +1{\cdot}13$,	$y' = +5{\cdot}59$
II.	$= +7{\cdot}55$,	$= -5{\cdot}01$

The latter ones (viz. y') divided by $\frac{a}{b}$ then give, with proper regard to the signs, these positions:

Sat. I.	$x = +1{\cdot}13$,	Sat. II.	$x = +7{\cdot}55$
	$y = -0{\cdot}09$.		$y = +0{\cdot}08$.

Both x and y are expressed in radii of Jupiter; x is the abscissa on the great axis of the ellipsis of the satellite taken positively in the direction of its motion or eastward; y in the direction of the jovicentric latitude, the northern one being positive. In the field of the telescope a positive x will indicate the satellite's position to the right of Jupiter, and a positive y its position to the south of it. It appeared unnecessary to give the angle which the great or small axis forms with a circle of latitude or declination, as the belts of Jupiter sufficiently exhibit the position of the great axis.

For the third and fourth satellites the eclipses have not been given, but instead of them the times of the middle of the eclipses taken in such a manner as if they were visible; and the semi-duration is added in order to reduce to the same form the moments in which no eclipse takes place. The calculation has been executed by M. Wolfers from Delambre's latest tables of the satellites. However well founded M. Hansen's remark respecting the incorrectness of the table of equation C for the first satellite may be, yet it was preferred to retain this table unchanged, partly because some other corrections in the preface likewise require amendments, partly because it is doubtful whether Delambre has not compared the observations with tables which contained the same small deviations. At any rate the difference will seldom amount to 1″ for the first satellite, and for all the others it will always be within this limit. The last page of this section contains the elements for the geocentric form of the ring of Saturn, with the explanation of the notation. For the node and inclination, Bessel's paper in the *Astron. Jahrbuch* for 1829, and for the dimensions of Saturn's ring, the measurements of Struve in the *Astron. Nachr.* v. No. 97, have been used.

The following section contains the places of the pole star, δ *Urs. Min.* and of Bessel's 45 stars, after the model of the excellent auxiliary tables of Prof. Schumacher, with this only difference, that the inferior culminations of the two polar stars have not been given. The apparent places refer to the time of culmination at Berlin, and the asterisk denotes that in that place not ten, as everywhere else, but eleven sidereal days are to be taken.

The mean places on which these positions are founded are enumerated together in the beginning. Their comparison with the corresponding numbers in the auxiliary tables for 1827, has shown that there is a small deviation in some of those stars only, which Bessel has not introduced into his fundamental catalogue, probably owing to a differently assumed proper motion. They are all founded on M. Bessel's latest determinations. The calculation has been performed with great care by M. Dannemann.

The daily aberrations for the polar stars are given below for the culminations. Its values for the other stars are to be found by the side of the last of them, α *Andromedæ*. For the reduction of other stars from their mean places in the beginning of the year to the apparent ones at any other time, two tables have been added, whose construction will be evident from the formulæ* at the beginning of this section. The first,

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* The tables here described, together with the formulæ alluded to, we hope to be enabled to publish in a future Number of the Phil. Mag. and Annals.—Edit.

the well-known one of Bessel, is accompanied with the necessary illustration of the manner of forming the argument. It is arranged by sidereal days. The other, which proceeds by mean solar days, is more convenient, if, as is the case in observations of comets, a single position only of a star is required; as it is constructed after Gauss's general tables, and does not require the calculation of the constants a, b, c, d. A small difference in the elements on which these tables are founded, which has been noticed too late, causes a want of rigorous agreement in the results; but the difference never exceeding hundredth parts of a second, it is of no consequence for practical purposes.

The last section contains the principal phænomena for observations.

In the first place the eclipses of the moon and sun are sufficiently described for determining the places on the earth where they will be visible. For those who are fond of constructions, the elements from which the phænomena may be determined, have been added at the end. In future the solar eclipses, which are interesting for our part of the world, will be treated rather more in detail.

Next follow the constellations of the planets. In these, regard has been had to the two principal points of the elliptic orbit, the perihelium and aphelium, the four principal elements of the position of their heliocentric orbit, the two nodes, and the maximum and minimum of their latitude, to the four principal elements of their synodic paths ☍ ☌ □, or those which correspond to them for the sun and superior planets.

I am not acquainted with any astronomical use of the conjunctions of the moon and stars commonly given in astronomical almanacs. It appears to me that the columns of right ascension and declination of the moon render this part quite superfluous; as the arrangement of our present catalogues of stars is such that there can be no trouble in determining the stars near which the moon will pass. These have, therefore, been omitted; but, on the contrary, the possible occultations of planets have been carefully investigated; and where there is a possibility of an occultation, should it even not really take place at Berlin, the conjunction has been noted. In the year 1830, Venus only will undergo an occultation at Berlin.

In the present almanac for the year 1830, no occultations of fixed stars by planets have yet been inserted; as I entertained doubt respecting the extent to which these investigations ought to be carried. An examination has proved that no bright star down to the third magnitude will experience such an occultation. I will leave it to the decision of astronomers

mers whether this examination ought to be extended to the stars of the fourth, fifth, and sixth magnitudes. A rigorous investigation to that extent insuring the certainty of not one having been omitted, would require considerable labour. Next come the moon-culminating stars, or those stars which being near the parallel of the moon at the time of her culmination are likewise not far distant from her in time. It was originally not my intention to give them. However successful the observations have been by the ready publication of them in Prof. Schumacher's *Astr. Nachr.*, they will then only be of use if a single catalogue only is annually published. Nothing but the request of a much esteemed correspondent, in consequence of the fear entertained in the beginning of this year that the publication of such a catalogue would be interrupted, has induced me to give the present one; should, however, another catalogue containing, perhaps, a greater number of bright stars be sent from England, I would request that this one should be laid aside. Its construction has been performed rather hastily; more convenient stars might perhaps have been selected, especially for the second limb of the moon.

In the application of it for ascertaining longitudes even with only moderate transits, it will be adviseable to consult principally the excellent paper by Prof. Nicolai, *Astr. Nachr.* ii. No. 26, and those by Prof. Bessel and M. Hansen on the calculation of the horary motions of the moon, *Astr. Nachr.* ii. No. 33.

The notation and the places of the stars, both of the moon-culminating stars and of those mentioned in the list of occultations which follows, have been taken from the excellent Catalogue of zodiacal stars, by which Mr. Baily has conferred a valuable benefit on the astronomical public.

From this Catalogue all those stars have been inserted which will be occulted during the time of the moon's being above the horizon, while the sun is below it. Sometimes those have likewise been mentioned which are so nearly approached by the moon's limb, that a calculation only could decide whether an occultation would take placeor not. For bright stars, the occultations which happen in the day-time, especially those of *α Tauri*, have likewise been inserted. Some immersions and emersions which happen below the horizon of Berlin, have still been given, because they may be visible in other places.

The headings show the contents of the columns of this section. The two columns "Ort" (place) indicate in what point of the moon's disc the immersions and emersions take place: the degrees being counted from that point of the disc which

which has most northern declination, through east, south and west, to 360 degrees. The immersions happen, therefore, with few exceptions in the two first quadrants, and the emersions in the two last.

After the occultations of stars follow the mean places of the stars occulted, taken from Baily's Catalogue, and so expressed as they are wanted in the calculation of the occultations, which forms the subject of another part of this book*.

The auxiliary tables which then follow will be explained in the paper just alluded to. The horizontal equatorial parallax here given, belongs to the moment of the moon's culmination; and the quantities $\Delta\alpha$ and $\Delta\delta$ added to the mean place of a star for 1830, give very nearly the apparent place of each star which can be occulted by the moon.

The uncertainty about the extent of the calculation and the distribution of the different parts, however worthy of a place in this almanac, has caused such frequent changing and copying, that possibly some single errors may thereby have been introduced. Should, therefore, some erroneous data occur, (for the communication of which I shall be very thankful,) I request that the blame may not be laid on the labours of my coadjutors, who have performed their part of the work with great sacrifices. Every imperfection which may be pointed out, and every improvement both in form and matter which may be suggested, shall be duly attended to.

The typographical beauty of the printing, a production of the Academical Press of this city, which has been carried to a high degree of perfection by a great sacrifice on the part of the whole Academy, and particularly of an individual member of it, one of those whose services are most in request,—will, it is hoped, satisfy every one as a worthy accompaniment, without laying any claim to ornament or splendour. On a close examination, judges in these matters will not fail to perceive the careful management of the superintendent of the press, who has spared no pains in the first arrangement to give all the aid of his experience to the execution of my wishes.

XLV. *On an improved Syphon-Hydrometer.* *By Mr.* HENRY MEIKLE†.

IN the Philosophical Magazine for September 1826, (vol. lxviii. p. 166) I proposed an instrument to be used as a hydrometer, consisting of an open glass tube thrice bent, so as to have four straight

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* The part of the Ephemeris here mentioned, will probably appear in a future Number of the Phil. Mag. and Annals.—EDIT.

† Communicated by the Author.

straight parallel legs; and though a little complex, it has obviously the property of being free from the effects of capillary action. In the Edinburgh Philosophical Journal for January 1827, a method is given for applying the simple syphon to the same purpose, but which is not so entirely unaffected by capillary action. The same method, however, appears to be still susceptible of considerable improvement, so as to be rendered one of the simplest, and at the same time furnishing a pretty accurate instrument. What I would suggest, as likely to render a simple glass syphon very convenient as a hydrometer, is merely to put a small hole in its upper or bent part. On immersing each leg of such a syphon in a separate liquor, a portion of the air escapes through the hole, and allows the liquids to rise in the tubes to the level of their cisterns. If we now apply the finger to the hole, and raise the instrument, I need scarcely say, not wholly out of the fluids, the liquors will be raised in the tubes by the pressure of the atmosphere, so as to form columns elevated to heights above their respective cisterns inversely proportional to their specific gravities. For the weights of the two columns must obviously be equal; each being the difference between the pressure of the atmosphere and that of the included air.

If the tube be pretty wide, the effect of capillary action may in most cases be neglected: so that, the one column being water, we divide its length by that of the other liquid, and obtain a quotient which is the specific gravity of the latter. But the effect of capillary action may be easily obviated altogether, by holding the syphon at two different heights, and noting the corresponding columns. Thus if at one height we have a column of water $=W$, and at another height $=w$; while the corresponding columns of another fluid are respectively A and a; the specific gravity of the latter, freed from capillary action, is

$$\frac{W-w}{A-a}.$$

For, if x be the capillary part of the column of water, and y that of the other fluid, we should correct the columns for capillary action, by diminishing them respectively by x and y; whence the specific gravity becomes

$$\frac{W-x}{A-y}=\frac{w-x}{a-y}=\frac{W-w}{A-a}.$$

We thus obtain the specific gravity free from capillary action, by dividing the difference of the columns of water by the difference of those of the other fluid. The greater these differences

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can be made, so much the better; even using, perhaps, for the shorter columns the mere capillary elevations.

In transparent liquors, we may make the one pair of columns A and W to be depressions under the surfaces of the liquids contained in glass cisterns; which may be effected by immersing the instrument with the hole previously stopped to confine the air. The depths of the depressions, when increased respectively by x and y, should, like the former columns, be inversely as the specific gravities of the liquids. Consequently the required specific gravity becomes

$$\frac{W+x}{A+y} = \frac{w-x}{a-y} = \frac{W+w}{A+a},$$

which, as the numbers may be larger, is likely to be more accurate than the former. For in this case we obtain the specific gravity by dividing the sum of the elevation and depression of the water by the sum of those of the other fluid.

There is still another case in which all the columns may be depressions, and which obviously makes the specific gravity

$$\frac{W+x}{A+y} = \frac{w+x}{a+y} = \frac{W-w}{A-a},$$

where the rule is the same as in the first case. I may remark, that in all the cases, we might use in place of one of the pairs of columns, the mere capillary elevations, with proper signs.

As a hole may be apt to weaken a glass tube, especially at the curved part where it should be strongest; two straight pieces of glass tube may be joined, as I have done, by means of a bit of bent tin-tube. The hole may then be more easily made, and will be less apt to weaken the instrument. The legs of the syphon should be graduated or divided into small equal parts. This may be very easily done by merely transferring to the tubes, with the assistance of a square, the divisions which are already made on any scale of small equal parts. It is obvious that the legs ought to be parallel.

Nearly allied to the syphon-hydrometer, is a more complex instrument, called *a pump-areometer.* It is so named, from its being furnished with a pump at its upper part for exhausting the air to induce the liquids to rise. The requisite degree of exhaustion, however, is so very trifling, that it may be effected, were it in the least necessary, by merely sucking with the mouth at the orifice of a stopcock attached to the top of a syphon.

HENRY MEIKLE.

XLVI. *A new Account of the Genus* Echeveria. *By* A. H. HAWORTH, *Esq. F.L.S. &c. &c.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

HAVING just examined and described a fine new succulent plant at Mr. Tate's Nursery in Sloane-street, which he has recently raised from Mexican seeds, and which is now blooming for the first time in Europe, amongst many other equally rare and well-managed plants; I send you hereunder a full account of it, and four other species of the same genus; to which I have added all their synonyms.

This new plant, belonging to DeCandolle's new genus *Echeveria*, I have called, from its ample leaves, *Echeveria grandifolia.*

In my ninth decade of new succulent plants, published in your Journal in 1826, I announced to you (*inter alia*) that *Cotyledon coccinea* of Cavanilles, and *Cotyledon umbilicus* of Linné, would each form the type of a new genus, but for want of proper specimens regretted my inability at that time to give you sufficient characters. This, however, is now the less to be lamented, as DeCandolle has done it for us, in the third volume of his *Prodromus*, just published; and to the above-mentioned *Cotyledon coccinea* has added my *Cotyledon cæspitosa*, (which is a native of California, although we used to think it African,) and two new species from Mexico.

If you can find room for this communication in the next Number of your Journal, you will much oblige

Your old correspondent and friend,

Chelsea, Aug. 10, 1828. A. H. HAWORTH.

ORDO NATURALIS.

Crassulaceæ DeCandolle. *Semperviveæ* Juss. &c.—*Cotyledones americanæ* Auctorum.

Genus, ECHEVERIA *DeCand. Prod.* 3. 401.

GENERIS CHARACTER.

Calyx 5-partitus, sepalis distantibus valdè foliiformibus, præinæqualibus basi coalitis. *Corolla* pentapetaloidea pentagona campanularis. *Petala* infernè concreta erecta rigidula acuta crassa, basi inter calycis folia, extùs gibba, intùs scrobiculata: duobus exterioribus petalis insuper tria interiora, arctè imbricatim adpressa. *Stamina* 10, basi cum petalis longioribus concreta. *Squamæ* ordinariæ breves

breves subquadratæ albæ, alternæ crassiores cerinæ, omnes in petalorum scrobiculis nidulantes. *Carpella* 5 erecta, in *stylos* acutos desinentia.

Suffrutices Mexicani parvi succulenti glauci. *Folia* basi soluta: rosularia sed alterna, integra, cum mucronulo, at sæpiùs valdè obtusa, et in spicis florigeris foliolosis, pedetentim in *bracteas* numerosas magnas subdistantibus omninò foliiformes abeuntia. *Flores* valdè bracteati, spicati, s. paniculati, vel cymosi, et tunc secus cymæ ramos sessiles, coccinei flavive.

SPECIERUM CHARACTERES.

* Suffrutices, floribus paniculatis spicatisve, coccineis.

grandifolia. E. (great-leaved) foliis orbiculato-cuneatis grossè
1. petiolatis, floribus paniculato-spicatis.

Habitat in Mexico.

Floret Aug. Sept. G. H. ♄.

Caudex in nostro exemplo, in caldario, apud Dom. Tate, in secundo anno triuncialis diametro subunciali, cylindricus carnoso-lignescens radiculos exiguos terram versus exerens. *Folia* numerosa conferta ambienter multifaria, seu in rosulam laxam digesta, patenti-recurvula dodrantalia plùsve incurvo-concavula, et in petiolum carnosum subsemunciam crassum obtusè canaliculatum attenuata, pruinoso glauca rufo marginata integra rariùsve minutim asperiuscula; *subtus*, basin versus præcipuè vivacitèr glauco-purpurascentia: et denique morientia inania lorea persistentia. *Florum* paniculæ sesquipedales, bracteatim foliolosæ, axillares teretes uti folia cæruleo-glaucæ; *bracteis* erectis lanceolatis mucronulatis (magìs quàm vera folia) distantibus sensim sensimque minoribus, et *Sedi* more singulariter basi planè obtusèque solutis. *Calyx* sepalis 5 valdè inæqualibus bracteis brevioribus omninò foliiformibus (excepto basi non soluto) tribus cæteris duplò majoribus, quarto minore, quinto minuto. *Corolla* ferè semunciam longa, calyce brevior rubro-aurantiaca, rore roseo-glauca purpureave. *Stamina* 10, petalis humiliora alba, *antheris* erectis *polline* luteo. *Carpella* grossa, alba in *stylos* virides abeuntia. Cætera ferè ut in *E. coccineâ*, infrà descripta, at non rectè vidi.

gibbiflora. E. (gibbous-flowered) foliis planis cuneiformibus
2. acutè mucronatis ad apices ramorum confertis, paniculâ patente, floribus secus ramos breviter pedicellatis. *DeCand. Prod.* 3. p. 401.

Habitat

Habitat in Mexico. ♄.

Petala basi albida, apice subcoccinea. *DeCand.* l. c.

coccinea. E. (pubescent) mollis: ramulis foliisque spatulato-
3. lanceolatis pallescente densè puberulis, florum spicis axillaribus elongatis foliolosis.

Cotyledon coccineum. *Cav. Ic.* 2. *t.* 170.—*Nob. in Suppl. Pl. Succ. p.* 26. A.D. 1819.—*Lodd. Bot. Cab. t.* 832.—Echeveria coccinea. *DeCand. Prod. v.* 3. *p.* 401.

Habitat in Mexico.

Floret autumno, hyemeve. G. H. ♄.

Suffrutex sesquipedalis, parùm et alternè ramosus. *Flores* densè elongato-spicati, *spicæ* sub foliorum capitulos adscendentes thyrsiformes bracteatim foliolosæ, supernè ferè comosæ, post florescentiam longum per tempus induratè denudatæ persistentes. *Flores* duplò minores quàm in *E. grandifoliâ*, horizontaliter sessiles. *Calycis* sepala subovato-lanceolata acuminata tumidè carnosa patenti-recurvula et inter bracteas irregulariter intertexta. *Corolla* 5-petaloidea campanulata coccinea, infernè pentagona, basi gibbulis 5, e foveolis totidem internis nectariferis: laciniæ (corollæ) rectæ ovato-lanceolatæ, acuminatæ calyce breviores carinâ densiùs ciliato-puberulâ saturatiore; intùs longè pallidiores glabræ foveolatæ. *Stamina* 10, albo-lutescentia corollâ subdimidiatim breviora, 5 exteriora germinum basi inserta, 5 alia in foveolâ supradictâ dimidiatim flexuosè adnata, solùm supernè libera, et 5 prioribus (staminibus) aliquantillum humiliora. *Antheræ* erectæ subparallelipipedæ emarginatæ, basi cordatæ, *polline* luteo. *Carpella* 5, erecto-adpressa, cum *stylis* continuantibus obclavatis luteis, *stigmate* purpureo inconspicuo, lente hemisphærico, et subinde ad lucem pellucente.

Obs. Corollæ laciniæ intùs argutè canaliculatæ, in quibus canaliculis insident exteriora filamenta, et ad eas adpressa, atque ad earum flexionem gibber parvus exstat utraque insuper apicem singulæ foveolæ supradictæ.

Ad basin singuli *carpelli* rudimentum solum squamulæ ordinariæ exstat tumidulum rhombeum subquadratumve, carpello omninò adnatum, pustulam minutissimam simulante. *Seminula* numerosa incipientia oblonga alba solùm vidi.

teretifolia. E. (cylindric-leaved) foliis teretibus acutis sparsis
4. basi subsolutis, spicis secundis paucifloris. *DeCand. Prod.* 3. *p.* 401.

Habitat

Habitat in Mexico. ♄. *Flos* omninò prioris. *De Cand.* l. c.

** Subherbaceæ, floribus subcymosis luteis.

cæspitosa. 5. E. (dwarf yellow-flowered) foliis rosularibus anguste linguiformibus, apice obcuneatis submucronatis, floribus cymosis.

Cotyledon cæspitosa. *Nob. Misc. Nat. p.* 180. A.D. 1803.—Cotyledon linguiformis. *Ait. Hort. Kew. v.* 3. *p.* 109.—Sedum Cotyledon. *Jacq. f. Eclog.* 1. *f.* 17.—Cotyledon reflexum. *Willd. Enum. Suppl. p.* 24.—Echeveria cæspitosa. *DeCand. Prod. v.* 3. *p.* 401.

Habitat in Californiâ.

Floret Jul. Aug. G. H. ♃. s. ♄.

P.S. I avail myself of the present opportunity of correcting the following errors, which time alone has enabled me to ascertain.

1. *Mesembr. deflexum, β.* Revis. Pl. Succ. p. 140, is the same as *M. imbricans*, p. 139, and the last is a good and most abundant-flowering species.
2. *M. leptaleon* is the young state only of *M. retroflexum*, l.c.
3. *M. flexile* is the young state only of *M. polyphyllum*, l. c.
4. And *M. torquatum* is a casual state only of *M. floribundum*. Revis. Pl. Succ. p. 187.

DeCandolle in vol. 3. p. 416 of his *Prodromus*, just published, says of *Mesembryanthema:* "Species pleræque hortenses ex cl. Haworth, &c.—sed forsan plures ut meræ varietates habendæ."

But all the new species which I have published, I was well and sufficiently assured, were raised from *wild* African, or Australasian seeds, except the following only, whose origin I cannot trace further than I have printed. *M. ficiforme; M. hybridum; M. nobile; M. mustellinum ; M. bigibberatum; M. cruciatum; M. Salmii; M. cultratum; M. coruscans; M. procumbens; M. variabile; M. mucroniferum; M. loratum*, and *M. hispifolium*. And even seven of the above I received from His Highness the Prince de Salm Dyck, whose genuine origin I believe he can point out.

In my last communication Phil. Mag. and Annals, N.S., vol. iii. p. 184, l. 15, for *Crassulam undosam*, read *Crassulam undatam*.

XLVII. *An Account of the Formation of Alcoates, Definite Compounds of Salts and Alcohol analogous to the Hydrates.* *By* THOMAS GRAHAM, *Esq. M.A. F.R.S.E.*[*]

IN determining the solubility of salts and other bodies in alcohol, it is desirable to operate with a spirit wholly free from water. But anhydrous or absolute alcohol is formed with difficulty, even by the most improved process—that of Richter. In rectifying alcohol from chloride of calcium, as recommended by Richter, I have never obtained it under the specific gravity 0·798 at the temperature of 60°, by a single distillation; but upon rectifying this product again from new chloride of calcium, I generally succeeded in reducing it to 0·796, which is the specific gravity of the standard alcohol of that chemist. The following experiment illustrates this process.

Four measures of alcohol of the specific gravity 0·826 were poured into a retort, and a quantity of well-dried chloride of calcium, amounting to three-fourths of the weight of the alcohol, gradually added with occasional agitation. Much of the salt was dissolved with the evolution of heat; and the combination was promoted by boiling the whole for a few minutes, the vapour being condensed in the neck of the retort, and returned to the solution. A receiver was then adjusted to the mouth of the retort, and the distillation conducted so slowly that the alcohol was condensed entirely in the neck of the retort, and fell drop by drop into the receiver,—nearly two seconds elapsing between the fall of each drop. The first measure of alcohol which came over was of the specific gravity 0·800, at 60°; the second measure, 0·798; and the third measure, 0·801: the distillation was then discontinued. These three measures were mixed together, and subjected to a second distillation, which was conducted in the same manner; and two measures of alcohol obtained of the specific gravity 0·796. It was found that further rectification did not reduce the specific weight of the alcohol below 0·796. From the analysis of alcohol by Saussure, and the determination of the specific weight of its vapour by Gay-Lussac, there can be little doubt that the alcohol thus obtained is perfectly anhydrous. It is true that such alcohol still contains oxygen and hydrogen to the amount of an atomic proportion of water; but this proportion of oxygen and hydrogen is essential to the constitution of alcohol,—the partial abstraction of it converting alcohol into æther,

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[*] From the Transactions of the Royal Society of Edinburgh: this paper was read before the Society on the 17th of December 1827.

æther, and its total abstraction converting alcohol into olefiant gas; while the supposition that the oxygen and hydrogen exist in the state of water, is altogether gratuitous.

The process of Richter is exceedingly tedious, from the necessity of conducting it so slowly, and the waste of alcohol is considerable. I tried newly burnt quicklime instead of chloride of calcium, and distilled by the heat of a saline water-bath. If it is merely our object to obtain alcohol perfectly free from water, no process could be more effectual. The product was of the specific gravity 0·794; but it contained a trace of æther, to which the extraordinary lowness of its specific gravity is attributable; and had an empyreumatic odour, notwithstanding the moderate temperature at which the distillation was conducted. This likewise is a very slow process.

The process which I preferred is founded on the principle of Mr. Leslie's frigorific apparatus. The alcohol is concentrated by being placed under the receiver of an air-pump, with quicklime. A large shallow basin is covered to a small depth with recently burnt lime in coarse powder, and a smaller basin containing three or four ounces of commercial alcohol is made to rest upon the lime: the whole is placed upon the plate of an air-pump, and covered over by a low receiver. Exhaustion is continued till the alcohol evinces signs of ebullition, but no further. Of the mingled vapours of alcohol and water which now fill the receiver, the quicklime is capable of combining with the aqueous vapour only, which is therefore quickly withdrawn, while the alcohol-vapour is unaffected. But as water, unless it has an atmosphere of its own vapour above it, cannot remain in the alcohol, more aqueous vapour rises. This vapour is likewise absorbed, and the process goes on till the whole water in the alcohol is withdrawn. Several days are always required for this purpose, and in winter a longer time than in summer. The following cases exhibit the rate, according to which the water is withdrawn. The first experiment was made in summer. Four ounces of alcohol of the specific gravity 0·827 were concentrated. The specific gravity was taken every twenty-four hours, and the following series of results obtained:

0·827
0·817
0·808
0·802
0·798
0·796

In this case the whole water was withdrawn in five days, but occasionally

occasionally a period somewhat longer is required, although it rarely exceeds a week. In winter the alcohol generally requires to be exposed to the lime for a day or two longer than in summer. The following rate of concentration was observed in one case in winter, the quantity of alcohol and other circumstances being the same as in the former experiment:

0·825
0·817
0·809
0·804
0·799
0·797
0·796

Quicklime, as a porous substance, appears to be capable of condensing a small portion of alcohol-vapour. It is therefore improper to use it in great excess. In one case, in which three pounds of quicklime were employed with four ounces of alcohol, about one-sixth of the alcohol was lost from this absorption. The quicklime should never exceed three times the weight of the alcohol, otherwise the quantity of alcohol absorbed becomes sensible. It should be spread over as great a surface within the receiver as possible.

In Richter's process it is improper to operate upon more than a few ounces of alcohol at a time; as when a large quantity of materials is introduced into the retort, the heat necessary to disengage the alcohol in the centre of the mass inevitably expels the water left in the chloride of lime, at the points where it is more exposed to the heat. In the air-pump also, only a few ounces can in general be concentrated at a time. But in a tall receiver, two or three shallow basins of quicklime can be supported at a little height above each other, each of them containing a small basin of alcohol resting in it. Or the process might be conducted with facility on the large scale, by means of a tight box of any size, furnished with numerous shelves, which might be covered with quicklime in powder, and support a large number of basins of alcohol. The box might be sufficiently exhausted of air by means of a syringe, for it is not necessary that the exhaustion be nearly complete; and indeed more inconvenience is to be apprehended from a complete than from an imperfect exhaustion. After producing the exhaustion, no further attention would be necessary; and upon opening the box at the expiration of a week or ten days, the alcohol would be found anhydrous. It is evident that absolute alcohol, procured by this process, could be sold at a price but little exceeding its original cost. It would moreover be of much greater value for the purposes for which it is

employed

employed in the arts and in medicine. I believe, however, that, by the excise laws as they at present exist, no rectifier of spirits is permitted to concentrate alcohol beyond a certain strength. Licensed apothecaries alone are allowed to prepare and sell absolute alcohol *.

Alcohol may be concentrated in a close vessel with quicklime, without exhausting; but the process goes on much more slowly, at least at the temperature of the air. The experiment was tried at a high temperature, by heating in a water-bath a large bottle with a very wide mouth, containing a quantity of alcohol at the bottom, and quicklime suspended over it in a linen-bag. When the water-bath attained the temperature of 150°, the bottle was corked, and the bath prevented from becoming hotter. Much of the lime was very quickly converted into hydrate, and the alcohol considerably concentrated. But the process is troublesome, and much inferior to that in which the air-pump is employed.

In the place of quicklime, sulphuric acid cannot be substituted in the foregoing process as an absorbing liquid, from a remarkable property which it possesses. It is capable of absorbing the vapour of absolute alcohol, in the same manner as it absorbs the vapour of water. I was led to make this observation from a consideration of the phænomena which attend the mixing of alcohol and sulphuric acid. Nearly as much heat is evolved as if water had been added to the acid, even although absolute alcohol be employed. Alcohol is also retained by the acid when heated to 500° or 600°, or at a temperature when the alcohol would be decidedly in the state of vapour,—which indicates the possibility of the same relation between sulphuric acid and alcohol vapour, that subsists between water and those gases which it detains in the liquid state, such as ammoniacal gas, when they would naturally assume the elastic form. But besides merely *detaining* such gases, water can condense and absorb them. Sulphuric acid, besides merely detaining alcohol-vapour, might therefore condense and absorb it.

As alcohol, like water, occasions cold by its evaporation, it may be substituted for water in Mr. Leslie's frigorific appa-

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* Care should be taken that the temperature be nearly equable during the experiment; otherwise, when the atmosphere becomes cold, a condensation of alcohol-vapour takes place upon the cooled bell-glass, which runs down upon the plate of the pump. The experiment, therefore, should not be performed in a room with a fire, or near a window, but in a dark closet or press. From the manner in which I performed the experiment, this condensation had never been experienced by myself; but Dr. Duncan junior observed it, on repeating the process.

ratus, sulphuric acid being retained as the absorbing liquid. In circumstances precisely similar, it was found that a thermometer, the bulb of which was covered with cotton, fell to 7° when moistened with water, but when moistened with absolute alcohol its temperature fell to −24°. Continuance of the pumping during the experiment, as is done in the case of æther, had a prejudicial effect. But alcohol diluted with a third of water was found to have as great a cooling power as absolute alcohol. The advantage to be derived from the great volatility of alcohol appears to be counterbalanced in part by the small latent heat of its vapour. Probably a mixture of alcohol and water, in certain proportions, would produce the greatest degree of cold attainable by this process. Sulphuric acid loses its power to absorb alcohol-vapour by being diluted with water. When impregnated with alcohol-vapour, the acid becomes of a pink colour; but no appretiable quantity of gas is emitted at the temperature of the atmosphere, even in the vacuum of an air-pump.

From one experiment, water appears to have the power to induce the evaporation of alcohol by absorbing its vapour, as sulphuric acid does, but much more feebly. Two cups, one containing alcohol and the other pure water, were inclosed together in a tin-canister which was nearly air-tight, and set aside in a quiet place for six weeks. The cups were not in contact, but a little apart from each other. At the expiration of that period it was found, on opening the canister, that the cup which originally contained pure water, now contained a mixture of water and alcohol, while the alcohol remaining in the other cup was of diminished strength. Professor Leslie informs me, that he performed a similar experiment a considerable time ago, although no account of it was published. But the absorption of alcohol-vapour by water is so feeble as not to occasion a sensible reduction of temperature in the alcohol.

Chloride of calcium is disqualified as an absorbent of aqueous vapour in the purification of alcohol, for the same reason as sulphuric acid. I find that chloride of calcium absorbs the vapour of absolute alcohol, and runs into a liquid, or it *deliquesces* in alcohol-vapour. A small quantity of this substance was suspended in a little capsule, at the height of two inches above a quantity of absolute alcohol, in a close vessel. In the course of twenty-four hours it was entirely resolved into a liquid, just as if it had been suspended over water. The liquid proved to be a solution of chloride of calcium in absolute alcohol. The experiment was frequently repeated. As salts which deliquesce from the absorption of aqueous vapour are always capable of forming hydrates, I was led from the observation

servation of this fact to attempt the formation of analogous compounds of alcohol and salts,—to which I now proceed.

These solid compounds of salts and alcohol, which are definite and imperfectly crystallizable, may be denominated *Alcoates*,—a designation which is not unexceptionable, but appeared to me preferable to the name *Vinates*, as there is a sulpho-vinous acid; or to any other name that might have been imposed upon them.

The alcoates which I succeeded in forming are not numerous. They were formed simply by dissolving the salts, previously rendered anhydrous, in absolute alcohol, with the assistance of heat. On cooling, the alcoates were deposited in the solid state. The crystallization was generally confused, but in some cases crystalline forms appeared of a singular description. The crystals are transparent, decidedly soft, and easily fusible by heat in their alcohol of crystallization, which is generally considerable, amounting in one instance to nearly three-fourths of the weight of the crystals.

I. *Alcoate of Chloride of Calcium.*

Pure muriate of lime was dried as much as possible on a sand-bath of the temperature of 600° or 700°, and then slowly heated to redness, and retained for some time at that temperature. The dry chloride of calcium thus obtained dissolves in absolute alcohol at 60° with great facility, and with the production of much heat, sometimes occasioning the boiling of the solution. The quantity of chloride taken up increases with the temperature; and at 173°, the boiling point of alcohol, 10 parts alcohol dissolve 7 parts chloride of calcium. This solution is thick and viscid, but perfectly transparent, provided the chloride be pure. It boils at 195°, alcoholic as well as aqueous solutions boiling at higher temperatures than the pure liquids. The viscidity of the solution of chloride of calcium increases greatly as it cools. Bright crystalline stars soon appear on the surface and on the sides of the vessel, which have been moistened by the solution. The solution, however strong, never crystallizes instantaneously, but gradually, in thin transparent and colourless plates, the forms of which cannot be made out, except on the surface of the solution and sides of the vessel.—To obtain the alcoate in a state of absolute purity, it is necessary to form a solution so weak, that, while hot, it will pass through thin filtering paper; and afterwards to concentrate the filtered solution by heat. A solution of one part chloride of calcium in five parts alcohol passes through the filter. It is remarkable that the most distinct crystalline forms are not obtained

obtained from the slow crystallization of comparatively weak solutions; but in solutions which have been fully saturated, or nearly so, at the boiling temperature. In the former case, the crystalline plates are large, but confused, and nothing but angles can be made out; while in the latter, the forms, under which the plates appear on the surface of the solution, and to the greater advantage, on the sides of the vessel, are generally distinct. These plates are always small, often beautiful, and delicately striated; and they always present the form of isosceles triangles. In general, four of these triangular figures are grouped with their apices together; and if similar, they form a square. But, as more frequently happens, the opposite pairs of triangles only are similar; and the figure presented is a rectangular parallelogram, divided by two diagonal lines into four triangles. The resolution of the rectangle into triangular figures is rendered perceptible by the discontinuance of the striæ, and the formation of clear diagonal lines, which have a beautiful effect. These crystals cannot be removed from the phial in which they are formed without injury, from their softness. Exposed to the air, they speedily deliquesce from the absorption of hygrometric moisture. The heat of the hand is sufficient to melt them. The whole of the alcohol is expelled by a heat amounting to 250°, and pure chloride of calcium remains, which emits nothing else upon being heated to redness.

A quantity of this alcoate was dried, first by strong pressure between many folds of linen, and then by pressure between folds of blotting paper. The alcoate, carefully dried in this way, had a white appearance much resembling bleached wax, and was soft, but without tenacity.

Ten grains were heated in a glass capsule, till the whole of the alcohol was driven off. There remained 4·1 grains chloride of calcium. The atomic weight of chloride of calcium is 7, and that of alcohol 2·875. In the alcoate, 4·1 grains chloride of calcium were combined with 5·9 grains alcohol.

$$4{\cdot}1 : 5{\cdot}9 :: 7 : 10{\cdot}0731.$$

In a second analysis, in which 20 grains of alcoate were employed, the result was precisely similar, as 8·2 grains chloride of calcium remained, which is just double what was obtained in the previous case from half the quantity of alcoate. If this alcoate should be considered a compound of one equivalent proportion of chloride of calcium, and three and a half proportions alcohol, the alcohol would amount to 10·0625, which approaches very nearly to the experimental results. But it would

would be better to express the composition of the alcoate thus:

Two atoms chloride of calcium	14·
Seven atoms alcohol	20·125
	34·125

In the solution of chloride of calcium, no crystallization takes place at the temperature of 50°, when the alcohol exceeds the proportion of 10 parts to 4 parts of the dry salt. But the solution crystallizes readily when further concentrated. A solution saturated at 170°, and which consisted of 10 parts alcohol and 7 parts chloride of calcium, or nearly the atomic proportions of the alcoate, crystallized slowly upon cooling, forming crystals upon the surface of the liquid and sides of the phial, of great regularity and beauty. The whole crystallized during a cold night, leaving no mother-liquor whatever.

The injurious effect of the presence of water, in the formation of this alcoate, was evident in alcohol of the specific gravity 0·798, in which the contaminating water did not amount to 1 per cent. A solution of chloride of calcium in alcohol of this strength did not crystallize readily, and the crystals eventually deposited were small and ill-formed. Chloride of calcium does not crystallize at all in alcohol of the specific gravity 0·827. The same inconvenience arises from employing chloride of calcium containing a little water.

Although the alcoate of chloride of calcium in a state of purity is entirely decomposed at a temperature not exceeding 250°, yet, when water is present, alcohol can be retained by the chloride of calcium at a much higher temperature. Thus I repeatedly found, that chloride of calcium, from which alcohol had been rectified, and which afterwards had been washed out of the retort by water, gave indications of the presence of alcohol, after being exposed on the sand-bath to a heat of 400° or 500° for several hours. Transferred in a crucible to the fire, after it ceased to lose weight on the sand bath, alcohol-vapour was emitted, which took fire and burned.

[To be continued.]

XLVIII. *Remarks on the Influence of Terrestrial Radiation in determining the Site of Malaria.* By Wm. Addison*.

THE diseases arising from atmospheric impregnations have long formed an important topic of inquiry among medical men, and are generally supposed to have an origin from some subtile

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* Communicated by the Author.

subtile poison, prevalent only in certain places, or over very circumscribed situations. Upon considering the various circumstances under which these diseases are produced, and the impossibility of any poison dispersed through the air from the ground becoming partial in its operation, or always confined to any particular district (when every wind must waft it away from the spot of its emanation), unless some adventitious circumstance influences its operations,—I am induced not to subscribe to the doctrine which teaches that they take place from a specific or peculiar and locally acting effluvium. On the contrary, I think we shall find that most of the ordinary atmospheric impregnations will produce the diseases of Malaria, when under certain peculiar circumstances they are liberated from their combinations; diseases which will, no doubt, be violent or not, according to the quantity or quality of the matters developed.

The atmosphere, as is well known, retains every where mingled with it variable proportions of aqueous vapour, mixed probably with various effluvia arising from the action of the sun upon the many substances on the surface of the earth. During a bright day, therefore, the air over those portions of the ground subjected to its influence becomes saturated with vapour, and any reduction of temperature by radiation will always be accompanied by the deposition of moisture and the precipitation of a portion of those subtile matters drawn up by the agency of heat; whereas any diminution of sensible caloric, which may ensue from a rush of cold air, may not be accompanied with the same effects: for it very often happens that such currents have not nearly attained their maximum point with respect to vapour, and therefore none of these things happen; or if they do, the deposits occur in the form of rain, far less prejudicial than those chilly fogs produced by the *radiation of caloric from the earth.*

When we think of the important process of radiation, the effects of which have excited the attention of philosophers, especially those connected with horticultural pursuits, it is extraordinary that it should wholly have escaped them to pursue their investigations into this curious subject, with reference to the momentous matter of local salubrity; for little doubt remains upon my mind, that a well conducted series of experiments instituted to discover the phænomena resulting from the *radiation of heat into the heavens*, in different situations and over various surfaces and soils in several places at the same time, would discover to us an important field well worthy of research as connected with the health of mankind.

I have already endeavoured to draw the attention of those who

who may possess opportunity and the means of entering into this interesting branch of inquiry, towards the benefits their labours are likely to confer upon us in a medical point of view*. I have shown that all those situations where the radiation of caloric goes on with rapidity, are occasionally, if not at all times, extremely unhealthy; while others, where this process is diminished, are on the contrary much less obnoxious to disease. I have shown that debilitated constitutions are invariably found to regain the tone and vigour of health much more perfectly and more quickly in places little influenced by radiation or removed from the sphere of its effects, than in others exposed to the depositions which it causes from the air; and I have endeavoured to confirm these observations, by pointing out that in the *radiation of caloric* may be found *the cause of the activity* of those exhalations with which the sun, in tropical climates especially, saturates the air: in fine, that in this important process one of the principal causes of malaria will be found.

I shall here offer a few more facts in support of the views I have taken. And as nothing has tended more to confirm me in them than the perusal of Dr. Macculloch's Essay on the Production and Propagation of Malaria, I shall proceed to the consideration of some of the passages in that publication.

"The careful observer will often perceive," says the Doctor, "that there are certain determinate places without any marshes, where fevers are almost annually prevalent; while other places in the vicinity are almost wholly or nearly exempt. A proof of this may be drawn from the fact that some localities are known to be unhealthy as compared with other neighbouring places.

"Thus it is the vulgar remark, that in certain houses or places a family is rarely without some sickness; or, to use the strong but coarse language in which it is generally stated, 'that the apothecary is never out of the house.' It is almost equally familiar, that families which before had been healthy, have become the reverse on changing houses or situations; as in the opposite cases, that they have recovered health by change of residence. Of such facts as these there is no observer who must not be able to recollect numerous examples." Again, "If a gravelly soil is healthy, it is because its easy drainage prevents the growth of that particular vegetation which is the cause of malaria; and if a clayey soil is the reverse, it is because by lodging superficial water it generates, however par-

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* Vide the last section of "A Dissertation on the Nature and Properties of the Malvern Water," &c. &c.

tially,

tially, those marshy or undrained spots, or wet woods or moist meadows, which are the sources of *this poison*, and consequently of the various diseases confounded under the vague term of unhealthiness."—*Essay*, pp. 19 & 21.

Now, upon this latter passage I may remark, that as water is one of the best radiators of caloric, so all wet, low, and marshy places will be found the most affected by it; and it will follow that any soil whose mechanical texture is such as to allow the water to permeate through it, or to drain off, at the same time that other circumstances combine to arrest the dissipation of heat by radiation, that soil will be found much more salubrious than one retentive of moisture, and particularly if the surface of this latter is covered with low herbage or grass, which is in itself an excellent promoter of terrestrial radiation.

"That woods and jungles in hot countries give origin to miasmata of the worst kind is well known to all medical men; but some doubt may be entertained as to their insalubrity in Europe."—"Dr. Macculloch thinks there is strong reason to believe that close and wet woods generate malaria in this as well as in the warmer countries of Europe. Certain woody districts in Sussex and Kent produce both intermittent and remittent fevers,—at least there is no other assignable cause. The same may be said of some parts of Hampshire and Essex; as about Epping Forest, for example."—"On the other hand, we have positive testimony that lands which were healthy when covered with wood, have become extremely unhealthy when cleared and cultivated."

The thick foliage, as I have elsewhere shown, of the trees composing most of the intertropical forests, and even of some of those also in this country, by obstructing the rays of the sun, preserve in their immediate vicinity a greater degree of stillness and a lower temperature than that attained by the atmosphere over the contiguous grounds; whence the heated air coming to slowly circulate among the branches of the trees of these forests, becomes cooled, and its vapours developed; and it is these which occasion the diseases of malaria.—"Yet it requires much circumspection," says the Doctor, "in deciding upon the propriety of clearing these grounds with the view of rendering them more salubrious."—And why? Because trees naturally tend to obstruct the force of radiation; and, if planted on a good radiating surface, not so close together as entirely to obstruct the genial influence of moderate warmth from the sun's rays, or to prevent the free circulation of the air, will prove a valuable defence against the appearance of malaria, by counteracting that unequal distribution of temperature

which,

which, *I believe*, develops its existence in the air: whereas, if these are cut down and the ground cleared, a good radiating surface becomes immediately exposed, and the dissipation of caloric with its accompanying effects directly ensues.—" A portion of grass-plat," says Mr. Daniell in his Meteorological Essays, " under the protection of a tree or hedge will generally be found on a clear night to be eight or ten degrees warmer than surrounding unsheltered parts; and it is well known to gardeners that less dew and frost are to be found in such situations than in those which are freely exposed."—Dr. Macculloch in noticing the comparative healthiness of ancient and modern Rome, thought it not unimportant to notice what Theophrastus has stated with regard to the plain of Latium, which this historian says was covered with laurel and myrtle-trees of such a size as to be used in ship-building; and this remark, if terrestrial radiation has any thing to do with the development of malaria, is not so fanciful as one of his reviewers seems to imagine it*. Again, If terrestrial radiation is the cause of the deleterious influence of those effluvia existing in the atmosphere, we are no longer surprised at finding rice-grounds, which are kept in a constant state of wet or moisture during the growth of the plants, prolific in the diseases which malaria occasions.

" Dr. Macculloch is convinced that the minute marshy or swampy spots which occur in thousands of low situations, whether on commons, near woods by road sides, or in innumerable other places where they hardly ever attract notice,—are productive of malaria; though their limited range of action generally renders their power insensible, unless when houses happen to be erected in their vicinity."—" In how far meadows which cannot be called marshy are capable of producing malaria, is an intricate and entangled question. It appears certain, however, that there are many tracts of meadow or of alluvial land not marshy, and often not intersected by ditches, at least in a conspicuous manner, which are the sources of malaria all over Europe." *Essay*, p. 69.—" Such is the case with all the alluvial tracts at the entrances and sometimes at the exits of the lakes of Switzerland and elsewhere; and in places innumerable where there is no proper marsh, nor even an approach to such a character, but where the prevalent diseases must be owing to malaria."—" Volney, while travelling in America, has averred that every valley in the country which he visited produced the fevers of malaria, enumerating among the sources of this poison not only marshes and wood, but

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* Medico-Chirurgical Review, January 1828.

rivers, millponds, &c."—"The meadow lands about Fontainbleau, at the junction of the Yonne and the Seine, are notorious for the *fièvre du pays;* so injurious are they, that few escape intermittents or remittents over a considerable tract." If some great portions of the meadow-land in England have been recovered by drainage from a state of marsh, and are now as dry as the ordinary low-lands of plains and valleys; and if these localities still produce malaria and its consequences,—it is another point of evidence against the salubrity of meadows generally. "It is a rooted opinion in England, that there can be no malaria on the banks of a running stream; and as far as mountain-torrents are concerned, this is probably true: but where rivers slowly meander through low grounds, we must not trust to the mere motion of the water."—"For whatever persons may still think as to rivers in general in our own country, there is no doubt that such streams as the Ouse, the Lee, and all others flowing with difficulty through fertile meadows, and with a flat vegetable margin, are productive of malaria."

But not to occupy more than necessary the time of the reader by quoting further from Dr. Macculloch's Essay, I shall only observe that this author has found small streams bordered by thin and grassy margins; tranquil and stagnant waters, especially in hot countries; and ponds occupying but a small space,—to be productive of '*evening mists*,' the results of which are autumnal and intermittent fevers." And is not the *terrestrial radiation of caloric*, I would here ask, the cause of those evening mists which favour the attacks of these disorders? Indeed it is remarkable to find that every locality pointed out by the Doctor as productive of malaria, will be found to possess one or other of those circumstances which promote the dissipation of heat from the ground. It has long been known that water and a grassy surface are excellent radiators of caloric; and the effects of this process—fogs, damps and dew—were observed long before the cause of them was properly understood. "A valley," says Mr. Daniell*, "is more liable to the effects of radiation, than the tops or sides of hills; and it is a well-known fact that dew and hoar-frost are always more abundant in the former than in the latter situations. The influence of high hills is, however, often prejudicial to the valleys at their feet; for the condensed and moist air rolls down their sides, and lodges at the bottom: these, therefore, are protected from the chill, while a double portion falls upon what many are apt to consider the more sheltered situation. It is a very old remark, that the injurious effects of cold occur chiefly in hollow places, and that

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* Meteorological Essays and Observations.

frosts are less severe upon hills than upon the neighbouring plains: and it is consistent with my own observations, that the leaves of the vine, the walnut-tree, and the succulent shoots of Dahlias and potatoes, are often destroyed by frosts in the sheltered valleys, on nights when they are perfectly untouched upon the surrounding eminences." The diminution of temperature which is produced upon the surface of radiating bodies during the night is communicated by slow degrees to the surrounding atmosphere; and if the process goes on for any considerable period, moisture and probably other matters are not only deposited upon them, but are precipitated in the air itself, affecting more or less the feelings of every one within its range, but particularly the weak or unhealthy.

[To be continued.]

XLIX. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones.* By J. G. CHILDREN, *F.R.S. L. & E. F.L.S. &c.*[*]

IN Samouelle's Entomologist's Useful Companion, as well as in several other works of deserved reputation, the names of the Genera established by Ochsenheimer, in his *Schmetterlinge von Europa*, are frequently quoted, but the characters on which they are founded wholly omitted, so that they can only be inferred from a laborious comparison of those of their respective types,—a task few persons will be disposed to submit to, in order to clear up an occasional doubt, as to what genus such or such an insect is to be referred. This inconvenience is attributable to the want of an English edition of Ochsenheimer's work; and in some measure to lessen it, the following translation of his Family and Generic Characters is offered to the British student.

Ochsenheimer died in 1822, leaving his work incomplete, only four volumes having been published in his life-time, the last of which appeared in 1816, and consists chiefly of an improved sketch of his arrangement of the Europæan Lepidoptera from the first genus to the eighty-seventh. Before his death, however, only the first forty-three genera were published in detail, with the characters and descriptions of their respective species; these occupy the first three volumes, the last of which terminates with the genus *Eyprepia;* for the fourth contains, besides the sketch of the arrangement, only notes concerning

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[*] Communicated by the Author.

some

some of the species published in the former volumes. The work is continued by M. Frederick Treitschke, and the specific descriptions are completed to the hundred-and-sixth genus inclusive; and M. Treitschke has also given a further sketch of the arrangement, including ten additional genera consisting of the *Phalænæ Pyralides* of Linnæus, the specific descriptions of which are not yet published*. More therefore still remains to be done, and we wait anxiously for the completion of the work. In the mean time we lay the present abstract before the reader; and should he entertain any doubts of the value of M.M. Ochsenheimer's and Treitschke's labours, we refer him to the Introduction to Dr. Horsfield's Descriptive Catalogue of the Lepidopterous Insects contained in the Museum of the East India Company, where he will find such ample testimony to their merit as cannot fail (unless he disregard the maxim "*laudari à laudato,*") presently and effectually to remove them.

1*st Division.*—PAPILIONES.

Wings when at rest, erect.
Antennæ filiform, generally capitate, or terminated by a knob; sometimes only slightly incrassate at the end.
Flight, diurnal.
Larva with sixteen legs; *head* globular, perfectly distinct from the body; *motion* indolent, and sluggish.
Pupa angular.
Metamorphosis generally naked, or not concealed by a web.

Genus 1. MELITÆA, *Fab.*

MELITÆA, *Fab.* Syst. Glossat.
BATTUS et GRAPHIUM, *Scopoli.* Introductio ad Hist. Nat.
NYMPHALIS, *Latr.* Gen. Crust. et Ins.
PAPILIO, *Schrank.* Faun. boïc.
LEMONIADES, Hübn.

Legs, first pair imperfect.
Wings, roundish; *upper surface* of the *anterior* wings, reddish-yellow with black maculæ and dots, or blackish, with reddish-yellow maculæ and dots; *under surface* of the *posterior wings* with alternate orange-yellow, and yellowish-white cross bands with black spots; not silvered.
Antennæ, knob oval, compressed, obtuse.

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* The last volume as yet published is the sixth, of which, Parts I. and II. appeared in the present year.

Larva with seven or nine conical, fleshy protuberances, covered with short hairs, on each of the middle segments of the body, and two larger on the side of the throat.

Pupa, anteriorly rather obtuse, hinder part usually with elevated points; not suspended in any constant manner.

	Species.	Icon.
1.	M. *Maturna*, Linn.	Ernst, I. Pl. XVII. f. 27. a. b.
2.	— *Cynthia*, Fab.	Ernst, I. Pl. XVII. f. 26. a—d.
3.	— *Artemis*, Fab.	Ernst, I. Pl. XVII. f. 28. a. b.
4.	— *Cinxia*, Linn.	Ernst, I. Pl. XIX. f. 32. a—f.
5.	— *Didyma*, Esp.	Ernst, I. Pl. XVIII. f. 29. a—d.
6.	— *Trivia*, Hübn.	Ernst, I. Pl. LXI. Suppl. VII. f. 29. a—d. bis.
7.	— *Phœbe*, Hübn.	Ernst, I. Pl. LXI. Suppl. VII. f. 28. a. b. bis.
8.	— *Dictynna*, Esp.	Ernst, I. Pl. LXII. Suppl. VIII. f. 31. a—d. bis.
9.	— *Athalia*, Esp.	Ernst, I. Pl. XIX. f. 31. c. d.
10.	— *Parthenia*, Borkh.	Hübn. Pap. Tab. 4. f. 19. 20. (fœm.)
11.	— *Lucina*, Linn.	Ernst, I. Pl. XVI. f. 25. a. b.

Genus 2. ARGYNNIS, *Fab.*

ARGYNNIS, Fab.
ARGYREUS, Scop.
NYMPHALIS, Latr.
PAPILIO, Schrank.
DRYADES, Hübn.

Legs, four perfect, gressorial.

Wings subdentate, *upper surface* generally reddish-brown with black spots; *under surface* with silvery bands or spots.

Antennæ capitate, knob compressed.

Larva with six longitudinal rows of ramose spines, and two others, generally larger than the rest on the first segment; a broad, longitudinal, dorsal band, divided by a medial line.

Pupa, suspended variously; cavity of the neck, and the neck, with brilliant points.

	Species.	Icon.
1.	A. *Aphirape*, Hübn.	Hübn. Pap. Tab. 5. f. 23. 24. (mas.) 25. (fœm).
2.	— *Selene*, Fab.	Ernst, I. Pl. XVI. f. 23. a. b.
3.	— *Euphrosyne*, Linn.	Ernst, I. Pl. XVI. f. 22. a. b.
4.	— *Dia*, Linn.	Ernst, I. Pl. XV. f. 21. a. b.

Species.	Icon.
5. A. *Pales*, Hübn.......	Ernst, I. Pl. LX. Suppl. VI. f. 21. a. b. c. d. bis, a. b. c. d. tert.
6. — *Hecate*, Fab.......	Ernst, I. Pl. LIX. Suppl. V. f. 20. a—d. tert.
7. — *Ino*, Hübn.	Ernst, I. Pl. XV. f. 20. c.
8. — *Daphne*, Fab.	Ernst, I. Pl. XV. f. 20. a. b.
9. — *Frigga*, Hübn.	Hübn. Pap. Tab. 9. f. 49. 50. (fœm.)
10. — *Thore*, Hübn....	Hübn. Pap. Tab. 3. f. 571—573.
11. — *Amathusia*, Fab.	Ernst, I. Pl. LXXX. Suppl. II. Pl. I. f. 21. a. b. quart.
12. — *Chariclea*, Schneid.	Herbst, Pap. Tab. 272. f. 5. 6.
13. — *Freija*, Schneid...	Herbst, Pap. Tab. 272. f. 7—10.
14. — *Latonia*, Linn. ...	Hübn. Pap. Tab. 11. f. 59. 60. (fœm.) Pl. CXX. f. 613. var.
15. — *Niobe*, Linn.	Ernst, I. Pl. XV. f. 19. a. b. c.
16. — *Adippe*, Fab.......	Ernst, I. Pl. XIII. f. 16. c—i.
17. — *Aglaia*, Linn......	Hübn. Pap. Tab. 13. f. 65. 66. (fœm.)
18. — *Laodice*, Fab.	Hübn. Pap. Tab. 13. f. 67. 68. (fœm.)
19. — *Paphia*, Linn. ...	Ernst, I. Pl. XII. f. 15. a—f.
20. — *Pandora*, Fab. ...	Ernst, I. Pl. XII. f. 15. g. h.

Genus 3. EUPLOEA, *Fab.*

BATTUS, Scop.
DANAIS, Latr.
LIMNADES, Hübn.

Legs, four perfect.
Wings, anterior with the external margin rather curved; colour reddish-yellow, margin black with white spots; a curved band of white spots towards the apex.
Antennæ oval, knob gradually incrassate. Head and breast black, with white spots.
Larva, with sixteen feet; feet sub-spinous, spines simple.
Pupa nearly cylindrical; suspended freely.

Species.	Icon.
1. E. *Chrysippus*, Linn....	Hübn. Pap. Tab. 133. f. 678. 679. (mas.)

† The only European species of the genus.

Genus 4. VANESSA, *Fab.*

Cynthia, Fab. Papilio, Schrank.
Nymphalis, Latr. Hamadryades, Hübn.
Battus et Graphium, Scop.

Legs, four perfect, gressorial.

Wings, exterior margin angular; upper surface spotted; under side with transverse bands; bands usually blackish-brown or variegated.

Antennæ capitate.

Larva sub-lanate, with several longitudinal rows of stiff, bristly hairs, or spines. (The first segment naked, second and third with four, and the rest with six spines.) Head blackish, bifid; in some species armed with ramose sub-obtuse spines.

Pupa suspended vertically; often externally with a brilliant gold or silver hue: head and dorsal segments mucronate; dorsal ridge acuminate.

	Species.	Icon.
A.	Wings slightly dentate.	
1.	V. *Cardui*, Lnin......	Ernst, I. Pl. VII. f. 7. a—g.
2.	— *Atalanta*, Linn. ...	Ernst, I. Pl. VI. f. 6. a—i.
B.	Wings furcate.	
3.	V. *Io*, Linn...........	Ernst, I. Pl. II. f. 2. a—f.
4.	— *Antiopa*, Linn.....	Ernst, I. Pl. I. f. 1. a—h.
5.	— *V. album*, Fab. ...	Ernst, I. Pl. LVI. Suppl. II. f. 5. a—d. bis.
6.	— *Polychloros*, Linn.	Ernst, I. Pl. III. f. 3. a—i.
7.	— *Xanthomelas*, Illig.	Ernst, I. Pl. LV. Suppl. I. f. 3. a. b. bis.
8.	— *Urticæ*, Linn......	Ernst, I. Pl. IV. f. 4. a—h.
9.	— *Triangulum*, Fab.	Ernst, I. Pl. V. f. 5. g. h.
10.	— *C. album*, Linn....	Ernst, I. Pl. V. f. 5. a—f.
	— *F. album*, Fab. ... (var. *C. album*) ...	Herbst, Schm. Tab. 163. f. 1. 2.
C.	Posterior wings slightly acuminate.	
11.	V. *Prorsa*, Linn......	Ernst, I. Pl. VIII. f. 8. a—e.
12.	— *Levana*, Linn.....	Ernst, I. Pl. VIII. f. 9. a—f.

Genus 5. LIMENITIS, *Fab.*

Neptis, Fab. Papilio, Schrank.
Nymphalis, Latr. Naiades, Hübn.
Battus et Graphium, Scop.

Legs, anterior pair very small; second and third perfect, gressorial.

Wings,

Wings, dentated, the anterior somewhat repand*; upper surface black, or blueish-green; under surface reddish-brown, or cinnamon colour; body griseous.

Antennæ clavate.

Larva variegated; head with two elevated points; body with two longitudinal rows of ramose spines.

Pupa variously suspended; head with two small elevations; the dorsal larger, securiform.

	Species.	Icon.
1.	L. *Aceris*, Fab.	Ernst, I. Pl. II. Suppl. III. f. 12. a—d. bis.
2.	— *Lucilla*, Fab.......	Ernst, I. Pl. X. f. 12. a. b.
3.	— *Sibylla*, Linn......	Ernst, I. Pl. XI. f. 13. a—f.
4.	— *Camilla*, Fab......	Ernst, I. Pl. XI. f. 14. a. b.
5.	— *Populi*, Linn......	Ernst, I. Pl. IX. f. 10. a—d.

Genus 6. CHARAXES, *Ochs.*

Paphia, Fab. Nymphalis, Latr.

Legs, first pair imperfect.

Wings, anterior elongated, angular; posterior dentate, the external margin bicaudate near the apex.

Antennæ clavate.

Larva smooth; head with four horns; body bicuspidate at the anal extremity.

Pupa, nearly oval.

	Species.	Icon.
1.	C. *Jasius*, Linn.	Drury, Illustr. of Nat. Hist. I. Pl. I. f. 1.

† Only one European species.

Genus 7. APATURA, *Fab.*

Nymphalis, Latr. Maniola, Schrank.
Argus, Scop. Potamides, Hübn.

Legs, first pair imperfect.

Wings, somewhat repand, and dentate; colour changeable according to the direction of the light, between brown and purple; posterior wings ocellated at the interior angle.

Antennæ clavate, knob sub-cylindrical, and rather slender.

Larva similar to that of *Charaxes;* but with faint yellow transverse bands: head smooth anteriorly, with two long, straight, obtuse, or bipartite horns.

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* *Ausgeschweift*, repandus, *repand:* cut into very slight sinuations, so as to run in a serpentine direction.—*Kirby* and *Spence*, iv. 297.

Pupa green, compressed: head bicuspidate; suspended vertically by the posterior extremity.

Species.	Icon.
1. A. *Iris*, Linn.	Ernst, I. Pl. XXXI. f. 62. a. b.
2. — *Ilia*, Fab.	Ernst, I. Pl. XXXI. f. 62. c. d. (fœm.) Pl. XXXII. f. 64. e. f. (mas.)

Genus 8. HIPPARCHIA, *Fab.*

NYMPHALIS, Latr. MANIOLA, Schrank.
ARGUS, Scop. OREADES, Hübn.

Legs, first pair less than half the size of the second and third.
Wings, generally brownish, with the margin ocellated.
Antennæ clavate; knob flattened; (often slightly curved.)
Larva, anal extremity bicuspidate: head globular, anteriorly depressed; generally hairy, with dark-coloured longitudinal striæ; hairs whitish.
Pupa short, anteriorly bicuspidate, points erect, small; suspended by the anal extremity.
Metamorphosis, usually in the air, but some species change under ground.

Species.	Icon.
A. 1. H. *Proserpina*, Fab.	Ernst, I. Pl. XX. f. 33. a. b.
2. — *Hermione*, Linn.	Ernst, I. Pl. XX. f. 34. a. b. c.
3. — *Alcyone*, Linn.	Ernst, I. Pl. LXII. Suppl. VIII. f. 35. a. b. c.
4. — *Anthe*, Hübn.	Hübn. Pap. Tab. 115. f. 589. 590. (fœm.)
5. — *Briseis*, Linn.	Ernst, I. Pl. XXI. f. 36. a—d.
6. — *Semele*, Linn.	Ernst, I. Pl. XXII. f. 38. a. b. c.
7. — *Hippolytus*, Fab.	Ernst, I. Pl. VIII. Suppl. III. f. 36. a. b. bis.
8. — *Arethusa*, Fab.	Ernst, I. Pl. XXII. f. 39. a. b. c.
9. — *Fidia*, Linn.	Ernst, I. Pl. XXI. f. 37. c. d.
10. — *Allionia*, Fab.	Ernst, I. Pl. XXI. f. 37. a. b.
11. — *Statilinus*, Fab.	Ernst, I. Pl. LXIII. Suppl. IX. f. 37. a. b. c. bis.
12. — *Phædra*, Linn.	Ernst, I. Pl. XXIII. f. 40. a—e.
13. — *Bryce*, Fab.	Hübn. Pap. Tab. 33. f. 149. 150. (fœm.)
14. — *Cordula*, Fab.	Hübn. Pap. Tab. 29. f. 132. 133. (fœm.)
15. — *Actæa*, Hübn.	Ernst, I. Pl. LXIII. Suppl. IX. f. 37. g. h.

	Species.	Icon.
16.	H. *Podarce*, Ochs.*	— — — —
17.	— *Aëllo*, Hübn.	Hübn. Pap. Tab. 102. f. 519. 520. (mas). Tab. 31. f. 141. 142. (fœm.)
18.	— *Norna*, Thunb.	Hübn. Pap. Tab. 34. f. 152. 153. (mas.) Tab. 30. f. 142. (fœm.)
19.	— *Tarpeia*, Fab.	Cram. Pap. Exot. Pl. CCCLXXV. E. F.
20.	— *Bore*, Fab.	Hübn. Pap. Tab. 29. f. 134. (mas.) 135. 136. (fœm.)
B. 21.	— *Tithonus*, Linn.	Ernst, I. Pl. XXVII. f. 53. a—e.
22.	— *Ida*, Fab.	Ernst, I. Pl. V. Suppl. III. f. 53. h.
23.	— *Pasiphäe*, Fab.	Ernst, I. Pl. LXVI. Suppl. XII. f. 53. a. b. bis.
24.	— *Clymene*, Fab.	Ernst, I. Pl. V. Suppl. III. f. 50. a. b. tert.
25.	— *Roxelana*, Fab.	Cram. Pap. Exot. Pl. CLXI. fig. C. D. E. F.
26.	— *Janira*, Linn.	Ernst, I. Pl. XXVIII. f. 54. a—h.
27.	— *Eudora*, Fab.	Ernst, I. Pl. XXVIII. f. 55. a. b.
C. 28.	— *Hyperanthus*, Linn.	Ernst, I. Pl. XXVII. f. 52. a—f.
29.	— *Dejanira*, Linn.	Ernst, I. Pl. XXV. f. 48. a. b.
30.	— *Hiera*, Hübn.	Hübn. Pap. Tab. 39. f. 176. (fœm).
31.	— *Mœra*, Linn.	Ernst, I. Pl. XXVI. f. 51. a. b.
32.	— *Adrasta*, Hoffmansegg.	Ernst, I. Pl. LXXXII. Suppl. II. Pl. 3. fig. 50. a. b. c. bis.
33.	— *Megæra*, Linn.	Ernst, I. Pl. XXVI. f. 50. a. b. c. d. (e. f. var.)
34.	— *Egeria*, Linn.	Ernst, I. Pl. XXV. f. 49. a—d.
35.	— *Meone*, Hübn.	Cram. Pap. Exot. Pl. CCCXIV. f. E. F.
D. 36.	— *Galatea*, Linn.	Ernst, I. Pl. XXX. f. 60. a—d.
37.	— *Lachesis*, Hübn.	Hübn. Pap. Tab. 41. f. 186. 187. (mas.) Tab. 42. f. 188. 189. (fœm.)
38.	— *Clotho*, Fab.	Ernst, I. Pl. V. Suppl. III. f. 61. a. b. bis.
39.	— *Ines*, Hoffm.	— — — —
40.	— *Arge*, Sulzer.	Ernst, I. Pl. XXX. f. 61. a. b.
41.	— *Syllius*, Herbst.	Ernst, I. Pl. XXX. f. e. f.

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* Sp. n.—H. alis subdentatis fuscis: anticis utrinque ocello, punctisque subtus duobus albis: posticis supra immaculatis, subtus albo fuscoque marmoratis, fasciâ crenatâ concolore albo marginatâ venisque albis.

		Species.	Icon.
E.	42.	H. *Epiphron*, Fab.	Hübn. Pap. Tab. 44. f. 202.
	43.	— *Pharte*, Hübn.	Hübn. Pap. Tab. 97. f. 491. 492. (mas.) 493. 494. (fœm.)
	44.	— *Melampus*, Esp.	Ernst, I. Pl. LXXXI. Suppl. II. Pl. 2. f. 41. a. b. bis.
	45.	— *Cassiope*, Fab.	Ernst, I. Pl. XXIV. f. 45. a. b.
	46.	— *Arete*, Fab.	Hübn. Pap. Tab. 50. f. 231. 232. (fœm.)
	47.	— *Mnestra*, Hübn.	Hübn. Pap. Tab. 106. f. 540. 541. (mas.) 542. 543. (fœm.)
	48.	— *Pyrrha*, Fab.	Ernst, I. Pl. XXIII. f. 41. a—d.
	49.	— *Oeme*, Hübn.	Hübn. Pap. Tab. 104. f. 530. 531. (mas.) 532. 533. (fœm.)
	50.	— *Psodea*, Hübn.	Hübn. Pap. Tab. 98. f. 497. (mas.) 498. 499. (fœm.)
	51.	— *Afer*, Fab.	Hübn. Pap. Tab. 98. f. 500. 501. (mas.)
	52.	— *Ceto*, Hübn.	Hübn. Pap. Tab. 112. f. 578. 579. (mas.)
	53.	— *Medusa*, Fab.	Ernst, I. Pl. XXIV. f. 44. a. b.
F.	54.	— *Stygne*, Hübn.	Hübn. Pap. Tab. 48. f. 223. 224. (mas.)
	55.	— *Melas*, Herbst.	Hübn. Pap. Tab. 45. f. 105. 106. (mas.)
	56.	— *Alecto*, Hübn.	Hübn. Pap. Tab. 104. f. 528. 529. (mas.) Tab. 101. f. 515. 516. (fœm.)
	57.	— *Medea*, Fab.	Ernst, I. Pl. XXIV. f. 43. a. b. e. f. g.
	58.	— *Ligea*, Linn.	Ernst, I. Pl. XXIII. f. 42. a. b.
	59.	— *Euryale*, Esp.	Esp. Schm. I. Th. Tab. 118. Cont. 73. f. 2. (mas.) f. 3. (fœm.)
	60.	— *Embla*, Fab.	Hübn. Pap. Tab. 109. f. 561. 562. (mas.) Tab. 49. f. 228. 229. (fœm.)
	61.	— *Pronöe*, Fab.	Ernst, I. Pl. LXIV. Suppl. X. f. 42. a—e. bis.
	62.	— *Goante*, Esp.	Hübn. Pap. Tab. 50. f. 233. 234. (fœm.)
	63.	— *Gorge*, Hübn.	Hübn. Pap. Tab. 99. f. 502. 503. (mas.) 504. 505. (fœm.)
	64.	— *Manto*, Fab.	Ernst, I. Pl. LXV. Suppl. XI. f. 42. a. b. tert.
	65.	— *Tyndarus*, Fab.	Ernst, I. Pl. LXV. Suppl. XI. f. 42. a. b. quart.

	Species.	Icon.
G. 66.	H. *Davus*, Linn. .	Ernst, I. Pl. XXIX. f. 58. a. b.
67.	— *Pamphilus*, Linn.	Ernst, I. Pl. XXIX. f. 56. a. b.
68.	— *Lyllus*, Esp....	Hübn. Pap. Tab. 109. f. 557. 558. (fœm.)
69.	— *Iphis*, Fab. ...	Hübn. Pap. Tab. 53. f. 249. (mas.) 250. 251. (fœm.)
70.	— *Hero*, Linn....	Ernst, I. Pl. XXIX. f. 59. a. b.
71.	— *Œdipus*, Fab..	Hübn. Pap. Tab. 52. f. 245. 246. (mas.)
72.	— *Arcania*, Linn.	Ernst, I. Pl. XXIX. f. 57. a—d.
73.	— *Dorus*, Esp....	Ernst, I. Pl. LXVIII. Suppl. XIV. f. 57. a. b. bis.
74.	— *Satyrion*, Esp.	Hübn. Pap. Tab. 53. f. 254. 255. (mas.)
75.	— *Corinna*, Hübn.	Hübn. Pap. Tab. 105. f. 534. 537. (fœm.)
76.	— *Leander*, Fab.	Hübn. Pap. Tab. 103. f. 526. 527. (fœm.)
77.	— *Phryne*, Fab. .	Ernst, I. Pl. VIII. Suppl. III. f. 58. a. b. bis.

[To be continued.]

L. *On the Crystalline Forms and Composition of the Sulphates of Nickel.* *By* R. Phillips, *F.R.S. &c.*

THE *Annales de Chimie et de Physique* for May last, contains a memoir by Mons. E. Mitscherlich, "On the crystalline forms and composition of some sulphates": his statements, with respect to sulphate of nickel, appear to require some notice.

In the present paper the author has given only one of the forms of sulphate of nickel, stating that in a memoir which will shortly appear he shall describe another. The primary form of the crystal now under examination, Mons. M. considers as an acute octahedron with a square base; but it may be regarded, as shown by Mr. Brooke in the Annals of Philosophy, vol. 6. N.S., p. 437, as a square prism, parallel to the planes of which it may be cleaved. The composition of sulphate of nickel M. Mitscherlich states to be:

Sulphuric acid	28·51
Oxide of nickel	26·71
Water	44·78
	100·00

M. Mitscherlich then makes the following statement: "In another

other memoir which will soon appear, I shall describe another crystalline form of sulphate of nickel and of sulphate of zinc, which is entirely different from that which I have now described; the production of these different forms depends upon the temperature at which the crystals are formed. The seleniate of zinc, which at a temperature of 50° Fahr. gives prismatic crystals, changes its form when the prismatic crystals are exposed on paper to the heat of the sun. This phænomenon may be also extremely well observed in sulphate of nickel. A temperature of 59° of Fahr., still produces prismatic crystals. If these crystals, of a certain size, be exposed to the sun in a close vessel, it frequently happens that they retain their external form, so that the angles at which the planes meet may be measured; but if they be broken, they are found to consist of crystals frequently several lines in length, which are octahedrons with a square base, the angles of which I have been able to measure. This change requires two or three days.

"I have determined by a very complete analysis the quantity of water contained in this compound. The octahedrons with a square base, into which the prismatic crystals were converted, by several days' exposure to the sun in an uncovered [covered?] vessel, gave me 30·14 per cent. of sulphuric acid; some other octahedrons with a square base derived from the crystallization of a hot solution yielded 29·88. If we take the mean of these two results, we must admit that the octahedron of sulphate of nickel with a square base contains:

Sulphuric acid	30·02
Oxide of nickel	28·13
Water	41·85
	100·00

"It follows from this phænomenon," concludes M. Mitscherlich, "as well as from several others which I have before announced, that the isolated particles of matter in solid bodies are moveable with respect to each other, and that they may assume different relative positions to those which they originally had, without its being necessary to render the bodies fluid.

Now without asserting it to be the case, I do most certainly think that Mons. M. has attributed the difference in the form of these crystals to a wrong cause; and at any rate I am quite sure that the crystals of sulphate of nickel of both kinds may be procured at pleasure, and totally independently of the temperature at which the crystallization occurs.

I have already stated that M. Mitscherlich considers as an octahedron that which Mr. Brooke regards as a square prism; either

either of which forms, from the relation which they bear to each other, may be assumed as the fundamental crystal: while he has not given at all the precise form of the prismatic variety, and which Mr. Brooke in a paper already quoted, has described as a rhombic prism so nearly approaching that of sulphate of zinc, that he is inclined to doubt whether there is any real difference between them.

In this memoir the difference between the crystalline forms is clearly traced by Mr. Brooke; and I have endeavoured to prove that the difference is dependent not upon the proportion of water, as Mons. M. appears to suppose, but owing to one of the crystals containing more sulphuric acid than the other, although not in atomic proportion.

The analyses which I have given in the Annals of Philosophy, N.S. vol. vi. p. 439, show that the quantity of acid in 100 of the square, is to that in the rhombic prisms as 30 to 28·16,—a difference of nearly 2 per cent.; and the quantities of water are respectively 45·54 and 43·8, a difference of almost 1¾ per cent. instead of nearly 3, as stated by M. Mitscherlich.

That excess of acid without any variation of temperature is capable of producing variation of form, is proved by the following experiment: I dissolved 200 grs. of rhombic prisms in water, and added to the solution about half its weight of sulphuric acid, and put the solution to crystallize in a room, the temperature of which varied from about 60° to 64°. The crystals first obtained were similar to those dissolved, viz. rhombic prisms; afterwards I procured a mixture of rhombic and square prisms; and lastly, square prisms only, and this without any greater variation in the temperature than that which I have already noticed.

From this experiment it is evident, that owing to the formation of rhombic crystals in the first instance without excess of acid, the relative proportion of sulphuric acid to the oxide of nickel was subsequently so much increased, that square prisms were formed, which from the analysis already stated contain a larger proportion of acid.

In corroboration of the inference that the difference of form is dependent upon that of the quantity of acid, I shall merely add that a solution of 200 grs. of rhombic prisms, to which no sulphuric acid was added, and crystallized in the same room already mentioned, yielded merely rhombic without any admixture of the square prisms.

To the foregoing statements I may add, that rhombic crystals of sulphate of nickel, when exposed to the air, effloresce, which is not the case with the octahedral variety; and it appears to me probable, that when rhombic prisms which have been

been deposited from a solution containing excess of acid, are exposed to the sun, the supposed formation of octahedral crystals is merely a removal of the enveloping rhombic crystals by efflorescence, and the consequent development of the inclosed octahedral crystals; for rhombic crystals formed in the requisite mode frequently contain minute octahedrons, which may be observed by merely breaking the crystal, which will explain their occurrence, even without any external change in the enveloping rhombic prism.

LI. *Chemical Examination of some of the Substances connected with an Egyptian Mummy.* *By* E. S. George, *F.L.S. Secretary to the Leeds Philosophical and Literary Society*[*].

I.—A PORTION of the pounded wood found about the throat and breast, was digested in boiling alcohol; a deep brown solution was thus obtained, which, after being filtered, remained permanently transparent. The odour of myrrh was very sensible, and the alcoholic extract afforded with water the characteristic precipitate of solutions of myrrh. By a careful examination of the wood, it was separated into two parts; the one, and that the most abundant, was myrrh, and the other cassia. The odoriferous wood from the abdominal cavity, subjected to the same treatment, gave similar results.

II.—The folds of cloth with which the mummy was bandaged, presented, near the body, a much deeper colour than the external wrappings. A portion having a deep chesnut colour was digested in boiling water ten minutes; a very deep brown-coloured solution was thus obtained. The addition of a few drops of gelatine to this solution, gave an immediate precipitate, indicative of the presence of tannin: this result was rendered more striking by concentrating the solution, when large flakes of the tannate of gelatine were precipitated. A few drops of a solution of muriate of barytes were added to this aqueous extract: an immediate precipitate fell down; it was found to consist principally, of carbonate of barytes, and by the requisite tests, the presence of the carbonate, muriate, and sulphate of soda was discovered, the former salt in the largest proportion.

III.—Analysis of the fleshy parts of the body.

1.—A piece of thick abdominal muscle, weighing 97 grains,

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[*] From Mr. Osburn's "Account of an Egyptian Mummy presented to the Museum of the Leeds Philosophical and Literary Society, by the late John Blayds, Esq."—A further notice of this work will appear in our next Number.

was macerated one hour in water, at about 170°; the solution had a light yellow colour and a saline taste.

2.—The portion remaining was repeatedly digested in boiling alcohol (·835 rectified spirit of wine), until the spirit ceased to acquire any colour: the alcoholic solutions deposited a yellow-coloured substance upon cooling. The whole of the solutions were mixed together and diluted by about twice their amount of water; an immediate yellow-coloured precipitate fell down: on the application of heat the precipitate melted, and floated upon the surface of the water; it was ascertained that this substance became solid at 110° Fahrenheit: it was thus removed, and after being dried between the folds of filtering paper, weighed 23 grains.

3.—The remaining liquid, when cool, was opaque, but upon being heated to 212° became transparent. On evaporation to dryness, it weighed 12 grains, and proved to be almost entirely gelatine.

4.—The aqueous solution, (No. 1.) was evaporated to dryness; the residue, which was of a dark-brown colour, brittle, and covered with bright saline crystals, weighed 9 grains. The addition of a few drops of water converted the whole of it into a mucilage; the saline part consisted almost entirely of carbònate of soda, with some muriate and sulphate, and appeared identical with the salt found in the bandages. The mucilaginous portion was gelatine.

5.—The part undissolved by the action of both water and alcohol, weighed, when dry, 51 grains; it did not inflame readily, and gave out when burning the peculiar smell of burnt horn.

6.—The substance (2) had a deep yellow colour, and a greasy feel very much like that of cerate; it possessed little either of taste or smell when cold: when fused, it gave out the odour of the spices found about the body; it inflamed, and emitted a large quantity of light during its combustion. It was entirely dissolved in liquid ammonia, and the solution remained perfectly transparent on the addition of water; this alkaline solution exposed in an evaporating-dish to the air, deposited a soapy substance as the ammonia evaporated. Potash formed with this substance a soap soluble in water. Boiling nitric acid scarcely acted upon it. Subjected to destructive distillation, it presented the following appearances. Upon the application of heat it melted, and bubbles of air were rapidly disengaged; —after a short time, the liquid became quiescent, the retort was filled with dense white fumes, and a few drops of water were condensed. No trace of the formation of ammonia was perceptible, nor did the water taste acid; at a more elevated temperature a dark-coloured oily fluid trickled down the beak of of the retort, and was condensed into a fatty substance, which increased and became more solid as the distillation advanced; at the same time a pungent and disagreeable vapour passed over, having very much the odour of candle-snuff. At the close of the experiment, a bright charcoal remained in the retort.

7.—A portion of muscle was digested in boiling spirit of turpentine: the solution, which was deep coloured, being evaporated to dryness, left a substance similar to that separated by alcohol.

8.—In order to determine whether the substance separated by alcohol and essential oil of turpentine was formed by their action upon the animal matter, a portion of muscle was digested one hour in boiling water; the surface of the water was covered by an oily substance, which, on cooling, became solid, and resembled in all its properties that separated 1. 2. and 7. The aqueous solution contained a considerable quantity of gelatine.

9.—A piece of thick muscle covered with skin was digested four days in cold alcohol (sp. gr. 835), the solution acquired a dark-brown colour; by spontaneous evaporation, a white substance in plates was deposited. The solution, when reduced to one-fourth of its original bulk, was filtered, and the solid part dried upon the filter: it had precisely the same properties as the substance obtained by the action of boiling alcohol, except being of a much lighter colour. Upon evaporating the solution which passed through the filter to dryness, a very small quantity of a body heavier than water, insoluble in that liquid, and which possessed all the characters of resin, remained.

IV.—A small fragment of the visceral substance, supposed to be the liver, was examined. It was covered with a thin coating of saline efflorescence, mixed with earth. The salts proved to be the same as those before examined,—the carbonate, muriate, and sulphate of soda; tests were carefully applied to detect, if present, the nitrate of potash, but without discovering any trace of that salt. The earthy substance effervesced with acids.

The liver was next repeatedly digested in alcohol and water. Gelatine was the only substance separated by these solvents—the aqueous solution contained a large quantity. I found in the course of this set of experiments, that although gelatine is insoluble in pure alcohol, yet the rectified spirit of wine (sp. gr. 835) dissolves it.

V.—The drops of a resinous substance from the cavity of the head, were found to be pure resin, having a very fine odour, which was not accertained to resemble that of any known resin.

In many of the substances discovered by this analysis, the characters are so unequivocal as to render their identification easy and certain;—such are the salts, the tannin, and colouring matter of the bandages; the gelatine obtained from both the muscular part and the viscera; the resins, and the pounded spices from the body. There is, however, some difficulty in arriving at a conclusion with the remaining, and indeed most important substance; for although its appearance, and many of its chemical properties closely resemble those of wax, some others approach very nearly to the properties of animal substances, as adipocire.

Like wax, this substance is soluble in alcohol, but differs in degree; cold alcohol, which scarcely acts upon wax, dissolving it readily. With wax, the alkalies form soaps almost insoluble in water: with this substance, the alkaline soaps are very soluble.—Nitric acid scarcely acts upon wax; boiling nitric acid exerts a very slight action upon this substance, for the loss of colour depends upon the removal of a small quantity of resin, which it was shown (9.) that the alcoholic solution from the muscular part contains*.

The results of the destructive distillation of both very closely agree. Comparative experiments with equal weights of wax were made; the only difference noticed was, that in the distillation of the wax the product was more acid and empyreumatic, and that the quantity of permanent gases liberated was larger. With adipocire this substance agrees in its solubility in cold alcohol, in forming alkaline soaps soluble in water, in its point of fusibility, which is lower than that of wax, and in the action of acids.

Whether this substance be an adipocirous body formed by the process of embalming, or wax introduced during that process into every part of the deepest muscle, I shall not determine. In the appearance of the mummy there is much to favour the former opinion; the bones of the most exposed parts, as the head, are not in the slightest degree penetrated by this waxy substance, in a fused solution of which, we must suppose the body to have been many days immersed; nor is the wax found in greater abundance upon and near the surface, than in the most deeply seated parts; the cuticle covers every part of the body, which scarcely would have been the case if exposed so long to an elevated temperature.

I am aware that Dr. Granville has, from a very elaborate and interesting examination of a mummy, concluded that wax

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* The oil of cedar is one of the ingredients in the process of embalming. The resinous appearance may, probably, have arisen from the use of this condiment.—*Note by Mr. Osburn.*

was employed in the process. This mummy, in some respects, differs from his, in the perfect state of the viscera, and in the total absence of bitumen, or of any but the most expensive woods and resins.

LII. *Proceedings of Learned Societies.*

GEOLOGICAL SOCIETY.

June 20.—JOHN, Earl of Shrewsbury, of Great Stanhope Street, May Fair, and of Alton Abbey, Staffordshire; Robert Allan, Esq. of Charlotte Square, Edinburgh; W. S. Henwood, Esq. of Perran Wharf, Truro, Cornwall; and the Rev. John Ward, Vicar of Great Bedwin, Wilts,— were elected Fellows of this Society.

A paper was read "On the Geology of Bundelcund, Boghelcund, and the districts of Saugor and Jabalpoor in central India." By Captain James Franklin, of the Bengal Army, F.R.S. F.A.S.

The tract of country described by the author is a portion of the lowest northern steps of the Vindáya mountains, situated between the latitudes 22° 40″, and 25° 20″ N., and the longitudes 78° 30″, and 83° E.; having on its north-eastern extremity the towns of Mirzapoor and Allahabad, and near its southern limit, those of Tendukaira, Singpoor and Mundla.

In this extent of country the principal situations examined by Captain Franklin were, the pass of Tara in the first range of hills; the pass of Kattra in the second range; the cataracts of Billohi, Bauti, Kenti, Chachye, and of the Tonse river; the neighbourhood of the villages of Simmereah, Hathee, Birsingpur, Sohawel, Nagound, and Lohargaon; the bed of the Cané river near Tigra; the neighbourhood of Hatta, Narsing-hagarh, Patteriya, Saugor, Tendukaira; the valley of the Nermada river; Garha-kota, Great Deori; the Bandair and Kymur hills; Jabalpoor, and the waterfall of Beragurh.

The succession of formations observed by the author consisted, in a descending order:—1. Of diluvial deposits.—2. Of overlying rocks of the trap formation.—3. Of a compact limestone.—4. Of red-sandstone.—And, lastly, 5. Of primitive rocks, including granite, gneiss, &c. The paper is illustrated by a geological map and section of the country; and the author particularly wishes to direct the attention of geologists to the limestone of the second range of hills, which he is of opinion corresponds with the lias-limestone of England, a formation which has not hitherto been shown to exist in India.

Having commenced his route at Mirzapoor on the Ganges,—in a district covered with alluvium reposing in some places on beds of "Canker," in others on sandstone, the author ascended the first range of hills at the pass of Tara. These hills are composed of fine-grained sandstone horizontally stratified, and more or less coloured by red oxide of iron; the rock appears to be saliferous, and is in many places quarried for architectural purposes; and it seems to correspond

respond with the central portion of the new-red-sandstone of England.

At the pass of Kattra, near the summit of the second range of hills, a friable variegated sandstone appears, in which thin laminæ of sandstone alternate with red clay, resembling the red marle of England, both reposing on slaty marle coloured by chlorite, which rests, apparently, on massive horizontal strata, resembling clay-slate or grauwacke.

At the bottom of the cataract of Billohi, 398 feet in height, argillaceous sandstone was found, tinged deeply by red oxide of iron, and containing disseminated mica,—on which reposed a siliceous sandstone of a more compact texture.

Greenish white arenaceous sandstone not quite so compact was found at the cataract of Bauti, 420 feet below the summit, varying in colour as it ascended: and twenty-four miles further westward, at the cataract of Kenti, and at a depth of 272 feet, as well as at the cataracts of Chachye and of the Tonse river, sandstone of the same general character was observed rising to the surface.

The sandstone of Simmereah is sometimes ferruginous, at others slaty, and interspersed with mica; in the neighbourhood of Hathee it is succeeded by what the author considers as the equivalent of the lias-limestone.

At Birsingpur, in the bed of a small river, is a stratum of red marle or sandstone, containing laminæ of calc-spar; at Sohawel the red marle underlies the limestone above mentioned; and at Nagound in the bed of the Omeron river, the lower and central beds of limestone are exposed to view, containing fragments of fossil wood, stems of ferns,—and, as the author states, the gryphite which is characteristic of this formation in Europe.

This limestone appears also at Hatta and Narsinghagarh reposing on red marle, and in the latter situation is tinged green by chlorite. At Patteriya, where the limestone comes into contact with trap, the strata assume in some places the form of chert.

The aspect of this limestone is dull and earthy; its stratification horizontal or nearly so, and always conformable to the red marle on which it reposes.

Between the pass of Patteriya and Saugor, the author met with no other rock than trap, generally in the form of boulders imbedded in friable wacken, and composed of concentric layers: beneath the boulders is a bed of indurated wacken and basalt; and under the latter a stratum of impure limestone, in some parts containing a large proportion of alumine; below the limestone is a stratum of amygdaloid, containing calc-spar and a few zeolites, which at Saugor reposes on sandstone.

The trap of Saugor continues without interruption to Tendukaira: it contains abundance of chalcedony, semiopal, mealy zeolite, cachalong, agates, jaspars and heliotrope.

At about the distance of three miles from the foot of the hills near Tendukaira, in the valley of the Nermada river, the older rocks are exposed to view, in strata which are highly inclined,—in some instances

stances nearly vertical, and in all cases unconformable to those already noticed.

On his route from Tendukaira to Garha-Kota, captain Franklin was enabled to ascertain the eastern boundary of the trap formation, which is throughout intimately associated with earthy limestone; the whole series reposing on red marle and sandstone.

Trap in horizontal strata was also observed for an extent of three miles near Great Deori, previous to the appearance of the sandstone of the Bandair hills, which last-mentioned rock the author is of opinion corresponds with the new-red-sandstone of England; the same chain of hills is composed of sandstone opposite Nagound, Lohargaon, Tigra, and Gurreha. The Kymur range in some parts appears to be composed of quartz-rock, varying to siliceous grit, in strata nearly vertical; but to the S.W. near Hirapur, the rock becomes more compact; and still further west, opposite Googni, it is intermixed with clay-slate and schistose limestone.

A broad valley covered with diluvium, intervenes between the Kymur range of hills and Jabalpoor; and near that town another range is situated, composed of granite containing flesh-coloured felspar, smoky quartz, black mica and hornblende;—and in which, also almost every rock commonly associated with granite is to be found.

Snow-white dolomite, traversed occasionally by chlorite schist, is to be seen near the waterfall of Beragurh, intimately associated with quartz; it is here capable of taking a fine polish, and scarcely effervesces with acids; but a few miles further west, near Bograi, it is exceedingly friable, and effervesces freely: it moreover contains crystals of Tremolite.

Captain Franklin observes that a part of the southern barrier of the valley of the Nermada river, like the northern barrier opposite Tendukaira, is composed of trap-rocks, the contour of which, to the extent of 80 miles, he has laid down on his map. The eastern deposit of overlying rocks extends southwards as far as Chuparah, and thence eastward towards Mandela, Omercuntuc, and Sohagpoor; but whether it is united with the great central mass, he was unable to ascertain.

The paper concludes with some inferences from the observations; and after stating the opinion of the late Dr. Voysey, that "the basis of the whole peninsula of India is granite," (Asiatic Researches, Vol. XV. page 123.) the author observes,—1. That although granite is very near the surface in many parts of the tract which fell under his examination, yet there is here, as in other countries, a series of primary stratified rocks intervening between the granite and secondary formations; which series however, there is reason to conclude, is thin and often wanting.

2. The sandstone formation has a visible thickness of 420 feet at the cataract of Bouti, and is considerably thicker no doubt near Chachye and the Bandair hills, &c. The limestone formation on the contrary, which in other countries sometimes forms mountain tracts, and occupies extensive portions of the earth's surface, is in India a mere plastering, as it were, over the red marle or sandstone; and Captain Franklin

Franklin doubts whether it ever attains a thickness of 100 feet; 50 feet being perhaps a fair average. He never met with it in any other situation than on the summit of the second range of hills.

3. The overlying trap-rocks are not only the most extensive, but, considering them in a geological view, the most important formation in this part of India. The thickness of this formation is variable: it reposes on every rock indiscriminately, from granite upwards; and at Saugor it may be seen on sandstone, where its inferior boundary is about 1350 feet above the sea. In the centre of India it occupies the summits of the highest mountains; and at Bombay it descends to the level of the sea.

There are two kinds of basaltic rock in the district of Jabalpoor, clearly of distinct formations; the older variety penetrates the grauwacke stratum, in the bed of Nermada river, near Lamaita; the younger is an overlying rock like that at Saugor,—but reposing on granite, and containing a greater proportion of augite and olivine.

Captain Franklin also describes a calcareous conglomerate, found in the beds of most of the rivers whose sources or channels are in the trap, and of sufficient cohesion for architectural purposes: its stratification is always horizontal, and in point of age he thinks it must be classed with the tufas and concretionary formations so prevalent in India.

An appendix to this paper contains the results of barometrical and thermometrical observations made between Nov. 1826, and Feb. 1827, on the route from Mirzapoor to Saugor, and thence to Tendukaira and Jabalpoor; with the heights of fifty-four places above the sea, and the latitudes and longitudes of the respective stations.

An extract was read of a letter from Samuel Hobson, Esq. to Dr. Roget, F.G.S. Sec. R.S. &c. (dated at New Orleans, 6th April, 1827,) and enclosing an account of some gigantic bones,—by Samuel W. Logan, M.D.

The place where these bones had been found is not mentioned; but at the date of the letter, they were exhibited publicly at New Orleans. Dr. Logan describes them as consisting of one of the bones of the cranium, fifteen or twenty vertebræ, two entire ribs and a part of a third, one thigh-bone, two bones of the leg, and several large masses of a cancellated structure.

The cranial bone was twenty feet and some inches in its greatest length, about four feet in extreme width (for the bone tapers to a point), and it weighed twelve hundred pounds. Dr. Logan inclines to think that this is the temporal bone.

The vertebræ, consisting of a body, oblique transverse, and spinous processes, gave sixteen inches as the mean diameter, and twelve inches as the depth of the bodies; while the passage for the spinal cord measured nine inches by six. The spinous processes stand off backwards and downwards, fourteen inches in the dorsal, and somewhat less in the lumbar vertebræ, three of which latter are entire.

The ribs, well formed and in a perfect state of preservation, measured nine feet along the curve, and about three inches in thickness.

The thigh-bone, measured in length, gave only one foot six inches, but is very thick. The bones of the leg are of similar dimensions, but perhaps a little more slender.

It had been conjectured that the animal to which these remains belonged, was amphibious, and perhaps of the crocodile family; and the conjecture appeared to Dr. Logan to be justified by the great length and flatness of the head (judging from the single specimen of the cranial bone), and the shortness of the limbs. It was also supposed that the animal, when alive, must have measured five and twenty feet around the body, and about one hundred and thirty feet in length.

An Extract was read of a letter from his Grace the Duke of Buckingham, to Professor Buckland, V.P.G.S. dated at Naples, 3rd April, 1828, giving an account of certain phænomena, which attended the late eruption of Vesuvius. The author states that the Solfaterra was in no degree affected by the eruption.

A Letter was read from Charles Stokes, Esq. F.G.S. F.R.S. to W. J. Broderip, Esq. Sec. G.S. explanatory of three drawings of Echini, representing,—1. A specimen of *Galeorites albo-galerus* (Lam.), from the chalk, in which the plates of the mouth, consisting of five pairs, are preserved *in situ*;—2. A *Cidaris,* also from the chalk, in which portions of the plates of the mouth and the teeth are visible: they are displaced, but exhibit a system quite analogous to that of the recent cidaris;—and, 3. A *Cidaris* from Stonesfield, in which the anal plates are in the best preservation.

At the close of this Meeting, which terminated the Session, the Society adjourned till Friday Evening, the 7th of November; when they will meet at their Apartments in Somerset House.

ASTRONOMICAL SOCIETY.

The reading of Mr. South's paper "On the Occultation of δ *Piscium* by the Moon, &c." commenced in April, was resumed and concluded.

Of all the phænomena which occupy the attention of the practical Astronomer, the Author of this paper considers, that no one admits of such accurate observation, as does the occultation of a fixed star by the moon: occasionally, however, a circumstance presents itself to his notice, which merits peculiar consideration, namely an apparent projection of the star, upon the lunar disk; the instances in which this anomaly has been observed in this country, are indeed rare; and has, he says, led many to consider it the attendant of a lively imagination. If, however, we dispassionately review the observations of Continental Astronomers, of unsullied reputation, there will, Mr. South says, be little reason to doubt the fact of apparent projection, although perhaps there may be considerable difficulty in arriving at its cause.

The only instance in which Mr. South has witnessed the phænomenon, was previous to the occultation of δ *Piscium,* on the 6th of February 1821. (Latitude of the Observatory 51° 30′ 2″,97 North. Longitude of the Observatory 21ˢ,76 West.) The night was beautifully

tifully fine, the moon's dark limb and unilluminated disk unusually distinct: the atmosphere peculiarly serene, and the moon's limb, as well as the star, remarkably steady. The observation was made with his five-feet equatorial, furnished with a power of 127; the observer was at the telescope 4 or 5 minutes before the immersion could happen: every thing went on as usual, till the moon's limb came in contact with the star; but the expected occultation did not occur. He noted the time when the apparent contact took place, which was at $3^{h}\ 20^{m}\ 54^{s},0$ by the clock. The star, unshorn of any of its splendour, remained visible on the unillumined lunar disk, till $3^{h}\ 21^{m}\ 2^{s},9$ by the clock, when it instantaneously disappeared. Not the slightest sensible deviation in the star's place occurred between the moments of apparent contact and subsequent disappearance; and it exhibited the same perfectly defined disk whilst on the moon's limb, as it was observed to have, previously to the contact.

The corrections for the clock's error being applied, the observations will stand thus:

	h	m	s
Apparent contact at	3	20	29,87
Instantaneous immersion ..	3	20	38,77
Emersion	4	14	32,88

The only corresponding observations of this occultation which have come to Mr. South's knowledge, were made by Mr. Littrow and Mr. Baily, and their results are given in the Memoirs of this Society. As Mr. Littrow has not narrated any peculiarity, it is probable none presented itself to him; and Mr. Baily has authorized Mr. South to state that he saw nothing anomalous; a circumstance certainly important, seeing that in Blackman Street the apparent projection of the star on the moon's disk, continued nearly nine seconds of time. On the same evening in Blackman Street, a star of the 8th or 9th magnitude suffered occultation by the moon's dark limb, nearly at the same part, at which *δ Piscium* entered on the disk; the star disappeared instantaneously at $5^{h}\ 2^{m}\ 6^{s},0$ by Mr. South's clock; prior to occultation, however, this star was not seen projected upon the limb; but the low altitude of the moon rendered the observation less satisfactory than was the previous occultation of *δ Piscium.*

The recorded observations of other Astronomers are then quoted in the words of their respective authors, or in authentic abstracts; and are principally derived from the *Mémoires de l'Academie Royale des Sciences,* the *Histoire et Mémoires de l'Academie Royale des Sciences de Toulouse,* the *Histoire Céleste Française,* the *Connoissance des Tems,* and the *Observations Astronomiques faites à l'Observatoire Royal de Paris,* tom. I.: this done, they are arranged in a tabular form, presenting at one view, the name of the observer, the place of observation, the nature of the occultation, the age of the Moon, and her motion at the time, whether northerly or southerly; information of a nature not easily to be abridged, and far too voluminous, to have insertion in the Monthly notices of the Society's proceedings.

On perusing them, however, we find, that more than 20 stars have exhibited peculiarities at, or on, the moon's limb, prior to immersion behind it, or emersion from it; that the anomalies are not confined

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to stars of a certain magnitude or colour; nor are they dependent upon any particular age of the moon. Most of them have furnished but solitary instances of peculiarity; viz. *Spica Virginis*, γ *Libræ*, 132 *Tauri*, α^1 *Cancri*, λ *Aquarii*, 249 *Aquarii*, 187 *Sagittarii*, γ *Tauri*, ρ *Leonis*, ρ *Geminorum*, δ *Cancri*, and δ *Piscium*. One, *Regulus*, affords three, whilst to *Aldebaran* we are indebted for no less than twenty instances of anomaly.

On reference to the list, the anomaly alluded to, it will be seen, stands not upon the testimony of a single individual, but is supported frequently by the evidence of a second, and sometimes even of a third person; occasionally they are co-observers at the same station; at other times they are at different parts of the same city; whilst in some instances, they are separated by a very considerable distance. On the other hand, the conflicting testimonies, where we should least expect to find them, are perplexing; a circumstance which together with the vague manner in which the observations are frequently recorded, and the habit, which in many instances unfortunately prevailed, namely, of observing the immersion and emersion of the same star, on the same occasion, with different telescopes, and the almost constant omission to register, if the moon's dark limb, *was* or was *not* visible, enable us, Mr. South says, to do little more than to state, with some appearance of probability, what are *not* the causes of the phænomena.

The hypotheses advanced as explanatory of the phænomena in question, are then stated: viz. A lively imagination on the part of the observer:—A spurious disc given to the moon's image by the instrument of observation:—A lunar atmosphere:—Irradiation:—And lastly, different refrangibilities to which the rays from the moon and star are liable, arising from their differences of colour.

As unfavourable to the first hypothesis, which would refer the phænomenon to a lively imagination on the part of the observer, Mr. South advances the fact, that 'more than sixty instances of anomaly stand attested by such men as Messier, Troughton, Bouvard, Arago and Mathieu; and that it is rather too much to suppose, that all of them are liable to the imputation, which such an hypothesis would require.

The second hypothesis, which supposes a spurious disk to be given to the moon's image, might, he observes, be entitled to some consideration, had refracting telescopes whose object-glasses were not achromatic, been solely employed for the observations; but seeing that refractors, long and short, achromatic and non-achromatic; reflectors, newtonian and gregorian, most of which were probably far above the rank of good instruments, and some of which certainly might be brought forward as the most perfect specimens of optical ingenuity,—have all exhibited the anomaly; there is considerable difficulty in receiving the hypothesis; unless indeed we could grant that a constant cause should not produce a constant effect.

The next hypothesis offers a lunar atmosphere as the occasion of the apparent projection of a star on the moon's disk. Were this the case, its effects would be similar upon all stars of similar colour; and should

should we not see evidence of its existence, in some shape or other, at every occultation which occurred? yet, how infinitely few are the instances, in which any thing whatever is observable of alteration in the star, on the moon's approach to it; indicated by derangement of its position, diminution of its splendour, or change of colour. Still it must be remembered, such changes do stand on record; but they are either so unsubstantiated, or are so referable to other causes than a lunar atmosphere, that we are scarcely warranted in lending ourselves to the hypothesis, to which they would conduct us.

The hypothesis next in order, suggests irradiation as the source from which the anomaly is derived. It seems, however, Mr. South thinks, incapable of answering the purpose for which it is brought forward; seeing that projections of stars upon the moon's *dark* limb, have been witnessed by Messier, by Maskelyne, by Arago, by Mathieu, and by himself.

That the last hypothesis,—namely, that which supposes the apparent projection to arise from the different refrangibilities of the rays issuing from the star and moon,—is not tenable, Mr. South advances the circumstance, that not only Aldebaran and the *red* stars, are liable to the anomaly; but that stars as remarkable for their *white* light, as is Aldebaran for its *red*, have exhibited the phænomenon of apparent projection. He also says that, as far as he knows, no instance of apparent projection of the planet Mars upon the moon's disk, is at present recorded amongst the list of lunar occultations of that planet; yet Mars is much more decidedly *red* than Aldebaran, or than any other star which has been observed on the lunar disk.

Having, as he thinks, shown that the above hypotheses are inadequate to the purpose for which they have been designed, Mr. South states that he should not be justified in advancing any hypothesis in addition to those which he has combated; but concludes his paper by stating that from the *Connoissance des Tems*, he finds that the moon's path will, during the years 1829 and 1830 furnish several occultations of Aldebaran; when it is to be hoped that a phænomenon, which has been so little observed in Great Britain, that if it rested solely on the authority of British Astronomers would be scarcely entitled to any notice, will not longer furnish an object for their reproach.

ROYAL ACADEMY OF SCIENCES AT PARIS.

Feb. 4th, 1828.—Dr. Panquy presented an Essay on a natural chemical method.—M. Moreau de Jonnès communicated some details relating to the late earthquakes in the Antilles.—M. Freycinet read a letter from MM. Quoy and Gaymard, dated from Tongatabou.—MM. Latreille and Duméril gave a favourable account of a memoir presented by Dr. Bretonneau, On the blistering properties of some insects of the Cantharides family.—M. Coquebert de Montbret reported respecting a memoir of M. Auguste Duvau, intitled: *A Statistical Essay on the department of Indre and Loire, or ancient Touraine.*—M. Gay-Lussac announced that M. Guimet, assistant-commissary in the Powder and Saltpetre Works, had succeeded in manufacturing ultramarine, by combining the principles which chemical

chemical analysis had discovered to exist in it. This new product is richer in colour and more splendid than the natural one.—M. Ozenne continued the reading of his paper on the study of delivery.—The Academy elected a Commission by ballot, for adjudging the prize founded by M. de Monthyon, in favour of him who should render an art or trade less unwholesome.—The Commissioners are: MM. Thenard, Gay-Lussac, Darcet, Chevreul, and Dulong.

Feb. 11.—M. Lermier sent Researches concerning the influence which the will of man exercises upon inanimate bodies.—M. Julia Fontenelle, a letter On the phænomena of the incandescence of strontian and barytes.—M. Baehr of Kœnigsberg, a memoir intitled, *De Ovi Mammalium et Hominis Generi.*—M. Beudant gave a favourable account of M. Rozet's geognostic description of the Bas-Boulonnais.—M. Cuvier, on behalf of a Commission, presented an analysis of all the specimens which MM. Quoy and Gaymard had sent to the Museum of Natural History since the sailing of the Astrolabe: these indefatigable observers render themselves increasingly worthy of the protection of authority.—M. Geoffroy Saint-Hilaire reported respecting the memoir of M. Lisfranc, relating to the Rhinoplastic; the opinions are very favourable.—M. Civiale began the reading of a new memoir on Lithotrity.

Feb. 18.—The Minister of the Interior invited the Academy to examine the weighing machines made by M. Paret.—M. Tournal, Jun. sent a memoir On the geognostic constitution of the basin in the environs of Narbonne.—M. Lassaigne sent, by request of the Director of the School at Alfort, a molar tooth of an elephant, found fifteen feet below the surface, in a mass of sand and flints worked near the village of Maison.—M. Levret presented a memoir, intitled *Des Courbes et des Surfaces semblables.*—M. Donné read a memoir On the employment of iodine and bromine, as tests of the vegetable alkalies.—MM. Saint-Hilaire and Martin read a memoir On the anatomy of some parts of the female tortoise.—MM. Legendre, Poinsot and Cauchy gave a favourable account of an extremely curious memoir very long since presented to the Academy by M. Poncelet: this memoir was intitled, *Théorie générale des polaires réciproques.*—M. Lassis read the first part of a memoir On the yellow fever.

Feb. 25.—The Minister of War invited the Academy to examine M. Longchamp's Theory of Nitrification. M. Longchamp wrote to request that the examination might be confined to the inquiry, whether it was advisable to construct artificial nitre-works according to his theory.—M. Jomard communicated some details respecting Captain Clapperton and Major Laing, whose death had been announced.—M. Saint-Hilaire made a favourable report on MM. Audouin's and Edwards's memoir On the nervous system of the Crustaceæ.—M. Desfontaines gave a verbal account of M. Chevalier's new Flora of the environs of Paris.—M. Lassis concluded the reading of his memoir On the yellow fever.—M. Comte read anatomico-physiological researches on the causes of the superiority of the right hand.

March 3.—M. Leymeries sent several treatises respecting the causes

causes of the yellow fever; M. Arago presented from M. Fiedler, several vitrified tubes produced by lightning; one of them was eighteen feet long.—M. Chevreul requested not to be one of the Commission appointed to examine the memoir of M. Longchamp on nitrification.—M. Latreille, on behalf of a Commission, gave a very favourable account of M. Edwards's memoir On the four undescribed species of Crustaceæ.—M. Savart, in the name of a Commission requested by the Minister of the Interior, announced that there would be no inconvenience in punching M. Paret's weighing machines.—M. Coquebert-Montbret gave a verbal account of several statistical researches by M. César Moreau, vice-consul of France in London, relating to the finances of Great Britain.

March 10.—M. Vauquelin presented a memoir by M. Farro On the copper extracted from vegetables—M. Raspail presented several plates relating to a memoir which he read in the month of September last.—MM. Duméril and Magendie, named by the Academy, at the request of M. Malbouche, to take cognizance of the processes received from America, and which, according to M. Malbouche, form a certain method of curing stammering, announced that the method succeeds in the greater number of cases.—M. Ampère gave an unfavourable verbal account of a publication by M. Opoix, respecting the sensations of sound and light.—There were afterwards read,—a memoir by M. Peclet, On the passage of hot air through pipes;—a memoir by M. Nicollet, On the latitudes of Barcelona and Montjouy, ascertained by M. Méchain;—a memoir by M. Raspail, On the granules of pollen;—and a memoir On the mechanism of the voice, by M. Begin.

March 17.—M. Deleau gave a written account of the progress of four deaf and dumb children, which had been put under his care.—M. Roche presented a memoir relating to the laws according to which the elastic force of vapour increases with the temperature.—M. Gendrin announced that he had obtained very good results in the employment of iodine in the gout.—An anonymous correspondent announced that he had discovered an infallible plan for stopping the leakages in the Tunnel under the Thames.—M. Brongniart read a letter from M. Acosta, respecting the earthquake which had destroyed a great part of the city of Popayan.—M. Warden communicated a note respecting two islands recently discovered in the Pacific Ocean, by Captain Joshua Coffin.—M. Arago replied to some doubts which had been expressed respecting M. Fiedler's vitrified tubes; and afterwards gave an analysis of an English memoir, which the President had sent him, respecting two auroræ boreales, observed in America.—M. Dumeril gave a very favourable account of the anatomical researches which MM. Martin and Isidore Saint-Hilaire presented respecting the anatomy of the tortoise and the crocodile.—M. Fourier presented a memoir On the conducting power of bodies.—M. Héricart de Thury read a notice respecting an overflowing spring, lately obtained by boring, in the park belonging to Madame Groslier at Epinay.—M. Dutrochet read additional researches on endosmosis and exosmosis.

March 24.—M. Poinsot presented a note on the formulæ, by the aid of which the invariable plan of our system is determined, regard being had to the rotary motion of the sun.—M. Cuvier exhibited a portion of a fossil jaw recently discovered in the gypsum of Montmartre, analogous only to that of an animal of Van Dieman's Land. —Dr. Foville presented his researches On the anatomy of the brain. —The Academy afterwards heard a verbal report by M. Damoiseau On the chronological researches of M. Eustache Oliveri;—a memoir On vision, by M. Vallée;—a memoir by M. Becquerel, On the effects of heat upon the tourmaline and bad conductors of electricity.

March 31.—The Academy received a sealed packet from M. Caventou, containing the results of some experiments on vegetable chemistry;—a letter from M. Coulier, On the means of preventing the falsification of writings;—a note by M. Sérullas, On the sweet oil of wine, oxalic æther, and bicarburetted hydrogen;—an extract of a memoir by M. Gaudin On colours;—an analysis of M. de Fermont's work On the circulation and on respiration;—a memoir by M. Vallot, On some ancient descriptions and drawings of the giraffe; —a notice by M. Thirria, On the grottos of Echenoz and Fouvent (Haute-Saône), and the fossil bones which they contain.—M. Mathieu, in the name of a Commission, reported on the memoir of M. Alexandre Roger, concerning the height of Mont-Blanc.—M. Beudant began the reading of a memoir On the chemical composition of mineral substances.

April 7.—The Academy received a memoir On the equilibrium of solid bodies, by MM. Lamé and Clapeyron;—a memoir by M. Duhamel, On the mathematical theory of heat;—a note by M. Braun, On the possibility of directing air-balloons;—a letter from M. Corencez, who offered himself as a candidate for the vacant place of member in the section of geometry;—a memoir by M. Farreau, On the presence of copper in vegetables, and the blood.—M. Geoffroy Saint-Hilaire stated that the anatomical facts discovered by his son and M. Martin, had been completely illustrated by examining yesterday a dead tortoise at the Menagerie.—M. Chevreul read a memoir On the influence which two colours may exert upon each other when seen together.

April 14.—The Academy received a sealed packet from MM. Chevalier and Langlumé, containing an account of some improvements in lithographic processes;—the results of meteorological observations made at Alais, in 1827, by M. d'Hombres-Firmas;—another letter from M. de Coulier, On the means of preventing the falsification of writings;—a memoir on the Euripode by M. Guerin;—a memoir by M. Corancez, On the integration of equations, &c.;—a note from M. Tournal, On the sulphur which had been found in the gypseous fresh-water formation at Narbonne.—M. Beudant read a notice on vitrified tubes.—M. Coquebert announced that, according to M. Pentland, there are in America several higher mountains than Chimborazo.—M. Geoffroy Saint-Hilaire gave an unfavourable account of M. Vallot's memoir On the giraffe.—M. Maisonabe exhibited a boy of twelve years old, who had club feet; one of them had

had already been subjected to treatment: M. Maisonabe will present him again when cured.—M. Arago, in the name of a Commission, reported on M. Bunten's modification of the barometer.—M. Beudant continued the reading of his paper On the analyses of minerals.—M. Héron de Villefosse communicated the results of statistical researches on iron.

April 21.—The Academy received: Considerations on light and colours, by Baron Blein;—a memoir by M. J. Cambessedes, On the families of the *Ternstromiaceæ* and *Guttiferæ;*—a memoir by M. Warden, On the civilization of the Cherokees;—Researches on the harvests of France formerly and at present, by M. Benoiston de Châteauneuf.— MM. Arago and Savart announced that the memoir of M. Braun On the means of directing air-balloons, contained nothing worthy of serious criticism.—M. Poisson read a memoir On the equilibrium and motion of elastic bodies.—M. Latreille gave a very favourable account of M. Guerin's memoir On a new genus of Crustacea, called *Euripode.*

April 28.—The reading of the minutes of the last sitting occasioned various explanations between MM. Poisson, Navier, and Cauchy, on the subject of differential equations proper to represent the internal motions of elastic bodies.—The Academy received A claim from M. Meller on the subject of M. Maisonabe's communication respecting the cure of club feet;—A sealed packet from M. Deleau, marked: Theory of stammering;—A letter from M. Despretz, relating to some fusible white crystals, volatile at a low temperature, which he had noticed during the decomposition of bicarburetted hydrogen subjected to a strong heat; and on the diminished density of iron, copper and platina, during the decomposition of ammonia by these metals. After the reading of this letter, M. Savart stated that he had himself long since found, in concert with M. Persoz, the last results obtained by M. Despretz. Several members of the Academy present at the sitting, asserted that M. Savart had mentioned it to them.—M. Delpech communicated several facts relating to *rhinoplasty*, to the disease known by the name of *trichyasis*, &c. &c.—Baron Blein read the memoir on light and colours, which he presented at the last sitting.—M. Warden communicated some information respecting the American colony established at Liberia, on the coast of Africa.—A Commission was appointed to propose a mathematical prize for 1830; it was composed of MM. Legendre, Fourier, Poisson, Lacroix, and Poinsot.—M. Longchamp read an additional notice on his theory of nitrification. A member, M. Arago, observed that M. Longchamp's memoir contained statements totally devoid of science; that he imagined he had even heard offensive personalities against a very distinguished foreign philosopher. He invited the President to listen attentively to the remainder of the memoir, and to decide, whether he ought not to stop the reading of it, in conformity with an article of the regulations.

Prizes adjudged by the Royal Academy of Sciences for the year 1828.

On examining the essays, it was found that no one of them sufficiently

ficiently answered to the terms of the question, to be entitled to the grand mathematical prize.

Astronomical Prize, founded by M. Lalande.—The medal was adjudged to MM. Carlini of Milan, and Plana of Turin, authors of a work On geodesical and astronomical observations, &c.

Prize for experimental Physiology, founded by M. Montyon.—A gold medal was adjudged to M. Dutrochet, for his discovery of the phænomena which he has detailed under the name of *Endosmosis.* —Another medal was given to MM. Andouin and Edwards, for their experiments and observations upon the circulation and respiration of the Crustacea.

Prize for discovering the means of rendering an art or trade less unhealthy, founded by M. Montyon.—This prize was not awarded.

Prize founded by M. Montyon, for improving the healing art.—To M. Chervin, for his work on the yellow fever, 10,000 francs were awarded. 5000 francs to Baron Heurteloup, for his important improvements and ingenious instruments introduced this year in lithotrity. To Dr. Gruethuisen, for his works on the same subject, a gold medal of the value of 1000 francs.

Statistical Prize founded by M. Montyon.— This was awarded to M. Thomas, for his statistical account of the Isle of Bourbon.

LIII. *Intelligence and Miscellaneous Articles.*

CHLORINE IN BLACK OXIDE OF MANGANESE.

IN a former number of the Phil. Mag. and Annals I have noticed a paper published by Mr. MacMullen in the Institution Journal, the object of which was to prove that the native black oxide of manganese contains chloric acid. In my remarks I supposed I had proved that the source of chlorine was chloride of lime, which I found in all the specimens of peroxide of manganese submitted to examination. Mr. MacMullen has replied to my observations, and contends for the accuracy of his experiments and the inferences deduced from them. The only answer I think it necessary to give, is the observation of Dr. Turner printed in the Phil. Mag. for August last. "It is the accidental presence of the muriates which gives rise to the disengagement of chlorine when sulphuric acid is added to some of the native oxides of manganese, and which induced Mr. MacMullen to regard chloric acid as a constituent of these ores. For the correction of this error we are indebted to Mr. Richard Phillips*, with whose observation my own experiments correspond; —none of the native oxides yield a trace of chlorine on the addition of sulphuric acid, provided the muriates have been previously removed by washing."

In the Institution Journal for April last, Mr. James F. W. Johnston has advanced opinions respecting some compounds of manganese, which are almost as extraordinary and quite as groundless as

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* Phil. Mag. and Annals, N.S. vol. i. p. 313.

those of Mr. MacMullen. I shall not notice all Mr. Johnston's statements; the correctness of the first two I admit; the third and fourth are as destitute of accuracy as the fifth, which is as follows: —"I threw down a *pure* carbonate from a pure muriate of manganese, obtained by Faraday's process. This was dried and partially decomposed by heating in an oven; with diluted sulphuric acid it gave also the smell of chlorine."

"From these experiments," continues Mr. Johnston, "we may legitimately conclude, first, that Mr. MacMullen was correct as to the *fact* of the emission of chlorine from the native oxide, which Mr. Phillips has called in question, for it is given off by *artificial* oxides, into which no trace of a muriate could possibly enter."

If Mr. Johnston had read my remarks upon Mr. MacMullen's paper, he would have found *not* that I called in question the fact of the emission of chlorine from the native oxide, but on the contrary that I admitted and explained it; nor can I discover the accuracy of the reasoning by which it is attempted to be proved, that the native peroxide of manganese must yield chlorine, because it is given off by the artificial peroxide, even admitting this to be a fact.

I assert, however, and every chemist will readily admit the correctness of my statement, that pure carbonate of manganese does not yield chlorine by the action of acids. I poured muriatic acid upon perfectly white and moist carbonate of manganese; no smell of chlorine was perceptible, and litmus paper was reddened instead of having its colour destroyed.

When, however, carbonate of manganese is dried, a portion of it is decomposed, oxygen being absorbed and carbonic acid evolved; and if muriatic acid is added to this mixture, chlorine is readily obtained, mingled with carbonic acid: this, however, will not account for the evolution of chlorine when sulphuric acid is employed to decompose the carbonate. But there are two modes of accounting for its production: first, if the precipitate be not sufficiently washed it will contain chloride of potassium or sodium, derived from the union of the base of the precipitating alkali with the chlorine of the muriate of manganese; or, which I have repeatedly found to be the case, a submuriate of manganese is formed; and sulphuric acid acting upon a mixture of carbonate, per- or deut-oxide and submuriate of manganese would readily occasion the evolution of chlorine for the disengagement of which Mr. Johnston finds it so difficult to account.

R. P.

BROWN OXIDE OF CHROMIUM.

This compound may be formed by mixing a solution of chromate of potash with protochloride of chromium, or by boiling chromic acid with protoxide of chrome; when the brown oxide obtained is digested with acetate of lead, chromate of lead and acetate of the protoxide of chrome are formed. Potash also converts it into chromic acid, and green oxide of chrome. Arsenic acid, carefully added, produces arseniate of chrome and chromic acid.

The brown precipitate produced by mixing chromate of potash and chloride of chromium, is decomposed by being repeatedly washed with water, especially if hot; chromic acid is removed, and green oxide of chrome remains. Chromate of chromium is decomposed in the same manner.

If chromate of ammonia be heated gradually to the point of decomposition, the salt is decomposed suddenly, pure deutoxide remains, which dissolves readily in concentrated acid. This oxide has been mistaken for a combination of protoxide and chromic acid. If at the moment of decomposition the temperature be suddenly raised, a luminous appearance is produced. Chromic acid dissolves the hydrate or the carbonate of chrome readily, and a dark brown solution is produced, which when evaporated leaves a brittle resinous-looking mass, which is deliquescent and soluble in alcohol. —M. Mans. *Annales de Chimie*, xxxvi. 216.

MASSES OF NATIVE PLATINA.

One by Humboldt from Peru, now in the Berlin museum, weight 1083 grains. Another from America in 1822, weighing 11,640 grains, now in the Madrid museum. A third within a few months from the Uralian mountains, deposited in the museum at St. Petersburgh, weighing above 81,000 grains.—*Jameson's Journal.*

PREPARATION OF TITANIC ACID.

The following is the method recommended by M. H. Rose:—Pulverize and wash titaniferous iron, expose it in a porcelain tube to the action of dry sulphuretted hydrogen gas, at a very high temperature. The oxide of iron is reduced and converted into sulphuret, whilst the titanic acid suffers no change: the product when cold is to be digested in concentrated muriatic acid; much sulphuretted hydrogen is given out, and sulphur is deposited; this mixing with the titanic acid, which the heat has rendered insoluble in the muriatic acid, the acid becomes grey. The acid is to be washed, dried and ignited, to expel the sulphur.

If the operation were to terminate here, the titanic acid would still contain some iron, and become red by calcination. The reason of this is, that the sulphuret of iron formed being in considerable quantity, agglutinates by heat with the titanic acid, and prevents the centre of the mass from being perfectly attacked by the sulphuretted hydrogen. On this account the operation must not be continued until water ceases to be disengaged, which would render it very long, but it must be stopped at the moment the water begins sensibly to diminish. The titanic acid is therefore to be exposed a second time in the porcelain tube to the action of sulphuretted hydrogen, and after having been treated with muriatic acid, well washed and ignited, it becomes perfectly white and pure. All varieties of titanic acid, which contain but little iron, and even rutile, may be treated by this process.

This process appears to me shorter and less expensive than that which I have before published, and which consists in dissolving titaniferous iron in muriatic acid, adding tartaric acid to the solution, and precipitating the iron by hydrosulphuret of ammonia. Not only is the newer process less complicated and expensive, but I have never yet found tartaric acid free from lime, and this base remains combined with the titanic acid. If during the treatment of the titaniferous iron by the sulphuretted hydrogen the heat is not very strong, the titanic acid obtained will render the washings milky, and will partly pass through the filter; but this will not occur if the heat be sufficiently great.

Hydrogen gas does not succeed so well as sulphuretted hydrogen: the oxide is indeed reduced, but the titanic acid obtained by this process is always ferruginous. Muriatic acid does not give a better result.

The time occupied in the operation now described may be shortened by fusing the titaniferous iron with sulphur in an earthen crucible. The mass is to be treated with concentrated muriatic acid, which removes much of the iron; but some remains with the titanic acid, and nearly as much as in rutile; by treating this impure acid with sulphuretted hydrogen as above described, it is obtained pure at one operation.—*Annales de Chimie*, xxxviii. 133.

ARTIFICIAL FORMATION OF UREA. BY M. F. WOHLER.

M. Wohler has already shown, that when cyanogen is made to act upon solution of ammonia, there are obtained, besides several other products, oxalic acid, and a white crystalline substance, which occurs also whenever the attempt is made to combine cyanic acid with ammonia by double decomposition. On prosecuting his inquiries, M. W. found that by the combination of cyanic acid with ammonia, urea was formed; this is a remarkable fact, as offering the artificial formation of organic matter, and even animal matter, by means of inorganic principles.

The white crystalline substance is most readily obtained by decomposing cyanate of silver by a solution of muriate of ammonia, or cyanate of lead by liquid ammonia; it is colourless, transparent, and crystallizes in the form of small rectangular quadrilateral prisms without any distinguishable pyramids. Neither potash nor lime evolves any trace of ammonia from this substance. Acids do not, as with the cyanates, disengage either carbonic or cyanic acid: it does not, like the cyanates, precipitate the salts of lead and silver; it is therefore evident that it contains neither ammonia nor cyanic acid. Most acids have no marked action on this substance, but the nitric acid when added to a concentrated solution gives a precipitate in the form of brilliant scales. These crystals are extremely acid, and were at first supposed to be a peculiar acid, but when decomposed by bases, nitrates of those bases were obtained; and by alcohol, the white crystalline matter was obtained unchanged in its properties: these properties, when compared with those of pure urea obtained from urine, indicated that this substance, or cyanate of ammonia, is absolutely identical with urea; a conclusion which is strengthened by the properties assigned to urea in the writings of Proust, Prout, and others. M. Wohler states some facts with respect to urea (and also with regard to this artificial substance,) which he says have not been previously noticed. When natural or artificial urea is decomposed by heat, there is produced, besides a large quantity of carbonate of ammonia, towards the end of the operation a smell of cyanic acid resembling that of acetic acid, precisely as occurs during the distillation of cyanate of mercury or uric acid, and especially urate of mercury. By the distillation of urea, a white substance is also obtained, the properties of which are under examination.

If cyanate of ammonia be similar to urea, then the composition of the former as obtained by calculation should resemble that of the latter; assuming one atom of water in cyanate of ammonia, as in all ammoniacal salts which contain any, and adopting Prout's analysis of urea as the most correct, it consists of

Azote............	46·650	4 atoms.
Carbon	19·975	2
Hydrogen	6·670	8
Oxygen	26·650	
	99·945	

Cyanate of ammonia should consist of 56·92 cyanic acid, 28·14 ammonia, and 14·74 water, which give as its elements:

Azote............	46·78	4 atoms.
Carbon	20·19	2
Hydrogen	6·59	8
Oxygen	26·64	

By the combustion of cyanic acid by means of oxide of copper, two volumes carbonic acid gas, and one volume of azote are obtained; but by the combustion of cyanate of ammonia, there should be procured equal volumes of these gases, which is what Prout actually found in the combustion of urea.—*Annales de Chimie*, April 1828.

NATIVE IRON IN THE UNITED STATES.

In the second volume of the Phil. Mag. and Annals, at p. 71, will be found an account of a variety of native iron found on Canaan mountain in Connecticut, extracted from Silliman's Journal. In the last Number of that Journal, which we have lately received, are the following particulars of the situation in which the iron was found, and of the probable existence of a mass of native iron at that spot. They are contained in Prof. E. Hitchcock's "Miscellaneous Notices of Mineral Localities."

"Sept. 6th, *Canaan, Connecticut.*—This is an interesting region, both to the geologist and mineralogist. We were attracted thither, principally by the hope of discovering the spot from which the native iron was obtained, that was recently announced in this Journal. We called upon Major Burrall, who, in search of the iron which he formerly obtained from this mountain, had recently visited it again, in company with his son, Mr. Wm. Burrall, a graduate of Yale-College, and Dr. Reed. Major B. not being able to go with us to the spot, the two other gentlemen just named, conducted us. About two miles north of the meeting-house, in the south parish in Canaan, is is a precipitous mountain, nearly a thousand feet in height; and it was on its top, and near the western edge, that the native iron was found,—not three years ago as stated in this Journal, but as Major Burrall informed us, sixteen or seventeen years since. At the base of the mountain is limestone, succeeded by an aggregate of quartz and mica, which appears to be one of the varieties of Dr. Macculloch's quartz-rock. The top of the mountain, however, is well characterized mica-slate, containing small imperfect crystals of magnetic iron-ore, sparinglydisseminated. On the top of the mountain we came to a pond, perhaps sixty or eighty rods across; and on the southwest margin of this pond is the spot where, as well as Major Burrall can recollect, he obtained the specimens in question. At this spot he found his compass liable to so great a variation that it was useless; and on examining the rocks for the cause, he found the specimens that have excited so much interest. Mr. Burrall, junior, took his father's compass with him, on our present excursion, and attempted to run over the same line which his father pointed out to him, as the one upon which he experienced so much difficulty. This line runs nearly east and west, just upon the southern margin of the pond; and we found that where it approaches the nearest to the pond, there was a variation of 30°, as shown by back objects. On setting the compass only two or three rods backwards or forwards on the line, however, the variation almost entirely vanished. This showed us that the magnetic mass, that produced the variation, could not be far removed from the line, either north or south; for had it been at a considerable distance, the removal of the compass a few rods either east or west, could not materially have affected the variation; since the radius of a large circle for a considerable number of degrees, differs so little from the secant. We removed the compass one or two rods to the north, and ran a line parallel to that above named, so as even to enter a little distance into the pond, where the water is highest. Here the variation was even greater than upon the first line; so that the attracting mass must lie north of that first line. Probably it lies just in the edge of the pond; and I have no hesitation in saying, that a circle, described with a radius of two rods, upon the point where the greatest variation was noticed, would embrace the ferruginous mass that here disturbs the needle; nor is there much reason to doubt but that mass is native iron. And whoever has observed how large a mass of iron it requires to turn aside the needle of a compass, at the distance of one or two rods, will presume that the mass here deposited must be a large one. The spot I have been describing is covered with trees and thick underbrush, and the moss and rubbish almost entirely hide the rocks underneath. The bottom of the pond is sphagnous; and perhaps it might be necessary partially to drain it, which is not difficult. Whoever will be at the trouble and expense of removing the brush, moss and soil, at this spot, under the direction of Mr. Burrall, or Dr. Reed, will, I have little doubt, be abundantly rewarded by the discovery of a mass of native iron."

"On seeing this pond, and considering this locality of native iron on on its margin, the inquiry forces itself on the mind,—may it not be the crater of an extinct volcano? But I could perceive not the least indication of any igneous action."

"Major Burrall presented me with a small specimen of the native iron, whose characters correspond exactly to those given in the 12th volume of this Journal; but it furnishes no additional information."—*Silliman's Journal*, vol. xiv. p. 223.

In the review of Prof. Olmsted's official "Report on the Geology of North Carolina," given in the same Number, p. 235, occurs the subjoined notice of specimens of native iron from that state.

"One of the specimens of iron-ore sent to Prof. Olmsted, from the slate-formation, or gold-region, proved to be native iron. Another was afterwards discovered that weighed twenty-seven pounds, and a part of it was wrought by the blacksmiths."—p. 31 and 108.

An account of the slightly arseniuretted native iron of Bedford county, Connecticut, (also extracted from Silliman's Journal,) will be found in the present volume of the Phil. Mag. and Annals, p. 73.

FOSSIL REPTILES.

M. Jæger, in his work *Uber die Fossile Reptilien, welche in Würtemberg aufgefunden worden sind*, Stuttgart, 1828, gives the following list of fossil reptiles found in the Wirtemberg rocks:

In the Lias	*Crocodilus Bollensis.*
	Geösaurus Bollensis.
	Ichthyosaurus platyodon.
	Ichthyosaurus communis.
	Ichthyosaurus intermedius.
	Ichthyosaurus tenuirostris.
	Plesiosaurus?
In the variegated Marl. (*Keuper.*)	*Cylindricodon.*
	Cubicodon.
In Aluminous Shale.	*Massodonsaurus.*
	Salamandroides giganteus.
In Muschelkalk	*Plesiosaurus.*
	Ichthyosaurus.
	A third Reptile.

H. T. D. B.

METHOD OF PRESERVING FUNGUSES.

Mr. Cooke, surgeon (Trinity Square, Tower Hill), having been very successful in his endeavours to preserve anatomical preparations in salt and water, was requested to try to preserve in the same way a specimen of *Clavaria muscoides* (Sowerby's English Fungi), supposing that it might answer for funguses of some kinds.

Mr. Cooke in a written account says: "I put it into brine a little below saturation, suspending it by a delicate thread of silk, and closing the bottle by means of glass. Since that time it has remained in the solution, and with the exception of having become a little deeper in colour it is unchanged. As spirits are not only expensive,

pensive, but usually deprive plants of all colour, the discovery of a cheap and effectual solution for the preservation of plants is a desideratum."

The specimen was gathered at the latter end of October 1826, and was presented to the Linnæan Society in May last, with an account of the process. As many species of funguses may be expected to appear at the latter end of this month and in the next, persons who are desirous of trying the before-mentioned method of preserving such vegetables, will no doubt have an opportunity of so doing.

Sept. 17, 1828. B. M. FORSTER.

DIFFERENCE OF LONGITUDE BETWEEN PARIS AND GREENWICH.

Captain Kater in his account of trigonometrical operations for determining this difference, (published in Part I. of the Phil. Trans. for the present year,) observes, p. 193, that the quantity $2^\circ\,30'\,17''{\cdot}73$, obtained by those operations, "converted into time is $9^{m}\,21^{s}{\cdot}18$, differing only $0^{s}{\cdot}28$ in defect from the admirable results obtained by the operations with fire-signals, reported in the Phil. Trans. for 1826, by Mr. Herschel."

It may possibly save trouble to some future inquirers, to state, that Captain Kater here refers to the results of Mr. Herschel's operations, *as corrected* by Mr. Henderson in the Phil. Trans. for 1827, p. 295 (see also Phil. Mag. and Annals, N. S., vol. ii. p. 142), which give $9^{m}\,21^{s}{\cdot}46$, or $9^{m}\,21^{s}{\cdot}5$, to the nearest tenth of a second, instead of $9^{m}\,21^{s}{\cdot}568$, and $9^{m}\,21^{s}{\cdot}6$, as given in Mr. Herschel's paper.

Mr. Ivory also, in his paper On the measurement of degrees perpendicular to the meridian, in the last Number of the Phil. Mag. and Annals, refers to the same determination as corrected by Mr. Henderson; though he, like Captain Kater, refers only to the original paper in the Phil. Trans. for 1826, without mentioning Mr. Henderson's recomputation in the same work for 1827.

FIGURE OF THE CELLS OF THE HONEYCOMB.

To the Editors of the Philosophical Magazine and Annals.

Messieurs,

En faisant des récherches *sur les alvéoles des abeilles* *, j'ai recueilli les détails suivans, qui peuvent servir à l'histoire du problème proposé par Reaumur.

1°. Le professeur Cramer, de Genève, envoya à Kœnig, en 1739, une solution qui ne différait pas de la sienne, étant appuyée comme elle sur le calcul de l'infini. Toutes les deux sont perdues.

2°. Le Père Boscowich, sans avoir connaissance de la méthode de Maclaurin, résolut comme lui le problème par la considération des *maxima et minima*. On trouve cette solution dans ses *remarques sur le poëme de Stay*.

3°. Enfin, Lhuilier, de Genève, a résolu aussi le problème, par un procédé plus simple encore que celui de Maclaurin, puisqu'il arrive au même résultat, sans employer la considération des *maxima et minima*: ce n'est plus qu'une question de géométrie commune.

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* See p. 20 and p. 233 of the present volume of the Phil. Mag. and Annals.—EDIT.

Vos lecteurs, pour s'en assurer, peuvent recourir aux Mémoires de *l'Académie de Berlin*, année 1781. FAYOLLE.

ON VARIGNON'S METHOD OF SOLVING EQUATIONS OF THE SECOND DEGREE. BY M. FAYOLLE.

To the Editors of the Philosophical Magazine and Annals.

Messieurs,

La méthode que vous avez insérée dans votre dernier numéro, pour la résolution des équations du second degré, m'en a rappellé une de Varignon qui est encore plus simple, et qui s'applique aux équations du troisième degré. Elle est si facile (disait Fontenelle), qu'on est tout surpris que Varignon l'ait trouvée le premier.

La voici en peu de mots:

Soit $z^2+pz+q=0$.

Faisons $z=x-y$; alors

$$z^2=x^2-2xy+y^2=x^2-2xy+2y^2-y^2$$
$$=x^2-2yz-y^2;$$

Et par conséquent, $z^2+2yz+\left.\begin{matrix}y^2\\-x^2\end{matrix}\right\}=0.$

Laquelle comparée terme à terme avec la proposée, donnera

1°. $pz=2yz$, ou $y=\frac{1}{2}p$,

2°. $q=y^2-x^2$, ou $q=\frac{1}{4}p^2-x^2$,

D'où résulte $x=\pm\sqrt{\frac{1}{4}p^2-q}$

Donc $z=x-y=-\frac{1}{2}p\pm\sqrt{\frac{1}{4}p^2-q}$.

Si l'on avait $z^2-pz+q=0$,

Il faudrait prendre $z=x+y$.

Cette méthode s'applique avec la même facilité à l'équation du troisième degré $z^3+pz+q=0$,

Laquelle est dégagée du second terme.

Ce 16 Aug. 1828. FAYOLLE.

MINERALOGICAL LITERATURE.

1. Dr. Naumann, professor in the Mining Academy of Freiberg, has published *Lehrbuch der Mineralogie* (*Treatise on Mineralogy*), Berlin, 1828, by A. Rucker, in 8vo. This treatise, by a scholar of the celebrated Professor Mohs of Vienna, is one of the best on that science. The crystallographic method of Professor Naumann is eclectic in reference to those of Mohs and Weiss, and is very good; the system is established according to the physical and chemical characters of minerals. He describes a multitude of varieties of crystals with the assistance of 556 figures. In general the work is very classical, and deserves to be recommended to mineralogists.

2. Dr. Charles Hartmann, Mining-officer in the service of his Highness the Duke of Brunswick, has published *Worterbuch der Mineralogie und Geognosie*, (*Dictionary of Mineralogy and Geology*). Leipsic, by Brockhaus, 8vo. This work gives a description of all known minerals and rocks in alphabetical order, and contains an introduction

introduction to mineralogy and geology, with the history and literature of the sciences in systematical arrangement. In reference to the crystallography, Dr. Hartmann pursues the methods of Professor Mohs and of Professor Weiss. This work merits the particular notice of all mineralogists, and also travellers, because the size of the book is not great, and the type very small. A German, an English, a French, and an Italian index facilitate the use of the book, and 312 figures illustrate the forms of the crystals.

3. Dr. Hartmann has also published *Vorlesungen über Mineralogie, &c.*,—(*Lectures on Mineralogy, particularly for Schools,*) &c. Ilmenau, by Voigt, 8vo. This elementary treatise is strongly recommended to young men who study the natural history of minerals, and to lecturers in schools. As in the elementary introduction of Mr. Phillips, the crystalline forms of minerals are illustrated with wood-cuts printed along with the text.

SCIENTIFIC BOOKS.

Just published.

No. I. of Zoological Researches and Illustrations; or Natural History of Nondescript or imperfectly known animals, in a series of Memoirs: illustrated by numerous figures. By John V. Thompson, Esq., F.L.S., Surgeon to the Forces; author of A memoir on *Pentacrinus Europæus.*

This first Number contains the following memoirs: 1. On the metamorphoses of the *Crustacea,* and on the animals forming the genus *Zoea,* exposing their singular structure, and demonstrating that they are not, as has been supposed, a peculiar genus, but the larvæ of *Crustacea:* with two Plates. 2. On the genus *Mysis,* or Opossum Shrimp; also with two Plates.

The author of this novel contribution to the stores of zoological science, has we understand devoted much time and exertion to the collection and preparation of materials for the work. They are wholly original, and the results of observation on animals of every class, but more especially on the marine *Invertebrata,* in both hemispheres of the world.

No. II. will be published in January; and the succeeding Numbers at intervals of three or four months.

Elements of Algebra. By Robert Wallace, A.M., late Andersonian Professor of Mathematics, Glasgow.

A Circular, explanatory of Skene's patent as applicable to steam-navigation, and undershot water-mills.

No. II., for the year 1829, of the "Enigmatical Entertainer and Mathematical Associate."

In the Press.

An American reprint of Mr. Bakewell's new and enlarged edition of his "Introduction to Geology" is announced, under the superintendence of Professor Silliman.

A second edition, considerably enlarged, of Mr. De la Beche's Tabular and Proportional View of the Tertiary and Secondary Rocks.

LIST OF NEW PATENTS.

To G. Stratton, of Frederick-place, Hampstead Road, for an improvement in warming and ventilating buildings.—Dated the 28th of August 1828.—6 months allowed to enrol specification.

To Granville Sharp Pattison, of Old Burlington-street, esquire, for a method of applying iron in the sheathing of ships, and of applying iron bolts, spikes, nails, and other fastenings in ships and other vessels.—4th of September.—6 months.

To J. Seaward and S. Seaward, of the Canal Iron-Works, Poplar, for a new method for propelling carriages on roads, and also ships and other vessels on water.—4th of September.—6 months.

To C. Sanderson, of Park Gate Iron-Works, near Rotherham, Yorkshire, for a new method of making sheer steel.—4th of September.—2 months.

To Admiral S. Brooking, of Plymouth, for his new mode of making sails of ships and other vessels.—4th of September.—6 months.

To J. Robertson, of Limehouse Hole, Poplar, for improvements in the manufacture of hempen rope or cordage.—4th of September.—6 months.

To W. Bell, of Lucas-street, Commercial Road, Middlesex, for his improved methods for filtrating water and other liquids.—4th of September.—6 months.

To W. Farish, Jacksonian Professor in the University of Cambridge, for his improved method of clearing out water-courses.—4th of September.—6 months.

To T. R. Williams, of Norfolk-street, Strand, for improvements in the making of hats, &c., and in the covering of them with silk and other materials with the assistance of machinery.—11th of September.—6 months.

To T. Minikew, of Berwick-street, for an improvement in the making of chairs, sofas, beds and other articles of furniture for similar purposes, and also of travelling and other carriages for personal use.—11th of September.—2 months.

To J. B. Neilson, of Glasgow, for the improved application of air to produce heat in fire-forges and furnaces where bellows or other blowing apparatus are required.—11th of September.—6 months.

To L. W. Wright, of Mansfield-street, Borough Road, Surrey, for improvements in machinery for making screws.—18th of September.—6 months.

To W. Losh, of Benton House, Northamptonshire, esquire, for improvements in iron-rails for rail-roads, and of the chains or pedestals in or upon which the rails may be placed or fixed.—18th of September.—2 months.

To J. Rhodes, junior, of Alverthorp, Wakefield, for improvements in machinery for spinning and twisting worsted yarn and other fibrous substances.—18th of September.—6 months.

METEOR.

On Sunday evening last, about half-past eight o'clock, I observed a most splendid meteor in the north-east, at an altitude of about 45°, and

and having a diameter of about 20′ of a degree. Its course (eastward) was rapid, inclined to the horizon at an angle of about 50°, and described in three or four seconds an arch of about 15°, when it disappeared quite abruptly. During its appearance the light was of a splendour equal to that of the mid-day sun.

At Newhouses, about a mile north of this place, it appeared at the commencement of a size not exceeding that of a shooting-star, but increased almost instantaneously to a diameter equal to that of the sun. On the point of disappearing it separated into numerous *scintillant* fragments.

Horton in Ribblesdale, Sept. 10, 1828. J. Nixon.

AURORA BOREALIS?

A remarkable light resembling the aurora borealis was lately observed at Boreham in Essex, by our correspondent Dr. Forster; it occupied the northern hemisphere, to which so late even as midnight it gave a fine clear *orange* tint, at times so clear that one might have read a large print by it. As it declined, a storm gathered in the same quarter, which is rather an unusual circumstance; and by about two o'clock thunder began to be heard. The storm increased before three, and became one of the most violent ever remembered in the county: an almost uninterrupted succession of flashes, with sharp and rolling thunder, continued till past four o'clock, when the storm gradually passed off.

SOLAR SPOTS.

The two solar spots described under our last Meteorological Report, p. 236, came on the sun's eastern limb again on the 6th instant, but from the interposition of clouds the time could not be ascertained. The lower spot, which had before divided into four, returned waning, and without any perceptible umbra: by the 9th they had increased to eight very small black specks, and on the 12th were evanescent, making the period on the sun's disk from the appearance of the original spot, sixty days. The upper one returned with additional spots near it, which we shall not notice at present, although one of them from its proximity has been found useful to a continuance of the observations. On the 9th its umbra was conspicuous, but the nucleus had decreased to a small size. On the 13th it was again nearest to the sun's centre, and on the 16th it had lost the eastern side of its umbra. On the 19th at sunset it was on the sun's western limb, having a large facula on the eastern side of it (in which it is probable another spot will soon appear), and must have gone round on his posterior side between 9 and 10 o'clock that evening. As it did not return again, we shall now close our remarks on it. Up to the 19th instant it had been on the sun's disk 91 days, a longer period perhaps than any solar spot on record; during which time it presented a variety of changes in appearance and magnitude, varying from 4000 to 14,000 miles in diameter, and afforded good opportunities from day to day in fine weather of ascertaining satisfactorily the *apparent time* of each revolution, namely, 27 days, 27 days, 7 hours, and a few minutes, which latter it would be difficult to determine with any degree of accuracy; however, the minutes cannot at the furthest exceed twenty, which we will allow. From this time, 27 days, 7 hours, 20 minutes, it is proper to subtract 1 day, 21 hours, 40 minutes for the angular distance in time that the earth made in the ecliptic during each revolution of the spot; hence the *real time* of each respective revolution, and also the real time of the revolution of the sun on its axis, which is the cause of the apparent motion of the solar spots, is 25 days, 9 hours, and 40 minutes. Our daily observations on other solar spots in the interim, after they had made one revolution, corroborate the accuracy of this time.

If any malign influence on the weather exist from the appearance of solar spots, it has been verified in the summers of 1816, 1823, and 1828, by the great number which then appeared on the sun's disk, and the wet and stormy state of the earth's atmosphere at these periods. But to demonstrate this hypothesis of a great man, which has recently been alluded to in the provincial newspapers, would require great labour and anxiety at the telescope in the day; yet we think the task is by no means insurmountable, where time is no object to an accurate observer.

METEOROLOGICAL OBSERVATIONS FOR AUGUST 1828.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·29 Aug. 26. Wind S.E.—Min. 29·36 Aug. 6. Wind S.W.
Range of the index 0·93.
Mean barometrical pressure for the month .... 29·860
Spaces described by the rising and falling of the mercury............ 4·300
Greatest variation in 24 hours 0·430.—Number of changes 22.
Therm. Max. 76° Aug. 24 & 25. Wind W.—Min. 47° Aug. 15. Wind N.E.
Range 29°.—Mean temp. of exter. air 63°·18. For 31 days with ☉ in ♌ 62·60
Max. var. in 24 hours 25°·00—Mean temp. of spring water at 8 A.M. 55°·20

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the evening of the 13th .... 94°
Greatest dryness of the air in the afternoon of the 15th.............. 45
Range of the index.. 49
Mean at 2 P.M. 59°·5 —Mean at 8 A.M. 66°·4—Mean at 8 P.M. 71·5
—— of three observations each day at 8, 2, and 8 o'clock......... 65·8
Evaporation for the month 3·05 inches.
Rain near ground 2·585 inches.
Prevailing wind, S.W.

Summary of the Weather.

A clear sky, 4½; fine, with various modifications of clouds, 12; an overcast sky without rain, 9; rain, 5½.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
23	15	30	0	24	26	21

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
1	4½	2½	3	1	12	3	4	31

General

General Observations.—To the 14th of this month the atmosphere constantly wore a humid aspect, and more or less rain fell daily (accompanied with high winds), which from its frequently interrupting the operations of the harvest, excited much alarm among the agriculturists in this and the adjoining counties for the fate of the outstanding part of their corn crops. The remainder of the period being fine and dry, has certainly proved a blessing to the country in general, and enabled the farmers to get in their wheat and barley in tolerable condition; and it is said from undoubted authority that the crops will yield at least an average quantity, and in many places much more.

In several of the northern districts, it would appear, from their reports, that the thunder-storms had been more frequent, and the rain more copious than with us, which beat down and spoiled much of the corn; but the weather having changed favourably, they say that all will be well with them, and that they shall have no necessity to advance the prices of their corn. On the morning of the 5th instant, thunder-storms with heavy rain were experienced both on Portsdown Hill and at Southampton: the storm at Portsdown was seen from this place, and the thunder repeatedly heard, yet only a few drops of rain fell here. On the 9th, 10th, and 11th, four strata of clouds one above another frequently prevailed, with a hard gale of wind from the S.W., which literally rooted up several trees in this town and neighbourhood, and was much felt at Plymouth. It was succeeded on the 13th and 14th by a gale equally as strong from the opposite quarter, N.E., which blew back the dense black clouds that had been carried thither by the S.W. gale. The latter day was remarkably cold, the mean temperature of the external air being only equal to that in the middle of May.

The atmospheric and meteoric *phænomena* that have come within our observations this month, are three parhelia, two solar halos, forty-four meteors; thunder on three different days; lightning in the evening of the 10th; and twelve gales of wind, or days on which they have prevailed; namely, four from the North-east, seven from the South-west, and one from the North-west.

REMARKS.

London. — August 1. Very fine. 2. Slight rain in morning; showery. 3. Rainy. 4, 5. Very fine. 6. Heavy rain with thunder in evening. 7. Cloudy with showers. 8. Very fine. 9. Stormy with showers. 10. Fine. 11. Cloudy, with rain at night. 12. Showery. 13. Heavy rain. 14. Rainy. 15. Fine. 16. Foggy morning: very fine. 17. Cloudy. 18—20. Very fine. 21, 22. Showery. 23, 24. Very fine. 25. Sultry and warm. 26. Foggy morning: very fine. 27—30. Very fine. 31. Cloudy.

Boston.—August 1. Cloudy. 2. Rain. 3. Fine: rain, P.M. 4. Fine: rain P.M., distant thunder P.M. 5. Fine: heavy rain P.M. 6. Cloudy: rain P.M. 7. Cloudy. 8. Fine: storm of wind: rain, thunder, and lightning, 5 P.M. 9. Fine: stormy day, rain P.M. 10. Stormy. 11. Cloudy: storm of wind, rain, hail, thunder and lightning, 4 P.M. 12. Stormy. 13. Fine. 14. Rain. 15. Cloudy. 16. Fine. 17. Cloudy: rain early in the morning and P.M. 18—20. Fine. 21. Fine: rain A.M. 22. Cloudy: rain A.M. and P.M. 23. Fine. 24, 25. Cloudy. 26. Misty. 27. Fine: 3 P.M. Therm. 74°. 28. Misty. 29. Fine. 30, 31. Cloudy.

Penzance.—August 1. Rain. 2, 3. Showers. 4, 5. Fair. 6. Rain: fair. 7. Rain: clear. 8. Clear: rain at night, stormy. 9. Cloudy: showers. 10. Clear: showers. 11. Clear: heavy showers. 12, 13. Fair: showers. 14. Heavy rain: fair. 15. Showers. 16. Rain: misty. 17. Rain: fair. 18, 19. Clear. 20—22. Fair. 23. Clear. 24. Fair. 25—31. Clear.

Meteorological Observations made at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1828.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost. 8½ A.M.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.										
Aug. 1	29·959	29·895	29·95	29·75	29·95	29·88	29·47	74	55	64	54	71	59	60	W.	SW.	S.	calm	...	...	...	0·135	...
☾ 2	29·691	29·630	29·70	29·68	29·71	29·64	29·23	69	53	67	57	69	56	60	S.	W.	SW.	calm	...	0·65	0·780	·260	...
3	29·584	29·543	29·65	29·65	29·60	29·56	29·05	68	52	66	57	69	56	60	SW.	W.	SW.	W.	0·15	·50	·200	·010	0·12
4	29·584	29·567	29·65	29·65	29·60	29·58	29·00	70	53	67	55	72	55	61·5	SW.	W.	W.	W.	...	·12	·045	·345	·03
5	29·644	29·616	29·72	29·70	29·65	29·60	29·03	72	50	65	54	74	56	62	SW.	W.	SW.	W.	...	...	...	·110	·03
6	29·477	29·420	29·45	29·45	29·43	29·36	29·02	70	56	67	55	71	60	61	S.	SW.	SW.	W.	·30	·42	·360	·150	·35
7	29·527	29·454	29·55	29·45	29·48	29·42	28·95	72	58	66	55	72	56	61·5	S.	W.	SW.	E.	...	·57	·385	·025	·19
8	29·742	29·614	29·75	29·62	29·65	29·58	29·10	72	55	68	58	73	59	63	SW.	SW.	SW.	calm	...	·13	...	·100	·04
9	29·502	29·406	29·55	29·15	29·51	29·42	28·90	68	56	65	56	70	58	64	SW.	SW.	S.	S.	·30	·04	·435	·090	·55
● 10	29·725	29·634	29·70	29·60	29·70	29·62	29·00	69	53	66	54	69	55	62	SW.	W.	SW.	W.	...	...	·060	·210	·04
11	29·804	29·707	29·75	29·70	29·70	29·67	29·16	69	55	64	54	69	56	61	SW.	SW.	SW.	W.	...	·36	·360	·270	...
12	29·869	29·794	29·85	29·80	29·83	29·80	29·21	69	46	64	54	70	58	60	W.	W.	SW.	W.	·40	·11	·050	·065	·17
13	29·836	29·698	29·78	29·68	29·73	29·70	29·35	62	54	62	51	70	56	60·5	SE.	NE.	E.	W.	...	1·14	·205	·785	...
14	29·724	29·552	29·80	29·65	29·62	29·47	29·21	58	47	61	54	60	48	57	E.	N.	NE.	NE.	...	0·12	1·190	...	·21
15	29·934	29·863	29·95	29·85	29·90	29·84	29·30	68	45	64	51	69	47	56·5	NW.	W.	N.	N.	·20	...	0·105	...	...
16	29·966	29·954	29·90	29·85	29·94	29·90	29·50	72	58	66	56	65	60	58	W.	SW.	SE.	W.	...	...	·130	...	...
17	29·905	29·838	29·87	29·85	29·88	29·86	29·30	68	51	64	58	73	55	64	SW.	SW.	SW.	W.	...	·04	·230	·005	·02
☽ 18	29·968	29·934	30·05	30·00	30·02	29·93	29·27	69	49	66	56	72	51	62	W.	NW.	W.	W.	·30	...	·040	·010	·17
19	30·147	30·127	30·10	30·08	30·14	30·12	29·51	74	46	67	55	68	53	60·5	SW.	W.	NW.	W.	...	...	...	...	...
20	30·081	29·959	30·05	30·00	30·08	29·97	29·50	73	52	67	54	70	58	62	S.	S.	SW.	W.	...	...	...	...	...
21	29·856	29·772	29·98	29·95	29·87	29·80	29·30	67	50	64	55	72	53	61	S.	NW.	NW.	calm	·40	·10	...	·010	...
22	29·834	29·804	29·96	29·94	29·88	29·77	29·06	65	49	64	54	68	51	57	NW.	NW.	NW.	W.	...	·05	...	·005	·11
23	30·137	30·025	30·20	30·15	30·13	30·03	29·47	67	44	66	54	71	51	59	W.	NW.	NW.	NW.	...	...	...	...	·23
24	30·201	30·187	30·24	30·23	30·23	30·17	29·64	76	61	70	58	76	58	62	W.	NW.	W.	W.	·35	...	...	...	...
○ 25	30·338	30·296	30·25	30·24	30·28	30·26	29·70	78	59	68	60	76	60	66·5	NW.	S.	NW.	N.	...	...	...	...	...
26	30·340	30·323	30·20	30·18	30·29	30·25	29·75	78	48	68	57	75	56	64	E.	SE.	SE.	calm	...	...	...	...	...
27	30·297	30·231	30·12	30·10	30·23	30·17	29·72	74	52	68	58	67	57	62	E.	SE.	E.	calm	·25	...	...	...	...
28	30·218	30·190	30·05	30·04	30·16	30·13	29·65	75	54	68	58	70	58	61·5	NE.	SE.	SE.	calm	...	...	...	...	...
29	30·198	30·192	30·05	30·03	30·15	30·13	29·65	74	58	69	59	74	57	63·5	E.	SE.	NE.	E.	...	...	...	...	...
30	30·193	30·140	30·08	30·03	30·12	30·10	29·65	72	55	68	58	72	57	62	NE.	SE.	NE.	E.	...	...	...	...	...
31	30·123	30·065	30·08	30·05	30·06	30·00	29·62	62	56	67	57	69	61	59	NE.	NE.	NE.	NE.	·40	...	...	...	...
Aver.:	30·340	29·406	30·25	29·15	30·29	29·36	29·33	78	44	70	51	76	47	61					3·05	4·35	4·575	2·585	2·26

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[NEW SERIES.]

NOVEMBER 1828.

LIV. *Answer to an Article by* Mr. Henry Meikle, *published in No.* VII. *of the Quarterly Journal of Science. By* J. Ivory, *Esq. M.A. F.R.S. &c.*[*]

IN the last Number of the Quarterly Journal of Science, there is an article of some length by Mr. Henry Meikle, in which he animadverts in a style which is hardly called for, on the analytical theory of sound, and on the variation of temperature which air undergoes when it changes its bulk. In his strictures on the first of these subjects he does little more than enlarge on the observations which Professor Leslie has more briefly made relative to the same matter in the article *Acoustics*, in the Supplement to the *Encyclopædia Britannica*. Whatever purpose such discussions may serve, one is at a loss to find out how they can benefit science. Great fault is found; no remedy is proposed; the subject is ultimately left just where the author found it; and the whole ends in a vain display of learning and fine writing. Whoever will attend to Mr. Meikle's remarks will soon be convinced that any attempt to answer them is not a very likely way to elucidate, or to improve, the theory he attacks. Besides, this theory has been long known; I have only made use of the most simple case of it for a particular purpose; and therefore I do not think myself indispensably called upon to defend it against such arguments as are contained in the article under consideration. Leaving, then, the analytical theory of the propagation of sound to stand on its own merits, I must, however, express my regret that Mr. Meikle has made so little progress towards that thorough reform which, he thinks, is so necessary.

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[*] Communicated by the Author.

I proceed next to Mr. Meikle's strictures on the explanation, I have given, of the variation of temperature when air changes its bulk. I have not seen any of the articles he cites in the Edin. Phil. Journ. What I have written on this subject is no more than an easy deduction from the usual theory of the thermometer; and the best way to enable the reader to judge of the justness of Mr. Meikle's animadversions, is briefly to explain the principles I proceed upon, disengaging them, as far as perspicuity will permit, from all purely mathematical calculations.

In an air-thermometer, or, which is the same thing, in a mass of air which changes its bulk by the application of heat, the pressure being constant, I take it for granted that the capacity of the air for heat, within certain limits, remains invariable; that is, I suppose that equal quantities of absolute heat, produce equal variations of volume and temperature. It will be admitted that this postulate is true, so long as two thermometers, one of air and the other of mercury, both exposed to the same flow of heat, continue to indicate the same temperatures. To speak more particularly, but without aiming at great precision, the capacity of air for heat may be supposed constant between $-40°$ and $+300°$ on the centigrade scale, comprising a range of temperature between 300° and 400°. The reasoning which follows is entirely founded on this experimental fact, and it must be considered as applying only within the limits mentioned.

Suppose that the given mass of air has undergone a certain variation of bulk; and let us put h for the whole quantity of heat which has produced this effect; and τ, for the change of temperature in passing from the one volume to the other; then we shall have $\frac{h}{\tau} = k$, k standing for some number not yet known, which however is invariably the same so long as the temperature τ is contained within the assigned limits. All this is manifest from what is said above; for the equation merely expresses that the absolute heat which causes any change of volume is proportional to the variation of temperature, according to the postulate laid down, and as must be the case if the thermometer be an exact measurer of heat. Now h, whether it is heat added to, or abstracted from, the mass of air, is always greater than τ, the rise or depression of temperature. For when heat is added, the volume of the air is enlarged, and some heat is absorbed and disappears without acting on the thermometer; on the other hand when heat is abstracted, the volume is diminished, and some heat is evolved which is instantaneously dissipated and produces no effect on the fall of temperature. We may therefore put $h = i + \tau$; and, on account of the foregoing equation, we shall have,

$$\frac{i}{\tau} = k - 1. \qquad \text{(a)}$$

The new symbol i stands for the difference between the absolute heat, and the heat of temperature, answering to any change of the bulk; or it is the heat which enters into the air when its volume increases, and is again extricated when the volume decreases, without affecting the thermometer in either case. I shall call latent heat, that portion of the absolute heat which in ordinary circumstances is not indicated by the thermometer, when a mass of air under a constant pressure changes its bulk. This term was introduced by Dr. Black; but it has been objected to and proscribed by some chemists, who express the same thing by a phraseology certainly not more perspicuous. There can be no impropriety nor inconvenience in using the term, since it is no more than the unambiguous expression of a fact, the existence of which is certain. It remains now to discover the value of the number k; for when this is done, the equation (a), taken always within the assigned limits, contains the whole of the doctrine under consideration.

In order to find the number k, or $k-1$, we must have recourse to an experiment contrived by MM. Clement and Desórmes. These celebrated chemists have invented a very ingenious process by which we can ascertain the proportion of the latent heat to the heat of temperature, that is, the value of $\frac{i}{\tau}$, when a given mass of air under a constant pressure suffers a small variation of bulk. Taking an average of many experiments, it has been found that $\frac{h}{\tau}$ and $\frac{i}{\tau}$, that is, k and $k-1$, are nearly equal to $\frac{11}{8}$ and $\frac{3}{8}$. Now, making $k - 1 = \frac{3}{8}$, the equation (a) will coincide with the conclusion which I have stated at p. 94 of this Journal for February 1827, and which enables us to compute the latent heat for a given variation of bulk. MM. Gay-Lussac and Welter repeated the experiment alluded to on air under a great variety of pressures, and in a range of temperature reaching from $-20°$ to $+40°$ on the centigrade scale; and the resulting proportion of the latent heat to the heat of temperature came out in every instance very nearly the same. By this means, not only are the numbers k and $k-1$ ascertained to a considerable degree of precision, but it is likewise demonstrated that, within certain limits, they are independent of the state of the air. Now this is a practical proof in favour of the theory we have been explaining; since, as far as experiments have been extended, the ratios $\frac{h}{\tau}$ and $\frac{i}{\tau}$ are found to remain constant, as the theory requires.

But in applying the foregoing doctrine to the velocity of sound, I made use of algebraic formulas, which are things held in abhorrence by a certain class, although it appears that others know very well how to turn them to their own purposes. Taking a mass of air at a given temperature, suppose zero of the centigrade scale, let α denote the dilatation under a constant pressure for 1° of temperature, and β the dilatation requisite for the absorption of 1° of latent heat; then it is obvious that shall we have,

$$k - 1 = \frac{\alpha}{\beta} = \frac{3}{8}.$$

I now take one of the formulas marked (C) at p. 252 of this Journal for April 1827, viz.

$$\frac{\varrho}{\varrho'} = \frac{1 + \alpha\theta}{1 + \alpha\theta + \beta i};$$

whence I get,

$$i = \frac{1}{\beta}(1 + \alpha\theta)\left(\frac{\varrho'}{\varrho} - 1\right).$$

It will perhaps contribute in some degree to perspicuity, if, instead of the proportion of the densities $\frac{\varrho'}{\varrho}$, we substitute the inverse proportion of the volumes, viz. $\frac{V}{V'}$; then

$$i = \frac{1}{\beta}(1 + \alpha\theta)\left(\frac{V}{V'} - 1\right).$$

The formula will be still more simplified if we make the initial temperature θ equal to zero, in which case V′ will be the volume of the air at the beginning of the thermometrical scale; then

$$i = \frac{1}{\beta}\left(\frac{V}{V'} - 1\right).$$

And, if τ be the variation of temperature, we obtain, by the theory of the thermometer,

$$\tau = \frac{1}{\alpha}\left(\frac{V}{V'} - 1\right).$$

These formulas show clearly the relation that subsists between the temperature and the latent heat, and in what manner both these quantities are derived from the volume. Both the expressions are significant, and represent what actually takes place in nature, so long as the postulate on which they are founded holds good; or so long as the capacity of the air for heat remains constant, and the absolute heat which changes the bulk of a mass of air is proportional to the variation of temperature. Beyond this limit on either side, the formulas become insignificant; they are mere abstract expressions which

which denote nothing that is true in nature. It is therefore absurd to contend from the numerical results obtained in some extreme cases, that the formulas are consonant to fact in no case whatever; I say, the formulas, for the argument applies equally to both. Suppose that the original volume is reduced to a very small space, or to a point; then, according to the centigrade scale,

$$\tau = -266^\circ{\cdot}7, \quad i = -100^\circ.$$

Now these numbers are either both true, or neither of them is so; and the latter may be affirmed, since it is very improbable, that a law, which has been verified only for a small part of the thermometrical scale, will continue to hold good without limit; it is even certain that it will not. Next let us suppose that the volume of air has decreased to half its original quantity; then, $\tau = -133^\circ, \quad i = -50^\circ.$

There is good reason to think that these numbers are not far from the truth; but it would be rash to affirm that they agree exactly with the phænomenon; for there is no proof, at least I am not aware of any, that a mass of air at the temperature zero, being cooled down to half its bulk, will still preserve the same capacity for heat. If we suppose a greater diminution of volume than one half, we are entirely ignorant of the manner in which the temperature and the volume vary in regard to the absolute heat; and, as the principle of the investigation now ceases to be exact, the conclusions obtained, whether expressed in algebraic language or otherwise, must no longer be applied.

All Mr. Meikle's objections to my doctrine are derived from the extreme cases just mentioned. His arguments have no force; since I have always confined my speculations to the limits within which the thermometer can be reckoned an exact measurer of heat. He finds many inconsistencies, and he descants on this topic with so much politeness, that he seems seriously to think, his remarks have some foundation. If such be the case, it will be allowed that the same ability does not attend the same person on all subjects and on all occasions; for we can here recognise very little of that acuteness and sagacity from which we expect the *thorough reform.*

M. Poisson has treated this subject in an able memoir in the *Conn. des Temps* 1826. His equations agree with the doctrine here delivered as far as the formula (7), p. 264, which is derived from an integral to which I have objected. On the preceding page he arrives at this equation, $\frac{\omega}{n} = k - 1$, k standing for the same value as in this article, and ω and n being the variations of latent heat and temperature arising from

from a small condensation γ. The equation may therefore be thus written, $\frac{di}{d\tau} = k-1$; and as it is true of any number of continuous variations of density or volume, the pressure being constant, it agrees with the equation (a) investigated above. Observing also that $\gamma = \frac{d\varrho}{\varrho}$, and $k-1 = \frac{\alpha}{\beta}$, his two equations (5) and (6) will become,

$$\frac{\alpha\, d\tau}{1+\alpha\theta} = \frac{d\varrho}{\varrho},$$

$$\frac{\beta\, di}{1+\alpha\theta} = \frac{d\varrho}{\varrho},$$

θ being the actual temperature of the air. In the first of these equations, $d\varrho$ is derived from $d\tau$; and in the second, $d\varrho$ determines di. The two equations are therefore intimately connected, and no just conclusion can be deduced from the second, if the first be overlooked. Now M. Poisson has integrated the second equation apart, and as if it were in no respect modified by the first. This is the ground of my objection. In reality the integral he obtains satisfies the second equation, but it does not satisfy the first, as it ought to do according to his own calculations. If we reason fairly, and fulfil all the relations of the differential quantities, we shall be necessarily led, even when we follow M. Poisson's train of investigation, to the same theory explained in the present and in former articles of this Journal*.

Oct. 13, 1828. J. IVORY.

LV. *Remarks on the Influence of Terrestrial Radiation in determining the Site of Malaria. By* WM. ADDISON.

[Concluded from p. 278.]

ONE of the chief arguments in favour of the important influence exerted by terrestrial radiation in the production of that state of the atmosphere favourable to the attacks of disease, and known by the name of malaria, is drawn from the fact that in almost, nay I might say every case, where the violence of the symptoms induced by it will permit us to observe *the first impressions* which it causes, we find that its baneful influence is exerted during the night-season, while in the day-time it is comparatively, if not quite, inert. It would be needless to reiterate here the numerous proofs of this, distributed among the writings of those many accurate observers who have been at the pains of noticing the habitudes of malaria.

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* See Phil. Mag. and Annals for October 1827, pp. 245, 246, 247.

laria. I shall content myself, therefore, with quoting only Dr. Ferguson, who observes in his History of the Marsh Poison, "that the rarifying heat of the sun dispels the miasms which create fevers and violent diseases, and that it is only during the cooler temperature of the night, that they acquire body, concentration, and power."

Now surely any miasmatous effluvia liberated from exposed vegeto-animal or other matters by the rays of the sun, must exist in the atmosphere as much if not more during the day-season than in the night; for it is more than probable that nothing is *given up by the ground* after sun-set. How is it then, we may ask, that the great potency of malaria at night, and its comparative harmlessness during the day, have so constantly forced themselves upon our notice? Is it not because the air during the former period is cooled by radiation and rendered incapable of retaining those matters which the warmer air of the day-time held in perfect solution? A still atmosphere containing miasmatous matters, therefore, becomes dangerous to health in proportion as it reaches, by a gradual reduction of temperature, such as ensues from radiation, its dew point: for during the period when its temperature is elevated above this point, the malarious matter is without any, or of but little injurious agency; while the nearer it approaches the point at which moisture will be liberated from it, the more those extraneous matters it may contain become developed, as is fully shown by the much greater potency of odours at that period, of which numerous instances might here be mentioned; but it will be sufficient to recall what every one must have observed during the summer months: after a hot day, if the air at night remains still, or is favourable to the process of radiation, it is truly astonishing how far odours will diffuse themselves, and how powerful they generally are: a few hours after sun-set, on evenings favourable to the deposition of dew, many effluvia become very perceptible, and are potent and concentrated in proportion to the stillness of the air and its approach to the *dew point.* Winds, although they very often cause considerable reductions of temperature, are not so prejudicial, or so frequently productive of ill effects upon the human body, as those abstractions of caloric resulting from radiation; and for this reason,—because in the former instance the morbific particles are dispersed, and so diluted by the aërial currents as to be rendered incapable of exercising any injurious influence upon the body, or only upon such as are rendered extremely sensible to the exciting causes of disease; whereas in the latter instance they become often greatly accumulated, and so highly prejudicial, that few escape.

In

In this country the pernicious nature of the morning and evening mists formed over low grounds has been observed, and in hotter climates I need scarcely say that their influence in generating fever is as notorious as any of the best established facts on this subject; and the progress of the sun upwards being a remedy for the morning mists, and the day altogether for those of the night, seems to confirm the opinion, that a watery and moist atmosphere is the active conductor or repository of malaria; and that when the former is dissipated, the latter is checked in its progress; when the one is entirely dispersed, the other may be destroyed: so that the matter of malaria seems to be defined as to its place and extent by vapour and mist*.

That the diseases arising from miasmata in the air do sometimes cease in a definite and sudden line, and terminate also at particular altitudes, has often been observed and recorded; and these remarkable instances cannot be satisfactorily explained upon any other supposition than that afforded by the *radiation of caloric*. To explain their cessation in the former instance, we may remark, that that depression of temperature which ensues at night over a good radiating surface, may be sufficient to render active the miasms existing in the air; while over others, less powerful in the dissipation of caloric, the depression of temperature may not be sufficient; and it is probable that in many cases an atmosphere rendered prejudicial by the one, is again made innoxious by passing over the other. With respect to altitude, I have before shown that slight elevations are frequently a protection against the heavy miasmatous air which subsides to the lowest situations.

But to place this important subject in the clearest possible light, let me endeavour (by an appeal to some well-known chemical facts) to set forth the nature of the connection existing between free caloric and the matter of malaria. Let us suppose that the former exerts over the latter an influence analogous to that exercised by an *acid* over an *alkali* (neutralizing its qualities and destroying its effects), and we shall immediately perceive that the mere presence of malarious matters in the air may not be sufficient to excite in the human body a state of disorder or disease: carry the reasoning a little further, and then we can fully understand the way in which *radiation* proves injurious. Are we not warranted in concluding, from those facts which observation and experience have discovered to us, that similar phænomena are exhibited in the relations subsisting between the matter of heat and miasmatous

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* *Vide* Macculloch's Essay, pp. 259 and 274.

effluvia

effluvia, as we witness among the various combinations of the chemical world? Withdraw one of the elements of a binary compound, and the other becomes immediately apparent, and is developed with all those potent qualities which had been destroyed or neutralized whilst in union. So miasmatous matters are inert while fixed to the ground, from which they can arise only in conjunction with caloric; and as long as they continue together no ill effects ensue: but diminish the temperature, or, in other words, take away the caloric, and the injurious qualities of the miasms immediately become apparent. It may be objected, that if the injurious agency of miasmata in the air results from the mere abstraction of heat, no reduction of temperature could ensue without the production of malaria.—But this is not true; for we may justly suppose that in a great majority of cases there is not sufficient noxious matter on the ground to saturate—if I may be allowed the term—the caloric existing in the air, and therefore that in these instances great reductions of temperature may take place without any appearance of malaria, in the same manner as (to carry on the analogy drawn from chemical combinations) we can detach a portion of the acid from a supersaturated salt, without developing the existence or qualities of the alkali. On the other hand, the miasmatous source may sometimes afford a supply amply sufficient to satisfy even a very high temperature; and then any trifling escape of caloric will be accompanied with an injurious precipitation: and if the cooling process continues, a highly noxious malaria will result.

It has been observed, that very often the diseases arising from malaria ensue upon the temperature of a place reaching a certain point; that they increase in frequency and violence as the heat increases, but diminish as the mean temperature falls. These facts are not at all irreconcileable with the phænomena of *radiation;* for in these cases we may justly suppose, that at the higher temperatures malarious matter is liberated from the soil, the quantity of which is greater in proportion to the thermometric rise, while the lower temperatures are not sufficient to liberate any quantity of the noxious effluvium and diffuse it through the air: in the former case the radiation of caloric will be attended with disease, in the latter it will not.

I might here relate many facts tending to show the intimate connection which subsists between caloric and miasmatous effluvia, but I conceive that what has been here stated will be ample to establish this point, as well as the fact that the latter become virulent in proportion to the abstraction of the former by the process of radiation.

In conclusion, I shall briefly point out the importance of the

the foregoing observations, if they shall be found correct, towards the attainment of that desirable end, *the protection of mankind against the injurious impregnations of the air.*

As regards the prevention of the rise of miasms from the ground, I fear we have too little controul over the powerful agency of the rays of the sun to adopt successfully any plan with reference to this head. The solar influence is too great and too general to enable us to obstruct the emanation of various effluvia from the soil: nevertheless, much may be done by removing as far as possible from the surface of the ground any thing likely to afford them; and although our endeavours on this point must be very inefficient, they may be more successful and beneficial if directed to obviate those conditions which, as we have seen, have such a considerable effect in rendering active the noxious properties of malaria; viz. 1st, by preventing the dissipation of caloric through a still atmosphere; and, 2ndly, by promoting those aërial currents which tend so much to dilute and carry off any deposition which may ensue from that process.

In order to accomplish the former of these indications, we must use every means in our power to diminish the radiation of heat from the ground after sun-set, or to remove as far as possible from the circle of its operation, by attaining during the night-season some moderate elevation, interspersed here and there with lofty trees, and hedges or inclosures, and placed to windward of the more rapidly radiating surfaces which may be near: for although we speak of a calm and still atmosphere as being highly favourable to the development of malaria, still it must be understood that in almost every instance there are gentle, although perhaps imperceptible currents in the air, fully sufficient to waft to a considerable distance the miasms liberated by the dissipation of caloric; and any increase of temperature which such currents may acquire in their passage over less perfect radiators, will not always be enough to disarm them of their injurious influence. In situations therefore more particularly, where we are likely to be subjected to miasmatous products, and where the air at night is generally still, or where the gentle breezes are found to sweep over tracts favourable to radiation, it behoves us to endeavour,—by exciting artificially aërial currents, and by raising or keeping up the temperature of the air of the place where we may be by circumstances constrained to remain,—to prevent the deposition and development of malaria. This may be accomplished by lighting *large fires* to windward of the place of our nightly sojourn.—This is not a new idea: fires have already been observed to be beneficial in warding off the nocent power of malaria, though

though the principle upon which they act has not been properly understood, and consequently they have never been employed to the best advantage for this purpose. Dr. Macculloch relates a very important case, where a superintendant engaged in directing the cutting of wood in Africa, erected thirty earthen furnaces on the spot where his men were employed, lighting them every day. Before this, he had always from forty to forty-eight of his workmen sick; when in a short time they were reduced to twelve, then to four, and finally to one. Napoleon adopted the same expedient very largely, and with success, when his armies were occupied in the very worst district of Italy*. Knowing the principle of their operation, I should recommend them to be lighted at sun-set, and to be allowed to burn until sun-rise, having a regard to their position as pointed out in the foregoing remarks. Where large numbers of human beings are congregated together, as in armies, camps, &c., and where their situation at night is too often determined by other circumstances than salubrity, the value of these observations, with the knowledge of the principles which should direct their application, cannot but be very apparent.

It will be easily seen, from what has already been said, that fires as defences against malaria will be much more necessary during the nocturnal period than at any other; and even at this season, when the wind is blowing strongly and the night is overcast, they will not be so much required as when the air is clear and still.—It is not my intention to speak here of those various extraneous circumstances which render the body more susceptible of injurious influences at night than during the day,—such as bodily and mental exhaustion, sleep and diminished temperature; nevertheless they are well worthy of our serious regard, as cooperating powerfully with noxious miasmata in producing a state of disease.

Malvern, July 1, 1828. WILLIAM ADDISON.

LVI. *An Account of the Formation of Alcoates, Definite Compounds of Salts and Alcohol analogous to the Hydrates. By* THOMAS GRAHAM, *Esq. M.A. F.R.S.E.*

[Concluded from page 272.]

II. *Alcoate of Nitrate of Magnesia.*

IT is difficult to expel the whole of the water with which nitrate of magnesia is combined, without driving off a portion of the acid, and decomposing the salt. For this salt may be

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* Macculloch's Essay, p. 286.

be wholly reduced [to magnesia] in a glass-tube by the heat of a spirit-lamp, and yet a sand-bath heat of 600° or 700° is not sufficient to drive off all its water of crystallization. But a partial decomposition of this salt is of no great consequence, as alcohol dissolves the undecomposed portion of the salt, while the magnesia resulting from the decomposition precipitates, and may be separated by decanting the solution, or by filtering.

Four parts alcohol at 60° dissolve one part nitrate of magnesia, and boiling alcohol dissolves more than half its weight of this salt. From the great difference between the solubility of this salt at high and low temperatures, the alcoate is obtained with facility. A hot solution, containing a greater proportion of nitrate than one part to three parts alcohol, became, upon cooling, an irregular dry mass, which could be indented by the point of a glass-rod, but was much harder than the alcoate of chloride of calcium. In solutions considerably weaker crystals were deposited on cooling, which sometimes resembled the crystals of the former alcoate, but were much smaller, and less distinct; but more frequently, the crystals were exceedingly minute, and detached, without any regular form which could be discerned. But the great mass of crystalline matter precipitated in scales of a pearly lustre and whiteness, but apparently made up of the small crystals.

Dried by pressure, in blotting paper, this alcoate much resembled the alcoate of chloride of calcium in external characters. It sank in water, but floated on the surface of a saline solution of the specific gravity 1·1. Heated, it melted readily; boiled, and much alcohol was given off. When boiled violently, red fumes rise with the alcohol-vapour; but when dried slowly, no loss of acid takes place.

Upon cautiously heating 13·4 grains alcoate of nitrate of magnesia to dryness, there remained 3·56 grains nitrate of magnesia. This gives 9·84 alcohol to 3·56 nitrate of magnesia. But the atomic weight of anhydrous nitrate of magnesia is 9·25. Now, 3·56 : 9·84 : : 9·25 : 25·57.

In another case, 16 grains alcoate were reduced to 4·2 grains. This gives 11·8 grains alcohol to 4·2 grains nitrate of magnesia.

4·2 : 11·8 : : 9·25 : 25·99.

On the supposition that this alcoate consists of one atom nitrate of magnesia united with nine atoms alcohol, the alcohol should amount to 25·875, a number intermediate between the two results. This alcoate will be thus represented:

One atom nitrate of magnesia	9·25
Nine atoms alcohol	25·875
	35·125

III. *Alcoate of the Nitrate of Lime.*

Nitrate of lime may be obtained anhydrous with much greater facility than nitrate of magnesia, as, after being dried on the sand-bath, it may be heated in a glass-capsule by the spirit-lamp without decomposition, although it partially fuses. Boiling alcohol saturated with this salt formed a solution, which became very viscid on cooling, and remained without crystallizing for a whole day. But during a frosty night it was resolved into an amorphous solid, slightly moist, but without any appearance of crystallization. This substance was carefully dried in the usual way.

14·8 grains were reduced by heat to 8·8 grains. This gives 6 grains alcohol to 8·8 grains nitrate of lime. The atomic weight of anhydrous nitrate of lime is 10·25. Now,

8·8 : 6 : : 10·25 : 6·98.

In another case, 15·6 grains were reduced to 9·2, which gives 6·4 alcohol to 9·2 nitrate of lime. But,

9·2 : 6·4 : : 10·25 : 7·13.

This approaches 7·1875, or two and a half equivalent proportions of alcohol. The composition of the alcoate of nitrate of lime would be represented on this view, by

Two atoms nitrate of lime............	20·5
Five atoms alcohol....................	14·375
	34·875

In another strong alcoholic solution of nitrate of lime, a few irregular crystals were deposited; but the quantity was not sufficient to admit of examination, although they proved that this alcoate is capable of crystallizing.

IV. *Alcoate of Protochloride of Manganese.*

The protochloride of manganese, dried in a glass-tube, at a red heat, was light, friable, and of a reddish colour. Alcohol dissolved a very large quantity of it. When the solution was made at a high temperature, the alcoate crystallized readily upon cooling in plates with ragged edges. 14·6 grains of this alcoate, carefully dried by pressure in blotting paper, were reduced by heat to 7 grains. The alcoate, therefore, consisted of 7 grains protochloride of manganese, and 7·6 grains alcohol. The atomic weight of protochloride of manganese is 8. Now,

7 : 7·6 : : 8 : 8·686.

This slightly exceeds three atoms alcohol = 8·625, but the approximation to the theoretical number is as close as could be be expected. The composition of this alcoate may therefore be expressed by

One atom protochloride of manganese	8·
Three atoms alcohol	8·625
	16·625.

V. *Alcoate of Chloride of Zinc.*

Alcohol dissolves chloride of zinc with great facility, and the solution when filtered is of a light amber colour. This solution may be concentrated to a very great extent without injury, and becomes so viscid when cold, that it may be inverted without flowing perceptibly. It is not till so concentrated that it begins to deposit crystals, which are small and independent, but apparently of no regular shape. A viscid solution, in which crystals formed, was found to be composed of 20 parts chloride of zinc, and 7 parts alcohol. The small proportion of alcohol is astonishing; yet no more alcohol was given out when the chloride was heated nearly to redness, and began to volatilize; nor did a portion of the chloride thus heated take fire when exposed directly to the flame of a candle.

The crystalline matter was dried with difficulty by pressure in blotting paper. When dry, it possessed the usual waxy softness of the alcoates, and was of a yellowish colour. Heated, it entered into a state of semifusion, and gave off its alcohol. Nine grains alcoate were reduced by the application of sufficient heat to 7·65 grains. Hence the alcoate consisted of 7·65 chloride of zinc, and 1·35 alcohol. But the atomic weight of chloride of zinc is 8·75.

7·65 : 1·35 : : 8·75 : 1·544.

1·544 slightly exceeds 1·4375, or half an atomic proportion of alcohol. It is probable that the excess was owing to the difficulty of freeing the alcoate completely from the viscid solution. According to this view, the alcoate of zinc consists of

Two atoms chloride of zinc.........	17·5
One atom alcohol	2·875
	20·375

Besides these alcoates, similar compounds of chloride of magnesium and of protochloride of iron and alcohol were formed, although in quantities too minute to enable me to ascertain their proportions. Alcohol is retained with great force by chloride of iron, and is partially decomposed when heated, as is the case with many metallic chlorides.

As I had it only in my power to present the fixed alkalies to absolute alcohol in the state of hydrates, no alcoate appeared

peared to be formed. The same was the case with the vegetable acids soluble in alcohol.

It is probable that many more alcoates of salts may be formed, particularly of the metallic chlorides. The great obstacle to their formation is the difficulty, and frequently the impossibility, of rendering the salts perfectly anhydrous, before their solution in alcohol is attempted.

I am not aware of any other compounds in the solid form of the same class as the hydrates and alcoates. But there is an oxide, classed by Dr. Thomson in his System of Chemistry, with water and other neutral and unsalifiable oxides, the habitudes of which with certain salts are exceedingly remarkable, and have been looked upon as anomalous, but on which the established properties of hydrates and alcoates appear to me to throw some light. I refer to the deutoxide of azote or nitrous gas. 100 volumes pure water are capable of absorbing only 5 volumes of this gas, according to the experiments of Dr. Henry. But Dr. Priestley and Sir H. Davy ascertained that certain metallic salts, particularly the protosalts of iron, are capable of absorbing this gas in large quantities; and again emit the greater part of it unaltered, on being heated. That the absorption of deutoxide of azote by these salts, is not dependent upon the oxygen of their bases, or the water which they contain, I have proved in two ways, in the case of protomuriate of iron. By heating this salt to redness in a glass-tube, it is reduced to the state of protochloride of iron. Now, I find that this chloride in the dry state absorbs deutoxide of azote, although in a comparatively small proportion. And the alcoholic solution of the chloride, where neither oxygen nor water interferes, appears to exceed the aqueous solution of the protomuriate in its capacity for deutoxide of azote.

Deutoxide of azote, formed by the action of dilute nitric acid on copper, was conducted into a globular receiver surrounded by cold water, and thence through a glass-tube of two feet in length, filled with small fragments of chloride of calcium. Thus dried, the deutoxide of azote was passed slowly over carefully prepared protochloride of iron in the state of powder, and contained in a glass-tube of small diameter. The protochloride immediately became darker in colour; and upon being withdrawn, after exposure to the current of gas for some time, was found to retain the smell of nitrous gas, and to have increased in weight. In one case, 30 grains chloride had increased to 31·1 grains; and in another case, 25 grains chloride to 25·5 grains. On being gently heated, the deutoxide of azote was evolved, and the chloride restored to its former colour.

The solution of protochloride of iron in absolute alcohol, absorbed a much greater quantity of deutoxide of azote, and became nearly black. A solution saturated with gas began to boil at 100°, evolving gas in great abundance, which, being collected in the pneumatic trough, proved to be pure deutoxide of azote. The greater part of the gas was expelled before the alcohol rose to its boiling point, and after the solution was in the state of ebullition for a few seconds gas ceased to rise, and the alcoholic solution recovered its original colour, which was generally a chocolate-brown, from the presence of a little bichloride of iron. The quantity of gas evolved from a solution of one part protochloride of iron in five parts absolute alcohol, amounted to 23 times the volume of the alcohol.

I think it probable that the absorption of deutoxide of azote by protochloride of iron, is analogous to the absorption of alcoholic and aqueous vapours by the same body. For I find that protochloride of iron absorbs alcohol-vapour as well as the vapour of water. The absorption of deutoxide of azote may depend upon a tendency of chloride of iron to *deliquesce* in like manner, in an atmosphere of that neutral oxide. At a very low temperature, which it is perhaps out of our power to reach, protochloride of iron would probably absorb this gas in sufficient quantity to exhibit the appearance of deliquescence, and might form with it a neutral compound similar to its alcoate or hydrate.

A reason can also be given for the superiority of the aqueous and alcoholic solutions of this chloride over the dry chloride itself, in absorbing deutoxide of azote. We formerly saw that the alcohol of the alcoate of chloride of calcium was completely expelled by a heat of 250°, when no water was present, but that, when a considerable quantity of water was present, alcohol was retained by that chloride at the temperature of 400° or 500°. Now, chloride of iron might be enabled to retain deutoxide of azote more powerfully, by the assistance of alcohol or water, in the same manner. But the *retaining* power we have formerly found in a similar case to be an index of the *absorbing* power. Hence solutions of protochloride of iron might absorb deutoxide of azote more powerfully than the chloride itself.

LVII. *On*

LVII. *On the Luminous Zone observed in the Heavens on the 29th of September last. By Capt.* H. Kater, *V.P.R.S.*

To Mr. Taylor.

Sir,

THE substance of the following communication was inserted in the Times newspaper of the 4th of October; but as it seems desirable that phænomena of this kind should be permanently recorded, I shall feel obliged by your giving it a place in the Philosophical Magazine.

On the 29th of September last, Professor Moll and myself, being at Chesfield Lodge near Stevenage, observed at $8^h\ 35^m$ mean time, a zone or luminous belt extending itself in the heavens from the eastern to the western horizon. The light of the zone was white, uniform or nearly so, and surpassing much in intensity that of the milky-way. Its breadth (nearly equal throughout) was about three-fourths of the distance from β to γ Aquilæ, or 3° 45′. The edges of the belt appeared perfectly well defined and equally luminous with the middle, and its transparency was such that the stars were distinctly seen through it.

The observations made at the moment were, that the belt covered the Pleïades, and appeared to be equally distant from α Arietis and γ Andromedæ. It passed between α Aquilæ and α Lyræ, at the distance from α Aquilæ of one-third or two-fifths of the interval between these stars. Professor Moll observed that its edges were upon β and γ Ophiuchi. Lower down, near the western horizon, this luminou szone suffered a very remarkable inflexion towards the north, and soon after was lost in the clouds at a little distance above the horizon. On tracing the course of this phænomenon upon a celestial globe, its path appears to have been nearly that of a great circle, meeting the horizon about the E.N.E. and W. by S. points. The altitude of the centre of the most elevated part appears to have been about 72°, so that it must have been nearly in the plane of the dipping-needle, and nearly at right angles to the magnetic meridian.

At $8^h\ 42^m$ mean time, the belt began to fade slowly from the east towards the west, and at $9^h\ 22^m$ no trace of it was perceptible. Its light during the whole time appeared perfectly steady and without any coruscations.

There was much wind from the S.E. The stars were unusually bright. The height of the barometer was 29·12 inches, and the thermometer 59°.

It may not be uninteresting to add, that a gentleman re-

marked

marked that the setting sun had a very unusual appearance, being, as he described it, of a pale dirty yellow: and a letter which I have received from Cromer in Norfolk, mentions on that evening "a very beautiful setting sun, quite out of the common way;" but it is not stated in what its peculiarity consisted.

The latitude of Chesfield Lodge is 51° 56′ 15″, and its longitude about 43 seconds in time west from Greenwich.

I am, Sir, your obedient servant,

Chesfield Lodge, Oct. 14, 1828. HENRY KATER.

LVIII. *Expression for the time of Vibration of a simple Pendulum in a Circular Arc. By* A CORRESPONDENT.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I TAKE the liberty of inclosing you an expression for the time of vibration in a circular arc, which does not appear to have been noticed by any writer on Dynamics.

I am, Gentlemen, your humble servant,

J. W. L.

Let ψ be the angle which the pendulum makes with the vertical, α the arc through which it moves, r the radius of the circle, g the force of gravity, t the time; then

$$dt = \sqrt{\frac{r}{2g}}\,\frac{d\psi}{\sqrt{\cos\psi - \cos a}},$$

Let $1 - \cos\psi = (1 - \cos\alpha)\sin^2\sigma$

$$dt = \sqrt{\frac{r}{g}}\,\frac{d\sigma}{\sqrt{1 - \frac{(1-\cos\alpha)}{2}\sin^2\sigma}} = \sqrt{\frac{r}{g}}\,\frac{d\sigma}{\sqrt{1 - \sin^2\frac{\alpha}{2}\sin^2\sigma}}$$

$$= \sqrt{\frac{r}{g}}\,\frac{d\sigma}{\sqrt{\sin^4\frac{\alpha}{4} + \cos^4\frac{\alpha}{4} + 2\sin^2\frac{\alpha}{4}\cos^2\frac{\alpha}{4}\cos 2\sigma}}$$

$$= \frac{1}{\cos^2\frac{\alpha}{4}}\sqrt{\frac{r}{g}}\,\frac{d\sigma}{\sqrt{1 + \tan^4\frac{\alpha}{4} + 2\tan^2\frac{\alpha}{4}\cos 2\sigma}}$$

$$\text{or,}\quad \frac{1}{\sin^2\frac{\alpha}{4}}\sqrt{\frac{r}{g}}\,\frac{d\alpha}{\sqrt{1 + \cot^4\frac{\alpha}{4} + 2\cot^2\frac{\alpha}{4}\cos 2\sigma}}$$

Expanding these series by the known methods, and integrating

ting from $\sigma = -\frac{\pi}{2}$ to $\sigma = +\frac{\pi}{2}$, the time of an oscillation is given by either of the following series:—

$$\frac{\pi}{\cos^2\frac{\alpha}{4}}\sqrt{\frac{r}{g}}\left\{1+\left(\frac{1}{2}\right)^2 \text{tang}^4\frac{\alpha}{4}+\left(\frac{1}{2}\cdot\frac{3}{4}\right)^2 \tan^8\frac{\alpha}{4}\right.$$
$$\left.+\left(\frac{1.3.5}{2.4\ .6}\right)^2 \tan^{16}\frac{\alpha}{4}+\&c.\right.$$

$$\text{or,}\quad \frac{\pi}{\sin^2\frac{\alpha}{4}}\sqrt{\frac{r}{g}}\left\{1+\left(\frac{1}{2}\right)^2 \cot^4\frac{\alpha}{4}+\left(\frac{1}{2}\cdot\frac{3}{4}\right)^2 \cot^8\frac{\alpha}{4}\right.$$
$$\left.+\left(\frac{1.3.5}{2.4.6}\right)^2 \cot^{16}\frac{\alpha}{4}+\&c.\right.$$

LIX. *A Letter to* William Morgan, *Esq. F.R.S. on the Experience of the Equitable Society. By* A CORRESPONDENT.

Dear Sir,

HAVING unfortunately failed, on some former occasions, of fully comprehending the meaning of your expressions, I earnestly intreat your attention to a few remarks on your late statement of the Experience of the Equitable Society, in order that you may correct, if possible, the exaggerated conclusions which appear to me to be fairly deducible from the numbers that you have published; for I have no doubt that you will unite with me in sincerely deprecating the dangerous consequences, that would result from the hasty adoption of these conclusions in the practice of life assurance, although they may still be very useful as cautions deserving the attention of the granters of annuities.

Your table, lately published, stands thus:

Age.	Number.	Died [annually].	One in	That is, *
20 to 30	4720	29	163	=188−25
30 to 40	15951	106	150	=185−35
40 to 50	27072	201	135	=180−45
50 to 60	23307	339	69	=124−55
60 to 70	14705	436	34	= 99−65
70 to 80	5056	219	17	= 92−75
80 to 95	701	99	7	= 94−87

[View of the Rise and Progress of the Equitable Society, 8vo 1828. p. 42.]

1. I have first to observe, that the numbers of the column marked with an asterisc, which vary from 188 to 92, ought all, according to Halley's earliest hypothesis, to be 100; and according to Demoivre's correction of that hypothesis, to be 86 only.

86 only. The mean of the numbers here computed is 137: and nearly in the proportion of 86 or 87 to 137 does the expectation of life, as exhibited by this table, exceed the estimate of the Northampton table: a result not materially differing from the proportion of 2 to 3, which you assign.

2. But a more remarkable peculiarity of the decrements, or rather the decremental quotients, derived from your table, is the regularity which is observable in their progress after the period of middle life; each of the numbers, which express them, being precisely or very nearly the half of the preceding number. Thus, disregarding fractions, we have $\frac{135}{2} = 67$ for 69, $\frac{69}{2} = 34$, $\frac{34}{2} = 17$, and $\frac{17}{2} = 8$ for 85, which is equivalent to 7 at 87½.

3. We may therefore continue this series with perfect confidence, until the whole number of lives is exhausted, taking the annual decrement at 95,¼, at 105,½, and at 115,1, which may be supposed to be a sufficient age for the termination of our computations.

4. The decremental quotient in your table, $-\frac{\Delta z}{z}$, is very nearly $\frac{1}{2^y}$; y being $\frac{115-x}{10}$, x the age, and z the number living: for this expression gives us, from 25 to 85, (512, 256,) 128, 64, 82, 16, 8: and if we wish to modify the formula, we may make it more generally $\frac{-\Delta z}{z} = a^y$, and $y = b - cx$; so that the computation might be adapted to the earlier ages, if we had sufficient documents for the purpose.

5. We might at once form a table of mortality from the quotients thus computed, proceeding downwards from a single life at the age of 115: but it will be much more convenient, and perhaps equally accurate, to employ the method of fluxions.

6. Since $\frac{-\Delta z}{z} = a^y \Delta x$, Δx being $= 1$, $y = b - cx$, and $\Delta y = -c\Delta x$, we have $-\frac{\Delta z}{z} = a^y . \frac{\Delta y}{-c}$; whence, substituting, as usual, $\frac{dz}{dy}$ for $\frac{\Delta z}{\Delta y}$, we have the equation $\frac{dz}{z} = a^y . \frac{dy}{c}$, of which the fluent is $\text{hl}\, z = a^y . \frac{1}{c\, \text{hl}\, a} + f$; which becomes, for the values $a = \frac{1}{2}$ and $c = \frac{1}{10}$, $f - \frac{10}{2^y \text{hl}\, z}$, or $\text{hl}\, z = f - \frac{14{\cdot}42695}{2^y}$: which, when y is 11·5, becomes $f - {\cdot}0049926$; and if we suppose the number born to be 100,000, $11{\cdot}5129254 = f - {\cdot}0049926$, and

and $f = 11{\cdot}5179180$, and $\text{h l}\, z = 11{\cdot}517918 - \frac{14{\cdot}42695}{z^y}$, y being $= \frac{115-h}{10}$. When $y = 0$ and $z^y = 1$, $\text{h l}\, z = -2{\cdot}90903 = \text{h l}\, \frac{1}{11}$, so that about one in a million only would survive at 115.

7. It is obvious that, according to this formula, the value of z can never become wholly extinct, and that a population may be imagined great enough to have an individual living at any given age: but notwithstanding Mr. Gompertz's ingenious speculations on patriarchal longevity, it can scarcely be admitted that the analogy is sufficiently strong to justify such a conclusion respecting more modern times; to say nothing of the population of the whole world as a limit which would require to be considered.

8. The results of the formula are exhibited in the following table, in which they are compared with Mr. Babbage's table of the Equitable Experience, with the Carlisle table, and with the table published in the Philosophical Transactions for 1826.

Age.	Living.	$B \times 2$	$C \times 2$	$Y \times \frac{3}{10}$	$N \times \frac{10}{3}$
(0	10000)				
(15	9900)				
(25	9761)				
(35	9490)				
45	8970	9612	9454	10535	10827
50	8561	8910	8794	9263	9523
55	8014	8060	8146	7928	8160
60	7299	7084	7286	6543	6793
65	6396	6048	6036	5130	5440
70	5310	4974	4802	3733	4107
75	4075	3876	3350	2432	2773
80	2808	2714	1906	1336	1563
85	1654	1302	890	571	620
90	785	340	284	177	153
95	26	40	60	31	13
100	6·1	0	18	7	0
105	·7		0	1	
110	·04			·3	
115	·01			0	

9. I am at a loss to understand how you will be able to reconcile the numbers of the first column of this table, with the opinion that "the experience of the Equitable Office confirms the accuracy of the Northampton table," which is represented by the fourth column, on the supposition that a given number of individuals about 55 is to be compared. From this age, and as far as 85, the first column certainly represents the

the numbers of your table, if I have not mistaken their import; but the formula may readily be made to extend with equal accuracy to ages somewhat above this limit, as well as to an earlier period. We may take, for example, 105 for the age at which the decremental quotient, indicating the *rate* of mortality, becomes $= 1$, and make it 150 at 35; it must then be $\sqrt{150}$ at the intermediate age of 70; and supposing $a^{70} = \frac{1}{150}$, $\frac{1}{a} = 1{\cdot}0742$, b being $=105$, and $c = 1$, and the fluent becomes $= f - \frac{1}{hl\,1{\cdot}0742} \cdot \frac{1}{a^y}$, y being $105 - x$, or $f - \frac{13{\cdot}974}{a^y}$: and $\log a = {\cdot}031087$, and for 10000 at birth, $f = 9{\cdot}218$; which gives, at 95, 11, instead of 26, and at 55, 7207, a number nearer to the truth than the former.

10. If, happily for the welfare of mankind, it should hereafter appear that any firm reliance ought to be placed on these conclusions, or if the formula could be any otherwise modified so as to serve for the purposes of calculation, it might be made to afford essential assistance in determining the values of two or more joint lives; and by means of a proper table of fluents, the labour would be little greater for combinations of lives than for single ones, since the sums of the fluents would represent the products of the quantities to be combined; and a single table might be computed, which would render the integration of the fluent of $e^{a^y}\,\mathrm{d}y$ a matter of little difficulty. But such an improvement would at present be premature.

While results like these, however, are fairly deducible from the face of the evidence that you have laid before the public, you must allow, my dear sir, that any government granting annuities would be highly culpable in reckoning on values of human life like those which are represented by the Northampton tables; and that any private office has a right to expect, beyond such a valuation, a fair percentage for the payment of their unavoidable expenses. On the other hand, I do not see how it is possible for any assurance office, not returning a large share of their profits, to satisfy the public that their terms are reasonable, without acting most improvidently for their own interests. Such offices as the Equitable are exempt from these objections; and I have not the least doubt of the judgement and integrity with which you have long conducted the business of that Society, nor of the impropriety of calling on a private body to adopt any other regulations than those which are approved by its members. But, as a man of science, it is natural to hope that you will be ready to allow other men of science to partake in the fruits of your researches, and that you will be be desirous of vindicating yourself from all possible suspicion of ambiguity and of inconsistency.

I am, dear sir, with great respect, yours, &c.

Waterloo Place, Oct. 13, 1828. * * * *.

LX. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones.* *By* J. G. Children, *F.R.S. L. & E. F.L.S. &c.*

[Continued from p. 287.]

Genus 9. LYCÆNA, *Fab.*

Thecla et Hesperia, Fab. Polyommatus, Latr.
Argyreus, Argus, Pterourus, Battus et Graphium, Scop.
Cupido, Schrank. Rustici, Hübn.

Fam. A.—*Legs*, first pair shorter than the rest.

Wings, upper surface generally blue, especially in the males; in the females often brown, with a row of reddish-yellow spots near the exterior margin; under surface almost constantly grayish, with numerous ocelli with black pupils surrounded by white irides*.

Antennæ filiform, terminated by an elongated, compressed club.

Larva onisciform; head black, and, as well as the feet, very small, and scarcely perceptible; the body laciniate as usual,

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* Latreille at first subdivided his genus *Polyommatus* into three great groups,—*les petits-porte-queue, les argus,* and *les bronzés;* and subsequently he established several smaller sections in each of those subdivisions. Mr. Stephens has arranged the British *Lycænidæ* in the three genera *Thecla, Lycæna,* and *Polyommatus,* including in the first, those insects "distinguished by the sombre tints of the upper surface of their wings, and the pale streaks with which they are adorned below; by the pubescence of the eyes, the abbreviated, triangular anterior wings, and the ovate-triangular posterior ones, which are usually furnished near the anal angle with one or more short linear tails, or are strongly denticulated on that part."—"The indigenous *Lycænæ* are known by the brilliant coppery tints which adorn the greater portion of the disc of the upper surface of the wings;" and though considerable diversity of habit and form prevails amongst the *Polyommati,* they are in general distinguished by the rich blue tints with which their wings are enlivened.

The *Lycænæ,* he adds, are further discriminated from the *Theclæ* by their naked eyes, and by the want of the tail-like appendages to their posterior wings; and from the *Polyommati,* by the abrupt obtuse club of the antennæ, the more evidently denticulated posterior wings, and the superior size of the pulvilli, or foot-cushions.—The antennæ of Stephens's *Polyommati* have an abrupt compressed club, terminating in a lateral point; those of the *Theclæ* have the club elongate, cylindric-oval.—See Illustr. of Brit. Entom. vol. i. (Haustellata), p. 75—83.

usual, the back elevated, and generally beautifully coloured.

Pupa rather long, naked; colour whitish, with some dusky spots on the back and side.

Metamorphosis usually on the stem of a plant; rarely under the surface of the ground.

Species.	Icon.
a. No transverse reddish-yellow fascia on the under surface of the posterior wings.	
1. L. *Arion*, Linn.	Ernst, I. Pl. XLI. f. 36. d. e. f.
2. — *Alcon*, Fab. …….	Ernst, I. Pl. XLI. f. 86. i. k. Pl. LXXXIII. Suppl. II. Pl. 4. f. 80. a.—d. tert.
3. — *Iolas*, Ochs.*	
4. — *Euphemus*, Hübn.	Ernst, I. Pl. XLI. f. 36. g. h.
5. — *Erebus*, Fab…….	Ernst, I. Pl. XL. f. 86. a—c.
6. — *Cyllarus*, Fab…..	Ernst, I. Pl. XLI. f. 86. o.
7. — *Acis*, Ochs. …….	Ernst, I. Pl. XLII. f. 88. a—d.
8. — *Argiolus*, Linn….	Ernst, I. Pl. XLI. f. 86. l. m.
9. — *Damon*, Fab……	Ernst, I. Pl. XLII. f. 87. a—d.
10. — *Alsus*, Fab. …….	Ernst, I. Pl. XLII. f. 88. e. f.
11. — *Lysimon*, Hübn. .	Hübn. Pap. Tab. 105. f. 534. 535. (mas.)
12. — *Pheretes*, Hübn. .	Hübn. Pap. Tab. 97. f. 495. 496. (mas.) Tab. 107. f. 548. 549. (fœm.)
13. — *Daphnis*, Hübn.	Ernst, I. Pl. XXXVIII. f. 81. a. b.
b. A transverse fascia of orange-coloured spots on the under side of the posterior wings, near the outer margin.	
14. — *Corydon*, Fab…..	Ernst, I. Pl. XXXIX. f. 83. a—d.
15. — *Dorylas*, Hübn…	Ernst, I. Pl. LXXXIII. Suppl. II. Pl. IV. f. 82. a—d. bis.
16. — *Adonis*, Fab…….	Ernst, I. Pl. XXXIX. f. 82. a—e.
17. — *Icarius*, Esp…….	Hübn. Pap. Tab. LIX. f. 283. (mas.) 284. 285. (fœm.)
18. — *Alexis*, Hübn ….	Ernst, I. Pl. XXXVIII. f. 80. g. h.
19. — *Eros*, Ochs. …… (*Tithonus*, Hübn.)	Hübn. Pap. Tab. 108. f. 555. 556. (mas.)
20. — *Orbitulus*, Esp….	Hübn. Pap. Tab. 103. f. 522. 523. (mas.) 524. 525. (fœm.)
21. — *Agestis*, Hübn….	Hübn. Pap. Tab. 62. f. 303. 304. (mas.) 305. 306. (fœm.)

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* Sp. n.—L. alis integris cœruleis, maris immaculatis, fœminæ fuscis, disco cœruleo, subtùs cinereis, lunula media strigaque punctorum nigrorum ocellarium.

22. L. *Eu-*

	Species.	Icon.
22.	L. *Eumedon*, Hübn..	Hübn. Pap. Tab. 62. f. 301. 302. (mas.) 138. f. 700. 701. (fœm.)
23.	— *Admetus*, Hübn...	Ernst, I. Pl. VI. Suppl. III. f. 80. a—d. quart.
24.	— *Optilete*, Hübn...	Ernst, I. Pl. LXXXIV. Suppl. II. Pl. 5. f. 85. a—c. tert.
25.	— *Argus*, Linn....... (var. *Acreon*, Fab.)	Hübn. Pap. Tab. 64. f. 316. (mas.) 317. 318. (fœm.)
26.	— *Aegon*, Hübn......	Hübn. Pap. Tab. 64. f. 313. (mas.) 314. 315. (fœm.)*
27.	— *Amyntas*, Fab. ...	Ernst, I. Pl. XXXVII. f. 78. a—d.
28.	— *Polysperchon*, Bergstraes.	Ernst, I. Pl. XXXVII. f. 79. a. b.
29.	— *Hylas*, Fab.	Ernst, I. Pl. XL. f. 85. e. f.
30.	— *Battus*, Fab.......	Ernst, I. Pl. LXXXIV. Suppl. II. Pl. 5. f. 85. a—c. bis.

Fam. B.—The upper surface of the wings usually of a reddish-gold, or copper colour, often with black maculæ; the under surface always spotted; the posterior wings with an orange-coloured plain fascia, or composed of a series of maculæ, near the posterior margin; anal extremity usually distinctly angular.

Larva, generally longer than those of the preceding family; usually pale green, and villose; hairs reddish; head light brown, or brownish-white.

Pupa brownish, usually obtuse at each end; suspended horizontally by threads attached to the neck and posterior extremity.

	Species.	Icon.
31.	L. *Helle*, Fab.	Ernst, I. Pl. LXXI. Suppl. XVII. f. 89. a—c. bis.

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* Ochsenheimer also quotes, *inter alia*, (though with a note of doubt,) Lewin's Ins. pl. 39. f. 8. 9, as icons of his *L. Ægon*, which, according to Haworth, represent *Papilio* (*Lycæna*) *Artaxerxes*. Through the kindness of James Wilson, Esq. of Woodville, Canaan, near Edinburgh, and author of the beautiful Illustrations of Zoology now in course of publication, my cabinet is rich in specimens of that singularly local and rare insect, by comparing which with Ochsenheimer's specific characters of *L. Ægon*, it is obvious that he never saw the true *L. Artaxerxes*. I subjoin his sp. ch. of *L. Ægon*, and the very accurate one of *P. Artaxerxes*, as given by Mr. Haworth.

L. Aegon. Alis integris cœruleis margine lato nigro; subtùs cœrulescenti-albidis, punctis ocellaribus: posticis fascia ferruginea ocellisque cœruleo argenteis marginalibus.—*Ochs. Schm. von. Eur.* I. part 2. p. 57.

P. Artaxerxes. Alis nigris, anticis puncto medio utrinque albo, posticis lunulis rufis, subtus margine albo rufo punctato.—*Haw. Lep. Brit.* p. 47. No. 62.

Species.	Icon.
32. L. *Circe*, Hübn…….	Ernst, I. Pl. XLIII. f. 89. a—d.
33. — *Thersamon*, Fab..	Hübn. Pap. Tab. 69. f. 346. (mas.) 347. 348. (fœm.)
34. — *Gordius*, Hübn. .	Ernst, I. Pl. LXXII. Suppl. XVIII. f. 91. a. b. bis. Pl. LXXIII. Suppl. XIX. f. 91. c. d. bis.
35. — *Hipponoë*, Esp…	Ernst, I. Pl. XLIV. f. 92. a. b. Pl. LXXII. Suppl. XVIII. f. 92. f. g.
36. — *Chryseis*, Fab.….	Ernst, I. Pl. LXXIII. Suppl. XIX. f. 93. a—g. bis.
37. — *Eurybia*, Ochs….	Hübn. Pap. Tab. 68. f. 339. 340. (mas.) 341. 342. (fœm.)
38. — *Hippothoë*, Linn..	Ernst, I. Pl. XLIII. f. 91. c. d. Pl. XLIV. f. 93. a—c.†
39. — *Virgaureæ*, Linn.	Ernst, I. Pl. XLIV. f. 92. c—e.
40. — *Phleas*, Linn.…..	Ernst, I. Pl. XLIII. f. 91. a. b. Pl. LXXII. Suppl. XVIII. f. 91. e. g. h.
41. — *Ballus*, Fab.…….	Hübn. Pap. Tab. 107. f. 550. (mas.) Tab. 72. f. 360. 361. (fœm.)
42. — *Rubi*, Linn. ……	Ernst, I. Pl. XLIII. f. 90. a. b.

FAM. C.—The posterior wings subcaudate, with generally one or more reddish-yellow maculæ above the short tail; a white transverse fascia (more or less distinct) either simple, or composed of minute maculæ on the under surface of both wings.

Larva similar to those of Fam. A., but less elevated, and rather broad at the fore-part; back hairy; hairs very fine and short.

Pupa flat beneath; back very convex; generally attached to a leaf by a web, and filaments across the back.

Species.	Icon.
43. L. *Roboris*, Esp.…..	Hübn. Pap. Tab. 73. f. 366. 367. (fœm.)
44. — *Quercus*, Linn.…	Ernst, I. Pl. XXXV. f. 71. a—c.
45. — *Bœticus*, Linn.…	Ernst, I. Pl. XXXVII. f. 76. a. b. Pl. LXXI. Suppl. XVII. f. 76. c.
46. — *Telicanus*, Hübn.	Hübn. Pap. Tab. 74. f. 371. 372. (mas.) Tab. 108. f. 553. 554. (fœm.)

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† 38*. L. *Dispar*, Haw. ……… Curtis, Brit. Ent. I. Pl. 12. ♂ & ♀.
Mr. Stephens observes, that this species may eventually prove to be the same as *L. Hippothoe*. Ochsenheimer has omitted it altogether.

47. L. *Spini*,

	Species.	Icon.
47.	L. *Spini*, Fab.	Ernst, I. Pl. XXXVI. f. 74. a. b.
48.	— *Ilicis*, Hübn.	Ernst. I. Pl. XXXV. f. 72. a. b.? Pl. XXXVI. f. 75. a. b.
49.	— *Æsculi*, Ochs.	Hübn. Pap. Tab. 109. f. 559. 560. (mas.)
50.	— *Acaciæ*, Fab.	Herbst, Schm. Tab. 308. f. 3. 4.
51.	— *W. album*, Knoch.	Ernst, I. Pl. LXXXII. Suppl. II. Pl. 3. f. 72. a—c. bis.
52.	— *Pruni*, Linn.	Ernst, I. Pl. XXXVI. f. 73. a—f.
53.	— *Betulæ*, Linn.	Ernst, I. Pl. XXXV. f. 70. a—f.

Genus 10. PAPILIO, *Fab.*, *Lat.*

Pterourus, Scop. Pieris, Schrank. Principes, Hübn.

Legs six, perfect (formed for walking).

Wings, exterior margin of the anterior wings longer than the interior; posterior wings caudate, and excised to allow freedom of motion to the abdomen, or grooved to receive it.

Antennæ filiform, terminated by an oval obtuse club.

Larva fleshy; head obtuse, small; neck furnished with a furcate, retractile organ.

Pupa angular, anteriorly bifurcate, fastened by a transverse thread.

Metamorphosis in the air.

	Species.	Icon.
1.	P. *Ajax*, Linn.	Esper, Schm. I. Th. Tab. LI. Cont. I. f. 1.
2.	— *Podalirius*, Linn.	Ernst, I. Pl. XXXIV. f. 69. a—d.
3.	— *Machaon*, Linn.	Ernst, I. Pl. XXXIV. f. 68. a—e.

Genus 11. ZERYNTHIA, *Ochs.*

Thais, Fab., Latr. Argyreus, Scop. Pieris, Schrank.

Legs six, perfect (formed for walking).

Wings, posterior elongated, dentate, ecaudate.

Antennæ short; knob oval; apex slightly pointed.

Larva similar to those of the preceding genus in form, with the segments of the body furnished with rows of stiff hairs.

	Species.	Icon.
1.	Z. *Polyxena*, Hübn.	Ernst, I. Pl. LII. f. 109. a. b.
2.	— *Medesicaste*, Illig.	Ernst, I. Pl. LXXVIII. Suppl. XXIV. f. 109. a—d. bis.
3.	— *Rumina*, Linn.	Hübn. Pap. Tab. 124. f. 633. 634. (mas.)

Genus 12. DORITIS, *Fab.*

PARNASSIUS, Latr. PIERIS, Schrank.
ARGUS et BATTUS, Scop.

Legs six, perfect.

Wings rather long, partially diaphanous; posterior excised, not enveloping the body.

Body very short, thick, and hairy; the females with a strong, carinated, concave membrane on the posterior segment of the abdomen.

Antennæ short; club elongated oval, straight.

Larva with tentacula, and nearly of equal thickness through its whole length, hairy, hairs short.

Pupa, oval, folliculated, inclosed in a thin web.

Species.	Icon.
1. D. *Apollinus*, Herbst.	Ernst, I. Pl. LXXVI. Suppl. XXII. f. 99. a—d. quart.
2. — *Apollo*, Linn.	Ernst, I. Pl. XLVII. f. 99. a—h. Pl. LXXV. Suppl. XXI. f. 99. a. b. bis.
3. — *Delius*, Esp.	Hübn. Pap. Tab. 110. f. 567. 568. (mas.)
4. — *Mnemosyne*, Linn.	Ernst, I. Pl. XLVIII. f. 100. a—c.

Genus 13. PONTIA, *Fab.* (Steph.)

PIERIS, Latr., Schrank. BATTUS et ASCIA, Scop.
MANCIPIA, Hübn.

Legs six, alike in both sexes.

Wings entire, opaque; anterior somewhat triangular, sometimes rounded at the tip, generally white, with some black spots; posterior rounded, with a groove on the inner margin to receive the abdomen, beneath often coloured yellowish or greenish.

Antennæ with an abrupt, obconic, compressed club.

Larva with a small, round head; body slender, tapering at each end, downy.

Pupa angular, acuminated in front, supported by transverse threads on the middle and posterior portion of the body*.

1. P. *Cra-*

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* Mr. Stephens, in his Illustrations, observes that the insects of this Genus, "from the simplicity of their colouring, and their common appearance, have been unworthily neglected in this country by collectors; and in consequence we still remain unacquainted with the history and metamorphosis of some of the species, which evidently are far from uncommon." Mr. Stephens has examined this group with considerable attention, and has been induced in consequence to introduce as distinct species, certain individuals which have hitherto

	Species.	Icon.
1.	Po. *Cratægi*, Linn....	Ernst, I. Pl. XLVIII. f. 101. a—f.
2.	— *Brassicæ*, Linn...	Ernst, I. Pl. XLIX. f. 102. a—e.
3.	— *Rapæ*, Linn.......	Ernst, I. Pl. XLIX. f. 103. a—d.
4.	— *Napi*, Linn.	Ernst, I. Pl. L. f. 104. a. b.
5.	— *Callidice*, Hübn...	Hübn. Pap. Tab. 81. f. 408. 409. (mas.) Tab. 108. f. 551. 552. (fœm.)
6.	— *Raphani*, Fab. ...	Esper, Schm. I. Th. Tab. LXXXIV. Cont. XXXIV. f. 3. (mas.) Tab. CXXIII. Cont. 78. f. 3. (mas.) 4. (fœm.)

hitherto been considered merely as varieties of long established species:—for instance, the smaller variety of *Po. Brassicæ* constitutes his species *Chariclea*. Now it has been generally considered, that the chief difference between the larger and smaller varieties of *Po. Brassicæ* consists in size and colour; to explain which, it is observed that the larger are the æstival, and the smaller the vernal brood; and that the paler colours and smaller size of the latter are owing, the one, to the solar rays not being sufficiently powerful, when the insect comes forth, to produce the intense hue so conspicuous in the supposed æstival brood of *Po. Brassicæ;* the other, to the diminution in bulk, which the animal is presumed to sustain in consequence of the longer period that it remains in the pupa state, namely, from September to April; whereas the æstival brood remains in that state a few days only. To these explanations Mr. Stephens objects, that *Po. Brassicæ* also occurs early in the month of May, so that the difference of the sun's influence can, in those cases, amount to little. And as to the supposed alternating increase and diminution of size in the vernal and æstival broods, it is an anomaly in Zoology, "unless *Po. Rapæ* and *Metra* offer an example; but these insects, I presume, are distinct, upon similar grounds to those which appear to separate the insects that have promoted these observations."—*Stephens*. These grounds are, at least as to *Po. Brassicæ* and *Chariclea*, that the latter is considerably smaller than the former; *Po. Brassicæ* has the tip of the anterior wings above, black, and the patch on its inner edge indented, the points of the indentations following the direction of the nervures, and the extreme tip being slightly irrorated with white, with the cilia waved with black and yellowish; *Po. Chariclea* has the tip ash-coloured, without any internal indentations; the cilia with which it is fringed are pale, and the under surface of the posterior wings of a deeper yellow and more thickly irrorated with dusky, than those of *Pontia Brassicæ*. Stephens divides his genus into two sections,—the first containing "the true *Pontiæ;* the second, those insects which, if necessary to create (*them*) into a new genus, may, after Hübner, be termed *Mancipia*."

The following are his characters of the two sections:

"A. With the terminal joint of the palpi longer than the second: the apex of the anterior wings obtusely angled: the posterior wings not variegated beneath: the pupa strongly angulated, with a distinct short process in front, and projecting lateral appendages in front of the wing-cases (PONTIA)."

"B. With the terminal joint of the palpi shorter than the second: the anterior wings distinctly rounded at the tip: the posterior variegated beneath: the pupa angulated, with an elongated acute process or beak in front: lateral appendages wanting (MANCIPIUM)."

7. P. *Chlo-*

Species.	Icon.
7. P. *Chloridice*, Hübn.	Hübn. Pap. Tab. 141. f. 712. 713. (mas.) 714. 715. (fœm.)
8. — *Daplidice*, Linn..	Ernst, I. Pl. L. f. 106. a—c. Curtis, Brit. Ent. I. Pl. 48. (figura optima.)
9. — *Glauce*, Hübn. ...	Hübn. Pap. Tab. 107. f. 546. 547. (mas.)
10. — *Belemia*, Hübn...	Hübn. Pap. Tab. 82. f. 412. 413. (fœm.)
11. — *Belia*, Fab.	Hübn. Pap. Tab. 83. f. 417. 418. (fœm.)
12. — *Ausonia*, Hübn...	Hübn. Pap. Tab. 113. f. 582. 583. (fœm.) Tab. 83. 416. (mas.)
13. — *Tagis*, Hübn.	Hübn. Pap. Tab. 110. f. 565. 566. (mas.)
14. — *Cardamines*, Linn.	Ernst, I. Pl. LI. f. 107. a—k.
15. — *Eupheno*, Linn....	Ernst, I. Pl. LII. f. 108. a. b. e. f. Pl. LXXVII. Suppl. XXIII. f. 108. g. h.
16. — *Sinapis**, Linn...	Ernst, I. Pl. L. f. 105. a—c.

Genus 14. COLIAS, *Fab.*, *Latr.*

ARGYREUS et BATTUS, Scop.   PIERIS, Schrank.

Legs six, alike in both sexes, moderate, slender.

Wings, anterior somewhat triangular, posterior rounded, with a groove to receive the abdomen.

Antennæ short, rather slender, filiform at the base, towards the tip gradually thickening into an obconic club.

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* On this species Stephens has formed a new Genus, which he has called LEUCOPHASIA. Its characters are as follows:

"Genus 5. LEUCOPHASIA[a], *mihi.*

"*Antennæ* with an abrupt, obconic, compressed club; *palpi* very short, depressed, three-jointed, the basal joint large, conic, the second small, quadrate, the terminal one minute, globose: *wings* opaque, suborbicular, the discoidal cell small, basal; posterior wings slightly grooved: *legs* alike in both sexes, moderate; *claws* distinct, bifid. *Caterpillar* cylindric, downy. *Chrysalis* angulated, fusiform, supported by a transverse thread."—*Illust. Brit. Entom.* (HAUSTELLATA), vol. i. p. 24.

Stephens refers *Po. Cratægi* to the genus *Pieris*, which he adopts as distinct from *Pontia;* and in the latter genus he inserts as separate species *Napææ*, Hübn., and *Bryoniæ*, Wallner, both of which Ochsenheimer considers (though with a note of doubt) as varieties of *Napi;* and Stephens himself suspects also, that the former may possibly be nothing more. He has substituted Petiver's name of *Sabellicæ* for that of *Bryoniæ*, adopted by Wallner on the score of priority.

[a] Λευκος, *albus;* Φασις, *apparitio.*

Larva

Larva elongated, nearly cylindrical, hairy, but the hairs so short that they appear naked; back pale, or dark green, no central, longitudinal stripe.

Pupa acuminated in front, gibbous, subangulated, fastened by a transverse thread.

"The *Coliades* are particularly gay and showy insects; they are eminently distinguished by the brilliant tints of orange and yellow with which their wings are adorned; they are of moderate size, and usually appear in their final state towards the autumn."—*Stephens.*

FAM. A.—Wings rounded, margin generally dark-coloured.

Species.	Icon.
1. C. *Edusa*, Fab.	Ernst, I. Pl. LIV. f. 111. a—e.
2. — *Aurora*, Fab.	Ernst, I. Pl. VIII. Suppl. III. f. 111. quint.
3. — *Myrmidone*, Hübn.	Ernst, I. Pl. LXXVIII. Suppl. XXIV. f. 111. a. b. bis.
4. — *Chrysotheme*, Hübn.	Ernst, I. Pl. LXXVIII. Suppl. XXIV. f. 111. a. b. tert.
5. — *Phicomone*, Hübn.	Ernst, I. Pl. LXXIX. Suppl. XXV. f. 112. a—c. bis.
6. — *Hyale*, Linn.	Ernst, I. Pl. LIV. f. 112. a. b.
7. — *Palæno*, Linn.......	Ernst, I. Pl. VI. Suppl. III. f. 111. a. b. quart.

FAM. B.—Wings somewhat angular[*].

8. C. *Rhamni*, Linn.......	Ernst, I. Pl. LIII. f. 110. a—e. Curtis, Brit. Ent. Pl. 173.
9. — *Cleopatra*, Linn....	Ernst, I. Pl. LIII. f. 110. f. g. (mas.)

Genus 15. HECAERGE, *Ochs.*

LIBYTHEA, Fab. NYMPHALIS, Latr.

Legs four, perfect.
Wings angular, dentate, dark coloured with lighter spots.
Antennæ short, rigid, fusiform.
Palpi very long, porrected, straight.

Species.	Icon.
1. H. *Celtis*, Fab.	Ernst, I. Pl. I. Suppl. III. f. 5. a—f. bis.

† Only one Europæan species.

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[*] Genus GONEPTERYX, *Leach.*
"*Antennæ* short, stout, very gradually thickening into an obconic club; *palpi* short, much compressed, the terminal joint very short; *wings* angulated, large, the *posterior* grooved to receive the abdomen: *legs* alike in both sexes, short, stout; *claws* minute, bifid. *Caterpillar* naked. *Chrysalis* angulated, acuminated in front; fastened with a loose thread round its middle."—*Stephens,* Illust. Brit. Entom. (HAUSTELLATA), vol. i. p. 8.

Genus 16. HESPERIA, *Latr.*

Thymele, Pamphila, Fab. (Steph.) Battus, Scop.
Erinnys, Schrank. Urbani, Hübn.

Legs six, perfect (formed for walking.)

Wings, anterior either short, broad, triangular, and rounded posteriorly (Thymele, Steph.), or nearly triangular, and slightly elongate (Pamphila, Stephens); *posterior* broad, rounded, triangular, entire, or slightly denticulated (Thymele, Steph.), or rather ovate-triangular, with an obsolete emargination on the hinder margin, and sometimes a rudiment of a tail at the anal angle (Pamphila, Steph.).

Antennæ short, a little elongate, with a curved, fusiform club, not terminating in an acute hook (Thymele, Steph.), or not very long, with an abrupt, fusiform club, varying slightly in form, and terminated generally in a hook (Pamphila, Steph.).

Head large.

Body short, thick.

Larva, naked (Thymele, Steph.), or pubescent (Pamphila, Steph.).

Pupa, with the head-case notched (Thymele, Steph.), or with the front acuminated (Pamphila, Steph.).

Species.	Icon.
1. H. *Malvarum*, Hoffmannsegg. O. * ...	Ernst, I. Pl. XLVI. f. 98. a—c.
2. — *Lavateræ*, Hübn.	Ernst, I. Pl. LXXV. Suppl. XXI. f. 98. d. e.
3. — *Tessellum*, Hübn.	Hübn. Pap. Tab. 93. f. 469. 470. (mas.)
4. — *Sidæ*, Fab.........	Ernst, I. Pl. VII. Suppl. III. f. 97. a. b. quart.
5. — *Carthami*, Hübn.	Ernst, I. Pl. VII. Suppl. III. f. 97. quint.
6. — *Alveus*, Hübn. ...	Hübn. Pap. Tab. 99. f. 506. (fœm.)
7. — *Fritillum*, Hübn.	Hübn. Pap. Tab. 92. f. 461. (mas.) 462. 463. (fœm.)
8. — *Alveolus*, Hübn.†	Hübn. Pap. Tab. 92. f. 466. 467. (fœm.)
9. — *Proto*, Ochs......	Esper, Schm. I. Th. Tab. CXXIII. Cont. 78. f. 5. (mas.) f. 6. (fœm.)
10. — *Sertorius*, Illig. ...	Hübn. Pap. Tab. 95. f. 471. 472. (fœm.)

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* Pa. *Malvæ*, Fab.—Thymele, Steph.

† Thymele, Steph.

11. H. *Encrate*,

Species.	Icon.
11. H. *Eucrate*, Ochs. ...	Esper, Schm. I. Th. Tab. CXXIV. Cont. 79. f. 6.
12. — *Tages*, Linn.[*] ...	Ernst, I. Pl.LXXV.Suppl.XXI. f. 97. a. b. bis.
13. — *Pumilio*, Illig.	Hübn. Pap. Tab.91. f.458. (mas.) 459. 460. (fœm.)
14. — *Steropes*, Hübn....	Ernst, I. Pl. LXIV. f. 94. a. b.
15. — *Paniscus*, Fab.[†]	Ernst, I. Pl. XLV. f. 96. a. b.
16. — *Sylvius*, Fab.[†] ...	Ernst, I. Pl.LXXIV. Suppl.XX. f. 96. e. f.
17. — *Comma*, Linn.[†]...	Hübn. Pap.Tab. 95. f. 479. (mas.) 480. 481. (fœm.)
18. — *Sylvanus*, Fab.[†]...	Ernst, I. Pl. XLV. f. 95. a—d. g. h.
19. — *Linea*, Fab.[†]......	Ernst, I. Pl. XLV. f. 95. e. f.
20. — *Lineola*, Ochs. ...	Hübn. Pap. Tab. 130. f. 660. 661. (mas.) 662. 663. (fœm.)
21. — *Actæon*, Hübn....	Hübn. Pap. Tab. 96. f. 488. 489. (mas.) 490. (fœm.)

Genus 17. CHIMÆRA, *Ochs.*

ATYCHIA, Latr. STYGIA, Godart.[‡]

Wings, anterior short, small, of nearly equal length throughout; posterior rounded.

Head small.

Antennæ bipectinate in the male, simple in the female (Latr.).[§]

Palpi, labial rising remarkably above the clypeus, anteriorly very hirsute. (Latr.)

Antlia very short, or wanting.

Abdomen posteriorly elongated.

Tibiæ, with elongated scales and calcaria. (Latr.)

Larva, unknown.

Species.	Icon.
1. Ch. *Pumila*, Ochs. ...	Hübn. Noctuæ, Tab. 86. f. 405.
2. — *Appendiculata*, Ochs.[‖]	Ernst, III. Pl. CII. f. 149. a—c. (fœm.) VI. Pl. CCLXXIII. f. 438. a—c.

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[*] THYMELE, Steph. [†] PAMPHILA, Steph.

[‡] *Histoire Naturelle des Lepidoptères, ou Papillons de France*, vol.iii. p.167. Although this volume is dated 1822, and the *fourth* of Ochsenheimer's work appeared six years before, Godart does not seem to have been aware that the German author had in this, his last volume, adopted Latreille's, or rather Draparnaud's Genus STYGIA, for the reception of Hübner's *Bombyx Terebellum*, which he accordingly transferred from its former place with the Chimeræ (vol. ii. p. 6. No. 4. *Ch. leucomelas*) to that Genus.

[§] Ochsenheimer's generic characters in this and several other instances are so insufficient, that I have often found it necessary, as in the present case, to quote other naturalists of acknowledged authority.

[‖] *Noct. Chimæra*, Hübn. *Pyral. Vahliana*, Fab.

Species.	Icon.
3. Ch. *Radiata*, Ochs....	— — —
4. — *Lugubris*, Ochs.*	Hübn. Bombyces, Tab. 51. f. 217. (mas.)

Genus 18. ATYCHIA, *Ochs.*

PROCRIS, Fab., Latr. AGLAOPE, Latr. GLAUCOPIS, Fab., Latr.
(INO, Leach, Stephens.) CHRYSAORES, Hübn.

Wings oblong, ciliated; submarginal cell of the inferior closed behind by a very angular nervure, from which three branches proceed, and terminate at the posterior margin. (Godart.)

Antennæ bipectinate in the male, simple in the female. (Latr.)

Palpi short, scarcely or not at all rising above the clypeus, densely clothed with scales, not hirsute. (Latr.)

Tibiæ scaly; posterior with small calcaria, and the two upper, interior spines very minute, or obsolete. (Latr.)

Larva, short, thick, nearly naked; head small.

Pupa soft, with moderately long wing-cases.

	Species.	Icon.
Fam. A.	1. A. *Infausta*, Linn. †	Ernst, III. Pl. CIII. f. 152. a. b.
Fam. B.	2. — *Pruni*, Fab.	Ernst, III. Pl. CIII. f. 151. a—e.
	3. — *Globulariæ*, Hübn....	Hübn. Sphing. Tab. 1. f. 2. (mas.) 3. (fœm.)
	4. — *Statices*, Linn. ‡	Ernst, III. Pl. CIII. f. 150. a—d.

[To be continued.]

Note.—The reader is requested to attend to the following corrections of some of the preceding synonyms.

Gen.				*Gen.*			
Argynnis	20.	*for* Fab.	*read* Hübn.	Hipparchia	38.	*for* Fab.	*read* Hübn.
Hipparchia	1.	— Fab.	— Hübn.	———	57.		
———	3.	— Linn.	— Hübn.	———	60.	— Fab.	— Thunb.
———	7.	— Fab.	— Herbst.	———	61.	— Fab.	— Esp.
———	11.			———	65.		
———	13.	— Fab.	— Hübn.	———	69.	— Fab.	— Hübn.
———	20.			———	77.	— Fab.	— Pallas.
———	23.	— Fab.	— Esper.				

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* *Bomb. lugubris*, Hübn.

† Genus AGLAOPE, Latr.

A. *lingua* nulla, aut obsoleta. *Palpi* minimi, articulo ultimo subgraciliore, minus squamato. *Tibiæ* posticæ calcaribus spinisque brevissimis, subobsoletis. *Anus* imberbis. *Latr. Gen. Crust. et Ins.* iv. 214. To which may be added: *Antennæ* sexu utroque bipectinatæ; *alæ* oblongæ, cellulâ marginali inferiorum posticè clausâ, ramisque duobus nervosis, ad lineam sepimenti sese invicem decussantibus, longitudinaliter divisâ. (Godart.)

‡ This and the preceding species are placed by Stephens in the Genus INO, Leach, "established by Fabricius by the name of Procris; but that having been preoccupied, Dr. Leach changed its appellation to the one it now bears." The generic characters of Ino are given by Mr. Stephens as follows:

"INO,

LXI. *Notice of the Geological Features of a Route from Madras to Bellary, in April and May* 1822. *By Capt.* W. Cullen, *of the East India Company's Artillery service*[*].

I BEG to submit to the Society an attempt to describe the geological features of a route which I lately passed over from Madras to Bellary. It accompanies a small collection of specimens of the prevalent rocks, and a barometrical section, which combined will, I hope, assist in affording some idea of the nature of the tracts in question.

The high road to Bellary was followed as far as Cuddapah; but from thence going north, by Chinnoor Nundialpett Poonnamila to Iddamacul, my route, from the last-mentioned village, lay nearly west by Giddeloor, over the Nulla Mulla range of hills by the Nundi Kunnuwi Ghaut[†], by Banaganapilly, Piaplee, and Gootty, to Bellary. A great proportion of this route must, in favourable weather, be as beautiful in point of scenery, as it is rich in geological interest; but at the period of my passing (the latter end of April and beginning of May), the excessive heat had checked all vegetation, and afforded but little inducement for excursions in quest of mineralogical specimens.

Referring the route to Arrowsmith's large map, which is sufficiently correct for the present purpose, it will be observed to offer an obvious distribution into five portions, each of them characterized by distinct geographical features.

First. The plain open tract from Madras to Naggery.

Second. The narrow mountainous belt extending from Naggery to the neighbourhood of Cummum.

"Ino, Leach.—*Antennæ* gradually thickening from the base to near the apex, straight, bipectinated, or simple, with the interior edge subserrated: *palpi* short, not reaching beyond the clypeus, densely clothed with scales: *head, thorax, abdomen,* and *femora,* thickly covered with scales, rather elongate on the former. *Larva* scaly, depressed; head small: pupa with long wing-cases."

"The species are known from the Anthoceræ (Zygænæ) by the form of the Antennæ, which are not curved, but nearly straight, and become gradually thicker as they approach the tip, which is again slightly attenuated; the males have this part bipectinated, and the females simple, but serrated beneath; the species (of which there are several on the continent) are all of rich tints of light green, blue, or brownish, and immaculate."—*Illust. Brit. Ent.* (Haustellata), vol. i. p. 105. Stephens gives only one species, (*Statices,* Linn.) as decidedly British: that considered as *Globulariæ,* Hübn. having, on examination, proved to be referable to *Ino Statices,* var. β. He conceives, however, that it is extremely probable that *Ino Globulariæ* may occur in England.

[*] From the Transactions of the Literary Society of Madras. Part I.

[†] Kunnuwi is Kanarese for Ghat. Nundikunnuwi means, therefore, Nundi Ghat.

Third. The open level country from the Nulla Mulla hills to Banaganapilly.

Fourth. The tract of tabular land between that town and Gootty.

Fifth. The level country from thence to Bellary.

The geological characters of this tract are equally remarkable, and admit of a division corresponding perfectly with its geographical features.

In the first division the prevailing rocks are granite.

In the second, clay-slate and sandstone.

In the third, compact blue limestone.

In the fourth, clay-slate and sandstone.

In the fifth, granitic.

I have ventured to characterize each division by one or two rocks only, because in each of them the rocks specified were, in general, beyond all comparison the most abundant. In the several divisions, of course, were found many of those minerals by which the principal rocks are usually accompanied; but to enumerate the whole of these as they occurred may not be deemed necessary, since the specimens themselves are forwarded.

Before entering into a detail of the rocks prevailing in these tracts, it may be proper to notice, in a general way, their absolute heights above the sea.

The north-west side of Pootoor, at the distance of sixty-four miles from Madras, exclusive of windings, stands about 500 feet above the sea; exhibiting a rise of eight feet in the mile; and this proportion holds good throughout that part of the route, interrupted only by one undulation on the east side of Naggery, and by a second between Naggery and Pootoor.

These undulations, which rise 100 or 150 feet above the general level, mark the course of chains of hills, which in such places cross the road; and, in general, in all these sections of the *terrepleine* of a country, similar abrupt elevations may be considered as indications of the presence, and course of a chain of hills. There is a third rise a little beyond Pootoor, indicating like the former, the presence of a mountainous range.

The valley of Tripetty is, on a mean, about 360 feet above the sea, but the river which runs through its centre little above 300. The mean height of the valley from Baulpilly to Wuntimettah, an interval of about 52 miles, is about 550 feet, and the town of Cuddapah itself a little below 500.

Chinnoor on the Pennar river, five or six miles north of Cuddapah, is about 30 feet lower than that place; but the height of Jungumpilly, the next march, is 700 feet. There is then a fall of about 100 feet to the Saghilair river; after which it rises gradually to Alinuggar and Iddamacul, both of which

which places are on the same level, about 900 feet above the sea. I was much disappointed in the height of the Nulla Mulla range, which, at the point where I crossed, did not attain an elevation of 1800 feet above the sea, and of little more, therefore, than 800 feet above the plains on either side.

The route across the plain, between the Nulla Mulla range and the table land at Banaganapilly, is nearly level, and about 800 feet above the sea; but the general declination of this plain appears to be from the Kistnah to the Pennar.

From Banaganapilly to Jeldroogum the ascent along the valley is pretty considerable, being 400 feet in about twenty miles, or 20 feet per mile.

The table land, commencing two or three miles west of Jeldroogum, and extending to Piaplee, a distance of eight or ten miles, is between 1700 and 1800 feet above the sea*; and Colonel Lambton has already stated that to be the mean height of the country between Gootty and Bellary†.

Although granitic have been mentioned as the prevailing rocks in the first division, none of them were seen *in situ* till about the thirty-seventh mile, in the bed of the river at the village of Nellatoor. The whole of the previous flat being a loose sandy soil, entirely free from rocky masses, and even almost so of fragments, with the exception of some stony swells to the north of Cunkama Choultry. I should observe, however, that all the pagodas, facings of tanks, &c., were built either of granite or laterite.

The blocks forming these latter have a rolled appearance, are a kind of coarse sandstone conglomerate or breccia, and perhaps originate from, or are connected with, the mountain-chain running north from Naggery Nose. The granite, which first makes its appearance at Nellatoor, may be traced as far as Curcumbaddy, with no other interruption save that of those singular beds or courses of trap which are apparently so common in all the granitic tracts of this country. All these beds appear to run nearly east and west. In the present instance they were remarkably numerous, forming chains of low hills, and crossing the route so frequently, as to occupy a space which, taken in the aggregate, would nearly equal that of the granite itself. Granite, however, evidently composes the great mass of hills, which commence a few miles to the south-west of

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* But there is a very rapid descent from Piaplee towards Gootty, of 400 or 500 feet in the first ten miles. The plains west of Gootty are about 1200 feet above the sea.

† This seems rather under the truth:—barometrical observations, which I have since had an opportunity of making, give from 1400 to 1500 feet for the mean altitude of the country between Gootty and the Hoggree river, eight miles east of Bellary.

of Naggery, and which continuing near to the left of the road as far as Woramallipett, then stretch off to the west, till they are lost in the prolongation of the Tripetty range. The peculiar features of the granite are very marked and conspicuous in the whole of this western mass of hills, exhibiting itself on their slope, in those great bare masses of rock, which are so familiar to most people in this country, and on their summits in enormous detached rugged piles and fragments. But what contributes most powerfully to the interest of this part of the route are these singular courses or dykes of trap rocks, which may be observed crossing the country, without experiencing the smallest deviation or interruption in their course from the granitic barriers, which seem to oppose themselves on all hands to their progress.

Their deep black hue, and sharp, well-defined outline, contrasted with the light colour of the granite-masses, through and over which they seem to pass, forcibly arrest the attention. Granite appears also to a considerable distance on the right or north-east side of the road, and probably constitutes the greater portion of the very remarkable hill called Naggery Nose, as I have traced it nearly to the foot of that hill. The hill just mentioned, however, as well as those immediately to the north of it, and whose outlines are equally singular, are evidently capped with rock of a different nature.

The caps, which occupy about one-fifth or one-sixth of the whole height of the hills, are precipitous and mural on their south and east sides, to the north sloping gradually off, until they fall almost into the same level with the plains. I attempted, both from Potoor and Woramullipett, to reach these hills, with the view of ascertaining their composition, but the distance was too great, and I could only approach their bases.

Judging from the external appearance of the cap, it is composed of two distinct rocks arranged in horizontal beds or strata. The upper and lower portion of it appeared to be of the same nature, being alike in colour, and marked by similar numerous, but irregular vertical seams and fissures; the effect, probably, of decomposition. The aspect of the central stratum or bed, was, however, different from either of those between which it lay. It was marked most distinctly throughout its whole extent, by regularly parallel and horizontal seams, which appeared to be those of stratification; its colour also, which was darker than the others, strengthening the supposition of its being a rock of a different nature*.

The

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* I have since had an opportunity of examining the hills at Tripetty, where both the cap and slope of the hills appeared to consist of but one rock,

The western approach to these hills, for one mile and a half or two miles from their bases, was thickly strewed with nodules of several varieties of sandstone, the most common of which were of rather a close fine grain, sometimes so much so as hardly to be distinguished from quartz or hornstone. The finer-grained varieties were of different shades of red or brown, but generally of a light colour. There was also great abundance of a very coarse variety, composed of rounded pebbles, and fragments of quartz of all sizes, in the same specimen, from that of a pin's head to two or three inches in diameter, imbedded in a dark green basis. This variety was very remarkable. It was composed of rolled fragments and pebbles of quartz, which were generally of a white colour in a ground of dark green. The cement appears (on the march from Naggery to Potoor there were rolled masses of this variety twelve to eighteen inches diameter) to be hornblende, which communicating its tinge to the finer and transparent particles of quartz, affords a beautiful contrast to the large white pebbles imbedded in it. These nodules I should be disposed to trace from one or both of the two first-noticed portions of the cap, but I met with no fragments of any kind of schistus, owing perhaps to my not having approached sufficiently near. It has been noticed that the summits of this group of mountains, of which Naggery Nose forms the southernmost point, are mural and precipitous to the east and south, while to the north they fall gradually away, till they nearly coincide with the general level of the country. This latter appearance is very striking from Curcumbaddy, where the whole of that group is seen in reverse; Curcumbaddy itself being situated at the foot of one of these declivities, being a prolongation of the Tripetty range, which, from its outline and general aspect, I would infer to be of similar structure with that of Naggery.

The clay-slate, which occupies so great a portion of the subsequent route, first makes its appearance at Curcumbaddy; but the accumulation of sand and alluvial soil in the Tripetty valley, which is crossed on leaving Woramallipett, prevented my thus far tracing the continuity of the granite, although it is to be observed, with occasional beds of green-stone, in several parts of the road. The last rock I recollect to have passed before reaching Curcumbaddy was a bed of porphyritic greenstone, about one mile and a half or two miles from the village.

rock, and that sandstone. From this, and other corroborative instances on the route between Cuddapah and Ryachootee, I have little doubt that the caps of the Naggery range, of the great mass of hills east of that line, and, in short, of all the ranges exhibiting the same remarkable outlines, consist of varieties of sandstone or conglomerates.

The granites of this division were generally of a light colour, shades of white and of a coarse texture; the darker varieties, however, inclining to brown or red, being, I think, the finer grained.

The quartz and felspar were by far the most abundant constituents, and gave the colour to the rock; the hornblende, which was of a dark green, being very irregularly and sparingly distributed. There seemed to be little or no mica.

The texture of the trap was very uniform, and of a fine grain, composed distinctly of hornblende, and greenish white felspar.

The porphyritic variety, alluded to near Curcumbaddy, contained irregular crystals of felspar, of from one-tenth to five-tenths of an inch in diameter, of the same colour as the felspar of the basis.

The transition of clay-slate is very sudden and complete. The low hills immediately at the back of Curcumbaddy consist of a compact quartzose sandstone, or hornstone, but the clay-slate may be observed in contact with it, within 100 yards of the north side of the village. From this spot clay-slate forms the grand and almost sole constituent; for, with the exception of occasional beds of calcareous schistus and flinty slate in the valleys and sandstone-caps on some of the hills, the great mass of the two singular mountain-chains which form the boundary of this interesting valley, on a line of upwards of 150 miles, appears to consist entirely of that rock. I must add, however, that should an actual personal examination of the strata be considered indispensable in subjects of this nature, these observations must of course, in such a case, be considered as only strictly applicable to the high road itself, or to a short distance on either hand.

The seams of stratification are, however, so entirely regular and distinct on the slope of the hills on either side, and in general so decidedly characteristic of these clay-slate tracts, that it is hardly possible to be mistaken in their nature, even at a distance of several miles. Towards the commencement, the hills are rather thickly clothed with wood; but on approaching Cuddapah, and all to the north of that place, the trees are stunted, and but thinly scattered over their sides, leaving the strata-seams, like so many artificial terraces or ploughed furrows, distinctly exposed to view. The internal structure and colour of the slate, in a tract of such extent, were of course very various. At Curcumbaddy, and for a stage or two afterwards, chiefly shades of red; about Wuntimettah, purple and gray. Shades of these two last prevailed, I think, generally, till within eight miles south of Poonnamilla, when

when it suddenly altered to green; and this colour subsequently seemed to be constant in all the plains and low grounds. The general direction of the strata of clay-slate corresponded with that of the ranges of mountains which they composed; viz. about north-north-west and south-south-east, with a very great dip to the north-east; all the associated rocks being conformable, unless the *sandstone*-caps should be an exception, which appeared to have a very slight dip, if the appearances noticed from Curcumbaddy and Nundialpett may be considered as indications of it. However, of the latter I had few favourable opportunities for examination.

The strata of clay-slate appeared sometimes to be nearly vertical; but the exact dip was never measured.

The same dip and direction of the strata were exhibited in the fourth division, of clay-slate.

Of the rocks associated with clay-slate, the more important and general were sandstone, hornstone, calcareous schistus, flinty slate, and quartz. Calc-tufa, and marls of infinite variety of colour and induration were also found nearly throughout, and in some places in extraordinary quantity.

The sandstone was usually found on the summits of the hills; the calcareous schistus and flinty slate in the valleys; the quartz forming veins and layers in the seams of the clay-slate, and appearing therefore only where the latter was not concealed by alluvial depositions.

These were sometimes found all together; but it may be more convenient to consider each of them separately.

The quartz was generally of a white colour, and the layers of all degrees of thickness, from one tenth of an inch to one foot and a half. It was extremely subject to disintegration, covering the ground frequently in such quantity with its nodules, as completely to whiten it. These appearances were particularly remarkable on the march from Curcumbaddy to Baulpilly, from the vicinity of the hills on both flanks. Afterwards the valley opens, and the strata are generally concealed by the soil; but whenever rocks appear to any extent, quartz, either in veins or layers, will almost invariably be found pervading them. It is very abundant in the clay-slate between Nundaloor and Wuntimettah, and here rather remarkable from containing numerous little nests of a kind of green earth; until, however, fifty miles north of Cuddapah, and clearing the hills beyond Jungumpilly, the individual masses of quartz are too inconsiderable in themselves, to serve in any other way than merely as a characteristic of the clay-slate, and other more important rocks.

The march from Jungumpilly to Poornamila, with the exception

ception of the first five or six miles, is through an open level country, of perhaps fifteen miles square, as if it had been formed by the abstraction of a part of the central chain of hills which divide the southern and northern portions of this tract into two narrow valleys. The Saghilair river is crossed nearly in the centre of this open space; and it is immediately on reaching its northern bank that the quartz is observed to assume quite a new character, to constitute, as appears subsequently, one of the most important features in the remainder of the route.

A green schistus seems to prevail throughout this plain, and it continues as far north as Iddamacul, as may be observed from an examination of the wells; latterly also appearing above the surface in ridges of considerable elevation.

The strata of schistus in the bed of the Saghilair, which are nearly vertical, and of a bright green colour, present a very interesting appearance.

The direction of the strata at the ford corresponds with that of the bed of the river; and the stream, which appears subject to a very rapid rise and fall, has in consequence worn numerous deep narrow channels through the slate, presenting on all sides sharp perpendicular dykes of fifteen or twenty feet high, while they are often but a few inches in thickness. Almost immediately on reaching the north bank of the Saghilair, the quartz, which hitherto had never been met with but in the seams of the slate, and there seldom exceeding a breadth of eighteen inches, is now observed alone in immense blocks, and continuous masses, of fifty or sixty feet wide. Their direction corresponded, I think, generally with that of the strata of schistus, but they appeared above the soil unaccompanied by any other rock, and forming ridges of such magnitude and extent, as to give them the appearance of the summits of quartz hills, commencing to be denuded of soil, and forcibly impressing one with the idea of being in the vicinity of granite: nor was the impression, perhaps, altogether without foundation, as the small fort of Iddamacul, twenty miles further north, is built on an insulated hill of sienite.

The quartz ridges became gradually more numerous and extensive on my progress up the valley; but I lost them after leaving Iddamacul, and striking off to the westward by Giddeloor towards the Nulla Mulla range. Nothing could possibly be more interesting or striking than this small pile of sienitic masses, which, possessing all the peculiar rugged outline of a granitic hill, afforded the most singular contrast to the smooth, bare, undulated contour of the clay-slate ranges on either side of the valley. The valley was here seven or eight miles wide, and this hill rose out alone, as if forced up from

from below by volcanic agency, from the dead marshy flat in the centre of it. Its base might be 150 yards in diameter, and its perpendicular height about 100 feet. This sienite is composed of large crystals of black hornblende, and yellowish white felspar, very irregularly aggregated, with but little quartz, and that only in patches, and very unequally dispersed.

The sandstone which has been mentioned was usually found occupying the summits of the hills of clay-slate, and the opportunities, therefore, of actual examination were but rare. These opportunities occurred also at points very distant from each other, (but, perhaps, not the less corroborative from that circumstance, of the inference that the whole of these ranges are capped with varieties of sandstone,) viz. at *Curcumbaddy*, in the ghaut close to *Baulpilly*, in the passage through the range to *Cuddapah*, in the passage of the *Nulla Mulla* range, and lastly, in the fourth division, where, from the small elevation of the hills, these caps may be traced without the slightest interruption for upwards of five-and-twenty miles. The characters of the sandstone vary from that of a coarse conglomerate, such as that noticed on the route between Naggery and Pootoor, to that of the finest grain where it is difficult to distinguish it from quartz or hornstone, into both of which it seemed occasionally to pass. The colours were as various as the texture, being of all shades of red*, white, and green; some of the varieties met with on crossing the hills to Cuddapah were rather handsome.

The sandstone forming the cap of the Nulla Mulla hills, where I crossed them between Kistnumchettypitty and Madapurum, was of great thickness, about 300 feet perpendicular, and its acclivity on both sides, the route lying directly over it, extremely steep and difficult. A great deal of rock, much of the same nature as the cap, and interstratified with the clay-slate, prevailed, however, for a space of three or four miles, on both sides of this central ridge, but the clay-slate still continuing by far the most abundant, and in deep wells immediately at the foot of the cap on the east and west sides, exhibiting that rock alone to the very bottom. The above-noticed were the chief occasions on which the sandstone was observed in extended masses; but nodules of that rock, as well as considerable apparently unconnected masses, were met with in several instances in the valleys, more particularly at the village of Chillumpett, between Codoor and Pollempettah, in the first part of the march from Nundaloor to Wuntimettah, between Poornamila and Alinaggur, in the ditch at Iddamacul, &c.

[To be continued.]

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* The red varieties were most common, I think, west from Banaganapilly.

LXII. *A Letter from* Professor Airy *in reply to* Mr. Galbraith's *Remarks* (p. 182.) *on some late Computations of the Earth's Ellipticity.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN an article which appears in your Journal for September last, Mr. Galbraith expresses himself much astonished at the difference between the value of the earth's ellipticity which he has obtained, and a result at which I had arrived. I think that any person who reads my paper on this subject will see the ground on which such a difference might have been looked for; but for those who do not, a single line may serve to point out the state of the case. Mr. Galbraith's calculations proceed on the assumption that the earth is known to be an ellipsoid: mine, on the supposition that this is not known. It is manifest that to satisfy the observed curvatures in different places we shall have different proportions of the axes, accordingly as the meridian is supposed to be an ellipse, or to be some other figure.

I am by no means disposed to consider his hypothesis to be better founded than mine: but more pressing employments compel me at present to abstain from the discussion of this "much-vexed" topic, to which he so obligingly invites me.

I am, Gentlemen, yours, &c.

G. B. Airy.

Observatory, Cambridge.
Oct. 17, 1828.

LXIII. *On* Mr. Dalby's *Method of finding the Difference of Longitude between two Points of a Geodetical Line on a Spheroid, from the Latitude of those Points and the Azimuths of the geodetical Line at the same. By* Dr. Tiarks, F.R.S. *&c.*

THE ingenious method first suggested by Mr. Dalby, of deducing the difference of longitude between any two points on a spheroid, from the latitude of these points and the inclination of the geodetical line connecting them to their meridians at these points, is founded on a remarkable property of spheroidical triangles formed by geodetical lines, which may generally be thus enunciated: The sum of the three angles of any spheroidical triangle formed by geodetical lines is a function of the latitudes of the angular points and their differences of longitude only, and is altogether independent of the excentricity of the spheroid. This sum, accordingly, is the same as the

the sum of the three angles of a spherical triangle whose angular points have the same relative situation to a particular diameter, which is considered as the polar axis; that is to say, the same latitudes respectively, and the same differences in longitude. The particular case of this general proposition which is employed by Mr. Dalby, is the one in which two of the geodetical lines are meridians, and where consequently one of the angular points is the pole of the spheroid itself: but it will be easily seen, that from the demonstration of the particular case the truth of the general proposition may be immediately derived. The method used in the Trigonometrical Survey requires, that if two points on a spheroid having respectively a certain latitude on meridians forming a certain angle are connected by a geodetical line, the sum of the angles of this line with the meridians of the points should be the same, whatever the ellipticity of the meridians may be; and, accordingly, that it should be equal to the two angles of the spherical triangle the sides of which are the co-latitudes of the points, and the inclosed angle the inclination of the two meridians. The inclination of the meridians of the spheroid or their difference of longitude is then derived from the two sides and the sum of the angles opposite to them: viz. the co-latitudes, and the sum of the azimuths. Mr. Dalby's method was first published by General Roy in the Phil. Trans. for 1790, in his own words and with his own demonstration. It would appear that this demonstration has not given general satisfaction; for I have observed that the want of success in the application of the method which is, indeed, acknowledged on all hands, has sometimes at least partially been ascribed to its incorrectness; whereas the principle on which it is founded is not only perfectly correct, but neither limited by the length nor the position of the geodetical line to which it is applied. Before I had seen Mr. Dalby's demonstration, I had convinced myself of the correctness of the method, with which I became acquainted through that part of the Trigonometrical Survey published in the Phil. Trans. for 1795, by a demonstration which, although perhaps substantially the same as Mr. Dalby's, yet differs in some respects from it. I hope that this demonstration will not be considered as perfectly useless at the present moment, and I shall add to it a few remarks on the cause of the failure of the practical application which has hitherto been made of this method.

Let 1. be the great semiaxis of the oblate spheroid or the radius of the equator.

e the excentricity of the elliptical meridians.

ω the

ω the angle formed by the planes of the meridians of the two points on the spheroid B and D. (fig. 1.)

λ, λ' their latitudes; and let λ be greater than λ'.

l, l' the reduced latitudes, or the angles dependent on λ, λ' by this equation $\text{tang.}\, l = \sqrt{(1-e^2)}\ \text{tang.}\, \lambda$.

m, m' the angles formed at the intersection of the geodetical line and the meridians between the former and each of the latter.

μ, μ' the angles in a spherical triangle, two sides of which are $90° - \lambda$ and $90° - \lambda'$, and angle between them $= \omega$; μ' being opposite to the side $90° - \lambda$, and μ opposite to the side $90° - \lambda'$, and

β the third side of the spherical triangle opposite to ω.

Let PDF and PEB represent the two meridians whose inclination to each other is $= \omega$, and let the lines BC and DA be perpendicular to the meridians at B and D. Draw AE parallel to CB and CF to AD, and join A and B and C and D by straight lines. Let CB be $= r$, and AD $= r'$; the angle EAB $=$ ABC $= y$, and the angle FCD $=$ CDA $= x$.

It is then clear, that the inclination of the plane BCD to that of the meridian PEB is $= m$, and that the inclination of the plane BCF to the plane of the same meridian, is $= \mu$, and that $\mu > m$. If we now assume that the three lines CB, CP, CF determine on a sphere described about C as a centre, the angular points of the spherical triangle PB$'$D$'$ (fig. 2.), and

Fig. 1.

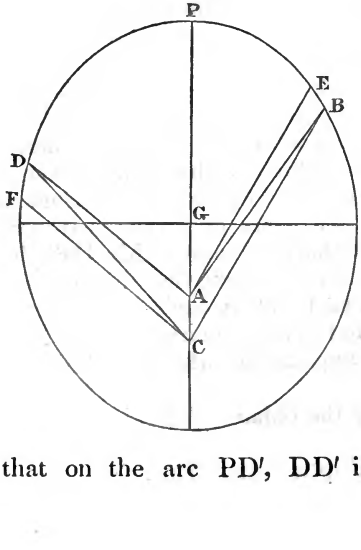
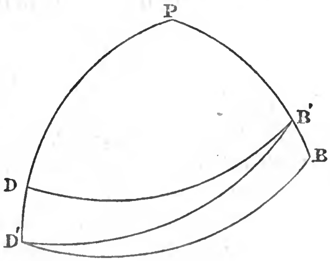


Fig. 2.



that on the arc PD$'$, DD$'$ is made equal to x, we shall have

have $PB' = 90° - \lambda$, $PD' = 90° - \lambda'$, $PB'D' = \mu$, $PB'D = m$, $PD'B' = \mu'$, $D'B' = \beta$. We have, therefore,

$$\text{Sin } D : \cos\lambda = \sin m : \cos(\lambda' + x), \text{ and}$$
$$\text{Sin } \beta : \sin D = \sin x : \sin(\mu - m), \text{ hence}$$

$$\text{Sin}(\mu - m) = \frac{\cos\lambda \,.\, \sin m}{\sin\beta.} \,.\, \frac{\sin x}{\cos(\lambda' + x)}.$$

In the same manner it will be seen that the angle of the geodetical line with the meridian of D is the inclination of the planes PAD and DAB $= m'$, and that the corresponding μ' is the inclination of the plane DAE to that of the meridian PAD. If we, therefore, assume a sphere whose centre is A, the lines AE, AD and AP will determine on that sphere the angular points of the triangle $PD'B'$ (fig. 2.); and if we produce PB' to B so that $BB' = y$, we shall have $PD'B' = \mu'$, $PD'B = m'$, and consequently,

$$\text{Sin } B : \cos\lambda' = \sin m' : \cos(\lambda - y), \text{ and}$$
$$\text{Sin } \beta : \sin B = \sin y : \sin(m' - \mu'), \text{ hence,}$$

$$\text{Sin}(m' - \mu') = \frac{\cos\lambda' \,.\, \sin m'}{\sin\beta} \,.\, \frac{\sin y}{\cos(\lambda - y)}.$$

From the triangles ACB and CAD (fig. 1.) we shall easily derive $\frac{\sin x}{\cos(\lambda + x)} = \frac{AC}{r'}$, and $\frac{\sin y}{\cos(\lambda - y)} = \frac{AC}{r}$, and as AC

$$= GC - AG = \frac{e^2 \sin\lambda}{\sqrt{(1 - e^2 \sin\lambda^2)}} - \frac{e^2 \sin\lambda'}{\sqrt{(1 - e^2 \sin\lambda'^2)}},$$

or nearly $$= \frac{e^2 (\sin\lambda - \sin\lambda')\,(1 + \frac{e^2}{2} \sin\lambda \,.\, \sin\lambda')}{\sqrt{(1 - e^2 \sin\lambda^2)} \,.\, \sqrt{(1 - e^2 \sin\lambda'^2)}}, \text{ and}$$

$$r = \frac{1}{\sqrt{(1 - e^2 \sin\lambda^2)}},\quad r' = \frac{1}{\sqrt{(1 - e^2 \sin\lambda'^2)}}, \text{ we have}$$

$$\frac{AC}{r} = \frac{e^2 (\sin\lambda - \sin\lambda')\,(1 + \frac{e^2}{2} \sin\lambda \,.\, \sin\lambda')}{\sqrt{(1 - e^2 \sin\lambda'^2)}}, \text{ and}$$

$$\frac{AC}{r'} = \frac{e^2 (\sin\lambda - \sin\lambda')\,(1 + \frac{e^2}{2} \sin\lambda \,.\, \sin\lambda')}{\sqrt{(1 - e^2 \sin\lambda^2)}}$$

Substituting these values of $\frac{AC}{r'}$ and $\frac{AC}{r}$ for $\frac{\sin x}{\cos(\lambda + x)}$, and $\frac{\sin y}{\cos(\lambda - y)}$ in the above equations, we obtain

$$\sin(\mu - m) = \frac{\cos\lambda \,.\, \sin m \,.\, e^2 (\sin\lambda - \sin\lambda')\,(1 + \frac{e^2}{2} \sin\lambda \,.\, \sin\lambda')}{\sin\beta \,.\, \sqrt{(1 - e^2 \sin\lambda^2)}}$$

$$= \frac{\cos l \,.\, \sin m}{\sin\beta} \,.\, e^2 (\sin\lambda - \sin\lambda')\,(1 + \frac{e^2}{2} \sin\lambda \,.\, \sin\lambda') \quad \text{and}$$

sin

$$\sin(m'-\mu') = \frac{\cos\lambda' . \sin m'}{\sin\beta} . \frac{e^2(\sin\lambda - \sin\lambda')(1+\frac{e^2}{2}\sin\lambda . \sin\lambda')}{\sqrt{(1-e^2\sin\lambda'^2)}}$$

$$= \frac{\cos l' . \sin m'}{\sin\beta} e^2 . (\sin\lambda - \sin\lambda')(1+\frac{e^2}{2}\sin\lambda . \sin\lambda').$$

But by the characteristic property of the geodetical line we have $\cos l \sin m = \cos l' \sin m'$; and it is therefore evident that $\mu - m = m' - \mu'$ or $m + m' = \mu + \mu'$, and the sum of the three angles $\omega + m + m' = \omega + \mu + \mu'$, independent of the ellipticity of the meridians. If we now conceive any three points on the spheroid connected by geodetical lines, and draw their meridians, the comparison of the angles of the three triangles thus formed, each by two meridians and a geodetical line, with the analogous ones on the sphere, will immediately prove the general proposition.

Example.—Professor Bessel has accurately deduced from the latitude of the observatory at Seeberg = 50° 56′ 6″·7 (λ'), the length of the geodetical line from Seeberg to Dunkirk (whose logarithm = 5·47830314) and the inclination of that line to the meridian of Seeberg = 85° 38′ 56″·82 (m') (the last two as resulting from General Müffling's great measurement), the following results, supposing $l\,e$ = 8·9054355 and log. semi-polar-axis = 6·51335464:

Latitude of Dunkirk	=51° 2′ 12″·719 (λ)
Inclination of the geodetical line to the meridian of Dunkirk..........	=87 51 15·523 (m)
Difference of longitude between Seeberg and Dunkirk.............	8 21 19·04 (ω)

These quantities, therefore, certainly belong to the same spheroid, whether right or wrong as to the places named. I find from λ, λ' and $m + m'$ in the spherical triangle

μ = 87° 51′ 25″·78
μ' = 85 38 46·61
β = 5 15 28·44
ω = 8 21 19·09. And,

next: $2e^2 . \frac{\cos l . \sin m}{\sin\beta} \sin\frac{\lambda - \lambda}{2} . \cos\frac{\lambda + \lambda'}{2}\left(1 + \frac{e^2}{2}\sin\lambda\sin\lambda'\right)$ = 10″·26 and $\mu - m$ = 10″·257 as it ought to be. The equation for $\sin(\mu - m)$ is a complete check upon geodetical calculations of this nature; for if the parts used do not strictly belong to the same spheroid, the difference between the calculated value of μ and the given value of m will vary considerably from the value of the same difference by the formula.

The operations of the Trigonometrical Survey alluded to may be thus represented.—The quantities λ, λ', m, m' referring to Beachy Head and Dunnose, were assumed to be exactly known, and

and ω was *correctly* derived from these quantities without the employment of any other quantity. But in the assumption of the correctness of these quantities, and by the use made of them in the further calculations, the ellipticity of the spheroid to which these quantities belong was implied. This is disguised by the introduction of the length of the geodetical line, but the *same* ellipticity may be obtained as accurately without this line. From the equation of the geodetical line it is easily proved, that making $\operatorname{tang}\psi = \left(\frac{\sin m}{\cos \lambda'}\right)^2$ and $\operatorname{tang}\psi' = \left(\frac{\sin m'}{\cos \lambda}\right)^2$ we have $\frac{e^2}{1-e^2} = \frac{\sin(\psi'-\psi)}{\cos\psi \, . \cos\psi \, . \sin(m-m') \sin(m+m')}$.

Now the calculations of the Survey lead to the value e contained in this equation, and, as conducted, could not possibly lead to any other. Not having logarithmic tables to more than seven decimals at hand, I cannot determine the angles ψ' and ψ as accurately as it might here be required. I find from the data given in the Survey the following quantities; $\psi = 67° \, 46' \, 45''{\cdot}37$, $\psi' = 67° \, 46' \, 47''{\cdot}37$, $\log e^2 = 8{\cdot}1252235$, and the ellipticity about $\frac{1}{149{\cdot}4}$, nearly the same as in the Survey. Next in the spherical triangle $\omega = 1° \, 26' \, 47''{\cdot}93$ as in the Survey, $\mu = 96° \, 58' \, 23''{\cdot}27$, $\mu' = 81° \, 54' \, 27''{\cdot}82$, $\beta = 0° \, 55' \, 28''{\cdot}52$, consequently $\mu - m = 2' \, 25''{\cdot}27$; and as a proof that these values are correct, and that the quantities of the Survey belong to the spheroid here deduced, it will be found that $2e^2 \sin\frac{\lambda-\lambda}{2} \, . \cos\frac{\lambda+\lambda'}{2} \sin m \, . \cos l \, . \left(1 + \frac{e^2}{2} \sin\lambda \sin\lambda'\right) = 2' \, 24''{\cdot}78$. The small difference $0''{\cdot}49$ arising from the imperfect determination of $(\psi'-\psi)$ above stated, shows that the excentricity is a little greater than the one I arrived at; namely, about $\frac{1}{148{\cdot}9}$ ($\mu - m$ being nearly proportional to the excentricity).

It will, therefore, be clear that the values used in the Trigonometrical Survey belong to a spheroid of an ellipticity equal to about $\frac{1}{149}$ and to no other, and that the corresponding difference of longitude was correctly derived. The employment of the geodetical line gave only the *linear* dimension of the spheroid, the figure of which was determined without it. But it will be seen how much this figure will change by a slight alteration of the data used for finding it. As e^2 is about $\frac{1}{75}$, the numerator of the fraction $\frac{e^2}{1-e^2}$ is to its denominator nearly as $1 : 74$, 1 : 74, and the change in the value of $\psi' - \psi$ will, therefore, principally determine the value of e^2. Now the logarithmic tables will show, that a change of $1''$ in m' and λ will produce a change in the logarithmic tangent ψ' (to seven decimals) of 6 and 51 . 6 and an equal variation of m and λ' will change the logarithmic tang ψ 5·2 and 51·2, and a change of 60·2 in the logarithms of tang ψ and tang ψ' will change these angles $1''$. The difference of ψ and ψ' is $2''$·00 . . and therefore a change of $1''$ in the value of $\psi' - \psi$ will reduce the ellipticity to one half or increase it by one half of its value; that is to say, will change it from $\frac{1}{149}$ to $\frac{1}{298}$ or to $\frac{1}{99}$. This circumstance is no doubt one of the principal causes of the failure of the method in its application to small geodetical lines; and however correct in theory, such an application of it must clearly always lead to erroneous results.

If we change the conditions of the problem, and assume the ellipticity of our spheroid or the length of any one of the axes, the length of the geodetical line together with λ and m of one place will give those of the other place their difference of longitude, and the linear dimensions of the spheroid very nearly correct, as has been satisfactorily proved by Mr. Ivory.

There can be little doubt at present that the difference of longitude between Beachy Head and Dunnose, does not much differ from 1° 27′ 5″; and this proves, as Professor Airy has correctly observed, that there is an error of about 13″ in the sum of the azimuths. A new determination of the azimuths at these places would certainly be desirable, and might lead to a decision of the question, whether local attraction has had any effect in producing these erroneous measurements.

Oct. 13, 1828. J. L. TIARKS.

LXIV. *Notices respecting New Books.*

Elements of Algebra: being a short and practical Introduction to that useful Science; on a new Plan; including a Simplification of the Rule for the Solution of Equations of all Dimensions. By ROBERT WALLACE, A.M. late Andersonian Professor of Mathematics, Glasgow. London, 1828; 8vo: pp. 60.

WE extract from this work the table of contents, and the simplified rule for solving equations of all dimensions; the latter involves some interesting particulars respecting part of the modern history of Algebra.

Contents: Definitions—Characters or symbols of operation—Less common symbols of operation—Terms—Equations—General Rule to obtain an equation—Axioms—Addition—Equations to be resolved by by Addition—Subtraction—Resolution of equations, Cases I. and II.—Multiplication—Equations solvable by multiplication—Division—Equations solvable by division—Resolution of equations, Case III.—Algebraic functions—Resolution of equations, Case IV.—Involution—Table of powers—Sir I. Newton's Rule for finding any power of a binomial—Evolution—Table of roots—Resolution of equations, Case V.—Proportion—Resolution of equations, Cases VI. VII. and VIII.—Resolution of adfected quadratic equations—Resolution of equations of all dimensions.

Resolution of Equations of all Dimensions.

" 180. *Rule.*—1. Arrange the terms of the given equation, whether quadratic, cubic, biquadratic, or any higher dimension, in the order of their powers, beginning with the highest, and place the numerical or absolute term on the right of the sign of equality, and all the other terms on the left.—2. Reduce the equation, if necessary, so that the coefficient of the first term shall be unity; and supply the want of any term in the regular series, putting zero for its coefficient.—3. Divide the absolute term into periods of as many figures each as there are units in the index of the first term, if necessary; and mark out a place for the quotient on the right.—4. Find by trial the first figure of the required root of the equation, and place it in the quotient.—5. Add this first figure to the coefficient of the second term and to each successive sum, as often as there are units in the index of the first term.—6. Multiply each of these sums, except the last, by the first figure, and add the products to the coefficient of the third term and to each successive sum.—7. Proceed in this manner to the coefficient of the last term, under which by this process will be found two sums; the first of which is the proper divisor for the first figure of the root, and the second the trial divisor for the next.—8. Multiply the first divisor by the first figure of the root, and subtract the product from the first period of the absolute term, bringing down the next period to the remainder for a dividend.—9. By means of the trial divisor, find the second figure of the root, making some allowance for its increment.—10. Add this second figure to the last sum under the second term, and to each successive sum, in the same manner as was done with the first figure; proceed to find the successive products and sums as in finding the proper divisor for that figure, till the proper divisor for the second figure of the root be found.—11. Multiply this divisor by the second figure in the root, and subtract the product from the dividend, bringing down the third period, if any, to the remainder for a new dividend.—12. Proceed in the same manner till the process terminate without a remainder, or till as many figures of the root be found as are required.

" 181. The method given in the preceding rule for the solution of equations of all dimensions, supersedes the necessity of giving in this short elementary treatise, the old methods of solving cubic and biquadratic equations by the rules of Cardan, Tartaglia, Euler, and others, as well as the various rules for approximating to the roots of equations, which are to be found in all the larger works on algebra."

" 183. The solution of equations of all degrees by the method from which

which this rule was derived, is generally ascribed to a Mr. Holdred of London, who published a tract on the subject in 1820. A similar method, by Mr. Horner of Bath, appeared in the Philosophical Transactions for 1819. It is not given, however, to one individual to accomplish the work of ages. For while we do not dispute the originality of either of these authors, we claim the priority of the invention for a Scotsman of the name of Halbert, (schoolmaster at Auchinleck,) in as far as regards the solution of equations of the *third* degree. While Mr. Bonnycastle in his elementary treatise asserted so late as 1818, that the solution of the *irreducible case* of cubic equations, except by means of a table of sines, or by infinite series, had hitherto baffled the united efforts of the most celebrated mathematicians of Europe; the rule for solving cubic equations of all kinds, whether *reducible* or *irreducible,* had been given by Mr. Halbert as far back as 1789, in his treatise on Arithmetic, published at Paisley in that year. The inventor, after giving his rule and a variety of examples, says, 'so that I reckon this method a valuable discovery, when compared with the jargon we meet with in other authors about *Transmutations, Limitations,* and *Approximations,* and what brings us never the nearer our purpose.'

"184. The step from the solution of the *irreducible* case of cubics to that of equations of all degrees, was evidently very easy, from the nature of the rule there given. Besides, it is a singular circumstance, that Mr. Holdred is said to have been in possession of his method for a length of time previous to publication, which tallies almost exactly with the date of Mr. Halbert's treatise.—Such are the facts respecting this invention, and we now leave the mathematical world to draw its own conclusions, and award the honour to whosoever it is due. In his next pnblication, the author may be induced to unfold this subject a little more than it is possible for him to do in the present, without encroaching on his prescribed limits."

Description of Six New Species of the Genus Unio, embracing the Anatomy of the Oviduct of one of them, together with some Anatomical Observations on the Genus. By Isaac Lea.—*Read before the American Philosophical Society, Nov. 2, 1827.—Extracted from the Transactions of the Am. Phil. Soc. 4to, p. 15. Four coloured engravings.*

The following are the specific characters, habitats, &c. of the *Uniones,* described and well-figured in this memoir.

1. Unio Calceolus.—*Testâ inæquilaterali, transversâ, aliquantulùm cylindraceâ, tenuiter rugatâ; dente cardinali prominente.*

Hab. Ohio. T. G. Lea. My cabinet. Cabinet of Prof. Vanuxem.

2. Unio lanceolatus.—*Testâ transversim elongatâ, compressâ, posticè subangulatâ; valvulis tenuibus; umbonibus vix prominentibus; dente cardinali acuto, obliquo.*

Hab. Tar River at Tarborough. My cabinet. Professor Vanuxem's cabinet. Cabinet of the Academy of Natural Sciences. Mr. Nicklin's cabinet. Peale's Museum.

3. Unio donaciformis.—*Testâ inæquilaterali, transversâ, curvatâ, rugatâ;*

rugatâ; dente cardinali prominente; umbonibus posticè angulatis; margine dorsali posteriori subcarinatâ.

Hab. Ohio. T. G. Lea. My cabinet.

4. Unio Ellipsis.—*Testâ figuram ellipseos habente, longitudinali, ventricosâ; valvulis crassis, umbonibus ferè terminalibus; dentibus grandibus et distinctis.*

Hab. Ohio. T. G. Lea. My cabinet. Cabinet of T. G. Lea. Cabinet of Prof. Vanuxem. Cabinet of Mr. Nicklin. Peale's Museum. Cabinet of the Academy of Natural Sciences.

Var. a—red inside, rare.

Cabinet of the Academy of Natural Sciences. My cabinet.

5. Unio irroratus.—*Testâ inæquilaterali, sub-orbiculatâ, longitudinali, tuberculatâ, rugosâ, longitudinaliter uni-sulcatâ; dente laterali abruptè terminante.*

Hab. Ohio. T. Bakewell. My cabinet. Cabinet of T. G. Lea. Cabinet of Prof. Vanuxem. Cabinet of the Academy of Natural Sciences. Mr. Nicklin's cabinet.

6. Unio lacrymosus.—*Testâ sub-quadrangulari, inæquilaterali, posticè angulatâ, transversâ, tuberculatâ; dente laterali abruptè terminante.*

Hab. Ohio. T. G. Lea. My cabinet. Cabinet of T. G. Lea. Cabinet of Prof. Vanuxem.

Philosophical Transactions for 1828, Parts I. and II.

The following are the contents of these parts of the Philosophical Transactions:—Part I.—Experiments to ascertain the ratio of the magnetic forces acting on a needle suspended horizontally, in Paris and in London. By Captain E. Sabine.—On the resistance of fluids to bodies passing through them. By J. Walker, Esq.—On the corrections in the elements of Delambre's Solar Tables required by the observations made at the Royal Observatory, Greenwich. By G. B. Airy, Esq.—Experiments to determine the difference in the length of the seconds pendulum in London and in Paris. By Captain E. Sabine.—On the measurement of high temperatures. By J. Prinsep, Esq.—On Captain Parry and Lieutenant Foster's experiments on the velocity of sound. By Dr. G. Moll.—An account of a series of experiments made with a view to the construction of an achromatic telescope with a fluid concave lens, instead of the usual lens of flint glass. By P. Barlow, Esq.—A catalogue of nebulæ and clusters of stars in the southern hemisphere, observed at Paramatta in New South Wales, by J. Dunlop, Esq.—An account of trigonometrical operations in the years 1821, 1822, and 1823, for determining the difference of longitude between the Royal Observatories of Paris and Greenwich. By Capt. H. Kater.—On the phænomena of volcanoes. By Sir H. Davy, Bart.—Abstract of a meteorological journal kept at Benares during the years 1824, 1825, and 1826. By J. Prinsep, Esq.—Appendix.—Meteorological Journal for 1827, kept at the Apartments of the Royal Society, by order of the President and Council.

Part II.—A description of a vertical floating collimator; and an account of its application to astronomical observations, with a circle and

and with a zenith telescope. By Capt. H. Kater.—On the height of the aurora borealis above the surface of the earth; particularly one seen on the 29th of March, 1826. By J. Dalton, Esq.—A comparison of the changes of magnetic intensity throughout the day, in the dipping and horizontal needles at Treurenburgh Bay in Spitsbergen. By Capt. H. Foster.—Experiments relative to the effect of temperature on the refractive index and dispersive power of expansible fluids, and on the influence of these changes in a telescope with a fluid lens. By P. Barlow, Esq.—On some circumstances relating to the economy of bees. By T. A. Knight, Esq.—On the laws of the deviation of magnetized needles towards iron. By S. H. Christie, Esq.—Description of a sounding-board in Attercliffe church, invented by the Rev. J. Blackburn.—On the mutual action of sulphuric acid and alcohol, and on the nature of the process by which ether is formed. By H. Hennell, Esq.—Experiments and observations on electric conduction. By W. Ritchie, Esq.—On magnetic influence in the solar rays. By S. H. Christie, Esq.—Appendix.—Meteorological Journal from January to June, 1828.

LXV. *Proceedings of Learned Societies.*

ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

Fifteenth Annual Report of the Council.

SINCE the last general meeting, an event has taken place which cannot but be regarded as most honourable to Cornwall, as well as gratifying to the Society,—the elevation of our President to the Chair of the Royal Society. A public meeting of the members of this Society was held for the purpose of congratulating him on that event; and to the address which was then sent to him (and which has been already published), he returned the following answer.

"My dear Sir, Eastbourne, December 27th, 1827.

"Your letter of the 24th, received this morning, has conveyed to me the most gratifying compliment with which I have ever been honoured; gratifying in every possible point of view, but most eminently so when my elevation to the Chair of the Royal Society is stated as reflecting credit on my native county; in conjunction too with Sir Humphry Davy, whose celebrity is established over the whole civilized world.

"I beg to present my most grateful acknowledgements and thanks to the members of the Royal Geological Society of Cornwall, and I will immediately communicate to Sir H. Davy, the condolence and well-deserved compliments paid to him, with which I am sure he will be most highly gratified.

"I trust it is quite unnecessary for me to add, that in all situations and under every circumstance, it will be equally my pride and my inclination to forward the views and to promote the interest of the Cornwall Geological Society.

Believe me, my dear Sir,
Your much obliged and faithful humble Servant,
To Joseph Carne, Esq. Davies Gilbert."

Surely

Surely it will not be considered presumptuous in the county of Cornwall to congratulate herself on the distinguished honour of having given two successive Presidents to the Royal Society, and the more so in the present instance, because of the persuasion that the additional duties which will consequently devolve on our President, will not, in the smallest degree, diminish his attachment, his zeal, or his exertions, in favour of this Society.

Soon after the last annual meeting of the Society, its third volume of Transactions was published : and it is hoped that the communications which have been thus sent into the world, have added some interesting facts to the general stock of geological information; and it may be presumed that the interests of Science are far better served by the promulgation of one well attested fact, than by the most laborious exposition of theories.—It should be the continued endeavour of this Society, to place on record as many facts as possible which bear upon the geology of Cornwall, notwithstanding any previous communications which may have been made on the same subjects; for differences in points apparently minute, and such as may be considered at first extremely trivial, may yet have an important bearing, either on the immediate subjects of inquiry, or on others connected with them.

On the stream-works, and the other alluvial deposits of Cornwall, our information is still extremely defective. One communication only has been made on this subject during the past year. It would be very desirable to obtain a particular description of every stream-work of any note in this county. By comparing these with each other, it would not be difficult to separate those circumstances which are of almost universal occurrence, from those which are partial, and which may, in a certain sense, be called accidental.—The Council beg particularly to recommend this subject to the attention of those members of the Society who reside in the vicinity of those deposits.

The Council have also to report to the Society, that in pursuance of the recommendation of the last annual meeting, some measures were taken with a view of obtaining lithographic copies of the different portions of the map of Cornwall, for the purpose of making another effort to complete the long promised geological map of this county; but they found that the expense would be too great for the funds of the Society. A zealous member of the Society, George S. Borlase, Esq. has, however, taken the trouble to divide the county into districts, which he has mapped on a large scale. The maps of the different divisions are now ready to be delivered to any gentlemen who will undertake to mark on them the boundaries of the different rocks at the surface, and also the direction of the principal metalliferous and cross veins, elvan-courses, &c. as far as it can be ascertained. The known talents and information of the principal agents of the different mines will be particularly serviceable in the accomplishment of this object. It would also be highly desirable, and of considerable importance to the Society, if those gentlemen who may undertake to assist in forming the geological map, would collect specimens

mens of the rocks in the different districts, with a view of placing in the Museum a complete series of Cornish Geology.

Within the last week, a proposal has been made to the Society by Mr. Thomas, who some years ago published a map of one of the principal mining districts in Cornwall. He has since surveyed other parts of the county, and is still proceeding in the work. He offers to the Society the result of his labours and observations, as he may complete them, on condition that the Society will undertake their publication, and allow him one half of the profit. This proposal has been so recently made, that the Council have not been able to pay any attention to it; but they recommend it to their successors to ascertain, in the first place, whether Mr. Thomas's labours include every thing which ought to be comprised in a geological map, and secondly, whether it is likely that the sale would defray the expense of publication. The profit, if any, should wholly belong to the meritorious individual who has thus devoted his time and abilities to the completion of such a desirable object. But whatever may be the result of this proposal, it ought not to interfere, in the smallest degree, with the mode already proposed, of proceeding with the geological map of Cornwall.

The Cabinet of the Society, which annually increases in interest and importance, has, in the present year, been enriched by various donations and purchases of minerals. At the last annual meeting, the Council had particularly to notice an extensive collection of specimens presented to the Society by Dr. John Davy: they have now the pleasure to mention another donation from the same gentleman, the particulars of which, as well as of the other donations, will be found in the Curator's Report *.

It was announced at the last annual meeting that arrangements were in progress for the removal of the Penzance library to a larger building, and that, in consequence, the room occupied by that Institution would be added to the Museum; of this room the Society will take possession about Christmas next: and it is intended to appropriate it entirely to the geological collection, leaving the present apartment for the mineralogical collection, which will even now occupy the greatest part of it.

As the copies of the laws of the Society have been long since exhausted, the Council recommend their revision and republication.

By order,
October 10th, 1828. EDWARD C. GIDDY, Secretary.

The following papers have been read since the last Report:—Some general

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* Dr. Davy's donation consists of the following articles: Specimens of malachite, native mercury, cinnabar, phosphate of lead, augite, rock-crystal, Egeran (from Eger,) Epidote, green felspar, Hauyne, leucite, Wollastonite, Fassaite, Sahlite, &c. &c. from various parts of Asia Minor, the Ionian Islands, &c. Also specimens of ancient coins, of which the metals appear to have been decomposed and mineralized; and specimens of lead, iron, bronze and glass, found in ancient tombs in Greece and the Ionian Islands.

general observations on the structure and composition of the Cornish Peninsula. By John Hawkins, Esq. F.R.S. &c. Honorary Member of the Society.—On the structure of the Lizard District, &c. By the Rev. Adam Sedgwick. F.R.S., Woodwardian Professor in the University of Cambridge, Honorary Member of the Society.—On the Geology of the Scilly Islands. By Joseph Carne, Esq. F.R.S. &c. Treasurer of the Society.—On the tin stream-works of Cornwall. By Mr. W. J. Henwood, F.G.S. Member of the Society.—On the commencement of copper mining in Cornwall. By George S. Borlase, Esq. Member of the Society.—On the manipulations to which the ores of tin and copper are subjected, in the central mining district of Cornwall. By Mr. W. J. Henwood.—On the Geology of some parts of Italy. By the Rev. Canon Rogers, Member of the Society.—On the granite veins at Wicca Pool in Zennor. By Joseph Carne, Esq. —Translation of a very ancient document on the stannaries of Cornwall and Devon, with some observations. By George S. Borlase, Esq. —On the separation of a solution of the carbonate of lime from a solution of the muriate of soda, in the large way, at the salt mines of Bex in Switzerland. By Mr. W. J. Henwood.—Notice of the geological structure of the Ionian Islands, and of some parts of the coast of Asia Minor, accompanied by a series of specimens. By John Davy, M.D. F.R.S. &c.—An account of the quantity of tin produced in Cornwall in the year ending with Midsummer quarter, 1828. By Joseph Carne, Esq.—An account of the produce of the copper mines of Cornwall, in ore, copper and money, in the year ending the 30th June, 1828. By Mr. Alfred Jenkin.

At the anniversary meeting of the Society held on the 10th October, 1828, Davies Gilbert, Esq. M.P. P.R.S. &c. President, in the Chair; the Report of the Council being read, it was resolved that it be printed and circulated amongst the members.

Officers and Council for the present year:—President: Davies Gilbert, Esq. M.P. P.R.S. &c. &c. *Vice-Presidents:* Sir Charles Lemon, Bart. F.R.S.; Rev. George Treweeke; George C. Fox, Esq.; John Scobell, Esq.—*Secretary and Curator:* E. C. Giddy, Esq.—*Treasurer:* Joseph Carne, Esq.—*Assistant Secretary:* Richard Moyle, Esq.—*Council:* G. S. Borlase, Esq.; Stephen Davey, Esq.; John D. Gilbert, Esq.; George D. John, Esq.; W. M. Tweedy, Esq.; Day P. Le Grice, Esq.; Francis H. Rodd, Esq.; Michael Williams, Esq.; Rev. John Rogers; H. P. Tremenheere, Esq.—*Ordinary Members elected since the last Report:* Thomas Hingston, M.D., and Mr. Richard Hocking, of Penzance.

ROYAL ACADEMY OF SCIENCES OF PARIS.

May 5.—Mr. Warden presented to the Academy three Indian skulls, sent to him by the Society of Rhode Island.—M. Biot communicated two letters from the Abbé Rendu, of Chambery, containing several experiments relating to the influence of magnetism in chemical combinations.—M. Arago announced that similar observations had already been published in several works *.—M. Manoury-Dectot, Jun. presented

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* See p. 385.

sented a work of his late father's On the direction of balloons.—M. Paul Laurent presented a second memoir On new methods of engraving.—M. Imbert sent a description of a support with a segment of a sphere for levelling, surveying, and geodetical instruments, followed with a memoir On the improvement of the spirit-level.—A memoir of M. Portal On putrid fevers was read.—M. Dutrochet read a memoir On the irritability of vegetables and animals.

May 12.—M. Miquel sent a sealed packet containing a memoir On urinary concretions, and a new method of treating gravel.—M. Cagniard-Latour communicated an observation which he had made during the course of his experiments on the vibrations of long brass wires. —M. Nanninga of Embden informed the Academy by letter that he had found the true theory of the resistance of water.—M. Leymerie communicated some new views respecting the yellow fever.—M. Morlet deposited a memoir On the form of the magnetic equator.—M. Reboul transmitted a manuscript memoir on the geological structure of the Pezénas basin.—The Academy afterwards heard—the remainder of M. Portal's memoir On putrid fevers :—a memoir of MM. Audouin and Milne Edwards on the aërial respiration of the Crustacea, and the modifications which the branchial apparatus undergoes in land-crabs :—a memoir by M. Julia Fontenelle On human combustion :—a memoir of M. Benoiston de Châteauneuf On the former and present wheat-harvests of France.

May 19.—The Minister of the Interior announced that he had given orders to substitute a marble bust of His Majesty, executed by M. Bosio, for the plaster one which is now placed in the room for public meetings.—M. Prony distributed a lithographic portrait of Lagrange.—M. Finot claimed the priority of invention in having substituted starch for isinglass in sizing paper.—M. Duchatel addressed a supposed solution of the problem of the trisection of the triangle.— The Academy afterwards heard—a notice by M. Beudant On the specific gravity of bodies, considered as a mineralogical character :— Observations on vegetable physiology by M. Du Petit-Thouars :—a notice On the phænomena of terrestrial magnetism by M. Le Grand : —a notice respecting the specific heat of the atoms of simple bodies.— The Commission named for the purpose, reported that there was no opportunity to adjudge the mechanical prize this year ; and the Commission for the prize founded by Lalande, proposed to adjudge the medal to MM. Carlini and Plana, authors of the second volume of a work recently published at Milan On the measure of a terrestrial parallel : this proposal was unanimously adopted.

May 26.—Mr. Warden gave some details respecting an earthquake felt at Washington on the 9th of March last, between ten and eleven in the evening.—M. Thounsend sent Observations on the yellow fever. —M. Lenoir requested that the platform which he had constructed for the division of astronomical and geodetical circles, might be examined. —M. Desfontaines, in the name of a Commission, gave a very favourable account of the work which M. Cambessedes had presented On the *families ternstromiaceæ et guttiferæ.*—M. Poisson read a memoir on some points of the *Mécanique Céleste.*

LXV. *In-*

LXV. *Intelligence and Miscellaneous Articles.*

COMMEMORATION OF THE SECOND CENTENARY OF THE BIRTHDAY OF RAY.

A MEETING is about to take place in London, which, to judge from the name of the gentleman who has consented to take the chair, and from the stewards who have undertaken to act on the occasion, may be regarded as a national festival in honour of our distinguished Naturalist Ray. Throughout the whole of a long and industrious life, that enlightened observer and systematist devoted himself unceasingly to the study of the works of the Creator, whom in those works he learned devoutly to adore. His researches extended into every branch of Natural History, and in each of these he excelled. His labours were deservedly esteemed by his contemporaries, and continued to receive from succeeding writers the attention to which their intrinsic value entitled them: to them Linnæus himself was deeply indebted, and Cuvier, the first of the Zoologists of the nineteenth century, does not hesitate to avow his obligations to our illustrious countryman, who laboured in the same vineyard during the seventeenth. The admiration and gratitude of every Naturalist, to what branch soever of the science his attention may be more particularly directed, are justly due to Ray, and are indeed on all occasions most freely tendered. How well he merited them will readily be illustrated by even a brief enumeration of a few only of those numerous and valuable productions which we owe to his observation, his study, and his research.

Ray has been pronounced by Cuvier to be the first true Systematist of the Animal Kingdom, and the principal guide of Linnæus in this department of Nature. To him chiefly the Zoologist is indebted for the excellent "Ornithology" and "Ichthyology" which pass under the name of Willughby. The notes collected by both were, after the decease of the latter, digested and arranged by Ray, who revised and methodized the whole, and gave to the works the form in which they were presented to the world. Both these productions are well known, and are still justly esteemed; the Ichthyology especially, the principles first applied in which have been adopted by Cuvier in his primary divisions of the Fishes in that great work for which he has been collecting materials during nearly the whole of his life, and of which the first *livraison* has just appeared. The posthumous publications of Ray, the *Synopsis Methodica Avium*, and the *Synopsis Methodica Piscium*, afford abridgements of the Ornithology and the Ichthyology, with numerous additions. His *Synopsis Methodica Quadrupedum et Serpentini generis*, was published during his life, and very shortly after his decease appeared his *Methodus Insectorum*. The *Historia Insectorum*, a work of real value, was printed some years after his death at the expense of the Royal Society.

By Haller, Ray was designated as the greatest Botanist in the memory of man. Still more emphatic is the character of him given by the late revered President of the Linnæan Society: "The most accurate in in observation, the most philosophical in contemplation, and the most faithful in description, amongst all the botanists of his own, or perhaps any other time." To Ray the British botanist is indebted for the first good Flora of his native land. At an early period of his life he gave to the world his *Catalogus Plantarum circa Cantabrigiam nascentium*, which was followed in a few years by his *Catalogus Plantarum Angliæ et Insularum adjacentium*. The third edition of the latter work was entitled *Synopsis Methodica Stirpium Britannicarum,* and is still universally known: this also passed through three editions, the last of which was considerably enlarged and improved by the celebrated Dillenius. His earliest attempt as a general systematist was the *Methodus Plantarum nova*, in which availing himself of the labours of former writers, corrected by his own philosophical genius, he produced an outline in several respects superior to those of his predecessors. His later *Methodus Plantarum emendata et aucta* adopts many of the views advanced by his generous rival and contemporary Tournefort. These systems, modified from time to time according to his continually increasing knowledge, had been employed in his *Synopsis*, and in conformity with them he digested his *Historia Plantarum generalis*, a work of immense labour and research, which contains descriptions of nearly 20,000 species of plants, arranged in a systematic order, many of the groups of which are purely natural, and agree perfectly with those admitted by the best informed of modern botanists. In the first book of this History, entitled *De Plantis in genere*, Ray fully established his rank as a physiological botanist. His detached remarks on the motion of the sap in plants, and on other points of vegetable physiology are there embodied with the principal discoveries made by previous or contemporary writers, so as to form, according to Du Petit Thouars, the most complete treatise which yet exists on Vegetation taken as a whole. "To isolate this book and to reprint it in a separate form," continues that distinguished botanist, "would constitute the most noble monument that could be erected to the memory of Ray."

As a Geologist the fame of Ray must rest on his Three Physico-theological Discourses concerning the primitive Chaos and Creation, the General Deluge, and the Dissolution of the World; a highly popular work, which was frequently reprinted, and which proposes a theory at least as plausible as any which had then appeared, or was advanced until long after its publication. A portion of his Collection of Unusual or Local English Words; with the Preparation of Metals and Minerals in England, &c., proves also that he was by no means neglectful of this interesting branch of natural science so often as he possessed opportunities of attending to it.

The preceding list, copious as it appears, contains only the more important works of Ray as a naturalist, without including his Appendices, his Supplements, his Catalogues, his detached Papers, &c., and without adverting to his various publications on Philology, his Travels, his Philosophical treatises and letters, and his Theological productions. Of the latter, one, however, cannot be passed by without

out notice. Few works have been more frequently reprinted than "The Wisdom of God manifested in the Works of the Creation," and none have better deserved the popularity they have enjoyed. On the character of its author, whether as a naturalist or a divine, that lasting monument of his knowledge and his piety confers equal and immortal honour.

Ray was born on the 29th of November 1628. The two hundredth anniversary of his birth-day is now rapidly approaching. It will be celebrated in a manner worthy of the man and of the occasion. The cultivators of Natural Science in each of its various branches are anxious to take a share in the commemoration of the event.

The President of the Royal Society, Davies Gilbert, Esq. M.P., has consented to act as Chairman at the proposed dinner, and the following gentlemen have already accepted the office of Stewards:

P. M. Roget, M.D. Sec. R.S.
E. Forster, Esq. V.P. and Treas. L.S.
J. Sabine, Esq. Sec. Hort. Soc.
Rev. W. Kirby, F.R.S., &c.
J. E. Bicheno, Esq. Sec.Linn. Soc.
R. Taylor, Esq. Assistant-Sec. Linn. Soc.
W. J. Broderip, Esq. Sec. Geol. Soc.
N. A. Vigors, Esq. Sec. Zool. Soc.
E. T. Bennett, Esq. Vice-Sec. Zool. Soc.
T. Bell, Esq. F.R.S. &c.
J. Brookes, Esq. F.R.S. &c.
Rev. W. Buckland, D.D. F.R.S. Prof. Min. & Geol. Oxford.
J. G. Children, Esq. F.R.S. &c.
Rev. J. Goodall, D.D.
R. E. Grant, M.D. Prof. Zool. Univ. London.
G. B. Greenough, Esq. F.R.S. &c.
Maj.-gen. Hardwicke, F.R.S. &c.
Rev. J. S. Henslow, F.L.S. Reg. Prof. Bot. Cambridge.
A. B. Lambert, Esq. V.P.L.S.
J. Lindley, Esq. F.R.S. Prof. Bot. Univ. London.
J. Morgan, Esq. F.L.S.
J. F. Stephens, Esq. F.L.S.
N. Wallich, M.D. F.R.S. Ed. Cur. Bot. Gard. Calcutta.
W. Yarrell, Esq. F.L S.

To this list additions are still making daily.

AGENCY OF CARBONIC ACID IN DECOMPOSING WATER BY THE CONTACT OF IRON.

Dr. Marshall Hall has lately investigated the supposed decomposition of water by the contact of iron, and finds that it does not occur without the presence of carbonic acid, and consequently that it is not derived either from the agency of light, electricity, or the relative quantities of metal and water, as has been supposed. The following is extracted from Dr. Hall's paper on the subject, contained in the Institution Journal for July last. "That this phænomenon (of the decomposition of water) is not dependent upon the agency of light, is is proved by the fact of its being totally prevented by the addition of a small quantity of lime-water, or of calcined magnesia. And that it is not an effect of galvanism, is proved by its being prevented or immediately arrested by the same means. It is equally certain from the same facts, that the relatively large quantity of metal has no influence upon the result: this is further quite obvious from the fact that the water is decomposed, however small the quantity of the iron, if the agency of carbonic acid be conjoined with that of this metal.

"The decomposition of water by the contact of iron, has indeed, in every instance, depended upon the concealed agency of carbonic acid contained in the water, or united to a portion of the oxide of the metal. This decomposition has been effected more slowly or more rapidly, according as the quantity of the acid has been smaller or greater. There is a most marked difference in the rapidity with which the water is decomposed, between a portion of distilled water which has been boiled for a short time, and another portion which has been simply charged with air exspired from the lungs, into each of which precisely the same quantity of iron has been put. And in every case the decomposition of the water has been prevented or arrested by withdrawing the influence of the carbonic acid altogether.—In some of my experiments, especially in those in which I had taken the greatest pains to expel the air from the water by long boiling, and to exclude it afterwards, I waited several months before I observed the slightest evolution of hydrogen gas, which however eventually took place in all cases in which the agency of the carbonic acid was not entirely excluded."

CONDUCTING POWER OF METALS FOR ELECTRICITY.

The following are the results of M. Pouillet's researches on this subject, and are highly interesting, especially as regards the effects of alloys on the metals; for even small quantities of foreign substances exert great influence on the conducting power. The purity of the silver is expressed by the proportion of pure silver, per cent., present in the alloy; the column of figures represents the conducting power.

Silver of 98·6......	860	Brass............	194
Copper..........	738	Iron	121
Silver of 94·8......	656	Gold 18 car. fine ..	109
Fine gold	622	Platina	100
Silver of 80	569		

M. Pouillet finds, 1. That the conducting power is very exactly proportional to the section of the wires from the smallest diameter to that of three lines. 2. That it is in the inverse ratio, not of the length of the wire, but of the length increased by a constant quantity λ. This quantity λ, unchangeable for various lengths of the same wire, changes with the nature of the metal, and for each metal is in the inverse ratio of the section of the wire. M. Pouillet therefore believes that the conductibility is truly in the inverse ratio of the length of the wires, provided that the resistance opposed to the electricity in traversing the fluid in the cells of the trough and different conductors which carry it to the experimental wire, could be taken into account.—*Bull. Univ. Institution Journal.*

CONDUCTING POWER OF DIFFERENT FLUIDS FOR VOLTAIC ELECTRICITY.

The following table is drawn up from the experiments of M. Foerstemann. The first column of figures indicates the specific gravity; the second the quantity of electricity conducted by the different substances in equal times; and the third the time required for the conduction of equal quantities of electricity.

Muriatic acid	1·126	2·464	0·410
Acetic acid	1·024	2·398	0·423
Nitric acid	1·236	2·283	0·438
Ammonia	0·936	2·177	0·459
Solution of mur. ammon.	1·064	1·972	0·509
Sulphuric acid	1·848	1·737	0·575
Sol. potash	1·172	1·709	0·585
Sol. common salt	1·166	1·672	0·598
Sol. acetate of lead	1·132	1·560	0·632
Distilled water	1·000	1·000	1·000

—*Ibid.*

HYPOPHOSPHOROUS ACID AND HYPOPHOSPHITES.

M. Rose obtained hypophosphorous acid in purity and quantity by boiling hydrate of barytes with water and phosphorus until the odour of garlic ceased; filtering the liquid and decomposing it by sulphuric acid in excess, separating the precipitate, and digesting the clear fluid for a short time with an excess of oxide of lead, then filtering the sulphate of lead from the solution of hypophosphite, and decomposing the latter by a current of sulphuretted hydrogen. The acid freed from the sulphuret of lead was then concentrated, until it became strong enough to form the required salts, all of which are soluble in water.

The hypophosphites of barytes, strontia and lime, may be prepared by boiling these earths with phosphorus and water; but in preparing that of lime the phosphorus should not be added till the cream of lime boils, and the ebullition should be continued until all the phosphorus has disappeared and the garlic-smell ceased. Carbonic acid is then to be passed through the solution to separate the excess of lime, the insoluble carbonate separated by the filter, and the solution evaporated under the air-pump, or in close vessels by heat. It then crystallizes with more or less water, according to circumstances, those obtained by heat having the least; the hypophosphites of baryta and strontia may be prepared in the same way. Hypophosphite of potash may be prepared by directly mixing the acid with carbonate of potash; the hypophosphite of potash may be dissolved in alcohol, and is a very deliquescent salt; with soda the acid forms a less deliquescent salt, which crystallizes in rectangular prisms. Hypophosphite of ammonia, when heated, yields ammonia, and hypophosphorous acid and water remains which ultimately produce phosphuretted hydrogen and phosphoric acid: the fixed alkaline salts, on the contrary, are converted into phosphates, with the evolution of phosphuretted hydrogen. Hypophosphite of cobalt is readily obtained in beautiful red efflorescent crystals, which contain 49·35 per cent of water.—*Ibid.*

COLLECTING AIR FOR ANALYSIS.

M. Gualtier de Claubry has successfully employed a strong solution of sulphate of magnesia instead of mercury, for collecting air under those circumstances in which it is requisite to invert a bottle containing a fluid in the air intended for examination.—*Ann. de Chim.* vol. xxxvii.

CHLORIDE OF SODIUM AND SILVER.

When chloride of silver is boiled in a strong solution of common salt, a compound of the two chlorides is produced, which crystallizes as the fluid cools. These crystals are not affected by light, and are decomposed by water; the solvent powers of the chloride of sodium over the chloride of silver may be usefully employed in analysis. Similar compounds may be obtained by using the chlorides of potassium or calcium.—*Institution Journal.*

OBSERVATIONS ON AMBER. BY M. BERZELIUS.

It is well known that amber is most commonly found in brown coal, and that it has been observed in the trunk of a tree lying in a mass of brown coal. There is no doubt whatever of this fossil resin having been originally a vegetable product. The numerous bodies found inclosed in it, as for example spiders, wings of all sorts of insects, a corollap erfectly blown, (contaied in the collection of the Upsal Academy,) impressions of barks and branches, which are not uncommon, sufficiently prove that amber, like common resin, originally flowed in the state of a balsam, and that it afterwards hardened under the form of a resin. The following observations, if it were needful, would furnish additional proof of the origin of amber.

This resin contains at least five different substances: 1st, an odoriferous oil in small quantity: 2nd, a yellow resin intimately combined with this oil, and which readily dissolves in alcohol, æther, and the alkalies; which is very fusible, and resembles common resins not of fossil origin: 3rd, a resin difficultly soluble in cold alcohol, better in boiling alcohol, from which it separates on cooling in the form of a white powder, and which dissolves in æther and the alkalies. These two resins and the volatile oil, which æther extracts from amber, form after the evaporation of the æther upon water a natural viscous balsam, of a strong smell and a bright yellow colour, which subsequently hardens, preserving a portion of its odour. There is every reason to suppose that this body is precisely what amber originally was, but still perhaps less rich in essential oil than then; and that the insoluble parts of amber have been formed by time from the alteration of this balsam, a portion of which has been enveloped and defended from further alteration. The fourth substance contained in amber is succinic acid, which is dissolved with the balsam by æther. The fifth substance is insoluble in alcohol, æther, and the alkalies, and bears some relation to the matter which John has found in gum-lac, and which he has designated by the name of principle of lac (*lackstoff*); this is formed in the greatest quantity when this resin is dissolved by an alkali, and bleached by chlorine and precipitated.—*Annales de Chimie*, xxxviii. 219.

INFLUENCE OF MAGNETISM UPON CHEMICAL ACTION.

The Abbé Rendu, professor of physics at Chambery, communicated to M. Biot the following experiment. "I took," says he, "a tube bent in the form of a V, its diameter was about a millimetre (nearly $\frac{4}{100}$ of an inch); each leg was 60 millimetres long. I filled the tube with tincture of red cabbage, and placed an iron wire in each leg; one of these wires was supported by the north pole, and the other by the south pole of a horse-shoe magnet. In a quarter of an hour from the commencement of the experiment the colour of the tincture was changed to a fine green, the same change occurring in both legs of the tube."

On repeating this experiment at the desire of M. Biot with an important modification, which consisted in placing the two iron wires suspended from the poles of the magnet in two small glass tubes closed at the ends, which were immersed in the liquid, M. Rendu obtained the same results, except that the blue tincture did not become green until after two days; but the colour was as intense as in the first experiments. The alteration of colour did not result from any spontaneous change in the liquid, for this solution left to itself, became red and not green*.—*Ibid.* xxxviii. 196.

INFLUENCE OF GUM-ARABIC IN THE PRECIPITATION OF LEAD BY SULPHATES.

According to Mr. A. J. Walcker, sulphate of soda after a few minutes produces a precipitate in a solution of crystallized acetate of lead, when it constitutes $\frac{1}{30000}$ part of the solution. But when water at the same time contained $\frac{1}{50}$ of its weight of gum-arabic, a precipitate was only obtained with $\frac{1}{10000}$ of the acetate. With $\frac{1}{15000}$ of the acetate there was no precipitation even after a few hours, and the same was the case when the liquid contained $\frac{1}{20}$ of gum-arabic, and the acetate amounted to $\frac{1}{10000}$. The cause of this anomaly cannot be ascribed to the suspension of the precipitate by the viscid fluid; for neither standing for a few days nor boiling assists the efficacy of the precipitant, whilst a few drops of acetic, nitric, or sulphuric acid, instantly occasions precipitation.—*Roy. Institut. Journ.*

COMBINATION OF CHLORINE WITH PRUSSIATE OF POTASH.

Mr. James F. W. Johnston, A.M. has a paper on the above-named subject, of which the following is an extract:

"The new compound described in this paper is considered as a chloro-ferro-cyanide of potassium, and consists of

$$\left.\begin{array}{ll}\text{1 atom chloro-ferro-cyanic acid....} & = 31 \\ \text{4 potassium..................} & = 20\end{array}\right\} 51$$

"This new acid may be obtained in a separate state by various processes, which Mr. Johnston promises to explain in a future paper. When pure, it forms beautiful red four-sided needles, not differing in appearance from those of any of its salts.

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* Some former experiments on this subject are mentioned in the *Annales*, of which we shall give an account in our next Number.—Edit.

"Mr. Johnston has formed the various salts resulting from the union of this acid with the base; and he gives the following account of their general properties:

"1. They are all of a deep red colour, crystallizing in four-sided pyramids and rhomboidal prisms. In minute needles their colour is golden-yellow.

"2. In the moist state the crystals are liable to decompose by light and heat, becoming externally of a greenish colour, and in solutions depositing a green sediment.

"3. They are very soluble in water, but insoluble in alcohol, unless considerably diluted.

"4. Their solutions, when hot and concentrated, have a peculiar smell, approaching to that of weak chlorine; and, with the exception of the salt of lead, they have all a bitterish taste; that of lead having the sweet taste of its other salts.

"5. These solutions are decomposed by sulphuretted hydrogen, becoming green and depositing sulphur. Some of the hydro-sulphurets have a similar effect, but they are not changed by hydrogen gas.

"6. Treated in powder with sulphuric acid, they give off chlorine gas. From the salts of barytes, strontian, and lead, it is also partially driven off by a gentle heat.

"7. Their solutions are also decomposed by metallic mercury, being changed into green, becoming greenish-yellow, and letting fall a blue precipitate; the solutions no longer giving a *red*, but a *white*, with nitrate of silver. They have likewise a strong action upon metallic iron, coating it immediately with Prussian blue.

"8. They all give similar precipitates with the metallic oxides.

"9. When dry they undergo no change by exposure to the air, the salt of cadmium excepted, which deliquesces.

"10. Most of them decrepitate when heated, and in the flame of a candle are combustible, throwing out bright white sparks, and leaving a dark brown residue. The salt of barytes melts without sensibly burning; and that of lead burns silently like tinder, giving minute globules of metallic lead."—*Brewster's Journal.*

PREPARATION OF PURE MALATE OF LEAD.

Dr. Wöhler states that a perfectly pure malate of lead is readily obtained by the following process: The juice of the berries of the service-tree, before they are quite ripe, is diluted with three or four parts of water, filtered, and heated; and while boiling a solution of acetate of lead is added as long as any turbidity appears. The solution is then quickly filtered. At first a small quantity of dark-coloured salt subsides; but on decanting the hot liquid, the malate of lead is deposited on cooling in groups of brilliant white crystals. —*Ibid.*

DESCRIPTION OF THE WINCH BRIDGE, THE OLDEST SUSPENSION BRIDGE IN ENGLAND. BY W. C. TREVELYAN, ESQ.

Having, along with my brother, lately made a short excursion in the upper part of Teesdale, where there is some very beautiful scenery, I took

I took the opportunity of examining the Winch bridge, which is the oldest chain-bridge in Britain, and probably in Europe. As all the accounts of it I have seen are very incorrect in regard to its dimensions, and as I think it interesting to preserve an account of it, I send you the measurements which we took.

The Winch bridge is formed of two chains, composed of links *six* inches in length, the iron of which is 1½ inch in circumference. The floor, which is laid on the chains, is *eighteen* inches wide, and has a hand-rail on each side. The chains are fixed by bolts into the rocks at each end. The lengths of the chains are as follow:—

	Feet.	Inches.
Length of chain between the rocks	59	4
———————— supported by the rock on N. side	12	0
———————————————————— S. side, not visible, being covered with rubbish.		

The centre of the bridge, which is about three feet lower than the ends, was, on the 2nd July 1828, *twenty-one* feet above the level of the water, the depth of which was 8½ feet. This measure is very different from that given in all the printed accounts of it I have seen, which vary in making it from fifty to sixty feet high.

The bridge, which is in a decayed state, and not pleasant to pass over, is steadied by two chains, which are passed round the floor, and fixed in the basalt rocks on the west side.—*Brewster's Journal.*

CHLOROPHÆITE DISCOVERED IN NORTHUMBERLAND.

Mr. William Hutton, of Newcastle-upon-Tyne, has discovered that rare and curious mineral called chlorophæite, in a basaltic dyke near Coquet Water in Northumberland, about two miles north-east of Felton. It exists in the form of small nodules, which, from a specimen kindly sent to Dr. Brewster by W. C. Trevelyan, Esq. has exactly the same appearance and properties as those of the chlorophæite which Major Paterson brought from Ferroe. Mr. Hutton has also observed the same substance at Coaly Hill near Newcastle, but in the earthy form.—*Ibid.*

NOVACULITE.

The hone, or whet-stone slate (the Novaculite of mineralogists), is by far the most interesting and important rock in the slate formation of North Carolina. In my examination of this region, (observes Professor D. Olmsted), I have made it an object to ascertain the localities, and the respective qualities and relative values of this substance. It is found in the greatest abundance in various parts of the slate-formation, although the qualities of different beds are various. The most valuable bed that I have met with, is about seven miles west of Chapel-Hill. It is known by the name of M'Cauley's quarry. It has been opened on the summit of a hill which forms one of three parallel ranges extending from north-east to south-west, and composed chiefly of a green slate, called chlorite. The hone-slate occurs in distinct beds, which present on the top, when exposed to view, a more rounded exterior than the slate rocks usually do. Although many thousand hones have been taken from this spot by travellers and others, yet as the quarry has not been wrought for the market, the excavations have been carried to a very little depth, and are insufficient to enable one to judge fully of the extent of the bed. I think, however, that there can be no doubt that its extent is quite adequate to the supply of the market. Being near the brow of the hill, and the bed being perpendicular to the horizon, a large surface on one side might very easily be exposed, and thus the quarrying would be greatly facilitated. Of those specimens which are found at the top of the ground, some are weather-worn, and a great difference in quality prevails among those that are obtained from the same spot. The properties which characterize the best variety are the following:—

Colour a soft olive green—general aspect, like horn—the thin edges, when held up to the light, transparent.

The olive green colour and the transparent edges are, when they meet, almost sure indications of a good quality.

The best of these hones answer with great exactness to the description of the genuine Turkey hones, and I have no doubt that they are identical with them. Some of the best specimens, when polished, present a clouded or chequered surface, with a high lustre, and possess no small degree of beauty. Mechanics in the vicinity of the quarry frequently supply themselves with masses of eight or ten pounds' weight. One side being faced, it is used as a hone, and is generally valued in proportion to the time it has been in use, for thus it acquires smoothness and hardness. The quality is frequently much improved by becoming thoroughly soaked with oil, and it probably would be still further improved by boiling in oil, a process which is said to be practised with the Turkey hones when they happen to be too soft.

The excellence of the hones obtained at M'Cauley's quarry is attested by this fact,—that our carpenters lay aside, for them, the best Turkey hones of the market. They combine two qualities that are particularly esteemed; namely, they *wear away* fast, and set a fine edge; that is, their grit is both fine and sharp. Some of them answer well for razors; but their principal use among us is for carpenters' tools. Their value has not yet been settled by actual trial; but several mercantile gentlemen whom I have consulted, have been of opinion, that if properly faced and shaped, their price would not be less than fifty cents per pound by wholesale.—*Silliman's Journal.*

CHELMSFORD PHILOSOPHICAL INSTITUTION.

Dr. Forster and Dr. Venables, aided by numerous scientific friends, are about to establish a Philosophical Institution at Chelmsford, on a plan similar to that of the Chelmsford Horticultural Society, but which is to embrace every branch of Natural Science, including Medicine and Medical Botany.

ON THE ZODIACAL LIGHT OF THE 29TH OF SEPTEMBER, AS IT APPEARED FROM CHELMSFORD. BY DR. FORSTER, F.L.S. &C.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I hasten to communicate to you a succinct account of a remarkable luminous appearance in the heavens on Monday evening last, the 29th of September. About eight o'clock on that evening, going out of doors, my attention was drawn towards a bright band of light extending from the western horizon to the zenith or rather beyond it. It appeared to me to be a portion of an arc which had extended quite across the sky from west to east, as I could trace the faint remains of it almost to the eastern point. By half past eight however it was reduced to an arc of about 90°, beginning abruptly at about five degrees above the horizon at the point W.S.W. by W., and, after bending a little toward the south, extending itself across the zenith, and terminating at about 5° east of it, fading into a sort of smoky appearance. This remarkable band of light was brightest at its lower or western part, and at above the middle, that is 45° of altitude, began to diminish in lustre; its average breadth was above three degrees; its colour a sort of reddish, giving the appearance of a column of brightly ignited smoke, or as if the reflected light of a great distant fire could be supposed carried in a circumscribed column into the air. It was brighter than any aurora borealis that I ever saw, and considerably excelled in brilliancy the light of some faint coruscations of that phænomenon which I observed at the same time in the north. Its duration was from eight to nine o'clock, when fading away and getting whiter as to colour, it disappeared. The thermometer standing at 57° .Barometer 29·55. Wind West. —Such was the appearance in this neighbourhood of this remarkable phænomenon; and it should be accurately recorded, and compared with distant observations. For I have received some accounts of it from observers in other parts of England, who discerned at first, the whole arc extending across the heavens: others made its situation rather more south-west, while in some places it seemed to rise, by the gradual elevation of its western termination above the horizon. Probably you will have other accounts to compare and to record collaterally with this, from a comparison of which its actual place in the regions immediately above our atmosphere may be ascertained. To me it seems that its elevation must have been very great; as the distance of a hundred miles, according to my comparison of observations, gave it no sensibly different apparent place. It must have been one of very unusual electrical communications which take place parallel to the earth's convexity through the rare air of a region much above our more dense atmosphere, and which from cutting the horizon just above the place of the recently set sun, and occurring about the period of either equinox, has been called the zodiacal light, and vainly imagined to be a real emanation from the sun's light. It is in fact more allied to the northern lights than to any other phænomenon, and like those beautiful illuminations must be be ascribed to effects of electricity whose precise local causes remain unknown. The most brilliant auroras have indeed usually happened about the time of the autumnal equinox. I may remark in conclusion, that on the same day and three hours previous to the light in question (Sept. 29), some beautiful rainbows are recorded; and that during the night, small meteors called falling stars, which left trains of light behind them, are said to have been abundant.

I am, Gentlemen, yours, &c.

Boreham, Essex, Oct. 4, 1828. T. FORSTER.

SOLAR SPOTS.

Having determined the time of the revolution of the *maculæ solares* under our last month's Meteorological Report, and minutely observed and noted for some years past their formation, as well as the mutations which they have undergone, independently of their apparent augmentation in approaching to, and linear contraction in receding from the sun's centre, we shall now make a few concise remarks thereon, and prove the sphericity of the sun by the comparative time of their apparent motion upon the diametrical divisions of his disc. We formerly pointed out the mutability of the nuclei and umbræ, or penumbræ of the large maculæ, or black spots; yet they appear to have a fixed position at their bases, and evidently increase in height, divide into several distinct spots in the same umbra, and the matter of their composition sometimes appears like a dark thick fluid, with a smoky substance proceeding from it, detaching itself from, and moving in a contrary direction to the course of the spot. On such occasions the umbra gradually disappears, as if to make way in the part where the separating matter moves from the original mass. Hence it would appear, that the matter of such spots is by some powerful agency liquefied; but whether from the effects of heat communicated to the body of the sun, in the same way as heat is produced by the union of the solar rays with the dense medium of our atmosphere and communicated to the earth, it would be impossible to determine. If we could be assured by any philosophical experiments of the probability of a superior calorific quality of the solar rays in the atmosphere of the sun to that which they possess in the earth's, we might be allowed to contemplate greater effects of heat at and below the sun's surface, than have ever been observed on the earth's, and also the probability of frequent eruptions from volcanic matter produced by such heat, similar to those of Etna, Vesuvius, &c. Indeed, the sudden appearance of the maculæ, their rising conically from their bases, and their liquid and smoky aspect on some occasions, seem to favour such an idea; but thermometrical experiments, and the perpetual snow on the tops of some of the highest mountains, prove the solar rays to possess but a feeble calorific quality in such high situations, in comparison of those that impinge on the plane of the earth's surface, and militate against the supposition, which was strongly entertained by the first observers of the solar spots. Modern observers have signified that the nuclei of the maculæ are opaque mountains on the sun's surface, some of them to the height of two or three hundred miles, and that they are seen through the solar atmosphere. Be this as it may, they increase in height from their bases, separate into two, three, and sometimes four distinct spots in the same umbra, and again unite with the original mass. We should think it a surprising phænomenon were we to observe a mountain one, two, or three miles in height on the earth's surface, undergo such unprecedented mutations; but as terrestrial matter cannot, from its gravitating tendency, be easily separated without a strong convulsion of nature, we should therefore be inclined to fancy that in the act of such changes it had become transformed from a solid to a liquid state. The general conclusions drawn by the first observers of the solar spots were, that they often appeared in such a state; nor can any observer now affirm from his notes, if faithfully taken by the aid of a high magnifying power, that their nuclei are solid inseparable masses: it may indeed appear so in many of the smaller spots, but it often has a different appearance in the larger ones. How then is the fact to be reconciled? Ingenious arguments may be advanced for and against their solidity and situation, yet doubts will remain. In the present stage of philosophy it is beyond the power of human knowledge to decide.

If heat exists in the sun's atmosphere, the faculæ, or lucid spots, which we have seen precede, accompany, and follow the maculæ, may be reasonably conceived to be the attenuated parts of that atmosphere, which may be caused by an extraordinary temperature, just as the earth's atmosphere is rarified by solar influence, or the extrication of heat, and strong terrestrial radiations.

The apparent motion of the solar spots from the sun's centre to his western limb, describes a diametrical line from a scale of chords of 30 degrees in two days and a half; but they take four days to advance the same distance from the end of that line to the extreme edge of his western limb; and the distance of their apparent motion in one day at or near the centre, is about equal to the same distance they move the last two days and three quarters of their appearance on the western side of the disk. By this unequal motion of the solar spots it may be easily proved by the uniform motion of an artificial globe on its axis, that, in addition to the sun's plane circular area as seen through a smoked or shaded glass, he is globular, but not a perfect globe; as from the effects of universal gravitation, or the gravitating of every particle of matter to every other particle, combined with rotatory motion, the celestial bodies of the solar system assume the form of oblate spheroids. The solar spots have also an apparent circular diurnal motion round the sun's disk, arising from the diurnal motion of the earth on its axis. They appear generally to pass near the centre of, or within the sun's tropics; but a few have been seen here with a declination of more than 50 degrees, both north and south. On the 26th ultimo, the blackest and most circular spot in the nucleus, and the brightest in the surrounding umbra we ever observed, was by measurement precisely in the centre of the sun's disk at six o'clock in the evening; but it disappeared before it reached the western limb.

The

The various positions which the lines of their direction assume across the sun's disk in the different months of the year, are caused by the angle which the sun's equator makes with the plane of the ecliptic, and the annual motion of the earth round the sun, which alter the observer's place with respect to the position of the spots.

It may be remarked that since Scheiner and Galileo first observed the solar maculæ in 1611 and 1612, there appears but little difference in the descriptive observations of succeeding observers in regard to their colour, motions, mutations, and in the general appearances of their formation, increase, separation, reunion, decrease and final disappearance; the differences in their opinions are chiefly as to their situation, and the nature of their composition. Much more may be said on this interesting subject, but we shall close our remarks for the present.

THE PLANET VENUS.

This interesting planet was so bright on the meridian in the morning of the 16th Sept. when her natural appearance through a telescope was nearly similar to the moon about two days after the beginning of her last quarter, as to enable us to take the following observations:—Her apparent distance from the sun's nearest limb at $9^{h}\,2^{m}\,3^{s}$ A.M. apparent time, was $43^\circ\,55'\,30''+$ sun's semidiameter $15'\,56'' = 44^\circ\,11'\,26''$, in time less than the sun's Æ $2^{h}\,56^{m}\,46^{s}$. Her true meridional altitude at $9^{h}\,2^{m}\,3^{s}$ A.M. was $53^\circ\,44'\,30''$, which subtracted from 90°, leaves for her zenith distance South, $36^\circ\,15'\,30''$, and her reduced North declination $14^\circ\,31'\,32''$ added thereto, gives the latitude of this place $50^\circ\,47'\,2''$ North, which is only half a mile less than the true latitude. Similar observations on Venus on the following morning were equally successful.

This planet will have arrived at her greatest western elongation on the 7th of October, and may be seen throughout the month in clear weather with the naked eye in the day-time, but to greater advantage through a telescope when on the meridian between nine and ten in the morning, subtending an angle from the sun's centre of from $43^\circ\,35'$ to $40^\circ\,26'$. The angular distance of Venus from the sun may, with a little practice, be taken with a sextant while she moves in that part of her orbit next to the earth, and 38 degrees from the sun, till she arrives at her greatest western elongation; also while passing from her greatest eastern elongation to within 38 degrees of her inferior conjunction.

AURORA BOREALIS.

Gosport, Sept. 1828.

This meteoric phænomenon was observed here to great advantage in the evening of Monday the 29th instant. At seven o'clock a segment of mild light first appeared about the north magnetic pole, and gradually increased in height till eight, when its altitude was 26 degrees, and extended from W. by N. to N.E. by N. The first four columns of light shot up nearly perpendicular from its base in the N.W. by W. point of the horizon at 20 minutes before eight, and

and were soon followed by others considerably wider from every part of the segment. About forty of these columns appeared in the course of 40 minutes, some of which reached to an altitude of 35 degrees, were from one to two and a half degrees wide, and varied in colour from light yellow to light red. At a quarter past eight a great deal of light emanated from the edge of this segment in the form of a broad band, and in five minutes afterward a perfect arch of flame-coloured light three degrees broad was formed by it: the arch gradually increased in altitude, was evidently thickened by a constant stream proceeding upwards from its western limb, and at first passed through the Northern Crown, a few degrees under Polaris, and between Capella and Algol: it continued to rise and increase in breadth till it was nearly 20 degrees above Polaris, when it had an altitude at its vertex of 70 degrees, was nearly parallel with the Milky Way, and extended through the northern hemisphere from W. by S. to E.N.E. Its breadth at this time, a quarter before nine, was about 4½ degrees, and was measured by means of the two stars β and γ in the head of the Dragon, as it exactly filled the space between them.

At ten minutes to nine part of the luminous arch to the eastward disappeared, but was again made perfect by vivid streams of light from its western limb, which was the most dense and brightest part of the arch. It again disappeared at its eastern side, gradually wore away, and at five minutes past nine, when some black clouds passed over, it could not be traced, except in the western horizon; yet the aurora, or segment of light from which it rose, was not entirely effaced till ten o'clock. This was the most beautiful luminous arch from the aurora we ever observed in this latitude, and stars of the first and second magnitude were seen through: it was more uniform in breadth, and its light more permanent than the one we observed here in the night of September 25th, 1827; as that arch was only made perfect at intervals by the meeting of coruscations in the zenith from its extremities.

Several long-trained meteors appeared during the aurora; and a hard gale blew from the S.W., which seemed to bend that part of the arch near the western horizon considerably out of its regular curve. The gale continued two days afterwards; and there was a faint appearance of the aurora on the two following evenings.

AURORA BOREALIS?

We extract the following particulars of the meteor visible on the 29th of September, of which several other notices will be found in our present Number, (at pp. 337, 389, and 392,) from a note addressed to the Editor of the Norwich Mercury, by Mr. J. Utting, dated Lynn Regis, October 1, 1828.

"I send you an account of a luminous appearance in the heavens, which took place on Monday last, about eight o'clock in the evening, as seen in this town.

"It rose North-east by East, passing over the Pleïades, and thence over the right shoulder of Andromeda, leaving the star Beta, or

Scheat, in the constellation Pegasus, about 3 degrees to the North; its altitude on the meridian was about 52 degrees; the centre of the luminous fluid then passed directly over the star Altair, in the constellation of the Eagle, passing by the stars Delta and Epsilon, in the constellation of Ophiuchi, reaching the western horizon about 8 degrees South of the West. It greatest altitude, 56 degrees, obtained in 25 degrees of azimuth East of the meridian, or the highest point of its centre, was nearly in the direction of South-south-east; when most brilliant and best defined, its width was from 2 to 3 degrees, from which it varied to 8 or 10 degrees during the latter part of the time of its appearance: it finally went off about nine o'clock. It resembled a narrow stratum of white smoke, and appeared to pass through the air with considerable velocity. If this luminous matter was at any very considerable height above the earth's surface, its apparent velocity was much increased by the earth's annual and diurnal motion from West to East, in a contrary direction to its apparent motion."

ON CERTAIN ERRATA IN DR. MACKAY'S TABLES OF VERSED SINES. BY MR. GEORGE INNES.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,—I have lately seen a loose MS. containing errata in Dr. Mackay's Tables of Versed Sines, in a copy of his Treatise on the Longitude, extending from 16° 0′ 40″ to 44° 29′ 10″. As I am aware that there are errors in other parts of this table, I suspect that it is only a small portion of the list which I have seen, and that the other part may have dropt out of the book. I would therefore request that any of your correspondents who may be in possession of the other part, will have the goodness to send it for insertion in your valuable Journal.

Page 91, at	16°	0′	40″	*for*	8729	*read*	8792
	16	24	10	—	0770	—	0700
	17	5	30	—	4168	—	4164
	17	30	50	—	6350	—	6356
92,	19	15	0	—	7911	—	5911
	19	17	50	—	6188	—	6183
93,	21	22	20	—	8797	—	8767
94,	22	42	20	—	7490	—	7500
95,	24	37	0	—	9885	—	0885
	24	41	40	—	1541	—	1451
	25	8	40	—	4766	—	4760
	25	41	0	—	8779	—	8797
96,	27	26	10	—	2775	—	2475
97,	28	41	30	—	3784	—	2784
	29	59	40	—	3929	—	3926
99,	33	43	40	—	8515	—	8315
100,	34	31	10	—	5066	—	6066
101,	36	12	0	—	3030	—	3040
	36	22	0	—	4771	—	4761

Page

Page 101, at	36°	51′	40″	*for* 9918	*read* 9908
	36	53	10	— 0710	— 0170
102,	38	38	40	— 8974	— 8964
	39	30	0	— 228325	— 228375
103,	40	31	30	— 8877	— 9877
	41	8	40	— 6942	— 6947
104,	42	52	20	— 7172	— 7127
	42	59	0	— 8498	— 8448
105,	44	21	50	— 5068	— 5086
	44	29	10	— 3580	— 6580

P.S. I felt much pleasure in perusing article XLIV. in your last Number, and anxiously hope you will favour your astronomical readers with a continued series of the Appendix to Encke. The next article, entitled "*Uber die Verausberechnung der Sternbedeckungen,*" must excite the interest of every astronomer. Yours, &c.

George Innes.

OBITUARY:—MR. JOHN ATKINSON, F.L.S. &C.

Mr. John Atkinson was the sixth son of the late Rev. Miles Atkinson, B.A. vicar of Rippax, and incumbent of St. Paul's, Leeds. He received his education at the Grammar School of Leeds, and at the age of fourteen became a pupil of that eminent surgeon the late Mr. Hey. Under such a preceptor, and aided by his own enthusiastic devotion to his profession, he could not fail in acquiring that eminence to which he subsequently attained. But it was as a Naturalist that Mr. Atkinson was most known to the world. It is interesting to trace the apparently accidental circumstances by which the mind is directed to pursuits for which it appears to have been peculiarly formed. A severe illness took Mr. Atkinson from Leeds to the retired village of Rippax, his father's vicarage: here, an admirer of the beauties of nature, his attention was attracted to her details; and he became engaged in the study of the kindred sciences of Botany and Entomology with that ardour which characterized all his pursuits. For some time he laboured with no other book than Berkenhout's Synopsis, and acquired an intimate knowledge of plants from studying them as presented by the hand of nature. On his removal to London to attend the courses of lectures required for examination in his profession, he made an acquaintance with several eminent Naturalists. He devoted the summer recesses to the cultivation of his favourite pursuits, and acquired an extended and correct knowledge of Botany and Entomology.

At a later period Mr. Atkinson devoted his attention to Ornithology and Zoology in general: the study of these sciences was in a considerable degree occasioned by his connection with the Leeds Philosophical and Literary Society, of which he was one of the earliest members, and whose museum he founded by his munificent presents in every department of Natural History. His office of Curator, to which the whole of not only the days but the nights he could spare from an extensive practice were devoted, prevented his taking any prominent part in the literary proceedings of the Society: the journals, however, record some valuable communications.

The merit of originating the Yorkshire Horticultural Society belongs to Mr. Atkinson. In the year 1820 he, with a very few supporters, held the first meetings in a small room at Kirkstall, and for some years, as its treasurer, the Society was mainly indebted to him for its existence. He lived to see the Society enrol amongst its members many of the first nobility and gentry of the county, and to witness the great improvement in Horticulture it has occasioned.

Nor were his exertions confined to the diffusion of scientific knowledge; his was a more enlarged philanthropy,—foremost in the support of every liberal institution, and at all times feelingly alive to the calls of suffering and poverty. In his own practice, many were the sacrifices he made to the wants of his more indigent patients. It is to him the town of Leeds is indebted for that valuable institution the Lying-in Hospital: with him the proposal originated, and from him it received the most zealous support.

Besides many communications to the scientific journals, Mr. Atkinson wrote a Compendium of British Ornithology, of which, during the melancholy illness that terminated in his death, he was preparing a second edition with lithographic plates. He communicated the valuable account of plants growing within ten miles of Leeds to Whitaker's *Ducatus Leodiensis*; and during his last illness, in addition to his work on Ornithology, had prepared an account of the Natural History of the neighbourhood of Askern.

But great as was the public spirit by which he was distinguished, it was in private life that the value of his character shone with pre-eminent brilliancy. To those who were admitted to the delightful society of his social circle, the pleasure with which he communicated his extensive knowledge, the winning manner in which he encouraged the beginner in the paths of science, the valuable assistance he so liberally afforded,—will long endear his memory. But Mr. Atkinson possessed a still higher character,—he was a Christian; and although walking in the highest paths of science, he remained undazzled by the splendid scenes around him, and through Nature with humility he looked to Nature's God.

He was a Fellow of the Linnean Society, Curator of the Leeds Philosophical and Literary Society, Treasurer to the Yorkshire Horticultural Society, Honorary Member of the Bristol, Yorkshire, and Hull Philosophical Societies, and Surgeon to the Leeds Lying-in Hospital. He died October 3, 1828, in his 40th year. E. S. G.

LIST OF NEW PATENTS.

To J. C. Daniell, of Limpley, in the parish of Bradford, Wiltshire, clothier, for his improvements in the machinery used for dressing woollen cloth.—Dated the 18th of September 1828.—6 months allowed to enrol specification.

To J. Melville, of Upper Harley-street, for improvements in propelling vessels.—18th of September.—6 months.

To E. F. Orson, of Prince's-square, Finsbury, for an improved cartridge for sporting purposes.—18th of September.—6 months.

To

To J. Jones, of Leeds, for improvements in machinery for pressing or finishing woollen cloths.—25th of September.—6 months.

To P. Rigby Wason, esquire, of the Middle Temple, barrister at law, for improvement in stick sealing-wax.—25th of September.—6 months.

To J. Neville, of New Walk, Shad Thames, Surrey, for his apparatus for obtaining mechanical power from falls and streams of water. 25th of September.—6 months.

To T. Fowler, of Great Torrington, Devon, for improvements in or for raising and circulating hot water, hot oils, and other hot fluids for domestic and other purposes.—2nd of October.—6 months.

To J. Brunton, of West Bromwich, Stafford, engineer, for improvements in the apparatus for manufacturing coal-gas and coke.—2nd of October.—6 months.

To D. Napier, of Warren-street, Fitzroy-square, for improvements in machinery applicable to letter-press printing —2nd of October.——2 months.

To T. Tippett, of Gwennap, Cornwall, for improvements in the construction and working of engines with steam and air, and in the boiler or generator of steam, and in the application of such improved engines to a new method of propelling of vessels and other floating bodies.

METEOROLOGICAL OBSERVATIONS FOR SEPTEMBER 1828.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·52 Sept. 16. Wind N.E.—Min. 29·43 Sept. 12. Wind S.W. Range of the index 1·09.

Mean barometrical pressure for the month .... 29·926

Spaces described by the rising and falling of the mercury............ 4·360

Greatest variation in 24 hours 0·420.—Number of changes 20.

Therm. Max. 74° Sept. 4. Wind E.—Min. 48° Sept. 15. Wind N.E.

Range 26°.—Mean temp. of exter. air 61°·28. For 31 days with ⊙ in ♍ 62·03

Max. var. in 24 hours 21°·00—Mean temp. of spring water at 8 A.M. 55°·85

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the morning of the 22nd.............. 94°

Greatest dryness of the air in the afternoon of the 2nd 45

Range of the index.. 49

Mean at 2 P.M. 60°·9 —Mean at 8 A.M. 70°·2—Mean at 8 P.M. 71·4

—— of three observations each day at 8, 2, and 8 o'clock......... 67·5

Evaporation for the month 2·80 inches.

Rain near ground 2·280 inches.

Prevailing wind, S.W. and N.E.

Summary of the Weather.

A clear sky, 3½; fine, with various modifications of clouds, 15; an overcast sky without rain, 7; foggy, ½; rain, 4.—Total 30 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
24	18	30	0	19	23	15

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
1	7	4	5	2	7½	2½	1	30

General Observations.—The weather this month has been generally pleasant, dry, and warm for the season. In the evening of the 4th instant we had lightning and several claps of thunder, occasioned by a wind springing up suddenly from the North, and meeting an upper current from the South, accompanied with a light shower of rain, which is said to have been very heavy at Fareham, Portsdown, and Havant; and the lightning killed one man in Farlington Marsh while in the act of pitching hay, the iron prongs of the fork having, it is supposed, attracted the electric fluid: it also played vividly about the ships' masts in Portsmouth Harbour, but without doing any injury. Sheet lightning occurred in the evening of the 8th, and was followed by a thunder-storm and copious rain about 2 o'clock in the morning, with a strong gale from S.W. This storm it is reported had a more awful appearance in many parts of the country northward.

In the evening of the 12th, sheet lightning was observed in the eastern horizon from 8 till 10 o'clock; also the following evening, when it terminated in a thunder-storm. The 14th was a very cold day and night, with a N.E. gale. In the evenings of the 19th, 23rd, and 24th, large lunar halos appeared, with paraselenæ on each side of, and 23 degrees distant from, the moon's centre.

The last brood of swallows departed from this place in a S.E. direction early in the morning of the 24th, making their stay here this year twenty-two weeks and two days.

The mean temperature of the external air this month, is about 1½ degree warmer than the mean of September for many years past.

The atmospheric and meteoric *phænomena* that have come within our observations this month, are six paraselenæ, four lunar and three solar halos, forty meteors; lightning on four different days; and thunder on three; an aurora borealis on the 29th; and nine gales of wind, or days on which they have prevailed, namely, two from the North-east, one from the East, one from the West, and five from the South-west.

REMARKS.

London. — September 1. Cloudy, with showers. 2. Fine. 3. Cloudy. 4. Slight showers in morning: fine. 5—7. Very fine. 8. Fine: rain at night, with much lightning. 9. Very fine. 10. Rainy. 11. Fine: stormy at night. 12. Rainy morning: fine. 13. Fine: rain at night. 14. Cloudy, with showers. 15, 16. Fine. 17. Slight fog in morning: fine. 18—20. Very fine. 21. Fog in morning: fine. 22. Cloudy: foggy at night. 23. Cloudy. 24—26. Fine. 27. Rainy. 28. Cloudy, with heavy showers. 29. Stormy. 30. Fine morning: showery.

Boston. — Sept. 1. Cloudy. 2. Fine. 3. Cloudy. 4. Fine. 5. Fine: rain P.M. 6. Fine. 7. Cloudy. 8. Fine. 9. Cloudy: thunder, lightning, wind, and rain early A.M. 10—12. Fine: rain, A.M. 13. Rain. 14. Fine. 15. Fine: a few drops of rain, with a beautiful rainbow, 9 A.M. 16—23. Fine. 24. Cloudy. 25. Fine. 26. Fine: thunder and lightning at night, with a few drops of rain. 27. Cloudy: rain A.M. 28. Cloudy: rain P.M. 29. Cloudy: very singular aurora borealis, 8 P.M. 30, Fine.

Penzance. — Sept. 1—5. Clear. 6. Cloudy: rain. 7. Fair. 8. Fair: clear: shower at night. 9. Fair. 10, 11. Rain. 12. Fair: rain. 13. Fair. 14. Fair: showers. 15. Fair. 16—20. Clear. 21. Clear: rain at night. 22. Rain. 23. Clear. 24. Fair. 25. Fair: rain. 26. Cloudy. 27. Clear. 28. Fair: rain. 29. Showery. 30. Showery.

Meteoro-

Meteorological Observations made at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1828.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.									
Sept. ☾ 1	30·019	30·001	30·04	30·00	29·96	29·92	29·52	69	53	66	59	68	58	61	NE.	NE.	NE.	NE.	...	·10	...	...	...
2	30·074	30·032	30·03	30·02	29·98	29·97	29·56	69	47	66	60	69	51	60	NE.	NE.	NE.	NE.	...	...	...	...	...
3	30·088	30·073	30·05	30·05	30·04	30·03	29·55	67	53	67	54	69	56	61	NE.	SE.	N.	NE.	0·40	...	...	...	...
4	30·065	30·008	30·05	30·02	30·02	29·98	29·57	72	52	68	53	74	53	60	NE.	SE.	E.	NE.	...	·04	...	0·010	...
5	30·054	29·994	30·00	29·98	30·01	29·97	29·50	72	46	68	52	69	53	60·5	NE.	SE.	NE.	NE.	...	...	...	...	...
6	30·100	30·023	29·95	29·85	30·03	29·96	29·62	69	57	66	57	69	61	58	E.	SE.	SE.	E.	·30	...	...	...	0·05
7	30·045	30·035	29·90	29·88	29·98	29·98	29·55	76	54	68	57	72	61	62	SE.	S.	SE.	SE.	...	...	0·235	...	...
8	29·959	29·780	29·75	29·65	29·91	29·76	29·44	79	59	70	60	73	62	68	SE.	S.	E.	SE.	...	·20	...	·255	...
● 9	29·932	29·447	29·75	29·70	29·90	29·86	29·20	73	49	68	60	72	59	64	SW.	SE.	SW.	W.	·45	...	·030	·010	·42
10	29·804	29·604	29·60	29·55	29·73	29·54	29·25	68	57	65	59	68	60	63·5	S.	S.	SE.	S.	...	1·27	·300	·285	...
11	29·696	29·582	29·54	29·50	29·58	29·57	28·98	75	59	67	58	71	60	62·5	SW.	S.	SW.	W.	...	·44	·400	·440	·30
12	29·464	29·418	29·50	29·45	29·45	29·43	28·86	70	56	65	58	70	59	62	SW.	SW.	SW.	W.	·20	·23	·155	·090	·26
13	29·736	29·584	29·60	29·55	29·64	29·57	29·05	69	46	65	55	69	51	57	SW.	W.	SW.	NE.	...	·40	·515	·530	·60
14	30·140	29·964	29·90	29·80	29·98	29·84	29·51	58	48	57	55	58	51	55·5	E.	E.	NE.	E.	...	·05	·060	...	·14
15	30·516	30·315	30·32	30·20	30·40	30·20	29·86	64	37	60	49	63	48	54	E.	NE.	NE.	NW.	·30	...	·140	...	...
☽ 16	30·594	30·307	30·34	30·32	30·52	30·42	30·05	63	39	64	50	61	51	50·5	E.	SE.	NE.	NW.	...	...	...	...	...
17	30·395	30·170	30·15	30·05	30·30	30·11	29·87	66	50	63	55	63	53	57	SE.	SE.	E.	NE.	...	...	...	...	...
18	30·055	29·962	29·96	29·95	29·98	29·96	29·54	67	41	66	52	64	49	59	E.	SE.	E.	E.	·30	...	...	...	...
19	30·168	30·089	30·00	29·96	30·10	30·02	29·55	71	47	64	53	65	52	60	E.	SE.	NE.	E.	...	...	...	...	...
20	30·217	30·187	30·05	30·03	30·15	30·12	29·50	70	41	67	55	64	51	61	E.	SE.	E.	calm	...	...	...	...	...
21	30·147	30·026	30·00	29·95	30·08	30·02	29·62	68	46	64	58	63	54	57·5	E.	SE.	SE.	calm	·35	...	...	·040	...
22	30·018	29·981	30·00	29·95	29·99	29·95	29·45	76	52	66	58	67	55	58	W.	SW.	SW.	calm	...	...	·490	·060	...
○ 23	30·146	30·131	30·10	30·10	30·14	30·10	29·57	69	46	66	54	70	55	58	W.	W.	W.	calm	...	...	...	...	...
24	30·115	30·090	30·05	30·00	30·10	30·04	29·50	70	55	65	58	72	58	61	SW.	SW.	S.	calm	·15	...	...	...	...
25	29·946	29·815	29·80	29·75	29·92	29·84	29·34	74	50	64	59	67	59	62·5	SW.	S.	S.	W.	...	...	...	...	...
26	29·881	29·794	29·80	29·75	29·86	29·79	29·22	79	54	66	58	73	55	63	SW.	SW.	NW.	S.	...	...	·185	...	...
27	29·900	29·852	29·90	29·88	29·87	29·86	29·31	63	42	62	51	66	51	58	SW.	W.	SW.	calm	·20	·46	...	·270	...
28	29·817	29·610	29·85	29·80	29·80	29·72	29·27	66	55	64	55	68	59	53	NW.	SW.	W.	W.	...	·45	·080	·160	·23
29	29·641	29·572	29·75	29·75	29·62	29·60	28·90	67	52	64	56	68	55	61	W.	W.	SW.	W.	...	·34	·155	·005	·15
☾ 30	29·698	29·679	29·75	29·73	29·70	29·70	29·05	64	48	61	55	67	53	57·5	W.	W.	SW.	W.	·15	·05	·300	·125	...
Aver.:	30·594	29·418	30·34	29·45	30·52	29·43	29·42	79	37	70	49	74	48	59·5					2·80	4·03	3·045	2·280	2·15

Calendar of the Meetings of the Scientific Bodies of London for 1828–9.

Societies.	Time of Meeting.	November.	December.	January.	February.	March.	April.	May.	June.
Royal . . . . Somerset-House.	Thursday, 8½ P.M.	20, 27	1*, 11, 18	8, 15, 22, 29	5, 12, 19, 26	5, 12, 19, 26	2, 9, 30	7, 14, 21, 28	4, 18
Antiquaries . Somerset-House.	Thursday, 8 P.M.	20, 27	4, 11, 18	8, 15, 22, 29	5, 12, 19, 26	5, 12, 19, 26	2, 9, 23*, 30	7, 14, 21, 28	4, 18
Linnean . . . Soho-Square.	Tuesday, 8 P.M.	4, 18	2, 16	20	3, 17	3, 17	7, 21	5, 25*	2, 16
Zoolog. Club Soho-Square.	Tuesday, 8 P.M.	11, 25, 29*	9	13, 27	10, 24	10, 24	14, 28	12, 26	9, 23
Horticultural Regent-Street.	Tuesday, 1 P.M.	4, 18	2, 16	6, 20	3, 17	3, 17	7, 21	1*, 5, 19	2, 16
Medico-Botanical . Sackville-Street.	Tuesday, 8½ P.M.	11, 25	9	16*, 27	10, 24	10, 24	14	12, 26	9, 23 July 14
Society of Arts Adelphi.	Wednesd. 7½ P.M.	5, 12, 19, 26	3, 10, 17	7, 14, 21, 28	4, 11, 18, 25	4, 11, 18, 25	1, 8, 15, 22, 29	6, 13, 20, 27	3, 10
Royal Society of Literature Parliament-St.	Wednesd. 3 P.M.	5, 19	3, 17	7, 21	4, 18	4, 18	1, 15, 30*	6, 20	3, 17
Geological . . Somerset-House.	Friday, 8½ P.M.	7, 21	5, 19	2, 16	6, 20*	6, 20	3	1, 15	5, 19
Astronomical Lincoln's-Inn Fds.	Friday, 8 P.M.	14	12	9	13*	13	10	8	12
Royal Institut. Albemarle-St.	Friday, 8½ P.M.	...	...	23, 30	6, 13, 20, 27	6, 13, 20, 27	3, 10	1, 8, 15, 22, 29	5, 12
Royal Asiatic Grafton-Street.	Saturday, 2 P.M.	...	6	3, 17	7, 21	7, 14*	4	2, 16	20 July 4, 18

* ANNIVERSARIES.—Royal, Dec. 1, 11 A.M.—Antiquaries, April 23, 2 P.M.—Linnean, May 25, 1 P.M.—Zoological Club, Nov. 29.—Horticultural, May 1.—Medico-Botanical, Jan. 16.—Royal Society of Literature, April 30.—Geological, Feb. 20, 1 P.M.—Astronomical, Feb. 13, 3 P.M.—Asiatic, March 14, 1 P.M.—Zoological Society, April 29, 1 P.M.

[Copies of the Calendar on Cards may be had at the Office of the Philosophical Magazine and Annals, Red Lion Court, Fleet Street.]

THE
PHILOSOPHICAL MAGAZINE
AND
ANNALS OF PHILOSOPHY.

[NEW SERIES.]

DECEMBER 1828.

LXVII. *Geological Observations made in the Neighbourhood of Ferrybridge, in the Years* 1826–1828. *By* JOHN PHILLIPS, *Esq. F.G.S. Honorary Member of the Philosophical Societies of Yorkshire, Leeds, and Hull* *.

[With a Plate.]

TWO journeys to Ferrybridge, in company with the Rev. W. Bulmer, have furnished me with some observations on the geology of that neighbourhood, which but for many engagements I should some time since have had the honour of presenting to the Society. Several years have passed since I examined the range of magnesian limestone from Doncaster to Ferrybridge, and possessed myself of the general facts relating to the composition and succession of the several beds associated with it. My attention was again awakened to the subject by the freshwater shells and petrified wood found by the Rev. Wm. Richardson, during the excavation of the new canal through the alluvial soil in the valley of the Aire. Mr. Richardson obligingly offered to satisfy my curiosity on this subject by conducting me to the spot; and accordingly, in May 1826, Mr. Bulmer and myself availed ourselves of his friendly guidance. The same active inquirer furnished us occasion for another interesting visit in April 1828, by collecting some bones of antediluvian quadrupeds from a limestone quarry at Brotherton. The results of these examinations I now beg to offer to the consideration of the Society. Illustrative specimens may be consulted in the cabinets of the Institution.

The deposits in the neighbourhood of Ferrybridge lie in the following order:

1. Alluvial deposit of silt or fine clay in the valley of the Aire.

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* Read to the Yorkshire Philosophical Society, Nov. 4, 1828; and communicated by the Author.

2. Diluvial deposit consisting of pebbles and sand and clay spread indiscriminately over the surface of the strata.
3. Red and white marl with layers of gypsum.
4. Upper limestone in thin laminæ, with hardly a trace of magnesia; and few or no organic remains, except at the bottom.
5. Red and blueish-white clay with layers of gypsum.
6. Magnesian limestone in thick beds, some of which abound in organic remains.
7. Yellow or purple sand and sandstone used for moulding at the iron-works.

Beneath are the shales and sandstones of the West Riding coal district.

My remarks will be confined to the limestone and red marl formations, and to the diluvial and alluvial accumulations which cover them.

No. 6.—The yellow magnesian limestone is in this country a fine-grained rather powdery rock, never indurated to marmorean hardness as at Roche Abbey, nor composed of granular rhomboidal crystals as in the southern part of Nottinghamshire. It exhibits in one of the Weldon quarries a remarkable course of siliceous nodules, of an irregular oval figure, lying in one continuous bed of stone, like a layer of flints in a bed of chalk. No organic body is connected with them. When accidentally thrown into the limekiln they suffer fusion on the surface, in consequence of the lime which surrounds them, and become coated with porcelain or solid transparent glass. In this quarry the hollow sparry concretions so common in the magnesian limestone lie in layers in the upper part of the rock. No fossils are seen here; but between this place and Ferrybridge, Mr. Richardson collected a considerable number.

On the road from Ferrybridge to Pontefract, and near to the latter place, the magnesian limestone has been cut through in the road, and exhibits the hollow balls of calcareous spar in great variety and profusion. While I was occupied in extracting some of these from the south bank at the brow of the hill, an angular red substance fell down with the debris of the loose limestone, which upon examination surprised me very much; for it was *rock-salt*. (May 31, 1826.) My inquiries on the subject produced nothing satisfactory. The specimen is in the cabinet of the Yorkshire Philosophical Society.

In the same road, nearer to Ferrybridge, divided veins of sulphate of barytes may be seen crossing the loose beds of magnesian limestone in a north and south direction. This rock sinks regularly beneath the town of Ferrybridge, and is covered

covered towards Knottingley by the other members of the magnesian formation. But there seems to be a considerable fault or dislocation in the valley of the Aire, which depresses the beds on the north side of that river; so that they have their outcrops further toward the west.

The fossils which I have observed in this rock in this neighbourhood, are the following:

Axinus obscurus	Min. Conch. of various magnitude, common.
Cardium........	N.S. one specimen.
Cucullæa.......	N.S. not plentiful.
Mytilus.........	N.S. This might be mistaken for *Gervillia*.
Terebratula ...	N.S. Differs from one in Durham, which resembles *T. sacculus*, Min. Conch.
Producta........	perhaps a new species, decidedly unlike *P. calva*, or any other hitherto described from this formation.

No. 5.—The red blue and yellow clay, with gypsum of different sorts, which lies above the yellow magnesian limestone, was cut through in the new canal where the first bridge is thrown over it in Knottingley. We there saw the limestone No. 4. resting upon a layer of yellow clay or marl; below this a layer of blue clay, and under all the red clay with gypsum. A greater thickness of these beds is exposed in the gypsum quarries at Fairburn, on the north side of the Aire. The section at Lord Palmerston's quarry is very instructive, and easily accessible. Diluvial sand and pebbles lie on the surface of about 45 feet of the thin bedded limestone No. 4; below is yellow clay 2 feet in thickness, then blue clay 6 feet, and at the bottom 21 feet of red clay with irregular layers of coloured gypsum. This gypseous red clay ranges to the north and south of Ferrybridge, and in some places has been found 11 yards, or even, it is said, 15 yards thick. It contains no trace whatever of organic remains.

No. 4.—The limestone which is burnt at Knottingley and Brotherton for agricultural uses, has at the utmost a thickness of about 15 yards. In the quarries at Knottingley, 11 yards is above the average. The rock is laminated through its whole mass, but the lower layers are thicker. These are also in general less hard and less compact, hold a few sparry concretions, and some imperfect *Axini* and other bivalve shells. By these characters they seem analogous to the lower or magnesian rock; and accordingly the lime burnt from them is excellent for building, but useless or even injurious to land. I know not if the stone of these beds has been analysed. My friend Mr. George, Secretary to the Leeds Philosophical Society, found the upper part of the Knottingley and Brotherton limestone to be nearly pure carbonate of lime, with a very small proportion of carbonate of magnesia.

Vertical joints ranging N. and S. and nearly E. and W. cross each other, and divide the rock from top to bottom into vast rhomboidal prisms. The spaces left between their smooth sides are of different widths, and filled with various materials. The narrow fissures of this kind are sometimes nearly empty, or only partially occupied by soft fine clay introduced by water, and laid against the faces of stone: the wider ones are sometimes ten inches across, and filled by a confused assemblage of pebbles and clay, exactly similar to the general diluvial covering which is spread over the surface of the neighbouring country.

We must therefore suppose that at the time of the deluge these fissures were open in their full width, and admitted the diluvial debris. Their extreme regularity and parallelism, and the correspondence of their opposite faces, leaves no room for the supposition that they owe their existence to convulsions within the earth. Condensation of volume, in consequence of the process of induration, seems decidedly indicated by all the appearances.

The quarrymen at Brotherton sometimes meet with little irregular cavities, called *guts* or *brashes*, in the limestone, which are more or less distinctly connected with the vertical joints; and sometimes these cavities are filled with clay or with clay and pebbles, exactly like those in the fissures or "seams" themselves. Evidently, therefore, the brashes have been filled with pebbles from the seams, as these from the surface; and both at the same time, viz. the deluge.

Such holes have on several occasions yielded fossil bones in considerable plenty, but being neglected by the workmen they were not examined. Mr. Richardson being informed of an occurrence of this kind in the spring of 1828, took pains to collect the bones and observe the attendant circumstances. I had the pleasure of examining all the bones, and carefully repeated the investigation of their repository.

It was an irregular oblong space in the limestone a few feet in diameter, 10 yards below the surface of the ground, and connected directly with one long vertical joint ranging N. and S., and by a cross joint with another in the same direction. (Plate II. fig. 1.) Through these joints, I conceive, the pebbles and bones passed into the cavity. The bones belonged exclusively to oxen and deer. They were so friable that it was hardly possible to extract them in an entire state; but they became hard by exposure. Among them are the following characteristic parts:—

Ox.

Ox.—Left condyle of the lower jaw. Astragalus.
Posterior molar tooth, lower jaw, left side.

Deer.—Base of the horn with a broken brow antler placed exactly as in the red deer.
Palmated portion of the horn, agreeing closely with that of the red deer.

Both specimens smoother and rather smaller than in the red deer.

Phalangial bone.
Part of the radius.
Upper part of a metatarsal bone.

The pebbles were numerous and various, and of different sizes, but none exceeded five inches in diameter. Those most easily recognised belonged to the following rocks:—

Dark mountain limestone.
Cherty sandstone, such as is dug near Leeds.
Sandstone with *Producta hemisphærica*, such as is found near Ripley and Harrogate.
Red sandstone of the carboniferous limestone series.
Clay and sand of different colours enveloping the bones.

The limestone quarries of Knottingley and Brotherton exhibit another phænomenon, of great interest to the geologist, and well known to the workmen from the loss and disappointment which it occasions:—I mean those masses of red and white clay called "*horses*" *, which range through the quarries, some twenty, and some a hundred yards in length, and from a few feet to many yards in breadth. On first viewing these "red horses," we are apt to imagine that they fill wide fissures in the rock, produced by ordinary dislocations, which uplift the strata on one side above those on the other: but this is not the case. They are indeed uniformly situated at the convergence of opposite declinations: but these are sometimes unaccompanied by any fracture in the upper beds; and the open space below, instead of being an ordinary fissure with parallel sides, widens greatly downwards like a wedge. In consequence of this peculiarity, the red horses do not always reach the surface of the limestone; and the workmen, after removing the upper beds of that rock, find with extreme vexation that they cover a subterranean mass of red clay. By tracing the course of one of these wedge-shaped dykes, we perceive that for some distance the limestone walls of the fissure are separate, and the red clay reaches to the diluvial covering; but further on, the limestone walls approximate,

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* A common term among workmen for dislocated and deteriorated strata.

and finally unite above and exclude the clay from the surface. (See Plate II.)

The red and white clay in the deepest parts of a "horse" contains not a single pebble such as lie in the diluvium, but abounds in fragments seemingly very little worn, of the lower shelly bed of the limestone. At the surface, indeed, where the red clay and diluvium come in contact, the pebbles of the latter deposit are more or less mixed with the former; but still the appearances are such that no person can doubt the conclusion, that the diluvium was laid on the surface long after the red clay had been introduced into the chasm of the limestone.

Observing that the spaces which are filled by these red horses are not necessarily connected with the surface, but are often subterranean, and descend quite to the base of the limestone, while the long straight joints which were open to the surface are filled by other materials,—I am induced to believe that the red clay was forced into its present situation from beneath. In appearance it is very similar to the stratum which lies beneath the limestone: from all that can be observed, it is probably connected with it; and it is remarkable that the angular fragments which it contains belong chiefly to the lower shelly bed of the rock. In what manner such an upward flow of the red clay could be occasioned, is not easy to conjecture; nor will my silence on this subject be condemned by those who have learned from experience what difficulties attend the theory of ordinary dykes and mineral veins.

No. 5.—The red marl formation is seen reposing upon the limestone of Knottingley at the third bridge over the new canal through that village. It presents the usual appearance of red and blueish layers in frequent alternations, but contains, I believe, no gypsum.

No. 2.—Diluvium.

Over all the strata which have been mentioned, sand and gravel are extensively spread; but seldom accumulated in such vast quantities as in the lower country, which lies to the east and north-east. The surface of the upper limestone is in general regular, and the gravel upon it of nearly uniform thickness. In almost every quarry at Knottingley and Brotherton the fixed rock is covered by a variable layer of its own substance in the form of rubble, which sometimes is so slightly waterworn and so unmixed with other materials, that it appears to have been merely loosened and disturbed, but not transported. Above, we commonly find sand, with or without pebbles of sandstone and mountain limestone, resembling the varying beach thrown up by the sea; and then, in the Brotherton quarries,

quarries, another layer of limestone rubble more mixed with pebbles from a distance. Sand and pebbles generally overspread the whole. The most curious circumstance relating to the arrangement of the diluvium is, that the rubbly limestone fragments are so deposited as to have their flat surfaces obliquely sloping toward the east, which could only have been occasioned by the continued action of a westerly current. Such a current is indicated by the nature of the sandstone and limestone boulders, which evidently belong to rocks in the western part of the county.

No. 1.—Alluvium.

The valley of the Aire is filled in its upper part with a variety of substances brought down by the stream and deposited in its floodway. Broken trees, pebbles, sand and clay, are met with in sinking on its banks. Nearer the sea this river flows through a flat country of silt or fine clay deposited by the tide, and protected by banks. The alluvial deposit at Ferrybridge and Knottingley is situated at the point to which the sea formerly flowed, and has probably been produced by land-floods and muddy tides. Its substance is a fine rather tenacious clay or silt, such as commonly subsides from agitated water.

The excavation for the new canal was continued for some length in this alluvium, and afterwards extended through the Knottingley limestone. When it approached the limestone, the workmen were surprised to find, at the depth of twelve feet, a quantity of hazel branches and roots, with abundance of nuts, some hawstones, green moss, bones, and shells. Their astonishment was increased when the hardness of the branches proved that they had become stone. Mr. Richardson collected the most interesting specimens, and presented duplicates to the Yorkshire Philosophical Society. The following is an enumeration of the varieties.

Shells.—None but freshwater kinds; as *Lymnæa putris, Cyclas cornea, Planorbis corneus.*

Nuts, in extreme perfection. Most of them were soft when first extracted, but they hardened by exposure. They were generally empty and light. But some few heavy specimens had undergone a singular change: the kernels were converted to solid white carbonate of lime, while the brown pellicle of the kernel remained unaffected, and the shells were not at all petrified. Sometimes crystallized calcareous spar was seen in the space between the pellicle and the inside of the shell.

Wood, believed to be chiefly *hazel roots.* Some of it is unaltered in substance, the rest more or less impregnated with

carbonate

carbonate of lime. Usually the central portion is lapidified, while the outward layers are unchanged: but sometimes the whole mass of wood is filled with stony particles, while the bark remains soft and pliable. One specimen shows the central wood petrified, the external layers decayed away, and the bark externally coated with pyritous carbonate of lime. Blue phosphate of iron, so common in alluvial deposits, colours some of the fragments of wood. The bark and soft wood and nutshells burn with a brilliant and continued light; even the fibrous stony substance emits a faint lambent flame.

Bones.—The lower jaw of a deer, about the size of the red deer, coloured by phosphate of iron.—Upper part of the tibia of an ox, in the sinuosities of which a hazel root has struck its branches, and over whose surface a pyritous layer is spread, like that which invests the bark of the specimen of wood already mentioned.

No other example has occurred to me of petrified nuts or wood in Yorkshire; and the cause of the peculiarity in this instance is not difficult of discovery. At Knottingley the vegetable relics were buried so near to the limestone rock that its calcareous springs obtained access, and in a long succession of years filled the interstices of the plants with a stony deposit. It is remarkable that the interior parts of the branches are often hardened to stone, while the bark and external layers of wood are not perceptibly altered; and that in the same manner the kernel of a nut should have become a mass of calc spar, while its shell has remained without any change of substance.

Except in the peculiar and interesting circumstance of the vegetable remains having become lapidified, little essential difference appears between this freshwater deposit and those in Holderness, which will be minutely described in my forthcoming publication on the Geology of the Yorkshire Coast; and in each case their high antiquity is proved by the deep sediment laid upon them. This sediment itself is of varying antiquity. It may conceal the most ancient and the most recent of the works of man;—a boat used in some distant ages of the world, as in Romney Marsh; or an English oar, coin, and horse-shoe, as in part of the excavation at Knottingley.

York, Nov. 3, 1828.

Reference to Plate II.

Fig. 1. A section representing the general appearance of quarries at Brotherton.

(*a*). The limestone rock, with straight fissures (*b*) and (*c*), (*c*), the latter filled with pebbles, clay, and sand, as also is (*d*) a "brash" connected with (*c*); (*e*) and (*f*) are red horses, the former not reaching to the top of the limestone, but the latter opening through it and covered by the diluvium.

(*g*) is the rubbly limestone with its fragments sloping to the east; (*h*) sand and pebbles of sandstone and limestone.

Fig. 2. Shows in a quarry at Brotherton a second layer (*i*) of limestone rubble above the sand and pebbles (*h*).

Fig. 3. Represents some irregular ramified layers of gypsum in red marl at Fairburn.

LXVIII. *On the Calculations requisite for predicting Occultations of Stars by the Moon**.

THE columns which are placed together on pages IV and VI of every month are to facilitate the approximate determination of the moon's daily motion. With regard to the manner of using them for the most frequent and most useful application of them, the prediction of the time at which the moon will occult a heavenly body, I beg here to give some further explanation on the most convenient form of the calculation.

Let α, δ, π, r denote the right ascension, declination, horizontal-equatorial parallax and semidiameter of the moon, as viewed from the centre of the earth, α', δ', r' the corresponding quantities for a point on the surface of the earth whose corrected latitude is φ, ϱ being the corresponding semidiameter of the terrestrial spheroid: next let θ signify the sidereal time, A, D the mean right ascension and declination of a star in the beginning of the year; A′, D′ the same for the apparent place of the star at another given time. The rigorous calculation of the time of the beginning and end of the occultation will require the following operations.

For at least two moments of time t, which are near the required one, the quantities α, δ, π, r, θ are to be deduced from the Ephemeris by interpolation; and from these the α', δ', r' are to be calculated. Developing the finite expressions into series, and neglecting the terms of the third order (π being considered as of the first), which are in most cases insensible, we have the following formulæ:

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* From Encke's *Astr. Ephem.* for 1830, p. 253.

$\alpha' = \alpha$

$$\alpha' = \alpha - \frac{\varrho . \sin \pi . \cos \varphi}{\cos \delta} \sin (\theta - \alpha)$$

$$- \tfrac{1}{2} \left(\frac{\varrho . \sin \pi . \cos \varphi}{\cos \delta} \right)^2 \sin 2 (\theta - \alpha) - \ldots .$$

$$\text{tang}\, \gamma = \text{tang}\, \varphi . \frac{\cos \frac{1}{2} (\alpha' - \alpha)}{\cos \left\{ \theta - \alpha - \frac{1}{2} (\alpha' - \alpha) \right\}}$$

$$\delta' = \delta - \left(\frac{\varrho \sin \pi . \sin \varphi}{\sin \gamma} \right) \sin (\gamma - \delta)$$

$$- \tfrac{1}{2} \left(\frac{\varrho \sin \pi . \sin \varphi}{\sin \gamma} \right)^2 \sin 2 (\gamma - \delta) - \ldots .$$

$$r' = r + r \left(\frac{\varrho . \sin \pi . \sin \varphi}{\sin \gamma} \right) \cos (\gamma - \delta) + \ldots .$$

From the calculations for two or more moments will be found the true parallactic motion of the moon in right ascension and declination $\Delta \alpha'$ and $\Delta \delta'$. The quantities A′ and D′ being likewise derived from A and D, we have, for the time of the beginning and end of the occultation, $t \pm \Delta t$; Δt being found by this quadratic equation

$$(A' - \alpha' - \Delta t . \Delta \alpha')^2 \cos \delta'^2 + (D' - \delta' - \Delta t\ \Delta \delta')^2 = r'^2$$

in which for r' the value corresponding to $t \pm \Delta t$ must already be adopted.

In the calculations for predicting occultations there is no preliminary knowledge of the times when they will happen. Numerous useless trials would therefore be necessarily made, if it were required to insure that no star had been passed over.

The distance of the two moments of time from which $\Delta \alpha'$ and $\Delta \delta'$ are to be calculated, may safely amount to an hour. The hour angle of the moon being $\theta - \alpha$, positive if west of the meridian, the calculations for parallax may be facilitated, if the motion of the moon is referred not to mean time, but to true lunar time. For if τ denote any hour angles (the western ones being positive), each differing 15° from the other during the greatest diurnal arc of the moon, consequently within about 15^h to 9^h, one may calculate for every τ a table with double entries δ and π, from which $\alpha' - \alpha$, $\delta' - \delta$, $r' - r$ may be immediately taken.

This would require altogether nineteen tables, which indeed would be only for one place, but of permanent use. We have here supposed that the quantities t, α, δ, r, π may be easily found for the different values of τ.

For this purpose are given the three columns on pages IV and VI, headed "Moon on the Meridian." They give the time and the place of the moon during her upper and lower culminations at Berlin; or if the sign ^{h} denote true hours of the moon, the time and place of the moon being referred to the centre

centre of the earth, for 0^h and 12^h at Berlin. From these may be found by an easy interpolation, as only entire numbers and second differences enter into the calculation, time and place for

$$0^h, \pm 1^h, \pm 2^h, \ldots .$$

referred to Berlin; for any other place on the earth whose longitude from Berlin, positive if eastern, is l, these places and times would correspond to

$$\tau = 0^h + l, \pm 1^h + l, \pm 2^h + l, \text{\&c.}$$

The deduction of these three columns is strictly founded on an interpolation with unequally increasing arguments. We know θ and α for every mean noon and midnight, and from these the times and α and δ are to be found which correspond to $\theta - \alpha = 0$, and $\theta - \alpha = 180°$. If the values of $\theta - \alpha$ are calculated for every noon and midnight, and are assumed as arguments of tables whose functions are respectively the mean half days, and α and δ from 12 to 12 mean hours, the formulæ explained in the paper "On Interpolation *" may be employed for finding the values of the above functions for $\theta - \alpha = 0$, and $\theta - \alpha = 180°$.

The greatest strictness, however, would not be required in these calculations. Even in the latest tables of the moon's motions there occur errors in longitude of $10''$, and the position of the smaller stars may possibly likewise be wrong by $5''$; and consequently the strictest calculation may still be liable to an error of half a minute in time. It is therefore not necessary in calculating the predicted occultations, to have the moon's place nearer than to 0·1 minute of a degree, and the time nearer than to 0·1 minute of time. Under these circumstances it will be sufficient, in deducing the time of the culmination from the values of $\theta - \alpha$ formed as above described, to use an indirect method by which, agreeably to the paper "On Interpolation," the mean days being considered as arguments, and the $\theta - \alpha$ as functions, the first differences of $\theta - \alpha$ are so corrected by an approximate estimation of the factor of correction, that they may be simply regarded as divisors, and the times of the culminations are then found by the quotients

$$\frac{\alpha - \theta}{\Delta(\theta - \alpha)}\, 12^h \text{ and } \left(\frac{\alpha - \theta - 180°}{\Delta(\theta - \alpha)} + 1\right) 12^h$$

In this manner the times of the culminations have been found accurately to 0·1 minute of time; an accuracy which has caused no greater trouble than the common results would have required, as it is always necessary to use logarithms.

By means of these times the corresponding places of the

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* This paper will appear in our next Number.—EDIT.

moon have been calculated from the differences of α and δ, which had already been calculated in examining the correctness of the tabular values. In general the limit of accuracy may be taken at $0'\cdot1$. But with regard to the δ in the places of the greatest changes, especially in the three first months, errors of $0\cdot3$ may occur, arising from the circumstance of these calculations having in the beginning only been made for the upper culmination. Greater deviations, if any should be found, must have been introduced by misprints.

In deducing the places for the single values of τ from the culminations, it appears unnecessary to go further than to second differences.

The tables for calculating the parallaxes for every value of τ will, however, considering the quick change of δ, not be of the most convenient form if made with double entries; and I have likewise in this case found more convenience in the method so frequently and successfully applied by Gauss, of avoiding the double entry by a table of single entry and a short logarithmic calculation.

As the moon's place is only known to $0'\cdot1$ of a degree, the parallaxes are only required to be known to $0'\cdot01$, in order to be quite sure that by them no other error shall be introduced. It will for this purpose be sufficient to have logarithms with only four places of decimals, which everybody may easily compile. Ten duodecimo leaves thus contain to the most convenient extent the numbers, the trigonometrical functions, and Gauss's auxiliary tables for addition and subtraction.

The form which I have chosen is this: For every τ from 15^h to 9^h I have calculated for all values of π from $10''$ to $10''$ within the limits of $\pi = 53'$ and $\pi = 62'\ 10''$:

$$a = -\varrho\,.\sin\pi\,.\cos\phi\,.\sin\tau\,.\,3437\cdot75$$

$$\operatorname{tang}\gamma = \operatorname{tang}\phi\,\frac{\cos\frac{1}{2}(\alpha'-\alpha)}{\cos(\tau-\frac{1}{2}(\alpha'-\alpha))}$$

$$b = -\frac{\varrho\,.\sin\pi\,.\sin\phi}{\sin\gamma}\,.\,3437\cdot75$$

In calculating γ, instead of $\frac{1}{2}(\alpha'-\alpha)$, has been adopted $\frac{1}{2}a\,.\sec.21^\circ$, the value of a being the one corresponding to $\pi = 57'\ 40''$; sec 21° is about the mean value between the greatest and smallest sec δ which can take place for the moon. The adoption of these mean values cannot sensibly change the result of the calculation. A table was formed of the logarithms of a and b to four places of decimals; in these tables the minute of a degree was considered as unity. Next the quantities of the second order were arranged in tables of double

double entry, δ from $-30°$ to $+30°$ for every fifth degree, and π from $53'$ to $62'$ for every third minute:

$$a' = -\tfrac{1}{2}\left(\frac{\varrho \,.\, \sin\pi \,.\, \cos\varphi}{\cos\delta}\right)^2 \sin 2\tau \qquad .\, 3437{\cdot}75$$

$$b' = -\tfrac{1}{2}\left(\frac{\varrho \,.\, \sin\pi \,.\, \sin\varphi}{\sin\gamma}\right)^2 \sin 2\,(\gamma-\delta) \,.\, 3437{\cdot}75$$

$$\Delta r = +\, r \,.\left(\frac{\varrho \,.\, \sin\pi \,.\, \sin\varphi}{\sin\gamma}\right) .\, \cos\,(\gamma-\delta)$$

The values are expressed in hundredth parts of minutes of a degree. By this means we find

$$\begin{aligned} \alpha' - \alpha &= a \sec \delta + a' \\ \delta' - \delta &= a \,.\, \sin(\gamma-\delta) + b' \\ r' - r &= \Delta r \end{aligned}$$

almost as accurately as it is required for the most exact calculation, as the error will very rarely amount to $1''$.

Besides these values, the parallactic velocity of the moon, as it may be called, or the quantities $\Delta\alpha'$ and $\Delta\delta'$ are required. The first differences of α and δ give her velocity in right ascension m, and in declination n, with reference to the centre of the earth; and as differences higher than the second are neglected, we may assume that for $\tau = 6^h$ and $\tau = 18^h$ the first differences are $12m$ and $12n$. The unity of time is here the true lunar time, whose ratio to mean time is determined by the first differences of the times calculated.

In the values for $\alpha'-\alpha$, $\delta'-\delta$, the three variable quantities are π, δ, and τ. The variation of the terms of the second order will never be of consequence; and in those of the first, π may without hesitation, and even δ may, be considered as constant. The influence of the latter assumption would only become sensible if the time of the beginning or end of the occultation should be far distant from the lunar hour assumed for τ; in which case, however, the first differential quotients only would likewise not be sufficient. If therefore we calculate for every τ, neglecting smaller quantities,

$$\begin{aligned} m' &= -\,\varrho \,.\, \sin\pi \,.\, \cos\varphi \,.\, \cos\tau \,.\, 900 \\ n' &= -\,\varrho \,.\, \sin\pi \,.\, \cos\varphi \,.\, \sin\tau \,.\, 900 \end{aligned}$$

and arrange their logarithms to four places of decimals for every π, we shall have very nearly

$$\begin{aligned} \Delta\alpha' &= m + m' \sec\delta \\ \Delta\delta' &= n + n' \sin\delta. \end{aligned}$$

It now remains only to facilitate the calculation of A′ and D′ from A and D; as the errors arising from neglecting this calculation, especially towards the end of the year, would far exceed the errors arising in the most unfavourable cases from the calculation,

calculation, as here described, of the apparent place of the moon. With this view it is only necessary to remark, that a star in occultation can be distant from the apparent place of the moon only 15′, and from the mean place of the moon only 1° 15′. Within the limits of the moon's declination it may be assumed, that stars which are so near each other have perfectly the same corrections of their places. If we therefore consider the mean place of the moon as the position of a star, and calculate by means of the auxiliary table in the Ephemeris for every superior culmination throughout the year, the correction which must be applied to the mean place of a star of the same right ascension and declination, in the beginning of the year, in order to have the apparent place for the time of the upper culmination,—we have a table giving very nearly the apparent place of each star, as far as it can be occulted by the moon. These are the quantities which, in the tables headed "Auxiliary Tables for the Occultations of Stars," have been denoted ΔA and ΔD; so that taking ΔA and ΔD for the given moment of time from them, we have for all stars occulted

$$A' = A + \Delta A$$
$$D' = D + \Delta D.$$

In calculating these tables, as the time pressed, some of the small terms have been omitted, and only these forms have been assumed:

$$\Delta A = f + h \sin (H + \alpha)$$
$$\Delta D = i + g \cos (G + \alpha).$$

The declination of the moon will not exceed $\pm$ 19° in this year; and the terms multiplied by tang δ and sin δ will become small; likewise sec δ and cos δ may be put = 1.

In order now to reduce everything to a certain form, which greatly facilitates calculations which are to be frequently repeated, we may abbreviate the solution of the quadratic equation by introducing trigonometrical auxiliary quantities; and with this view the following expressions may be used:

$$\text{For } \tau = \begin{array}{l} 0^h + l \\ \pm 1^h + l \\ \pm 2^h + l, \text{\&c.} \end{array}$$

the following quantities may be arranged in a table with single entry: log a, log b, γ, r, m', n', the argument being π for every tenth second: the quantities a', b', Δr for every τ, will form tables with double arguments δ and π.

Thus *ex. gr.* that part of the general table for Berlin (latitude 52° 31′ 15″, ellipticity $\frac{1}{302 \cdot 78}$), which is used for the occultation of 82 Leonis on the 5th April 1830, is as follows:

21ʰ

21^h

π	log *a*	log *b*	γ	*r*	log *m*′	log *n*′
54′ 0″	1·3670	1·6862$_n$	61° 27′·7	14′·72	0·7850$_n$	0·7850
10	1·3684	1·6876$_n$		14 ·76	0·7864$_n$	0·7864
20	1·3697	1·6889$_n$		14 ·81	0·7877$_n$	0·7877
30	1·3710	1·6902$_n$		14 ·85	0·7890$_n$	0·7890
40	1·3723	1·6915$_n$		14 ·90	0·7903$_n$	0·7903
50	1·3737	1·6929$_n$		14 ·94	0·7917$_n$	0·7917
55 0	1·3750	1·6942$_n$	61 27′·9	14′·99	0·7930$_n$	0·7930

a′

	π =	53′	56′	59′	62′
δ =	0°	+0′·15	+0′·17	+0′·19	+0″·21
	± 5	+0 ·15	+0 ·17	+0 ·19	+0 ·21
	10	+0 ·16	+0 ·17	+0 ·19	+0 ·21
	15	+0 ·16	+0 ·18	+0 ·20	+0 ·22

b′

	π =	53′	56′	59′	62′
δ =	−10°	−0′·20	−0′·22	−0′·25	−0′·27
	− 5	−0 ·24	−0 ·27	−0 ·30	−0 ·33
	0	−0 ·28	−0 ·31	−0 ·34	−0 ·38
	+ 5	−0 ·30	−0 ·34	−0 ·38	−0 ·42
	+10	−0 ·32	−0 ·36	−0 ·40	−0 ·44

Δ*r*

	π =	53′	56′	59′	62′
δ =	−10°	+0′·06	+0′·07	+0′·08	+0′·09
	− 5	+0 ·08	+0 ·09	+0 ·10	+0 ·11
	0	+0 ·10	+0 ·11	+0 ·12	+0 ·13
	+ 5	+0 ·11	+9 ·12	+0 ·14	+0 ·15
	+10	+0 ·12	+0 ·14	+0 ·15	+0 ·17

For the whole Berlin lunar hour which is contained in τ, we take from the Ephemeris, pages IV and VI, the mean time T, α, δ, the length of the true lunar hour 60′ + Δ*t*, as also *m* and *n*. The first quantities are to be taken with due regard to the second differences, where the interpolation requires only these convenient factors $\frac{1}{12}$ $\frac{1}{6}$ $\frac{1}{4}$ $\frac{1}{3}$ $\frac{5}{12}$ $\frac{1}{2}$.

From

From the auxiliary tables for occultations of stars we have π, ΔA and ΔD; and from the catalogue of stars, A and D. We have then to calculate

$$\begin{array}{ll} \alpha' = \alpha + a \sec \delta \qquad + a' & \\ \delta' = \delta + b \sin(\gamma - \delta) + b' \;, & r' = r + \Delta r \\ \Delta\alpha' = m + m' \sec \delta, & \Delta\delta' = n + n' \sin \delta \\ A' = A + \Delta A \;, & D' = D + \Delta D \end{array}$$

If we now put

$$\begin{array}{ll} (A' - \alpha') \cos \delta' = N \sin \eta & \Delta\alpha' \cos \delta' = M \sin \zeta \\ (D' - \delta') \qquad = N \cos \eta & \Delta\delta' \qquad = M \cos \zeta \end{array}$$

where the different signs determine the quadrants in which η and ζ are, (N and M being always considered as positive,) and if we likewise determine i by this equation: $\frac{N \sin(\eta - \zeta)}{r'} = \sin i$, we have for the mean time of the beginning and end of the occultation $T + t + l$, the double value of t in minutes of time being derived from this equation:

$$t = \frac{60 + \Delta t}{M} \left\{ N \cos(\eta - \zeta) \mp r' \cos i \right\} .$$

The upper sign is for the beginning, the lower for the end of the occultation.

If $N \, . \sin(\eta - \zeta) > r'$, no occultation takes place: the moon passes to the north of the star if $\sin \eta - \zeta$ is positive, to the south if $\sin(\eta - \zeta)$ is negative. For the place of the star's disappearance and reappearance on the moon's limb, the angle u, counted from the northernmost point of the moon's disk through east, south, and west, is found by these equations:

$$r' \sec \delta' \sin u = A' - \alpha' - \Delta\alpha' \left(\frac{t}{60 + \Delta t} \right)$$

$$r' \cos u = D' - \delta' - \Delta\delta' \left(\frac{t}{60 + \Delta t} \right)$$

where, with rare exceptions, u must be taken for the disappearance in the two first, for the reappearance in the two last quadrants. As an approximate value of u is only required, the second formula will be sufficiently accurate.

Among the various values of τ, it is most advantageous to take the one which lies nearest to the true conjunction of the star with the moon in right ascension. The choice of this value is facilitated by the consideration, that for positive values of τ the apparent right ascension is smaller than the true one; for negative ones greater; or that the parallax in right ascension has a contrary sign to τ. If, however, the true conjunction should happen in the middle of a lunar hour, it would be necessary, in order to attain all the accuracy of which the method admits, to make the calculation for the two hours between

tween which it lies, and to take out of the two values, always the one which is nearer to a lunar hour, if one would not besides apply for this case a simple interpolation.

As an example, I add the complete calculation of the occultation of 82 Leonis, where every one will easily perceive the signification of the numbers from the auxiliary and parallax tables.

1830, April 5.

82 Leonis.	169° 13′·70	+4° 14′·29
	+0·41	−0·21
	169 14·11	+4 14·08

$\tau = 21^h$ $\pi = 54' \, 11''$

7^h 20′·9	168° 47′·8	+ 4° 40′·8	+ 29′·31	− 9′·35
1·3685	1·6877$_n$	61 27·7	0·7865$_n$	0·7865
0·0014	9·9225	56 46·9	0·0014	8·9116
+ 23·44	− 40·75	14·76	− 6·10	+ 0·50
+ 0·16	− 0·31	+ 0·11	+ 23·21	− 8·85
+ 23·60	− 41·06	+14·87	log. 61′·8...	1·7910
			log. cos δ′...	9·9989
169 11·40	+ 3 59·74	259° 45′·6		
+ 2·71	+ 14·34	9·9930^n	9·2499^n	+ 12·1
0·4319	1·3646	9·9918	1·5609	+ 14·8
1·1565	0·9469$_n$	9·4146	− 6·5	1·0828
10 40·6	110 55·0	1·5691	7 14·4	1·1703
9·9924	9·9704		+ 9·6	1·1723
1·1641	1·3942	Disappearance	7 4·8	35°
1·1723	0·3968	Reappearance	7·24·0	5

The rigorous calculation has given

Disappearance	7^h	4′	21″
Reappearance	7	24	16

The calculations for the Ephemeris may be facilitated by some auxiliary tables.

With this view I have calculated by interpolation the position of the moon for every third lunar hour. This table, while it increases the safety, reduces besides the calculation of the rising and setting of the moon, every one of which would otherwise have required a separate calculation, to a mere copying of figures. For if we write the table from which we take for any given declination the semidiurnal arc of the moon, in such a manner that the lunar hours of the form $3n$ are always taken separately, and the excess of the semidiurnal arc above these lunar hours is converted by the mean motion of the moon into mean time, we have without any further correction the times of rising and setting, more accurately than they are ever required for any purpose. A second auxiliary table

table for occultations of stars, is a table which contains the time in which the moon is above, and the sun below the horizon.

The times of rising and setting of both these heavenly bodies being placed opposite to each other, this is likewise only copying of numbers.

A third auxiliary table contains the stars which within the largest possible limits may be occulted. For this purpose I sought for the beginning, middle, and end of the year, the declination which the moon has for every 5° of right ascension, and took in all the stars which are 40′ further north, and 1° 40′ further south, than the northernmost and southernmost limits of those zones.

By means of these tables the decision of the possibility of an occultation is in general so much facilitated, that besides the 130 occultations given in the book, only two were calculated in which the moon remained distant somewhat more than 2′, the limit to which I had proposed to myself to find out the conjunctions.

LXIX. *On the Height of the Aurora Borealis above the Surface of the Earth; particularly one seen on the 29th of March, 1826.* *By* JOHN DALTON, *F.R.S.*[*]

APPREHENDING that the Royal Society will favourably receive accounts that have a direct tendency to determine the height of that interesting phænomenon, the Aurora borealis, I have been induced to transmit some observations that were made upon a very remarkable one, which appeared in the evening of the 29th of March, 1826. From some recent observations, an opinion seems to be entertained by some writers, that the aurora is not so high as has generally been estimated; but it is only from facts and observations such as the following, I conceive, that any near approximation to the true height can be obtained.

The aurora borealis above mentioned, was of a kind very rarely occurring. It assumed the appearance of a rainbow-like arch, stretching across the mid-heaven, at right angles to the magnetic meridian. It was subject to very little change of position for an hour or more, and therefore afforded time to observe the angle of its elevation above the horizon. In the period of five years' observations at Kendal formerly, above one hundred appearances of the aurora occurred to me, and only

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[*] From the Philosophical Transactions for 1828. Part II.

only one of the kind just described. I had not an opportunity of seeing the one which is the subject of this paper, but it was seen here (at Manchester) by a friend of mine about 9 o'clock on his returning home from a visit to me. He did not indeed observe the luminous arch, either from its having vanished, or from the obscurity of our atmosphere; but he remarked some beams or corruscations in the north-western hemisphere, of a low altitude; and not having seen an aurora for a long time, he induced the family at home to go out and catch a glimpse of the phænomenon, now much more rarely seen than formerly.

A few days afterwards I accidentally noticed a paragraph in the Lancaster Gazette describing the luminous arch of the aurora, as well as the accompanying appearances; and as such a striking and unusual phænomenon could not fail to attract general attention, I examined the provincial newspapers and other periodicals of the time, and took occasion soon after to make inquiries personally, or by writing, of such individuals of judgement as had seen the phænomenon in various places near the line of the magnetic meridian. The result was, a collection of a more complete and extensive series of observations than was ever before made, in all probability, towards determining the height of the luminous arch of the aurora.—I shall now proceed to detail some of the particular observations.

The accounts represent the arch to have been seen in places 170 miles distant in a north and south direction, and forty-five miles distant in an east and west direction, comprising an area of seven or eight thousand square miles; but it must have been much more extensively visible, as in most cases the writers of the different accounts describe their situation as central with regard to the phænomenon. It was seen at Edinburgh and Leith, Kelso, Jedbergh, and Hawick in Scotland; at Carlisle, Penrith, Keswick, Cockermouth, and Whitehaven in Cumberland; at Kendal and at Kirkby-Stephen in Westmorland; at Lancaster, Preston, Warrington, and Manchester in Lancashire; and at Doncaster in Yorkshire. Descriptions of the phænomena as seen at most of these places were immediately given in the newspapers of Lancaster, Kendal, Carlisle, Whitehaven, Kelso, &c., and some of these accounts were copied into the London papers soon after.

All the accounts that I have seen from places between Lancaster and Edinburgh, as well as at these two places, agree that a luminous arch was first seen about 8 o'clock in the evening; that it continued without much motion for an hour nearly, and then gradually vanished, leaving the northern sky illuminated as usual after an aurora borealis of the common kind; so that it seems impossible to doubt that the same arch was seen at all the places of observation, and at the same time.

A good description of the phænomenon was published by Messrs. Coldstream and Foggo in the Edinburgh Journal of Science for June 1826; it is as follows:

"March 29th. Immediately after the fading of the evening twilight, at 8h 15m P.M., a bright luminous ray was seen to rise from the eastern horizon, gradually to extend itself towards the zenith, and thence towards the western horizon, presenting, when completed, the appearance of an arch of silvery light, similar to that seen here on the 19th March, 1825.

"When first formed it was a few degrees to the north of the zenith of this place; the light in the centre was rather diffuse; its edges were irregular; and the western limb had, as it were, a plumose appearance. It soon evinced a decided motion towards the south, and in a few minutes reached our zenith. Its edges were now sharply defined, and throughout its whole course it was nearly uniform in appearance and breadth; the intensity of its light in the zenith had increased, while in the same quarter the breadth had considerably diminished.

"The direction it now had was very nearly at right angles with the magnetic meridian.

"At ½ past 8, faint beams of the aurora began to rise from the northern horizon, and at one time promised to form a splendid display; but the corruscations never became very vivid; they were not rapid in their motions, and did not flit along the horizon.

"The arch still continued its motion towards the south, and in 15 minutes passed through a space of about 20°. Its southern edge reached a point about 24° or 25° south of the zenith, beyond which it did not go. The light now became gradually fainter, and at length disappeared.

"Meanwhile the aurora in the north continued to play, but with no increase of vividness. For some minutes, soon after 9 o'clock, we observed broad bands of light, having their longer axes (which generally subtend angles of about 18° or 20°) parallel with the horizon, darting with great velocity across the illuminated space from east to west and from west to east. These formed, ran their course, and vanished in a moment; they had no vertical motion, but they appeared at various degrees of elevation, never higher however than 30°. Soon after this interesting (and perhaps unusual) display, the beams disappeared, and nothing was left but a diffuse luminousness along the horizon."

At Jedburgh, Hawick and Kelso, places about forty miles south of Edinburgh, the phænomena were much the same as above, as appears from the Kelso Chronicle. (See also the London Courier, April 7th, and other of the daily papers.) At Jedburgh the arch is said to have commenced at $8^h\ 15^m$ on the W. by S. point of the horizon, to have passed south of the star Aldebaran, between Castor and Pollux, and over Arcturus; its altitude 60° from the S.; waves of light seemed to run along the arch. At $8^h\ 30^m$ the whole advanced 20° to the S. At Hawick it was at first 20° S. of the zenith, and at $8^h\ 40^m$ it was stationary at 37° S. of the zenith; the arch passed 6° N. of Arcturus, 7° S. of Cor Caroli, 6° N. of Coma Berenices, through the hind foot of Ursa Major, 4° N. of Asellus Borealis, 6° S. of Pollux, through the head of Monoceros, through the three stars in Orion's girdle, and 1° S. of Rigel. From this it would seem that the arch, instead of appearing low in the north from the last-mentioned places, as it must have done if situated only five or even ten miles above the earth's surface, appeared as far to the south of the zenith as at Edinburgh, or rather further. This latter it could not do; and in such circumstances it is reasonable to allow a difference of a few degrees in the estimates of altitudes of arches neither well defined nor absolutely fixed, and possessing several degrees of breadth; but it clearly shows the arch was not low. The author of the Hawick account signs, Gideon Scott.

At Carlisle, seventy-five miles S. of Edinburgh, the phænomena were much the same as in the preceding accounts. See the two weekly newspapers of that city.

About Cockermouth, twenty-five miles S. of Carlisle, I conversed with many persons who had seen the phænomena. One young gentleman, Mr. Harris, had committed to paper at the time some notes upon it, with which he favoured me. According to these, he first saw the arch at $7^h\ 45^m$ P.M., it extended nearly from the western to the eastern horizon, through the W. part of the head of Orion, over Castor and Pollux, S. of Ursa Major, and ended in Corona Borealis; it continued with little variation in its situation till near 10 o'clock. At first the west end of the arch was most luminous, and finally before it vanished the east end was the most brilliant. The eastern end waxed and waned frequently. The sky was very clear, a few streamers appeared low in the horizon.

At Keswick, about twelve miles east of Cockermouth, the appearance was described as follows, in a letter to me from Mr. Otley.—This gentleman is known to the public by an elegant little description of the Lakes and Mountains of the North of England, and is familiar with observations relating to to meteorology, and to the angles of elevation of objects. "About 8 P.M., a luminous arch appeared very brilliant; the outside of the curve seemed a little south of the zenith. The eastern end tapered to a point above the horizon; the western end was broader, and lost in a cloud which rested on the mountain. It disappeared about 10 o'clock."

At Whitehaven, one hundred miles from Edinburgh, and a few miles more to the westward, a minute description of the phænomenon was given in one of the newspapers of that place, by Mr. Holden, lecturer on astronomy, who happened to be there at that time. At $8^h\ 45^m$ the east leg of the arch covered α Coronæ Borealis, the northern edge of the bow touched Castor near its greatest altitude, and the west leg went over the three small stars marked λ in the head of Orion. The breadth at greatest altitude was 4° 40′, but tapered down to the horizon, where it was not more than one-fourth of that breadth. The east leg was 15° north of the east point, and about the same number of degrees south of the zenith; and the west leg was 15° south of the west point. At $9^h\ 8^m$ the arch had moved southward, Pollux touched the north of the bow, the west leg extended over α Orionis, and the east leg was still upon α Coronæ Borealis, but this star had been moving in its apparent track by the earth's motion for the space of twenty-three minutes. He saw several small clouds move before and cover portions of it for a few seconds of time.

From Kirkby-Stephen, about forty-five miles east of Whitehaven, a good description of the phænomenon is given in the Westmorland Gazette. The mean breadth of the luminous arch exceeded that of the rainbow, the vertex broader, the extremities narrower, and the light more dense. The arch gradually faded about 10 P.M., having existed nearly two hours. The light was white and transparent. Position at 9 P.M., the arch of a great circle from E. 25° N. through the zenith to W. 25° S. At first the eastern extremity of the arch was near β Herculis, thence it passed the north side of Corona Borealis, through the midst of the seven stars in the Great Bear, over the zenith to the north of Castor, exactly over Bellatrix, after which it contracted to a point in Eridanus just above west. This writer makes no mention of any appearance of the common aurora borealis at the same time.

Accounts from Penrith were much the same as the preceding ones; but I had no opportunity of seeing any of them.

At Kendal, which is 110 or 115 miles S. of Edinburgh, and very nearly on the same magnetic meridian, (consequently the same part of the arch must have crossed the meridian at both places,) the following is a description of the phænomena as they appeared there, and might have been adopted with very little error, it should seem, for that at Edinburgh or any one of the intervening places, except as to the altitude of the summit of the arch. "A most magnificent meteor was observed here between 8 and 9 o'clock. The appearance was that of a luminous arch, stretching quite across the heavens. Its direction was that of the magnetic east and west, intersecting the magnetic meridian at right angles. At the same time a splendid light was observable in the northern horizon. This meteor was similar in some particulars to one which appeared a few years ago." [Query in 1819?] "The arch itself appeared like two frustums of cones, with the less extremity in the horizon, and their bases meeting in the zenith. The densest parts of the bow were those near the horizon, and the west end the denser of the two."

The phænomenon was seen at Lancaster, twenty miles S. of Kendal, and 130 miles S. of Edinburgh; it was described in the next Lancaster Gazette, but without being specific as to the altitude of the centre of the arch. Inquiry having been made of an intelligent medical gentleman who had seen it, he described the luminous arch as extending from east to west across the zenith, the light increasing in intensity from the arch of the zenith to the line of the horizon; there were those faint corruscations which usually attend an aurora borealis. This was about 8 o'clock: at 10^h 30^m P.M. there was a luminous appearance along the northern horizon.

The aurora was seen at Preston, twenty miles S. of Lancaster; but I have not been able to learn the particular appearances at that place. It was also seen at Doncaster in Yorkshire, but I have not noticed any description of its appearance at that place.

At Warrington the luminous arch was seen by a friend of mine, Mr. Joseph Crosfield, who was so obliging as to give me interesting information on the subject, both verbally and by writing. He saw the arch about 9 o'clock, or between that and 10, in company with two other persons, to whom he pointed it out at the time. At the first glance he took it for the milky way, but soon discovered his mistake. The direction of the arch was from W.S.W. to E.N.E. passing to the north of the zenith. The western branch was longer and more brilliant. He saw no northern lights at the time, neither did he apprehend the phænomenon was connected with them. On elevating the pole of a celestial globe till the axis passed through a series of angles with the horizon, I desired him to fix upon an elevation which he judged most nearly to coincide with the elevation of the centre of the luminous arch. On examination, the

the angle was found to be 61°. I then fixed the axis at 70°; this he was almost certain was too high. When it was fixed at 50°, he was still more certain it was too low.

The aurora was seen at Manchester, as has been stated; but it does not appear to have attracted much attention at this place. I have not been able to trace any account of the phænomena having been seen further south.

These are all the material observations I have collected; from which it must appear that the descriptions every where given evidently apply to the same luminous arch. In proceeding from north to south we find the arch gradually advancing in altitude, always crossing the meridian to the *south* of the zenith, till we arrive about Kendal, at which place it crossed nearly in the zenith, and when at Warrington its culminating was to the *north* of the zenith. It is further remarkable, that in all the places the arch seemed to terminate nearly in the magnetic east and west, or at two opposite points of the horizon; these facts indicated the great height and extension of the arch.

In order to apply the data to calculate the height of the arch, it is evident that observations at the extremities of the magnetic meridians are to be preferred, and those on or near the same meridian, all other circumstances being the same. Unfortunately, the Edinburgh and Hawick observations do not harmonize together: however, those at Jedburgh, a place nearly of the same latitude as Hawick, seem to show that both the others are wrong, or rather perhaps, that they had not been cotemporary with each other and the rest of the observations. The Hawick altitude is probably too low, and that at Edinburgh considerably too high.

In this uncertainty we may be allowed to take the observations at Whitehaven and Warrington as guides. Those places are very nearly on the same magnetic meridian; they are distant eighty-three miles, giving an extensive base: the observations were nearly cotemporary, and made on the same part of the arch, the altitude at Whitehaven being 75° from the south, and that at Warrington 61° from the north. From these data, I find the height of the arch very nearly one hundred miles above the earth's surface, and its position vertical about Kendal and Kirkby-Stephen, which accords well with the observations at those places. This conclusion is corroborated by the observations at Jedburgh and Warrington, where, if we take the angles of elevation at 60° and 61° respectively, and the distance on the magnetic meridian 120 miles, the height will be found between 100 and 110 miles. But, lastly, if we assume the angle at Edinburgh to be correct at at 65°, and that at Warrington at 61°, the height comes out 150 or 160 miles, and its position vertical about Carlisle, which is in opposition to the general tenor of the rest of the observations.

As for the heights of the streamers or vertical beams seen low in the north, we have no sufficient data for determining it. But it is evident that the beams which were seen low at Edinburgh were the same as those seen still lower at Cockermouth, Kendal, Lancaster, and Manchester, at which last place the angle was about 10°, as my informant says. Now an object elevated about 25° from the north at Edinburgh would apparently be 10° or 12° at Manchester, if its real height were about one hundred miles above the earth's surface.

On the whole, I think it is fairly to be inferred that the height of the arch could not differ much from one hundred miles; and that its breadth would be eight or nine miles, and its visible length in an east and west direction, from any one place, would be about 550 miles.

Observations on other Auroræ.

The height of a luminous arch calculated by the late Mr. Cavendish, F.R.S. in the Phil. Trans. for 1790, is entitled to notice. It was found to be betwixt fifty-two and seventy-one miles. The observations, however, were made at too small a distance from each other to admit of precision. A base of at least forty or fifty miles seems necessary, where the object to be measured is generally neither steady nor well-defined.

The luminous arch seen at Keswick and Kendal by Mr. Crosthwaite and myself, on February 15th, 1793, was calculated to be 150 miles high; but this was from a base of only twenty-two miles. (See my Meteorological Observations and Essays, page 69.)

Dr. Thomson has given a brief history of the Aurora borealis in the Annals of Philosophy for 1814, vol. iv. He has copied a table from Bergman, being estimates of the heights of about thirty auroræ observed during the last century, calculated from observations made by different persons in various places. According to these results, the auroræ would seem to be of variable heights, from 130 to 1000 or more miles. The places of observation are often unsuitably situated; and the data from which the calculations were made not being given, I apprehend the great differences in the heights arise more from defects in the observations than from real differences.

In the same volume Mr. Longmire gives a description of a luminous arch seen at Troutbeck near Kendal, on the 11th of September, 1814. It was similar to that above described, and was most extensively seen: namely, at Glasgow, Dumfries, and Annan in Scotland; at Dublin and Newry in Ireland; and at Whitehaven, Carlisle, Kendal, Lancaster, Warrington, and Liverpool in England. It was accompanied with the usual appearances of the aurora borealis, or streamers distant in the north. The observations are insufficient for calculating the height. I find in my journal the aurora was noticed at Manchester that evening, but no particulars are given. Mr. Longmire mentions a similar arch seen at Kendal and Dublin on the 17th of April the same year. An aurora was seen in London at the same time. (Annals of Phil. vol. iii. p. 400.)

1819, October 17th.—A remarkable aurora borealis was seen this evening in very distant parts of England and Scotland. Mr. Otley of Keswick first drew my attention to this, by communicating the notes he made at the time upon it, on the occasion when he favoured me with his remarks upon that of the 29th of March, 1826. After which I collected such other accounts as I could meet with from the journals of the time. The series of observations is as follows:—

Annals of Philosophy, vol. xiv. p. 472. Account from Newton-Stewart, (Scotland,) October 18th.—"A singular and beautiful phænomenon appeared in our atmosphere here last night (17th), about 8 o'clock: it was a bow or arch of silvery light stretching from east to west, and intersecting the hemisphere [meridian] at a few degrees to the southward of the zenith. After it had remained very bright for twenty minutes or so, dark blanks were first observed to take place here and there, and then, after expanding a little in breadth and shifting for a short way further to the southward, it disappeared. Some time before its appearance the atmosphere had been very cloudy; but when it was formed the sky was free from clouds, except towards the horizon to the westward and northward, where they hung very dark and heavy.—It was strikingly different from any of the usual forms of the boreal lights, which too were seen very vivid in the course of the evening."

Keswick.—Mr. Otley's account:—"About 7 P.M. (the 17th), a dense cloud appeared in the horizon to the N.N.W. bounded by a bright line, the rest of the heavens being starry. Presently beams of an aurora began to shoot towards the Great Bear. About 8 o'clock a luminous arch extended from west to east, the crown of the arch at first appeared to me a little to the north of the zenith, and after some time to the south of it, and again more northerly before it disappeared, which it did suddenly, a few minutes after 9 o'clock."

Manchester.—I have an account in my journal of an aurora seen here the same evening, but no particulars are given.

London.

London.—The aurora was seen in and about London the same evening. (See pages 478 and 480, vol. xiv. Annals of Philosophy.)

Gosport.—In the same volume of Annals, page 395, there is an account of the same aurora as seen at Gosport Observatory, Hampshire, on that evening, by Dr. Burney. The following is an extract: "On the 17th instant, at 7 P.M. a light about 30° on either side of the magnetic north point appeared in the shape of a luminous arch whose apex was 18° above the horizon." He then describes several beams of the common aurora which successively appeared and traversed about for a time chiefly within the arch, and then vanished and were succeeded by others. After which, he adds: "Soon after this (9 o'clock) the luminous arch in the northern hemisphere entirely disappeared, and some haze collected near the horizon."

Gosport and Keswick are very nearly under the same magnetic meridian, and 265 miles distant. Newton-Stewart is N.W. by W. of Keswick, distant about sixty-five miles, but only thirty-five miles in a meridional direction. Now I imagine it will be allowed that an extraordinary luminous arch seen at Newton-Stewart to cross the meridian a few degrees south of the zenith, and to continue from 8 to near 9 o'clock, nearly in that position, must have been the arch seen at Keswick at the same time to cross the meridian in like manner from east to west, and to pass nearly through the zenith. It may well be supposed, then, that this arch crossing through the zenith at Keswick would have a very diminished altitude if seen at Gosport, 265 miles south. From the account I have extracted, it appears that a luminous arch was seen there at the same time it was seen at the other places, and crossing the meridian at right angles, only its altitude 18° from the north, instead of being in the zenith, as at Keswick, or a few degrees south of it, as seen in Scotland. And further, the arch vanished at all the places at the same time. It scarcely admits of doubt, then, that these arches were all one and the same. By calculation from the data at Gosport and Keswick, I find the height of the arch above Keswick to be 100 or 102 miles; from which the angle of elevation from Newton-Stewart must have been 71° from the south, or the zenith distance of the arch 19°.

A luminous arch was seen at Kendal on the 27th of December 1827, of which my friend Samuel Marshall was so good as to write me a circumstantial account. It was first seen at ten minutes past 6 in the evening, being an arch between the magnetic east and west, and passing through the zenith. It

was

was broadest in the zenith, and it was more condensed in the eastern extremity than in the western. Another parallel arch appeared about 20° north of the former, of rather less intense light; and the northern horizon was luminous as usual on such occasions. After ten minutes or more, the arches advanced each of them to the south 20° with their centres. The appearance lasted about half an hour. A few streamers were seen in the east, which moved slowly northward. Mr. Marshall thinks the appearance would have been splendid if the moon had not shone at the time: a halo round the moon vanished when the bow approached it. I observed a halo round the moon at Manchester that evening.

Mr. Buchan, a gentleman accustomed to meteorological observations, had mentioned his having seen a similar arch at Manchester on that evening; but apprehending it might only have been a local phænomenon, I did not inquire particulars till I received the above account from Kendal. Mr. Buchan informs me he saw a luminous arch that evening, about nine o'clock; the arch was highest to the west of the meridian, and its altitude was very nearly the same as the north pole, just under which it passed; he estimates it at 53°, and thinks it could not be above 1° more or less. As this observation was not contemporary with that at Kendal, nothing certain can be deduced from them; but it may not be amiss to observe that an object in the zenith at Kendal, and elevated 53° from the north at Manchester, must be nearly one hundred miles high.

The results of this series of additional observations agreeing so nearly with that of the 29th of March 1826, I am induced to believe that these luminous arches of the aurora which occasionally appear, stretching from east to west, are all of the same height, and that height about one hundred miles. What length the upright beams,—or to speak more properly, those parallel to the dipping needle,—may be, which are the ordinary forms of the aurora, we have not observations to determine. Whether those beams arise above the arches, as from a base, or whether they descend below, as if appended to the arches, we cannot absolutely determine. It is remarkable that the arches and beams should rarely, if ever, be seen cognate or in juxta position, but always in parts of the heavens at a considerable distance from each other.

Manchester, March 18, 1828.

P.S.—Query, Are the parallel bands usually about 20 degrees asunder? If so, their distance from each other will be about thirty-six miles.

LXX. *On*

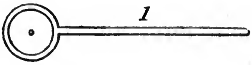
LXX. *On the Fitting-up of Microscopes for the Examination of Opaque Objects requiring high powers; and on the Construction of a Focimeter.* *By Mr.* G. Dakin.

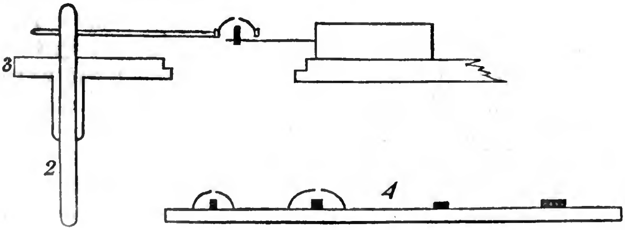
To the Editors of the Philosophical Magazine and Annals.

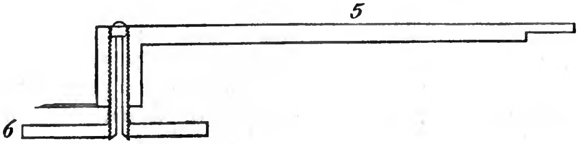
Gentlemen,

As microscopes are now fitted up by the opticians, a numerous and beautiful class of objects is entirely lost to observers; viz. those opaque objects which require a high power. My single microscope, which I had purposely fitted up with the highest powers both opaque and transparent, is almost useless for this purpose, as the highest opaque eye-piece is 1-6th of an inch focus. I have seen the scales of the diamond-beetle as an opaque object through a lens which I think Dr. Goring said was 1-60th of an inch focus. He has certainly carried it quite to the maximum, as there was rather a want of light and distinctness, which I attribute in a great measure to the best part of the speculum being lost by the introduction of the deep convex cup which holds the lens; nevertheless the beautiful lines on the scales were plainly to be seen, even with this high power. I have made the whole of my transparent eye-pieces answer as opaque ones, in which the lenses are placed on the *outsides* of the speculums; consequently the whole of the central and best part of the speculum is brought into action. Opticians seem to forget that the light which is thrown on the speculum is already condensed, and that such large ones are not necessary, unless it be to compensate for the clumsy manner in which they generally fit up the opaque slides. Objects of this sort ought to be fixed on small cylinders of jet or ebony, and these glued on slips of glass: by this means little or no light is lost. The speculums I made were about $\frac{1}{2}$, $\frac{3}{8}$, $\frac{1}{4}$, $\frac{1}{6}$, and $\frac{1}{8}$th of an inch diameter: they should be fitted into a brass ring (fig. 1.), to which should be soldered a piece of wire, fitting a hole in a larger piece of wire (fig. 2.), which should slide easily through the stage (fig. 3.); or they may be laid on the slips of glass over the objects (fig. 4.), provided the cylinders are adjusted to bring the objects into the focus of the speculums. When the highest powers are used, take a very small piece of the object and lay it on a small cylinder, which must have a fine hole in the side, for the purpose of fixing it on the point of a fine needle; place the object in the centre of the stage, and bring the speculum down so as to illuminate the object as much as possible. The eye-piece must then be brought down close to the hole in the speculum, the eye being now placed in its right position. The eye-piece may be raised to its true focal distance; this will prevent the lenses being injured by coming in contact with the speculum.

The highest power in my microscope is about 1-46th inch focus; but a lens of 1-30th inch focus may be used by a novice with ease and very great advantage, and the object will be as well illuminated as by one of the large speculums. As they are very easily made, I shall describe the method of making a 1-4th inch one. Melt a little fine silver by the blow-pipe into a globule about 1-10th of an inch diameter; hammer it out till it is full 1-4th inch wide, and as thick as stout fools-cap paper: take a piece of brass wire, barely 1-4th inch thick, and file one end of it hemispherically; then lay the silver on a piece of lead about 1-4th inch thick. Hollow the silver to the shape of the wire, and then drive it quite through the lead, turning the wire at the same time: make a small hole in the centre, and fix it on the end of a stick of sealing-wax; then file a piece of slate-pencil, barely 1-4th inch diameter, to fit the silver cup, and grind them together with fine emery, till it is of a uniform figure quite over the surface; then wash the emery off, and grind the scratches out with the pencil, washing the mud away with clear water. To polish it, cover the pencil with thin silk, rub a little tallow and jeweller's rouge on the silk, and work them together till the speculum is beautifully polished.







I strongly suspect that the focal distances of lenses are generally

nerally underrated by opticians. To prove mine, I made what may be called a Focimeter. It consists of a flat piece of brass, which fixes on the arm of the microscope (fig. 5.); at the end is a female screw that has exactly fifty threads to the inch, to which is fitted a male screw about half an inch long, with a hole drilled quite through it, and a large ivory head (fig. 6.), with twenty divisions fixed on its lower end; consequently one division on the head is equal to the 1-1000dth of an inch. After the end of the screw and the brass plate are ground together on a flat hone, there must be glued over the hole in the male screw, a small piece of the outer membrane of the eye of the *Libellula grandis*, and a piece of very thin foil with a small hole in its centre laid over the female screw. When used, fix it to the arm of the microscope, and throw the light up the hole by the mirror; lay the highest power on the foil, turn the screw up till it just touches the foil, and set down the number of turns and divisions that it takes to bring the object down to the focus of the lens.

Proceed in the same manner with the rest of the powers; they may then be easily reduced to the nearest fraction having one for a numerator: by this means I found that my highest power, which I considered 1-60th of an inch focus, was only 1-46th inch focus, and the rest in proportion. I have made a double convex lens, which is the smallest I have ever seen, and is only 1-100dth inch focus, as it took but half a turn of the screw to bring the object down to the focus. The thickness of the foil may be neglected even in the highest powers; as it does not amount to the 1-1000dth of an inch.

Dr. Goring uses the scales of the *Lepidoptera* as test-objects: but the most beautiful and delicate test-objects that I have ever seen are the scales of the *Lepisma saccharina;* they are so very thin, and the lines upon them are so very fine, that they will bear almost any power. The beautiful green convex scales of the small English diamond-beetle, which is very common in the summer months, is a very good opaque test-object.

The focal distance of large lenses for telescopes, &c. is reckoned from the centre of the body of the lens (under half an inch focus); but in my opinion the focus of microscopic lenses ought to be computed from the surface next the radiant object, otherwise another operation is necessary; viz. taking the thickness of the lens and adding half of it to the focal distance: but as small lenses are so very apt to be lost or cracked, it is much safer and better to reckon from the surface.

I beg to remain yours, &c.

Ninesham, Oct. 23, 1828. G. DAKIN.

LXXI. *On*

LXXI. *On the Method in the Trigonometrical Survey for finding the Difference of Longitude of two Stations very little different in Latitude.* *By* J. IVORY, *Esq. M.A. F.R.S. &c.**

IN this Journal for October last, I endeavoured to prove that the method in the Trigonometrical Survey for finding the difference of longitude of two stations, not much different in latitude, was insufficient, and led to erroneous results. The principle of the method is this, That the latitudes being the same, the difference of longitude is independent of the excentricity, or it is the same on the surface of a sphere and a spheroid of small oblateness; which, in reality, is consistent neither with experience, nor with other methods of investigation of undoubted accuracy. We are told indeed, that the incorrectness of the method, and its want of success in practice, is now allowed on all hands; but the date at which the delusion was dissipated is not mentioned. As my intention was merely to overturn an insufficient method of calculation, not to establish a new rule, I neglected such small quantities as could not be distinguished from the unavoidable errors of observation. Thus the small quantity in the value of β, which I neglected (p. 243), would be produced by a small variation in the length of the chord γ, amounting to about 18 feet in the distance between Beachy Head and Dunnose, more than 65 miles. Assuredly a method of calculation which requires such nice accuracy in the data of observation is not a very solid foundation on which to place any conclusion respecting the figure of the earth. There is also an omission in the equations (x) (p. 243), arising from supposing $R = a$ (p. 242), which, however, will affect the azimuths only a small fraction of a second in the ordinary circumstances of the problem; that is, when one azimuth is greater, and the other less, than 90°. In the extreme case, of which there is no instance that I know of, when the azimuths are both less than 90°, and nearly equal, the last-mentioned omission will affect the accuracy of my formula, because the quantity neglected does not vanish when the two latitudes become equal. There is, however, no doubt that, in the ordinary circumstances of the problem, my method, which takes the excentricity into account, comes nearer the truth than the method in the Survey, which entirely neglects the figure of the earth; and this seemed sufficient to answer my purpose. But it is not easy to put down an authorized error; although I shall now attempt to accomplish this task by new investigations, to which it will be impossible to object.

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* Communicated by the Author.

Using

Using the same symbols as in this Journal for October, the two following equations, which are rigorously exact, contain the full solution of this problem; viz.

$$\left.\begin{array}{l}\Delta = \sqrt{1-e^2\sin^2\lambda},\ \Delta' = \sqrt{1-e^2\sin^2\lambda'},\ Q = \dfrac{\sin\lambda}{\Delta} - \dfrac{\sin\lambda'}{\Delta'},\\[2ex] \dfrac{\sin\omega}{\tan m} + \cos\omega\ \sin\lambda - \cos\lambda\ \tan\lambda' = \dfrac{\cos\lambda}{\cos\lambda'}\cdot e^2\,\Delta'\,Q\\[2ex] \dfrac{\sin\omega}{\tan m'} + \cos\omega\,\sin\lambda' - \cos\lambda'\tan\lambda = -\dfrac{\cos\lambda'}{\cos\lambda}\cdot e^2\,\Delta\,Q\end{array}\right\}\text{(A)}$$

These equations express the condition that two vertical planes, one at each station, intersect in the chord joining the stations. As the investigation is merely elementary, it may be omitted. The two equations, although very simple, are alone sufficient for the solution of the problem, since the excentricity and the difference of longitude are the only unknown quantities they contain. In order to simplify, I shall put $x = \sin\lambda - \sin\lambda'$; and I shall write $\frac{\cos\lambda}{\cos\lambda'}\cdot e^2 x$ and $\frac{\cos\lambda'}{\cos\lambda}\cdot e^2 x$, for the quantities on the right-hand sides. The equations coincide with the surface of a sphere when $e^2 = 0$, and when $x = 0$; and as x is always very small in the practical application of the problem, it is with difficulty that the quantities on the right-hand sides enable us to distinguish between the sphere and a spheroid of small oblateness. It is here indeed that the difficulty of the problem lies; and it will easily be conceived that, without nice discrimination, one case is apt to be confounded with the other, as it actually is in the method of the Trigonometrical Survey. In order to solve the equations so as to give full effect to the excentricity of the spheroid, it would be requisite to free them from the almost evanescent factor x; but this is what I shall not at present attempt to accomplish. As I write in haste, I shall not inquire how the value of the excentricity is to be deduced, but shall confine my attention to the difference of longitude, supposing that the observations have been made upon a spheroid of a known figure.

The two equations may be brought to a form fit for calculation by the following transformation: viz.

$$\left.\begin{array}{l}\tan u = -\dfrac{1}{\sin\lambda\tan m},\quad \tan u' = \dfrac{1}{\sin\lambda'\tan m'},\\[2ex] \dfrac{\cos(u+\omega)}{\cos u} = \dfrac{\tan\lambda'}{\tan\lambda}\left(1+\dfrac{e^2 x}{\sin\lambda'}\right),\\[2ex] \dfrac{\cos(u'-\omega)}{\cos u'} = \dfrac{\tan\lambda}{\tan\lambda'}\left(1-\dfrac{e^2 x}{\sin\lambda}\right).\end{array}\right\}\text{(B)}$$

With

With the data at Beachy Head and Dunnose, and making $\frac{e^2}{2} = \cdot 00324$, I have deduced these values of ω, viz.

$$\begin{array}{l} \omega = 1^\circ\ 26'\ 58''\cdot 3 \\ \omega = 1\ \ \ 27\ \ \ 0\ \cdot 8 \end{array}$$

These results approach near the true quantity, but they do not agree, which shows that there is some inconsistency in the observed quantities. If we add $0''\cdot 6$ to the difference of latitude, the formulas will give results very nearly equal to one another and to the true quantity. Thus, making

$$\begin{array}{l} \lambda = 50^\circ\ \ 44'\ \ 21''\cdot 3 \\ \lambda' = 50\ \ \ \ 37\ \ \ \ 4\ \cdot 7, \end{array}$$

I have found

$$\begin{array}{l} \omega = 1\ \ \ 27\ \ \ 3\ \cdot 8 \\ \omega = 1\ \ \ 27\ \ \ 7\ \cdot 2, \end{array}$$

and the mean of these values almost coincides with the exact quantity.

What has now been said is decisive of this question. The equations to which the problem has been reduced, which are rigorously exact, prove that the excentricity has an influence on the difference of longitude, however minute that difference may be, and however difficult to bring it to an exact valuation. The investigation we have employed is drawn from the principles of elementary geometry. We have advanced no vague reasoning about the well-known properties of spheroidical triangles and geodetical lines, in a case where, in fact, there is neither any such triangle nor any such line.

If we combine the two equations (A) so as to exterminate the excentricity, we shall obtain the following equation; viz.

$$0 = \sin\omega\left(\frac{\cos\lambda'}{\cos\lambda\tan m} + \frac{\cos\lambda}{\cos\lambda'\tan m'}\right)$$
$$+ \cos\omega\,(\cos\lambda'\tan\lambda + \cos\lambda\tan\lambda') - (\sin\lambda + \sin\lambda').$$

Here, then, we have an equation which is independent of the excentricity, and which therefore expresses a property common to the sphere and to any spheroid. But if any one should imagine that, now certainly by this exact equation, the difference of longitude may be found independently of the excentricity, he is advised to consider well the principles on which he proceeds before he begins to calculate, lest he should lose his labour.

Dr. Tiarks has treated of this subject in the last Number of this Journal. He is fortunate enough to take the right side of the question, standing forth as the champion of the method in the Survey. But he has entirely mistaken the nature of the problem and the difficulties that must be overcome in solving it.

it. There is no spheroidical triangle; there is no geodetical line. The data consist of the latitudes, nearly equal, and the azimuths, of two distant stations, yet sufficiently near for one to be seen from the other. Now in the case of such distant stations, the observed azimuths are not the same with the azimuths in an imaginary geodetical line passing through the stations. In this, and in other respects, there is great want of precision and geometrical rigour in Dr. Tiarks' argumentation. He has, in fact, brought forward nothing new either in proof, or in elucidation of the problem of which he treats; he has merely added the name of Dr. Tiarks to the other authorities that have upheld the correctness of the method of calculation in the Survey, which it is, nevertheless, just to characterize as the greatest delusion that has ever prevailed in practical mathematics. I can add nothing more on this subject at present; but on another occasion I will give another solution of the same problem, more nearly allied in point of form to the speculations of Dr. Tiarks, which will enable us better to appreciate their merits. When the principles of the problem are fully unfolded, we may then discuss the question, Whether the calculations in the Survey are correct or not?

Nov. 1828. J. IVORY.

LXXII. *Notice of the Geological Features of a Route from Madras to Bellary, in April and May* 1822. *By Captain* W. CULLEN, *of the East India Company's Artillery service.*

[Concluded from p. 363.]

THERE are two instances of the occurrence of a rather remarkable variety of quartzose rock in the course of the preceding route, which have not been yet noticed, because it differed very sensibly from any of the others, both in its colour and composition, and appeared likewise to be altogether independent of them. The first occurred on the west side of the pass between Baukrapett and Cuddapah, occupying about one mile of the route, and appearing to constitute the hills on both sides. The lower end of the line of hills, crossed three or four miles before reaching Nundialpett, were composed of rock precisely similar, and were, I imagine, merely a continuation of those forming the pass. I do not recollect any appearances of stratification in either case, although the course of the range was conformable to the general direction. Perhaps this rock rested on clay-slate, and may be considered as merely one of those transitions, formerly alluded to, from sandstone

stone to quartz*. All the hills on the right of the road from Chinoor towards Nundialpett exhibited parallel lines on their slope, similar to those of clay-slate formerly adverted to.

The second variety occurred four or five miles north of Poornamila, distinctly interstratified with clay-slate. Immediately on leaving that village, a low but very extensive and sharp ridge is observed to issue from the eastern boundary of the Poornamila plains, and crossing the road obliquely, to enter the clay-slate range forming the western boundary of the valley, which extends by Alinuggur towards Cummum.

This low range is very conspicuous, being at least six or eight miles in length, and running directly across the north-east portion of the plain. The high road lies immediately over it, near its western extremity. The rocks, in this instance, were distinctly stratified, and formed the crest on the centre of the ridge, bounded on both sides by clay-slate of a brownish gray colour and silky lustre.

I do not observe that I have any specimens of the quartz rock forming the west side of the pass to Cuddapah, but externally it resembles the specimens from Nundialpett. This latter was internally of a dark bluish gray colour, with rather a granular appearance, and having small earthy specks of a rusty brown, sparingly dispersed through it. The second variety in the ridge north of Poornamila appeared to be composed of similar ingredients, but the earthy specks in much greater quantity, and giving a decided colour to the rock. It contains also a few distinct crystals of a black or deep red colour, which appear to be garnets, and which may explain the nature of the rusty specks.

No limestone of any consequence was observed before reaching Wuntimettah, although calcareous depositions are to be met with; such as a white tufa in wells between Codoor and Pollumpettah, occasional traces of marl, and a singular reddish coloured limestone, or marl conglomerate, near Rajampett, between Pollumpettah and Nundaloor.

From the similarity of colour in the clay-slate, flinty-slate, and calcareous schistus, it is not improbable, however, that I may have occasionally been mistaken in my judgement as to their nature in the early part of my march, and even when

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* I have since visited the inner range of hills near Cuddapah, running north-west from the pass. They consist of sandstone; towards their base rather coarse grained and dark coloured, but on the summit extremely compact and of a light colour, and giving the hills much of the appearance of quartz. This upper portion is very like the variety alluded to near Nundialpett, but wanted the rusty specks.

better acquainted with them; for their resemblance is sometimes so strong as to render recourse to a test absolutely necessary; an operation which would have occupied too much time to be constantly put in practice while actually on route.

An old pagoda at Wuntimettah is built of a dark blue limestone, of a fine and close texture, taking a good polish, and altogether a handsome, though rather a brittle building material. Some of the blocks were varied with shades of gray or white. Stratified masses of this limestone cross the road in great abundance for the first five miles, as far as the village of Baukrapett, from whence commences a considerable ascent, leading through the clay-slate range which forms the eastern boundary to the low and extensive flat country of the district of Cuddapah.

The deep covering of soil on the plains on the west side of this range concealed all traces of rocks; but the same dark blue limestone appeared to be the universal building material at Cuddapah, and must doubtless have been procured close at hand, although I did not myself meet with any quarries in the immediate vicinity. Varieties of this limestone were, however, common during all the rest of my progress to the north; although latterly, that is to say, after passing Poornamila, it altered considerably in its colour as well as in its texture, becoming more granular and crystalline, as well as of a light gray colour.

Calc-tufa, marls, and conglomerates were in great abundance from the first appearance of the regularly stratified limestone, in distinct depositions of considerable extent, as well as filling the seams of the clay-slate, particularly in the green variety near and subsequent to Poornamila. The red coloured, porphyritic-like limestone, which I have mentioned as occurring first near Rajampett, was met with frequently afterwards in the defile between Nundaloor and Wuntimettah, on entering the plains of the Saghilair, between Poornamila and Alinuggur, &c., and always in horizontal masses of very considerable extent, and from one and a half to two or three feet thick. Schist was generally found immediately below, and its seams filled with depositions of the same nature.

This conglomerate is composed principally of spherical nodules of a kind of calc spar of a dull reddish colour, from one-tenth to five- or six-tenths of an inch diameter, in an earthy basis of a light brown; small angular particles of quartz are also sparingly dispersed through it. This conglomerate is extremely hard, but not always compact, having frequently numerous vesicular cavities.

At Cuddapah I first noticed a very singular variety of calc-tufa

tufa in nodules, or blocks, of from six to eighteen inches diameter, extremely hard, and of a dirty white or gray colour, as if from an intermixture of clay. They were very vesicular internally, and externally covered with hard, knotty, irregular-shaped protuberances, which were of a size proportionate with that of their respective nuclei. They were used, loosely piled together, to form inclosures.

This variety of calc-tufa was met with frequently afterwards, and in great abundance; but I never had a good opportunity of examining it *in situ.*

In the banks of a nulla between Cuddapah and Chinnoor, as also in the bank of the Pennar at the latter village, I had a transient view of it in the mass; and it there appeared to form a horizontal stratum of two or three feet in thickness, a few feet below the surface.

Flinty slate and hornstone still remain for notice. I have mentioned the appearance of the latter at Curcumbaddy, in contact with the clay-slate; and the only recurrence of it that I recollect, possessing decidedly the character of that rock, was at the village of Yenapilla, three or four miles south-east of Nundaloor, where it appeared in large globular blocks, very much intersected by veins of quartz, over a space of four or five square miles. The flinty slate was much more abundant, being found interstratified with the clay-slate almost every march from Curcumbaddy to Wuntimettah.

The colour and texture of the hornstone were generally very uniform in each situation; but the flinty slate was frequently very much veined with different shades of gray or blue. The strata were sometimes, however, perfectly uniform in their colour, being occasionally of a dark blue, at other times of a light gray, and externally strongly resembling the dark blue limestone of the district of Cuddapah.

These were the principal rocks that occurred in the clay-slate of the second division.

Besides varieties of all the rocks hitherto enumerated, several others will be found amongst the specimens forwarded, which the limits proposed for this paper will not admit of describing at present.

The third division, or compact blue limestone, will easily be disposed of, as it occupies the whole of the flat country, extending from the Nulla Mulla range to Banaganapilly, to the exclusion of every other rock. Its texture within this tract was tolerably uniform, but it exhibited a considerable variety of colour; near the Nulla Mulla hills it was generally of a dull lead gray, and this variety, on fracture, presented a foliated appearance; about Jellila, and particularly in the bed

of

of the nulla at Tungtoor, where it was quarried for building, the limestone was of a dull brick red, and frequently also variegated with stripes and shades of a light gray or white.

In approaching Banaganapilly, and all about that town, the limestone was in great abundance, and its colour blue of different shades, but chiefly dark. The deposition of soil on these plains afforded only a few opportunities of examining the limestone; but, where visible, the strata seemed to be *nearly horizontal.* These varieties, especially the last, were very compact and fine grained, and with rather a conchoidal fracture. The fine village of Banaganapilly, and the celebrated diamond deposit, is situated near the base of a low range of tabular land, running about north and south, and forming the western boundary of the great limestone field just described. The range is here abrupt and precipitous, and very irregular and broken in its outline, running out into headlands, as well as having deep narrow valleys penetrating far within it to the westward.

Banaganapilly lies under the point of one of these promontories, which projects five or six miles from the main range. These hilly tracts form the fourth division, or second of clay-slate, but, perhaps, do not terminate that of the limestone; for, although the depth of alluvium in this narrow valley is so great as to conceal all rocky strata, yet, from the numerous nodules of limestone on the surface, and the amazing depth and extent of the depositions of calcareous tufa, and the reappearance of strata of limestone some miles east of Jeldroogum, which then continue, with little interruption, even on to the table land three or four miles west of that village, it is not improbable that a connection subsists throughout. With exception of the cap, which is of sandstone, and which has already been adverted to, the whole mass of land forming the right hand boundary of the valley commencing near Banaganapilly, and extending to Jeldroogum, appears to consist of clay-slate nearly to the summit. There appeared to be table land also to the left, or south, and which, I imagine, also to be covered with sandstone (the Banaganapilly promontory I ascertained to be so, by ascending three or four miles to the west); but the immediate boundary of the valley on this side, although, like the former, composed of clay-slate, instead of a sandstone cap, was crested in its whole length with a sharp black ridge of trap rock, formed of loose blocks piled upon each other.

The apparent base of the trap observed a pretty uniform level; nor was the ridge of much depth, the peaks, merely by rising somewhat higher occasionally, giving the bed an appearance of greater dimension. Its extreme narrowness, deep black colour, and the total absence of all traces of vegetation, formed a singular contrast to the rest of the hills, which were covered with long dry grass, and scattered jungle bushes. The connection of this singular bed of trap with the rocks at its two extremities, would probably offer a most instructive subject of investigation.

At the end, near Banaganapilly, it first offers itself to notice in a small, steep, conical hill, composed solely of green-stone. I had previously, however, immediately almost on leaving Banaganapilly, observed several partial appearances of lines of black rock, jutting out a few feet above the soil, in the plain on the north side of and near the base of the Banaganapilly promontory. These, I have now little doubt, were a continuation of the green-stone bed. But it is at the western extremity at the head of the valley, close to Jeldroogum, where the hills close in on all sides, and where the route is crossed by the bed of trap, and all the rocks with which it is associated, that the attention is most forcibly excited. About one-half or one-third of a mile west of Jeldroogum the route lies over a ghaut, or ridge, of 300 or 350 feet perpendicular height, and, descending nearly as much on the opposite side, continues up a pretty level narrow valley for a mile or two, and then finally leads up another ghaut, of about the same height, on to a continuous table land, extending to Piaplee.

Blocks of limestone, of a light blue or gray colour, are common in the interval between Jeldroogum and the ghaut; but the low hills, forming the foot of the ghaut, were covered with large dark masses of rock, which I had imagined to be trap, but which, on examination, also proved to be limestone of a very dark blue. Limestones of other colours were also found intermixed, such as green, gray, &c.; the former on fracture, at a little distance, resembling a good deal a fine-grained green-stone; but the whole of these were covered with a dark crust of clay-slate, so that, unless close to them, it was not easy to distinguish the line of separation between the limestone and trap, which was the next in the order of succession, and at only a short distance from the foot.

The trap was again succeeded by limestone, and the latter by clay-slate, nearly to the summit, which was capped with rock of a beautiful flesh colour, with specks and shades of a delicate green, as if connected with its vicinity to the trap, and of so close and fine a texture as to appear homogeneous even through a lens. It exhibited a conchoidal fracture. The descent of the ghaut on the opposite side consisted of clay-slate nearly to the foot, when the limestone reappeared, and these two rocks then continued to alternate with each other to the foot of the second ghaut, which, like all the former, was composed of clay-slate, capped with quartzose sandstone. Limestone of a yellowish white colour was found in considerable quantity near the top of the ghaut. This high land appears to extend far to the north and south, and uninterrupted by hills; but on the west side, at the distance of three or four miles, was bounded by a chain of hills, running also nearly north and south, and marking the termination of the second tract of clay-slate. This line of hills appeared to be composed of clay-slate and the quartz sandstone, but neither of them exhibiting, at a distance, those distinct stratified appearances hitherto so common. The route lies over a low part of the chain, and almost immediately afterwards all traces of clay-slate disappear. The last rock, connected apparently with that formation, was a sandstone conglomerate, precisely similar to those singular nodules picked up between Naggery and Pootoor, and which here constituted two or three entire hills. Close to the road, a small open space of level ground, not more than three hundred yards wide, separated them from another small group of hills composed wholly of granite.

From this point commences the fifth, or granite division, the rocks prevailing, I believe, over the whole remaining interval to Bellary. I can, however, only speak with perfect certainty of the first fifteen or twenty miles, and of the last eight, having passed over the remaining part at night. The trap dykes, holding their usual course, were very common during the first-mentioned portion of granite.

Regarding the œconomical purposes to which the several rocks met with in the course of the foregoing route might be applied, I believe I shall best consult the pleasure of the Society in simply referring to the specimens which have been forwarded. These, although individually extremely small, may enable persons better acquainted with the subject than myself, to form a judgement of the probable degree of their utility. The principal rocks, granite, trap, sandstone, schistus, and limestone, were, it will have been observed, in great abundance, and in considerable variety, even on the high road; but a little inquiry would probably discover numerous other varieties, more useful, as well as more ornamental. The limestone particularly, of which there would appear to be a great variety, in colour as well as texture, from its facilities of working, would seem to merit some attention. I have seen some very handsome tablets of black or dark blue limestone from Kurnool. It has already been noticed, that the whole of the plain between the meridians of Kurnool and Cummum, and from the

the Kistnah to the Pennar, is composed of that rock. Some of the limestones, or marbles, may prove to possess that peculiar combination of clay, silica, and carbonate of lime, which is found to afford those valuable cements having the property of setting under water. Major De Haviland, of the Engineers, had, I believe, already directed his attention to the discovery of such varieties.

From my imperfect acquaintance with the subject, I am aware, that in the above summary of the situations of the rocks over so great a space, I must necessarily have omitted noticing many circumstances which it would have been of consequence to record; but daily marches of from fifteen to twenty miles in the hottest season of the year, may of themselves be deemed an apology for those, as well as other inaccuracies that may, perhaps, hereafter be discovered. I have, however, endeavoured to be faithful in my narrative of facts; and as such, in the present limited state of published information on these subjects in this country, they will, I trust, be received with indulgence.

W. Cullen,
Captain of Artillery.

Bellary, May 1823.

The altitudes, in the section which accompanies this paper, are deduced from barometrical observations, regularly made throughout the march. Observations of the maximum and minimum heights of the column of mercury were taken daily at each stage, and the mean of these was generally used in the calculations. Corresponding observations were obligingly furnished to me by Mr. Goldingham from the observatory; from a comparison with which, and with another series of observations made by Major Beckett at Bellary, the altitudes of the several stations have been determined.

In former instances, most of the approximate altitudes which I have had opportunities of ascertaining in different parts of the peninsula, have been deduced solely from my own observations, a mode originating in some degree in necessity, and subsequently adhered to, partly from the same cause, but partly also from choice, from a desire to ascertain how far such approximations might be depended upon.

Few or no barometrical observations were at that period regularly made at any of the inland stations under this Presidency; and the stations where such records were kept were so remote from each other, as well as from my routes, as to occasion frequently very great differences in the altitudes derived from them.

I proposed accompanying this paper with a copy of my own barometrical observations, as well as of the corresponding ones

ones at Madras and Bellary, with the several altitudes deduced from them; but I have not been able to accomplish my intention.

Colonel Lambton's base line near Gooty is nearly 1200 feet above the sea, and he assumed this as the mean altitude of the interval between that station and Bellary; an inference to which he was perhaps led by the plain, open appearance of the intermediate country. The barometer, however, stood on the 2d June at

Guddicul,	28600 m.	99°	Goontacul,	28528 m.	91°
	29920	92½		29910	87

Feet.
making Guddicul 1420 } nearly above the sea.
Goontacul 1479 }

Madras, July 1823. **W. Cullen.**

Although the section referred to above, is not given in the Madras Transactions, we have thought it right not to suppress the Postscript, in which some of the altitudes in question are stated.—Edit.

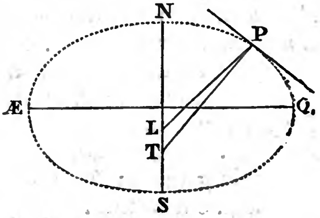
LXXIII. *On the Figure of the Earth.* *By* S. Sharpe, *Esq. F.G.S.*[*]

MOST of the investigations into the figure of the earth have been on the supposition that its section through the poles were an ellipse, which, however, several mathematicians have shown not to be exactly true.

Thomas Simpson has shown, that in an elliptical globe, with a given axis major, and a given period of rotation on its axis minor, its ellipticity is given also.

There is water enough on our earth to show that its shape is that which it would take if liquid, therefore the plumb-line is every where perpendicular to the tangent.

Let PT be perpendicular to the tangent at P on the ellipse ÆNQS: then if the earth were at rest, the plumb-line would point nearer to the centre, as PL; and the angle LPT is the measure of the centrifugal force caused by the rotation on its polar axis NS. Hence the connection between the ellipticity and velocity of rotation.



I have gone over Thomas Simpson's work, and find:

1st, If the pendulum at the equator be 39·014 inches, a

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[*] Communicated by the Author.

body falls 16·044 feet per second; not $16\frac{1}{12}$ feet, as according to Thomas Simpson,—

2dly, If the earth's equatorial radius be 20,927,442 feet; not 21,000,000,—

3rdly, If a sidereal day contain 86,164 mean solar seconds; not 86,160,—

The gravity at the equator is to the centrifugal force as 1 to $\frac{1}{288{\cdot}33}$, and the ellipticity $\frac{1}{233}$; not $\frac{1}{231}$, as according to T. Simpson: the difference is not much.

And as we know from observations with the pendulum that the ellipticity is less, the polar section of the earth is not an *exact* ellipse, and the usual reduction of the observed latitude ($\tan \lambda = (1 - e^2) \tan l$) not *strictly* correct.

Canonbury. SAMUEL SHARPE.

LXXIV. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones.* *By* J. G. CHILDREN, *F.R.S. L. & E. F.L.S. &c.*

[Continued from page 354.]

Genus 19. ZYGÆNA, *Fab.*, *Latr.*, *Hübn.*

ANTHROCERA, Scop. (Steph.)

Legs, tibiæ with short, close-set scales; the posterior with very small calcaria, or spines. (Latr.)

Wings, deflexed, (Latr.) broad; anterior generally steel-blue, with red spots; posterior generally red.

Antennæ slender at the base, thickening into an abrupt, bent fusiform club, with the apex simple; in the males robust. (Steph.)

Palpi reaching beyond the clypeus, cylindric-conic, acuminated, densely clothed with hair. (Steph.)

Antlia fine, moderately long.

Abdomen nearly cylindrical, obtuse; (Latr.) thickly clothed (as well as the *head* and *thorax*) with short silken hairs, with a few scales intermixed. (Steph.)

Flight, diurnal.

Larva, villose, fusiform, generally spotted with black on a pale ground; *head* small. (Steph.) No horn on the last segment of the body. (Latr.)

Pupa elongate. (Steph.)

Metamorphosis in the air, in a pretty solid silken cocoon, attached to the branch or leaf of a plant. (Latr.)

Obs. These insects are sluggish, and fly but little; they commonly

commonly remain on the plants on which the females deposit their eggs. Neither sex lives longer than is necessary for copulation and laying the eggs, resigning their lives as soon as those objects of their existence are accomplished.

	Species.	Icon.
1.	Z. *Erythrus*, Hübn..	Hübn. Sphing. Tab. 18. f. 87. (fœm.)
2.	— *Minos*, Hübn.....	Ernst, III. Pl. XCV. f. 133. a—d.
3.	— *Pluto*, Ochs.......	Hübn. Sphing. Tab. 18. f. 88. (mas.)
4.	— *Brizæ*, Hübn.....	Hübn. Sphing. Tab. 18. f. 85. (mas.) Tab. 2. f. 6. (fœm.)
5.	— *Scabiosæ*, Fab.....	Ernst, III. Pl. XCVI. f. 134. a—d.
6.	— *Achilleæ*, Esp.....	Ernst, III. Pl. XCIX. f. 141. a—d.
7.	— *Punctum*, Ochs....	Hübn. Sphing. Tab. 26. f. 119. (mas.)
8.	— *Sarpedon*, Hübn..	Hübn. Sphing. Tab. 2. f. 9. (mas.)
9.	— *Exulans*, Hübn..	Hübn. Sphing. Tab. 2. f. 12. (mas.) Fab. 20. f. 101. (fœm.)
10.	— *Cynaræ*, Hübn....	Hübn. Sphing. Tab. 17. f. 80. (fœm.)
11.	— *Meliloti*, Esp......	Hübn. Sphing. Tab. 17. f. 82. (mas.)
12.	— *Trifolii*, Esp......	Ernst, III. Pl. XCVII. f. 136. a—e.
13.	— *Loniceræ*, Hübn..	Hübn. Sphing. Tab. 2. f. 7. (fœm.)
14.	— *Filipendulæ*, Linn.	Ernst, III. Pl. XCVII. f. 137. a—f.
15.	— *Transalpina*, Hübn.	Hübn. Sphing. Tab. 3. f. 15. (mas.) f. 19. (fœm.)
16.	— *Medicaginis*, Hübn.	Hübn. Sphing. Tab. 4. f. 20. (mas.) ?
17.	— *Hippocrepidis*, Hübn.	Hübn. Sphing. Tab. 5. f. 32. (fœm.) Tab. 17. f. 83. (mas.)
18.	— *Angelicæ*, Ochs...	Hübn. Sphing. Tab. 26. f. 120. (mas.) f. 121. (fœm.)
19.	— *Dorycnii*, Hoffmansegg *.	
20.	— *Peucedani*, Hübn.	Ernst, III. Pl. XCVIII. f. 139. a—e.
21.	— *Ephialtes*, Linn...	Ernst, III. Pl. C. f. 144. a. b.
22.	— *Stoechadis*, Borkh.	Hübn. Sphing. Tab. 4. f. 24. (mas.)
23.	— *Lavandulæ*, Fab..	Ernst, III. Pl. CI. f. 145. a. b.
24.	— *Rhadamanthus*, Hübn.............	Hübn. Sphing. Tab. 4. f. 23. (mas.)

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* Z. alis anticis viridibus, punctis sex coccineis: posticis coccineis, margine latissimo cyaneo; abdomine cingulo suprà coccineo.—*Ochs.* II. 69.

25. Z. Ono-

	Species.	Icon.
25.	Z. *Onobrychis*, Fab.	Ernst, III. Pl. XCIX. f. 140. a—h.
26.	— *Occitanica*, de Villers	Hübn. Sphing. Tab. 22. f. 106. (mas.) 107. (fœm.)
27.	— *Fausta*, Linn.	Ernst, III. Pl. C. f. 142. c. d.
28.	— *Faustina*, Ochs.[*]	
29.	— *Hilaris*, Ochs.	Hübn. Sphing. Tab. 26. f. 123. (fœm.)
30.	— *Læta*, Hübn.	Ernst, III. Pl. C. f. 142. a. b.
31.	— *Sedi*, Fab.	Hübn. Sphing. Tab. 28. f. 132. (fœm.)

Genus 20. SYNTOMIS, *Hoffmansegg*[†], *Latr.*

AMATA, Fab.
SPHINX, Linn.
GLAUCOPES, Hübn.
ZYGÆNA, Ross.

Wings, anterior large, posterior very small; deflexed.
Antennæ filiform; (subfusiform. Latr.)
Palpi, inferior nearly cylindrical, obtuse, not reaching beyond the clypeus. (Latr.)
Abdomen cylindrical. (Latr.)

	Species.	Icon.
1.	S. *Phegea*, Linn.	Ernst, III. Pl. CII. f. 147. c. d.
2.	— *Cerbera*, Linn.[‡]	Cram. Pap. exot. Tab. 83. f. F.

Genus 21. THYRIS, *Hoffmansegg*, *Latr.*, *Hübn.*

SPHINX, Fab.

Legs hairy, spinous.
Wings divaricate, nearly horizontal, eroso-dentate, (Latr.) with white semi-transparent maculæ.
Antennæ, scarcely fusiform, nearly subsetaceous, simple; apex not tufted, (Latr.) alike in both sexes.
Palpi cylindrico-conical, the last joint nearly bare, acuminate; reaching much beyond the clypeus. (Latr.)
Abdomen conical, anus not barbate. (Latr.)
Flight, diurnal.

	Species.	Icon.
1.	T. *Fenestrina*, Fab.	Ernst, III. Pl. CXXII. f. 167. a. b.

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[*] Z. alis anticis nigro-viridibus; maculis sex rubris confluentibus luteo marginatis; posticis rubris, limbo æquali nigro; collari rubro; pedibus nigro-viridibus cinguloque abdominis rubro subtus non coeunte.—*Ochs.* II. 99.

[†] According to Latreille, this genus was established by Illiger:—*Nouv. Dict. d'Hist. Nat.* xxxii. 320.

[‡] An Europæa?—*Ochs.*

Genus 22. STYGIA, *Drap.*, *Latr*[*].

BOMBYX, Hübn.

Legs, posterior tibiæ with very distinct spines and calcaria.

Antennæ short, insensibly diminishing in size from the base to the apex, curved, covered beneath with a double row of small laminæ; apex simple.

Palpi thick, cylindrical, squamate, reaching beyond the clypeus.

Tongue obsolete, or none.

Anus barbate.

Species	Icon.
1. S. *Australis*, Drap. (Bombyx terebellum, Hübn.).	Hübn. Bombyces, Tab. 57. f. 244. (mas.)

Genus 23. SESIA, *Fab.*

ÆGERIA, Fab. TROCHILIUM, Scop. SESIA, Hübn.

Legs, tibiæ clothed with long scales; the posterior with four elongated spines or calcaria, disposed in pairs. (Latr.)

Wings long and small, displayed nearly horizontally; the superior incumbent on the inferior; the latter hyaline; the former very narrow, and usually fenestrate. (Latr.)

Antennæ fusiform, incrassate towards the middle, simple; apex with a small scaly tuft.

Palpi reaching beyond the clypeus, pointed. (Latr.)

Antlia long and thin, except in the two first species.

Abdomen sub-cylindrical; anus barbate. (Latr.)

Flight, diurnal.

Larva, nearly bare, cylindrical, without any horn at the extremity of the body. (Latr.)

Pupa elongate; back spinous.

Obs. The caterpillars of the *Sesiæ* gnaw out the interior of vegetables, and make themselves a more or less solid cocoon therein, composed of the detached and pulverized portions, which they agglutinate, and connect together by silk. They usually pass the winter in that state, and become perfect insects in the following spring. (Latr.)

Ochsenheimer very justly observes that the term *Sesia*, being derived from the Greek word σης, (*tinea*,) would be more correctly spelt *Setia*, since the genitive of the original is σητος.

Authors are not well agreed as to the arrangement of the species of this genus. Stephens separates those which occur in Britain into two families, *Sesiidæ* and *Ægeriidæ*; the first

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[*] Generic Characters, from Latreille.

containing the genera *Macroglossa*, Ochs. and *Sesia*, Fab. the second those of *Trochilium*, Scop. and *Ægeria*, Fab. Ochsenheimer comprehends the whole in the two former genera; but two out of the six species which he places under *Macroglossa*, namely *S. Fuciformis* and *Bombyliformis*, Stephens arranges with his *Sesiæ*. Latreille observes (*Nouv. Dict. d'Hist. Nat.* xxxi. 105.), that "Scopoli separated from the *Sphinges*, properly so called, certain species which have the abdomen terminated by a tuft, and of them he formed his genus *Macroglossum*. Other naturalists united them to the *Sesiæ*. Fabricius, in his *Systema Glossatorum**, comprehends under the latter generic name only those species (i. e. the *Macroglossa* of Scopoli); our *Sesiæ* being considered by him as forming the genus *Ægeria*. M. Ochsenheimer, in his work on the Lepidoptera of Europe, has, with reason, rejected this arrangement, and in that respect his opinion and mine coincide."—*Latr.* l. c.

Species.	Icon.
1. S. *Apiformis*, Linn.†	Ernst, III. Pl. XCI. f. 121. a. b.
2. — *Bembiciformis*, Hübn.†(*Crabroniformis*, Steph.)	Hübn. Sphing. Tab. 20. f. 98. (fœm.) Lewin, Linn. Trans. III. Pl. I. f. 6—10.
3. *Asiliformis*, Fab.‡ ...	Ernst, III. Pl. XC. f. 119. a. b.

4. S. *Rhin-*

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* Where is that work to be met with?—C.

† Trochilium, Stephens. The first genus of his family Ægeriidæ, which he thus characterizes:—"Fam. IV. ÆGERIIDÆ." "*Antennæ* fusiform, a little curved, ciliated in the males, the apex terminating in a plume of scales: *ocelli* two, minute, placed between the antennæ and the base of the thorax: *palpi* elongate, thickly clothed with scales and long hairs, the last joint elongate: *abdomen* cylindric, tufted at the apex: *wings* horizontally displayed, generally naked, with the tips above opaque: *larva* sub-cylindric, hirsute, tail-less: *pupa* elongate, with a row of spines on each segment; changes in the interior of plants."—*Illust. Brit. Entom.* I. 136.

The generic characters of Trochilium are detailed as follows:

"Genus 29. TROCHILIUM, *Scopoli.*

Antennæ short, more or less serrated, especially in the males, stout, gradually incrassated nearly to the apex, which is curved, acuminated, and terminates in a hairy tuft: *palpi* moderately long, parallel, suddenly recurved, the base very hairy, the apex scaly and attenuated: *head* small: *clypeus* densely clothed with elongate hairs: *thorax* and *abdomen* stout, the latter with a very small tuft at its apex: *wings* with the tips not clothed transversely with scales."—*Steph.* l. c. p. 137.

‡ Ægeria, Stephens.—"Genus 30. ÆGERIA, *Fabricius.*

Antennæ long, slender, gradually increasing in size nearly to the apex, which is slightly curved and acuminated; in the males they are slightly ciliated, sub-serrated, or pectinated: palpi longer than the head, divaricating, gradually reflexed, thickly clothed beneath with scales and long hair; the terminal joint somewhat naked and acuminated: *head* moderate;

	Species.	Icon.
4.	S. *Rhingiæformis*, Hübn.	Hübn. Sphing. Tab. 7. f. 41. (fœm.)
5.	— *Sphecicormis*, Hübn.*	Ernst, III. Pl. XC. f. 120. a. b.
6.	— *Scoliæformis*, Laspeyres.	Hübn. Sphing. Tab. 23. f. 111.
7.	— *Hylæiformis*, Lasp.	Hübn. Sphing. Tab. 22. f. 108. (mas.) Tab. 8. f. 48. (fœm.)
8.	— *Doryliformis*, Hoffm. †	
9.	— *Chrysidiformis*, Hübn. ‡	Ernst, III. Pl. XC. f. 118. a. b.
10.	— *Prosopiformis*, Ochs.	Hübn. Sphing. Tab. 19. f. 93. (mas.)
11.	— *Ichneumoniformis*, Fab. ‡	Ernst, III. Pl. XCII. f. 124. a—d. Curtis, Brit. Ent. Pl. LIII.
12.	— *Cynipiformis*, Esp. ‡	Ernst, III. Pl. XCII. f. 125. a. b. (mas.) c. d. (fœm.) Steph. Pl. II. f. 2. ♂.
13.	— *Melliniformis*, Lasp. §	Lasp. Ses. Europ. f. 5. 6.
14.	— *Andrenæformis*, Lasp.	Esp. Schm. II. Th. Tab. XLIV. Cont. 19. f. 1. 2.
15.	— *Stomoxyformis*, Hübn. ‖	Ernst, III. Pl. XCIII. f. 126. a. b. d. Steph. I. Pl. XI. f. 3.

moderate: *clypeus* densely clothed with flat scales: *thorax* and *abdomen* rather slender, the latter with a large trilobed tuft, variable in form at its apex: *wings* transversely covered with scales at the tip."—*Steph.* l. c. p. 138.

Stephens subdivides the genus Ægeria into sections.

A. *Antennæ* much shorter than the body: of the males distinctly pectinated: *anterior wings* nearly clothed with scales: *abdomen* robust.

B. *Antennæ* as long as the body: of the males generally ciliated: *anterior wings* with the disc, hyaline.

- a. *Abdomen more or less robust and abbreviated, fasciated with whitish or yellow.*
- b. *Abdomen slender and elongated, generally with a single red belt.*
- c. *Abdomen beltless.*

The last subdivision of Sect. B. has only one individual, viz. *Sphinx,* (*Sesia*) *Ephemeræformis,* Haworth; a species not mentioned by Ochsenheimer.

* Ægeria, Sect. B. a. *Steph.* l. c. p. 140. Sp. 2. Pl. 11. f. 1.

† *Ses. Doryliformis*—alis hyalinis, marginibus fasciâque fuscis; abdomine barbato, nigro, segmento quarto margine albo; antennis ferrugineis, apice nigris.—*Ochs.* II. p. 141. *Sp.* 9.

‡ Ægeria, Sect. B. a.—*Steph.*

§ *Ses. Melliniformis*—alis hyalinis, anticis apice inauratis, marginibus fasciâque nigris; abdomine barbato, nigro, cingulis flavis; barba flava.—*Ochs.* II. p. 154. n. 14.

‖ Ægeria, Sect. B. b. *Steph.*

	Species.	Icon.
16.	S. *Culiciformis*, Linn.[*]	Ernst, III. Pl. XCV. f. 126. e. f. Pl. XCIII. f. 126. c. Steph. I. Pl. X. f. 3.
17.	— *Mutillæformis*, Lasp.[*]	Ernst, III. Pl. XCIII. f. 127. a—d.
18.	— *Typhiæformis*, Lasp.	Bork. Eur. Schm. II. Th. S. 174. n. 13. c. fig. 4. 5. Tab. adj. Hübn. Sphing. Tab. 7. f. 42. (mas.)
19.	— *Formicæformis*, Lasp.[*]	Ernst, III. Pl. XCV. f. 132. a—d. Steph. Pl. XI. fig. 4.
20.	— *Nomadæformis*, Lasp.	Ernst, III. Pl. XCIV. f. 129. a—d.
21.	— *Cephiformis*, Goldegg.[†]	
22.	— *Euceræformis*, Ochs.[‡]	
23.	— *Tipuliformis*, Linn.[§]	Ernst, III. Pl. XCIV. f. 130. a—d.
24.	— *Masariformis*, Ochs.[‖]	
25.	— *Tenthrediniformis*, Hübn.	Ernst, III. Pl. XCIII. f. 128. a—d.
26.	— *Philanthiformis*, Lasp.	Laspeyres, Ses. Europ. fig. 23, 24. (mas.) 25, 26. (fœm.)
27.	— *Tineiformis*, Hübn.	Hübn. Sphing. Tab. 7. f. 46. (fœm.)
28.	— *Brosiformis*, Hübn.	Hübn. Sphing. Tab. 25. f. 116. (mas.)

[To be continued.]

LXXV. *Attack of* Berzelius *on* Dr. Thomson's "*Attempt to establish the First Principles of Chemistry by Experiment.*"

OUR scientific readers need not be reminded, that in the work above quoted, Dr. Thomson has endeavoured to fix the combining equivalents of chemical substances.

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[*] Ægeria, Sect. B. b. *Steph.*

[†] *Ses. Cephiformis,* alis hyalinis, anticis marginibus fasciâque nigro-cæruleis; abdomine barbato flavo, cingulis tribus flavis.—*Ochs.* II. p. 169. *Sp.* 22.

[‡] *Ses. Euceræformis,* alis anticis fuscis apice inauratis, maculis duabus hyalinis; abdomine barbato nigro, strigâ medii interruptâ flavâ.—*Ochs.* IV. p. 171. No. 22.

[§] Ægeria, Sect. B. a. *Steph.*

[‖] *Ses. Masariformis,* alis hyalinis, anticis apice flavo irroratis, marginibus fasciâque nigris: abdomine nigro, cingulis tribus flavis; barbâ terminali flavâ.—*Ochs.* II. p. 173. *Sp.* 24.

Dr. Thomson has found reason to adopt an idea, suggested some years ago by Dr. Prout, that the numbers which express the atomic weight of bodies are multiples by a whole number of the atomic weight of hydrogen; and his favourite object, visible in almost every page, is to prove the coincidence to be perfect. In this attempt he has been so successful, that the correspondence between his hypothesis and the result of his experiments is startlingly precise. As the accuracy of his results, which, if true, are very important, can be duly estimated only by an analyst of extensive experience, we looked forward with impatience to hear the opinion of Berzelius. His opinion has at length reached us; and as it is expressed in language extremely strong and extremely unusual, we think it necessary to employ his own words. We have accordingly translated a few passages from the *Yahres-Bericht* for 1827 (Woehler's Translation).

" This work belongs to those few productions from which science will derive no advantage whatever. Much of the experimental part, even of the fundamental experiments, appears to have been made at the writing-desk; and the greatest civility which his contemporaries can show its author, is to forget that it was ever published." (page 77.)

" Thomson has published an essay ' On the method of analysing sulphate of zinc;' a subject scarcely requiring, one would think, a separate essay, since the composition of this salt is known with considerable certainty. The great importance attached to it is owing to the circumstance; that in his large work on the atomic weights and chemical proportions, the analysis of this salt is the basis on which the whole superstructure is founded. In describing this analysis, Thomson states that the oxide of zinc was precipitated by carbonate of soda, and that 18·125 grains of crystallized sulphate of zinc yielded 8 grains of anhydrous neutral carbonate of zinc. In this fundamental analysis are two errors;—errors of such a nature as it is difficult to commit, and which appear to prove that the results were invented. Some one had told Thomson that his whole work was of little value, because, in the fundamental experiment, the zinc was precipitated by carbonate of soda in the cold. To this privately communicated remark, Thomson openly replied, That he had supposed chemists would have given him credit for a knowledge of the mode of separating oxide of zinc from acids, and had therefore omitted details; but as he found this opinion erroneous, it became necessary to publish a full account of his process. Ninety grains (five atoms) of sulphate of zinc were precipitated by carbonate of soda, and yielded from 29·3 to 31·03 grains of of carbonate of zinc dried at the temperature of 212° Fahr. As this carbonate, when heated to redness, yielded 20·37 of oxide, it was anhydrous and neutral. The filtered solution was boiled, and the oxide of zinc which subsided, after being collected and ignited, weighed 4·54 grains. The solution was then evaporated to dryness in a porcelain vessel, and the salt again dissolved in water; when some oxide of zinc remained, which, when dried at a red heat, weighed 0·431. The solution was then again evaporated to dryness, and the residue ignited; and on being dissolved in water a little silicate of zinc was left, which after decomposition yielded 0·22 grains of oxide of zinc. To the remaining alkaline solution, after being neutralized by muriatic acid, a few drops of hydro-sulphuret of ammonia were added, which threw down a quantity of sulphuret corresponding to 0·65 grains of oxide of zinc. All these five portions together make up the sum of 26·211 grains, the weight of five atoms of oxide of zinc; so that 5·245 is the weight of one atom. Thomson, on this occasion, does not appear to have reflected on the fact, that neutral carbonate of zinc is never obtained by precipitation from an alkaline carbonate; and he has left this difficult point unexplained. The reason why all the oxide of zinc contained in a solution cannot be precipitated in the cold, is, that a portion is dissolved in the form of bicarbonate, while that portion of oxide which loses its carbonic acid, subsides in the form of a subcarbonate. We have seen in the experiments of Boussingault, that even the sesquicarbonate of soda precipitates a subsalt. Consequently, the statement as to the nature of the first and largest quantity of the precipitated oxide of zinc is obviously erroneous. And such is the method and result of one of the fundamental experiments on which Thomson's whole system stands, by which he obtained more accurate results than any preceding chemist, and through which he established for ever the atomic weights of bodies. The character of this work of Thomson's ought to exclude it from notice here; but it appears to me, that love for the real progress of science makes it imperative to detect quackery, and expose it to the judgement of every one as it merits." (page 181.)

We have thought it right to give as nearly as possible the very words of this critique, that scientific men may judge of its tone and merits. With respect to the former, we regret to see the dignity of science sacrificed by the intemperance of those who profess to be her advocates. It well becomes Berzelius to expose fallacy in argument, or detect error in analysis; but let him not pass beyond the limits of fair criticism: let him not arraign the character of an individual, who may be actuated

actuated by motives and principles as pure as his own. Intemperate attacks, such as this, reflect back upon their author, and indicate a mind inflamed by pique, jealousy, or some unworthy passion. We know not whether any cause for such feelings may exist in the present case, nor does it concern us to inquire; but we know Dr. Thomson to be devotedly attached to his profession, and we believe him to be sincere and honourable in his transactions. If deception exists at all, we are satisfied that Dr. Thomson himself is more deceived than any one. It is possible that, misled by a favourite hypothesis, he may, like many before him, have been too eager in seizing facts favourable to his views, and too tardy in perceiving those that are unfavourable. On this we offer no opinion at present; but must confess that several circumstances concur in shaking that confidence in the accuracy of his results which we once entertained. Dr. Thomson must be aware that the composition of the chloride of barium, as stated by him, has been declared by Berzelius to be erroneous; and that this error, if such, will vitiate many of his analyses. Would it not be prudent in Dr. Thomson to come forward and correct any mistake which he may have committed, rather than by delay allow others to do so for him? Does not the deference which British chemists have of late paid to him in adopting his atomic weights, impose on him the duty of admission or defence?

LXXIV. *On the Luminous Belt of September the 29th.*

To Mr. Richard Taylor.

Sir,

THE luminous belt which exhibited itself on the evening of September the 29th, in the present year, having been noticed and described from various parts of England, I beg leave to communicate its position as observed at a point very distant from most of the other stations, and therefore likely to be affected by a considerable parallax.

I was then at Rosemorran, the seat of George John, Esq., an elevated situation near Penzance, and about twelve miles from the Land's End. My attention was called to this unusual phænomenon at about eight o'clock. The belt then appeared to rise from the horizon, somewhat to the southward of west, and ascended with a steady light and uniform subtense, of perhaps three degrees, towards the zenith, passing over various stars that were scarcely altered in their appearance, till it reached Alpha Lyræ, then somewhat south of west, and nearly

62 or 63 degrees high. From thence diminished in brightness it became soon blended with the milky way, and ceased to be distinguishable. The belt seemed exactly similar to a ray of the northern light, except that not the least corruscation was to be observed. Its position could not be much out of the magnetic equator.

Sir William Elford, F.R.S. has favoured me with a detail of the appearances seen near Totness, very much agreeing with the above statements.

I am, yours, &c.
DAVIES GILBERT.

LXXVII. *Proceedings of Learned Societies.*

LINNÆAN SOCIETY.

Nov. 4.—MR. Bicheno read a paper On the advantages attending the use of the English Language in Natural History.

The author insists that the use of Latin and other foreign languages in the classification of Natural History has retarded its progress; and that an acquaintance with the productions of nature was more extensively diffused before the Latin became the vehicle of communication. Gerard has recorded some thousands of English names of plants, derived from an English stock, which are no longer in use; while every indigenous species, however, to our ancestors seems to have had a familiar name in English, Welsh and Erse. Every word particularly had its appropriate appellation. Ask a farmer now how many plants he is acquainted with, and he will betray an incredibly scanty stock of knowledge, for one who is traversing the carpet of the earth many hours of every day of his life: he will confound under the name of Charlock more than half a dozen species, and out of a hundred kinds of Grass he will be acquainted with a most insignificant number.

Professor Michaelis remarks, that the Eastern nations must have been better acquainted with the vegetable kingdom than ourselves; since we find more than 250 plants named in the Old Testament, by writers who have made use of these names in prose and metre only incidentally, and not as botanists; and that in all probability such knowledge must in those times have been very generally diffused.

Of all sciences Natural History is one of observation. To lock it up therefore in a dead language, or to give it less currency among the rural part of the population, whose business is with the operations of Nature, is to confine it within the bounds of the closet. For the want of names the attention of the English scholar is not arrested, or he has no means of recording his observations; and the learned, pent up in cities, or only making an occasional excursion out of them, turn their more copious vocabulary to less account, and their faculty of observing to such trifling and minute particulars as their studies will afford.

The great storehouse of botanical and zoological names is still to be found in the writings of the Greeks. Among them, learning and science

science, philosophy and poetry, went hand in hand. The people were taught every thing; Natural History was diffused; and they have handed down for our use a stock of names which no other language can equal.

It may perhaps remain doubtful whether the old English names are not too much forgotten to be revived, and whether it is not now, in many cases, as easy to establish the foreign names. Still there would remain much that might be familiarized to the English scholar by the use of his native language.

Among living languages, ours is admirably adapted for the teaching of sciences in which new terms are requisite. Foreign words are easily engrafted or transplanted into it. It allows of a great variety of compounds and diminutives, and those terminating either as substantives, adjectives, verbs or participles, both active and passive. It has been asserted by competent judges, that it is in these respects as accommodating as the Latin, and not much less so than the Greek. To the honour of the late President of the Linnæan Society, he did much to familiarize the recondite language of botany to the English student. The probability is, that naturalists will very soon be forced to adopt their native language as a vehicle of communication. Our popular schools, universities, gardens and publications all tend this way.

Such an occurrence need not prevent the learned of all nations from still holding intercourse, and it would throw open to multitudes a boundless field of experiment and observation. Wherever a learned language has been in the possession of a privileged class, history and experience show that the excluded party is left in ignorance; and the establishment of a "universal character," so much desired by some of the philosophers of the 17th century, instead of advancing knowledge, as they imagined, would most materially have retarded it, and have kept the people in darkness.

A paper was also read, entitled, Description of a new species of *Phalangista,* by Thomas Bell, Esq. F.R. & L.S.

Ord. *Marsupiata.* Genus *Phalangista.*

Ph. gliriformis, Dorso rufo-cinereo, gulâ fulvâ, maculâ post aurem utrinque albâ: auribus nudis. *Hab.* Australasia.

ROYAL ACADEMY OF SCIENCES OF PARIS.

June 2.—The Academy received an essay On the duodecimal calculus, by M. Gautier de Nuits.—A memoir On the developments of plane curves, by MM. Dubois Aimé, and Bigeon.—A new notice respecting the yellow fever. By M. Leymerie.—A note by M. Julia de Fontenelle, in reply to the claims which had been made on the subject of his memoir On human combustions.—A letter from M. Baudelocque, inclosing some discoveries in the art of Midwifery.—Afterwards, the reports of the several Committees respecting Montyon's prizes were read.—The sitting terminated with hearing part of a memoir by M. Villermé On the mean height of the inhabitants of France.

June 9.—The following manuscripts were presented. A letter from MM. Parkes and Company, with some specimens of salt from their establishment.

establishment.—A note from M. Dizé On an indelible ink.—A sealed packet from M. Comté, containing a continuation of some physiological experiments.—M. Cuvier presented some teeth of the gigantic tapir, dug up in the arrondissement of Saint-Gaudens, by M. Cabuel, engineer of bridges and highways.—The Commission deputed to examine the memoirs on statistics, made a report.—M. Le Roy d'Etielles read a memoir On asphixy.

June 16.—In this public sitting there were heard: The historical eulogy of M. Ramond, by M. Cuvier.—The historical eulogy of M. Charles, by M. Fourier.—And a physiological memoir On the brain, by M. Magendie.—Want of time prevented M. Prony from reading a memoir which he had compiled On the labours of the late M. Perronet.

June 23.—Manuscript pieces received at this sitting: A letter from the Minister of the Interior respecting a memoir by M. Braun On the direction of balloons.—A letter from M. Pétard relative to a disease by which he had been attacked.—A description of the instruments used in measuring geodesical bases. By M. Imbert.—Notice of the discovery of a luminous liquid. By M. Kirch.—M. Mathieu, on behalf of a Committee, made a favourable report on the *Sécateur perspectif* of M. Lalanne.—M. Navier gave an advantageous account of a memoir by M. Corancez, intitled *De l'Integration de quelques équations aux différences partielles, et du mouvement de l'eau dans les vases.*—Agreeably to the report of a Committee, the Academy decided that the memoir presented by M. Foville On the anatomy of the brain should be printed in *Recueil des Savans etrangers.*—M. Adolphe Brongniart read a memoir, intitled *Nouvelles récherches sur le pollen et les granules spermatiques des végétaux.*

June 30.—M. Lionville presented a memoir On electro-dynamic phænomena, and particularly on the mutual actions of the pole of a magnet and a conducting wire.—M. Timel, author of a work On the intellectual organization of man, requested the appointment of Commissioners.—The Academy afterwards heard at this sitting: A note by M. Mirbel, On a remarkable development of the stalk of the *Calycanthus floridus.*—A memoir by M. Becquerel, On the electricity excited by the friction of two metals.—A memoir by M. Daussy, intitled *Détermination des positions géographiques de Malte, Milo et Corfou.*—The conclusion of M. Villerme's memoir On the mean height of man in France.—A report by M. Ampère, On a projected instrument by M. Nobili, intended to measure the intensity of electric currents.—M. Gay Lussac presented a specimen of the ultramarine prepared by M. Guimet, and a new pyrophorus formed by calcining sulphate of potash with charcoal.

July 7.—M. Delattre de Rougemont deposited a sealed packet containing a description of a new method of curing a severe disease.—M. Tournal sent the second part of his Geognostic description of the environs of Narbonne.—The Minister of War communicated the report which he had received respecting the effects of lightning upon the powder-magazine at Bayonne.—M. Russel d' Inval requested that the processes which he had proposed for facilitating arithmetical calculations

calculations might be examined.—M. Lassis again expressed his opinion on the subject of epidemic diseases.—A letter was read, in which chloride of lime was mentioned as a remedy for the distemper in dogs.—MM. Chevalier and Langlumé sent their memoir On lithography.—M. Poisson read a notice On the problem of waves.—M. Benoiston de Chateauneuf communicated a manuscript work respecting the wheat-harvest of France in former and present times.

LXXVIII. *Intelligence and Miscellaneous Articles.*

METEORIC IRON IN FRANCE.

M. HERICART DE THURY, on 13th of October last, read a notice to the Academy of Sciences respecting the discovery of a mass of meteoric iron existing at Caille, near Grasse, department du Var. In August last, M. Brard sent from Fréjus a specimen of the mass in question, with respect to the origin of which he did not decide. The examination made by the author caused him to suspect that it might be meteoric iron, and he therefore wrote to M. Brard to beg that he would go to the place, in order to determine the nature of the mountain on which it was discovered; to examine the mass of supposed meteoric iron; and to collect from the inhabitants all the information which they could give him. The following is extracted from the account given by M. Brard:—The mass of iron, which had been for two years placed at the door of the church at Caille, has been in that village about 150 years. It was discovered in the mountain of Audebert, a league off, and was drawn by four oxen into a court or garden in the village, where it seems to have been forgotten; but an inhabitant having inclosed it in a wall, it was claimed as an object held in some veneration; the wall was pulled down by the authorities, and the enormous mass was deposited in the principal street of the village, from which it was removed to the spot which it now occupies.

The form of the mass is very irregular; its external colour blackish brown, with a shade of lead-colour; it is shining, but occasionally spotted with yellow rust; its internal colour is whiter than that of common iron. It weighs about 1000 or 1200 pounds.

The mountain on which this mass was found is of considerable altitude, and similar to those which surround it; there are no appearances of iron-works having ever existed in the neighbourhood.

This iron has the crystalline appearance which marks its meteoric origin, and M. Laugier has found that it contains nickel. Application has been made for its removal to Paris, and this has probably been already accomplished.

It was reported in the village that two smaller masses were found with it, which were used for making horseshoes, nails, &c. It was also proposed to heat this mass, and thus divide it and apply it to the same purposes; fortunately for the interests of science the greatness of the mass prevented the intended destruction.—*Le Globe.*

IRON TRADE.

In the year 1740 the whole iron made in Great Britain was 17,000 tons from 59 furnaces.
In 1788, it had increased to 68,000 tons from 121 furnaces.
In 1796, it had increased to 125,000
In 1806, it had increased to 250,000
In 1820, it had increased to 400,000
In 1827, it had increased to 690,000 tons from 284 furnaces.

The different counties in which it is made are as under in 1827.

Staffordshire	216,000 tons from	95 furnaces.
Shropshire	78,000 tons from	31 furnaces.
South Wales	272,000 tons from	90 furnaces.
North Wales	24,000 tons from	12 furnaces.
Yorkshire	43,000 tons from	24 furnaces.
Derbyshire	20,500 tons from	14 furnaces.
Scotland	36,500 tons from	18 furnaces.
	690,000 tons from	284 furnaces.

About 3-10ths of this quantity is of a quality suitable for the foundry, which is all used in Great Britain and Ireland, with the exception of a small quantity exported to France and America. The other 7-10ths is made into bars, rods, sheets, &c., of which a large quantity is exported to all parts of the world.—*Repertory of Arts, October* 1828.

EARLY HISTORY OF ELECTRO-MAGNETISM.

In the year 1801, Gautherot brought two fine piano-forte strings in contact, one with the upper and the other with the lower end of the pile, keeping the extremities fluttering in the air. When these ends touched each other, he says, (*Ann. de Chim. tom.* xxxix. p. 209.) "A very decisive adhesion took place; they seemed united as by a magnetic power, which was so strong that he could move the united wires in every direction to a distance of some centimetres." Thus it may be seen that, in the investigation of Nature, a few detached observations are insufficient, but that they must be pursued and combined; by which means it was that Œrsted became the discoverer of electro-magnetism.—*Schweigger's Jahrbuch,* 1828. p. 110.

RUSSIAN COINAGE OF PLATINA.

A letter from Professor Breithaupt to Dr. Schweigger-Seidel, an extract from which is given in a late Number of the *Jahrbuch de Chemie,* &c., confirms the statement some time since made by the newspapers, that the Russian Government had resolved to coin a large sum in Siberian platina. It appears that Count Denidoff, the proprietor of the locality where the platina was discovered, has disposed of to the Government the quantity of that metal which had been collected. He has sent four young Russians, destined for official situations in Siberia, to be educated at the Mining Academy of Freyberg.

ANALYSES OF MINERALS.

Radiolite, by Professor Hünefeld.

Silica	0·41880
Alumina	0·23790
Soda	0·14069
Potash	0·01012
Water	0·10000
Oxide of iron	0·00910
Carbonate of lime	0·02500
Matrix	0·05500
	0·99661

Datholite from the Hartz, by Dr. DuMenil.

Lime	35·59
Silica	38·51
Boracic acid	21·34
Water	4·60
	100·04

Bismuthblend of Breithaupt, by Professor Hünefeld.

Carbonate of bismuth	58·8
Arsenic acid	2·2
Silica	23·8
Arseniate of cobalt, copper and iron	5·9
Matrix	9·1
	99·8

White ironsinter from Freiberg, by M. K. Kersten.

Arsenic acid	30·25
Oxide of iron	40·45
Water	28·50
	99·20

Schweigger's Jahrbuch, 1828.

ANALYSIS OF THE IPECACUANHA BRANEA. BY M. VAUQUELIN.

This is the root of the *viola ipecacuanha* from Rio Janeiro; it is of a pale white colour, of the size of a quill, crooked and knotty at unequal distances. Its fracture is even, and slightly resinous; its odour is disagreeable, and its taste, at first scarcely perceptible, is afterwards acrid and nauseous. Sixteen grammes of this root reduced to a fine powder were macerated in water for forty-eight hours. The liquor was decanted and fresh water added to the powder, and the maceration continued for the same time: this water was scarcely coloured; it was poured off, and the residuum was treated with boiling water till it was exhausted. The whole of the liquors were mixed and filtered, and evaporated with a very gentle heat.

The liquid became turbid, and deposited a flocculent substance of a dirty white colour, which being collected by a filter was proved to be albumen, by the ammonia and fetid oil which it yielded on distillation. The liquor from which the albumen was separated, after due evaporation

ration, was treated with a small quantity of carbonate of magnesia to saturate the acid it contained; an insoluble salt was formed, which being separated by the filter was found to be gallate of magnesia, but in very small quantity.

The solution again evaporated to dryness on a salt-water bath yielded a brown extract, which attracted moisture slightly. This extract being digested in cold alcohol, the resin and emetin were dissolved, and the other substances remained unacted upon: the solution after filtration was evaporated in a similar way, a dark-coloured extract obtained, which being treated with hot water the emetin was dissolved and the resin separated.

The solution of emetin gently evaporated to dryness, weighed a gramme and a half. On again treating, the precipitate formed, at the time of the separation of the emetin and resin, with hot alcohol, and filtering it, a fatty matter and wax separated on cooling: the residuum being treated with cold water, the gum was separated, and the amylaceous fecula was precipitated. During the exposure of the emetin to heat, a pellicle of small crystalline scales is formed, which is probably the matter that imparts bitterness and acridity to the emetin.

Sixteen parts of the root appear to consist of

Emetine	1·50
Resin	0·60
Gum	0·20
Albumen	0·30
Starch	3·20
Crystalline scaly matter	0·85
Ligneous matter	7·00
Fatty matter, wax, and loss	0·05
	16·00 *

PROSPECTUS OF A PLAN FOR INVESTIGATING THE NATURAL PRODUCTIONS OF JAMAICA.

It is with great pleasure that we give insertion to the following circular, which has been transmitted to us for that purpose: we hope, for the interests of science, that the proposed investigation will speedily be set on foot.

"It has long been matter of regret among men of science, that those natural productions of Jamaica which are not as yet the immediate objects of commerce, should be so little known in England. Its geology and mineralogy have been but partially examined. The history of its quadrupeds, birds, insects, reptiles, and fish, has been almost entirely neglected. The botany has, indeed, been more attended to; but it is acknowledged by the most intelligent men, and among the rest by Humboldt, that there is no tropical region where the native plants have been as yet accurately enumerated; that the Flora of none of the greater islands of the Antilles has been properly examined; and that, even in our times, travellers in Hispaniola, Jamaica and Cuba, daily find lofty trees which constitute new genera; while the medicinal

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* There is a considerable error in the statement of this analysis; the products amount to only 13·65 instead of 15·95, as here stated.—Edit.

medicinal and other useful qualities of its innumerable vegetable productions remain, in a great degree, unascertained. This account of the very imperfect state of our knowledge, which is by no means confined to one island, but is almost equally true *in respect to all,* has suggested to a few persons the expediency of an attempt to investigate the natural history of Jamaica.

"They are persuaded that whatever information may be acquired in respect to it, will be immediately beneficial to the other West Indian colonies, Jamaica being only selected as affording the most extensive field for studying the productions of a climate common to all. They consider it an object of great importance to the whole body, that no means should be omitted or overlooked which may contribute to connect the West Indies with the more enlightened classes at home; and they should very much regret if *all* did not seek to participate in the honour arising from the prosecution and dissemination of scientific discoveries, as well as in the other advantages which have hitherto closely and inevitably attended them. Impressed with these opinions, and in part relying on the known spirit of philosophical research which exists so remarkably in this country, they have ventured to hope that it may be possible to raise such a sum among those more closely connected with the colonies, as well as among those who are influenced by a general attachment to the cause of knowledge, as may be sufficient to send out scientific men well fitted for examining the state of Jamaica as connected *exclusively* with its natural history, and the *probabilities afforded* by its advantages of soil and climate for the cultivation of articles as yet new to its commerce. They have reason to think that it will be easy to find such competent persons, in whose zeal and intelligence entire confidence may be reposed, and who will be most ready to undertake the investigation. They have sanguine hopes that some public bodies may take an interest in the object, and be inclined to give it countenance and support without depriving it of the character of an individual and scientific enterprise; and they feel persuaded that the subscription of a comparatively moderate sum would fully accomplish this desirable object within a very limited period.

"Being anxious to forward a plan which appears to them so full of utility, they have taken the liberty of circulating this address: but as all arrangements for carrying it into execution, for disposing of the seeds and specimens, as well as for giving publicity to the information which will no doubt result from it, must of course depend upon the money raised, and the view which the subscribers may take of the best mode of accomplishing their own objects;

"It is proposed that if the scheme meets with such support as they fully anticipate, a general meeting should be called as early in the fall of the year as is convenient, for the purpose of considering the general arrangements, and the best means of carrying them into effect. In the mean time, those gentlemen who are inclined to afford their cooperation, are requested to send such an intimation to Henry Bright, Esq. M.P. 2, Stone Buildings, Lincoln's Inn, London, who has undertaken to lay the substance of the information received before the gentlemen at whose suggestion this circular has been issued."

ON A METHOD BY LAPLACE OF SOLVING EQUATIONS OF THE THIRD DEGREE. BY M. FAYOLLE.

To the Editors of the Philosophical Magazine and Annals.

Messieurs,

Je vous envoie, comme une suite à l'árticle sur les équations du second degré *, une méthode très élégante de Laplace, pour résoudre les équations du 3ᵉ degré par les tables des sinus.

Dans l'équation

$$x^3 \mp px + q = 0,$$

q étant positif, supposons

$$x = r\left(z \pm \frac{1}{z}\right),$$

nous aurons

$$x^3 \mp px + q = r^3\left(z^3 \pm \frac{1}{z^3}\right) \pm (3r^3 - pr)\left(z \pm \frac{1}{z}\right) + q = 0.$$

Soit $r^2 = \frac{p}{3}$,

et $-3q\sqrt{3} = 2h$;

on aura $z^3 \pm \frac{1}{z^3} = 2h,$

équation du 6ᵉ degré, mais résoluble à la manière de celles du second.

Supposons 1° que le signe supérieur ait lieu, et que h, abstraction faite du signe, soit < 1.

Alors $\frac{q^2}{4} - \frac{p^3}{27}$ est une quantité négative, et l'équation proposée tombe dans *le cas irréductible.*

Si l'on fait $z = \cos u + \sin u \sqrt{-1}$,

on aura d'abord

$$x = \sqrt{\frac{p}{3}}\left(z + \frac{1}{z}\right) = 2\cos u\sqrt{\frac{p}{3}};$$

on aura ensuite

$$z^3 + \frac{1}{z^3} = 2\cos 3u,$$

et partant $\cos 3u = h$.

Soit A le plus petit des angles dont le cosinus est h, et que les tables feront connaître. On aura pour $3u$ les trois valeurs, (c étant la demi-circonférence,)

$$A,\ 2c + A,\ 4c + A;$$

et parconséquent les trois valeurs de x seront

$$x = 2\sqrt{\frac{p}{3}} \,.\, \cos\frac{1}{3}A,$$

$$x = 2\sqrt{\frac{p}{3}} \,.\, \cos\left(\frac{2c + A}{3}\right),$$

$$x = 2\sqrt{\frac{p}{3}} \,.\, \cos\left(\frac{4c + A}{3}\right).$$

---

* See above, p. 314.

Ainsi,

Ainsi, par leur comparaison avec l'expression

$$\cos u \pm \sin u \sqrt{-1},$$

les imaginaires ont servi à déterminer les quantités réelles; et l'on en voit des applications nombreuses dans le calcul infinitésimal.

Supposons 2° que h, abstraction faite signe, soit > 1.

Dans ce cas, on fera $z^3 = \text{tang}\, u$, ce qui donne

$$z^3 + \frac{1}{z^3} = \frac{2}{\sin 2u},$$

d'où l'on tire

$$\sin 2u = \frac{1}{h}.$$

Par une opération semblable à la précédente, on déterminera les trois valeurs de x, dont une est réelle, et les deux autres imaginaires, savoir

$$x = \frac{2\sqrt{\frac{p}{3}}}{2 \,\text{tang}\, u'},$$

$$(u' \text{ étant } = \sqrt[3]{\text{tang}\, u});$$

$$\text{et } x = -\sqrt{\frac{p}{3}} \cdot \left(\frac{\cos 2u' \pm \sqrt{-3}}{\sin 2u'}\right).$$

FAYOLLE.

LUMINOUS BELT OF SEPT. 29TH.

About ten minutes or a quarter past eight o'clock in the evening on Monday 29th September last, I observed an uncommon luminous arch, which I imagine was the Aurora Borealis, having a different appearance to what is usual. This arch extended from west to east; I cannot say that it reached from one part of the horizon to the other completely; the western part of the Aurora appeared bent towards the north, and like a straight column of light, which column extended upward beyond the lower portion of the bow towards the south. When I first (or soon after) saw it, the vertex of the arch or bow appeared to include part of the constellation Ursa minor; the stars β and γ, I think, were included. Some time afterwards the vertex was rather southward of the zenith: the apparent change of place of this phænomenon was so rapid that I supposed if I stood still I might see the motion; but in this opinion I was disappointed. During my observing this appearance, I walked some distance from Hale-End towards Woodford and back: this change of place I imagine made no difference in the apparent situation of the bow, with respect to the stars; as the Aurora was probably at too great a distance to have any effect in this respect. After the *arch* was gone, there remained in the west the straight leg of it (if so it may be called) for a considerable time, and then the appearance was much like the sunbeams

beams which are frequently seen at sun-set and other times; that is, of rays of light diverging: the upper part was broader than the lower, evidently. The colour of the bow was much like that of the milky way, and appeared so blended with it as not to be clearly distinguished from it when it (the arch) was fading away. From first to last I think it was more than an hour that I observed this very extraordinary appearance.

Hale-End, Walthamstow, Essex, B. M. FORSTER.
Nov. 24, 1828.

We are indebted to Mr. J. H. Matthiason, of Bedford, for a communication on this subject; in which it is stated that the belt, as seen from Bedford, intersected the milky way in the S.W., at the altitude of about 30°. The phænomena of the belt, as described by Dr. Forster, at p. 389 of our last Number, agree in general, we are informed, with those it presented to observers at Bedford.

ENCKE'S COMET.

Between 7 and 8 o'clock in the evening of the 5th instant, a *faint nebulous circular spot* was observed here with a Dollond's achromatic telescope, about half a degree on the eastern side of the star marked μ in the constellation Pegasus, when it was on the meridian. As there was a quick succession of attenuated cirrostratus clouds passing over towards the N.W., nothing more could be done than to determine its position, as a guide to future observations; and from its having no distinguished central light, some doubts were entertained as to its being a comet.

From the interposition of light clouds and mists, no favourable opportunity offered again till the evening of the 11th, when the sky became very clear and frosty; yet the comet could not be found till the moon had set, about 8 o'clock, when it was observed on the breast of Pegasus, or in right lines with η Pegasi and o Aquarii, and α Pegasi and ϵ Cygni, the intersection of which lines gave its position. The comet was more luminous this evening than on the former; still it was a turbid coloured misty-looking circular light, but sufficiently luminous to measure its diameter. When the moon had set, its diameter was measured with a Dollond's divided object-glass micrometer, by means of a small telescopic star situated at its western edge, and the angle it subtended was nearly three minutes of a degree.

Nov. 12th.—The first part of this evening the atmosphere was very hazy, but it cleared away soon after 6 o'clock; and the comet was again seen while it was bright moonlight, and was found to have advanced more than one degree from its position the preceding evening, between two telescopic stars, with which it had formed an equilateral triangle.

Nov. 13th.—The sky was clear this evening till 7 o'clock, which gave another opportunity of seeing the comet on the meridian; but as the moon is approaching it, it is with difficulty seen with the telescope. Its Right Ascension this evening was $22^h\ 5^m\ 30^s$, or $331°\ 22'\ 30''$; and its Declination $19°\ 17'$ north.

Nov. 14th.

Nov. 14th.—The clouds cleared away this evening upwards of an hour; but as the moon was nearly under the comet, her light was too great to admit of its being seen.

It is generally denominated Encke's Comet, from that astronomer having truly calculated its orbit, and was first discovered in the year 1786: it was afterwards discovered in 1795 by Miss Herschel, whose researches in the science are entitled to universal praise; also in 1805, 1819, 1822, 1825, and in the present year. It makes a complete revolution round the sun in about 3¼ years; consequently it must have made thirteen revolutions.

From its uniform orbicular motion, the shortness of the period of its revolution, and its dull appearance without any perceptible nucleus, it may be regarded as a singular cometic body with some planetary qualities, and perhaps in a state of progressive condensation.

Observatory, Gosport, Nov. 14, 1828.

LIST OF NEW PATENTS.

To S. Lawson, and M. Walker, of Leeds, for improvements in machinery for preparing and dressing hemp, flax, silk, &c.—Dated the 9th of October 1828.—6 months allowed to enroll specification.

To H. Duxbury, of Pomeroy-street, Kent Road, for a new machine for splitting hides and skins.—9th of October.—6 months.

To E. Hancorne, of Skinner-street, London, for certain improvements in making nails. Communicated from abroad.—16th of October. —6 months.

METEOROLOGICAL OBSERVATIONS FOR OCTOBER 1828.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·42 Oct. 12. Wind E.—Min. 29·35 Oct. 6. Wind S.W.
Range of the index 1·07.
Mean barometrical pressure for the month .... 30·050
Spaces described by the rising and falling of the mercury............ 4·800
Greatest variation in 24 hours 0·390.—Number of changes 23.
Therm. Max. 65° Oct. 5. Wind S.—Min. 35° Oct. 30. Wind N.E.
Range 30°.—Mean temp. of exter. air 53°·69. For 30 days with ⊙ in ♎ 57·13
Max. var. in 24 hours 20°·00—Mean temp. of spring water at 8 A.M. 56°·06

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the evening of the 21st .... 100°
Greatest dryness of the air in the afternoon of the 29th.............. 38
Range of the index.. 62
Mean at 2 P.M. 60°·9 —Mean at 8 A.M. 72°·5—Mean at 8 P.M. 75·6
—— of three observations each day at 8, 2, and 8 o'clock......... 69·6
Evaporation for the month 1·60 inches.
Rain near ground 1·69 inches.

Summary of the Weather.

A clear sky, 5; fine, with various modifications of clouds, 13½; an overcast sky without rain, 8½; foggy, 1; rain, 3.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
20	11	30	6	21	15	10

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
1	5	4½	2	3	5	4	6½	31

General Observations.—This month to the 27th was generally fine, dry, and mild for the season; but the last four days, though remarkably fine, were cold, and the nights frosty. This wintry change was brought on by a dry land-wind from the North-east. The first hoar-frost that occurred this autumn was early in the morning of the 3rd instant; it was accompanied by a fog, and followed in the day by a large solar halo, whose prismatic colours were well defined. In the night of the 5th much rain fell here, with a gale from the South. From 8 o'clock till midnight of the 6th, there was sheet lightning, which terminated with thunder and rain. Distant thunder was also heard in the morning of the 7th. In the evening of the 21st a thick fog appeared, and was succeeded by one of the heaviest dews we ever remembered to have fallen, it being measurable from the rain-gauge.

The mean temperature of the external air this month, is half a degree higher than the mean of October for many years past.

Spring water did not come to its maximum temperature till the beginning of the month, and it continued so nearly throughout.

The atmospheric and meteoric phænomena that have come within our observations this month, are one solar halo; eighteen meteors; lightning and thunder on two different days; and seven gales of wind; namely, one from the North-east, one from the South, two from the South-west, and three from the West.

REMARKS.

London. — October 1. Drizzly: fine. 2. Fine. 3. Very fine. 4. Rainy morning: cloudy. 5. Fine: stormy and wet at night. 6. Cloudy: fine. 7. Cloudy: slight fog at night. 8, 9. Fine. 10. Cloudy: fog at night. 11. Very fine. 12. Slight fog in morning: fine. 13. Very fine. 14. Cloudy: fine. 15. Slight fog: cloudy. 16, 17. Cloudy. 18. Very fine. 19. Fine. 20. Very fine: dense fog at night. 21. Foggy: very fine. 22. Very fine. 23. Drizzly. 24. Dense fog: fine. 25, Fine. 26. Dense fog: drizzly. 27. Cloudy: drizzly. 28. Cloudy: fine. 29. Slight fog: fine. 30. Fine. 31. Cold and cloudy.

Boston. — Oct. 1—3. Fine. 4. Rain. 5. Fine. 6. Fine: heavy rain early A.M. 7. Fine: rain at night. 8. Cloudy and stormy. 9—12. Fine. 13. Cloudy. 14. Fine. 15. Cloudy. 16, 17. Fine. 18. Cloudy. 19, 20. Fine. 21. Cloudy. 22. Fine: rain at night. 23. Rain. 24—26. Fine. 27. Rain. 28. Cloudy. 29. Fine: some frost in the morning: rain P.M. 30. Fine. 31. Cloudy.

Penzance. — Oct. 1. Fair: showers. 2. Showery: clear. 3. Fair: rain. 4. Fair: showers. 5. Rain. 6. Rain: showers. 7. Fair: showers. 8, 9. Fair. 10. Fair: showers. 11. Fair: rain. 12. Misty. 13. Misty: fair. 14. Fair. 15. Fine. 16, 17. Fair. 18. Fair: misty. 19. Fair: clear. 20. Clear. 21. Clear: fair. 22. Fair: rain. 23. Clear: showers. 24. Fair: rain. 25. Rain. 26. Fair: rain. 27. Clear. 28. Fair. 29, 30. Clear. 31. Fair.

Meteorological Observations made by Mr. BOOTH *at the Garden of the Horticultural Society at Chiswick, near London; by* Mr. GIDDY *at Penzance,* Dr. BURNEY *at Gosport, and* Mr. VEALL *at Boston.*

Days of Month, 1828.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.									
Oct. 1	29·671	29·607	29·75	29·72	29·72	29·62	29·26	67	50	60	51	61	49	53	SW.	W.	W.	W.	...	·05	0·055	...	...
2	29·906	29·831	29·87	29·85	29·93	29·80	29·43	66	38	60	49	63	44	50	SW.	NW.	W.	W.	...	...	·200	...	...
3	29·940	29·776	29·87	29·70	29·93	29·77	29·43	65	47	61	48	64	56	47·5	SW.	SW.	S.	W.	0·20	...	·400	0·390	...
4	29·644	29·588	29·58	29·55	29·64	29·54	29·03	66	43	60	48	64	52	55	SW.	SW.	SW.	S.	...	·08	·345	...	0·25
5	29·601	29·433	29·50	29·38	29·58	29·43	29·06	66	51	60	52	65	52	55·5	W.	SW.	S.	S.	...	·50	·400	·770	·11
6	29·578	29·348	29·55	29·40	29·57	29·35	28·68	63	48	58	52	63	51	55	SW.	SW.	SW.	W.	·15	·03	·280	·070	1·36
7	29·653	29·498	29·70	29·65	29·63	29·54	29·03	62	49	58	52	61	51	52·5	W.	NW.	SW.	W.	...	·11	·320	·050	...
8	29·784	29·615	29·85	29·78	29·77	29·60	28·87	60	45	57	52	59	47	54·5	W.	NW.	W.	NW.	...	...	·120	...	·09
● 9	30·175	29·990	30·15	30·08	30·10	29·95	29·42	62	41	58	52	61	49	51·5	SW.	NW.	NW.	NW.	·20	...	...	...	...
10	30·171	30·073	30·18	30·15	30·13	30·08	29·52	60	57	58	52	62	49	52·5	S.	W.	SW.	calm	...	...	...	·065	...
11	30·414	30·286	30·25	30·25	30·35	30·29	29·70	66	45	60	49	61	51	56	SW.	S.	SW.	NW.	...	...	·220	...	...
12	30·474	30·456	30·30	30·25	30·42	30·40	29·83	70	42	61	55	61	49	55	W.	S.	SE.	W.	·10	...	·090	...	...
13	30·426	30·355	30·32	30·32	30·39	30·34	29·75	69	47	58	53	62	49	56	NW.	NE.	W.	calm	...	...	...	...	...
14	30·404	30·378	30·35	30·30	30·36	30·34	29·80	60	40	57	53	60	45	51·5	N.	N.	N.	N.	...	...	...	...	...
15	30·377	30·341	30·35	30·33	30·34	30·30	29·73	58	47	60	48	59	50	49	NW.	NE.	NW.	calm	·15	...	...	...	...
☽ 16	30·305	30·284	30·32	30·30	30·30	30·26	29·72	55	48	56	49	56	51	52	NW.	NE.	NW.	W.	...	...	...	...	...
17	30·189	30·136	30·25	30·20	30·17	30·12	29·60	58	40	56	52	60	49	52·5	W.	E.	NW.	N.	...	...	...	...	...
18	30·337	30·284	30·15	30·12	30·27	30·24	29·82	57	33	57	51	57	48	47	NE.	SE.	E.	N.	·20	...	...	...	...
19	30·244	30·172	30·10	30·08	30·18	30·10	29·75	56	32	55	52	56	43	48	E.	SE.	NE.	NW.	...	...	...	...	...
20	30·228	30·152	30·05	30·05	30·10	30·06	29·70	57	38	56	47	61	47	40	NE.	NE.	E.	NW.	...	...	...	...	...
21	30·184	30·108	30·05	30·00	30·10	30·02	29·55	61	43	56	49	64	53	51	SE.	NE.	E.	calm	·15	...	...	...	...
22	29·928	29·782	29·82	29·75	29·90	29·75	29·32	67	54	60	52	64	53	55	W.	SW.	S.	calm	...	...	·100	·220	...
○ 23	30·001	29·743	29·90	29·85	29·95	29·72	29·20	57	32	54	50	60	40	53	S.	W.	NW.	calm	...	·34	·050	·050	·40
24	30·160	30·152	30·00	29·95	30·10	30·10	29·60	55	35	56	44	56	49	42	S.	SW.	E.	W.	·10	...	·200	·045	·08
25	30·364	30·207	30·05	29·90	30·24	30·13	29·73	61	32	57	52	60	46	50	E.	SE.	SE.	E.	...	...	·410	...	...
26	30·281	30·198	30·15	30·05	30·26	30·14	29·86	52	46	57	52	58	49	47·5	E.	S.	E.	E.	...	·03	·065	·030	...
27	30·447	30·320	30·15	30·12	30·22	30·15	29·75	54	49	56	48	56	51	57	NE.	NE.	NE.	E.	·15	·04	...	...	·06
28	30·503	30·391	30·25	30·20	30·36	30·33	30·00	54	32	53	50	54	42	50	E.	NE.	NE.	calm	...	...	...	...	...
29	30·486	30·359	30·25	30·25	30·36	30·28	30·06	56	35	52	47	55	40	38	E.	E.	NE.	calm	...	...	...	...	...
☾ 30	30·358	30·318	30·24	30·20	30·28	30·22	29·90	48	28	50	40	51	35	46	NE.	NE.	NE.	calm	...	...	...	...	·03
31	30·316	30·279	30·30	30·30	30·27	30·23	29·79	52	41	51	39	52	43	46·5	SW.	NE.	NW.	calm	·20	...	...	...	...
Aver.:	30·503	29·348	30·35	29·38	30·42	29·35	29·54	70	28	61	39	65	35	50·4					1·60	1·18	3·255	1·690	2·38

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END OF THE FOURTH VOLUME.

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1828.

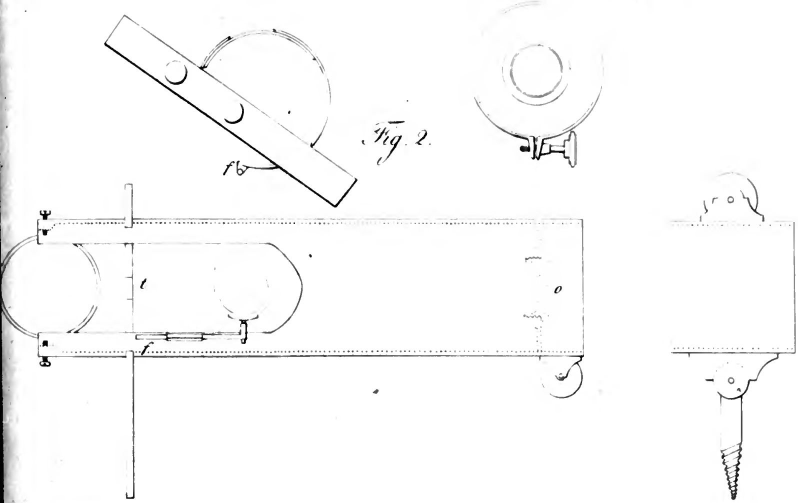
Fig. 2.

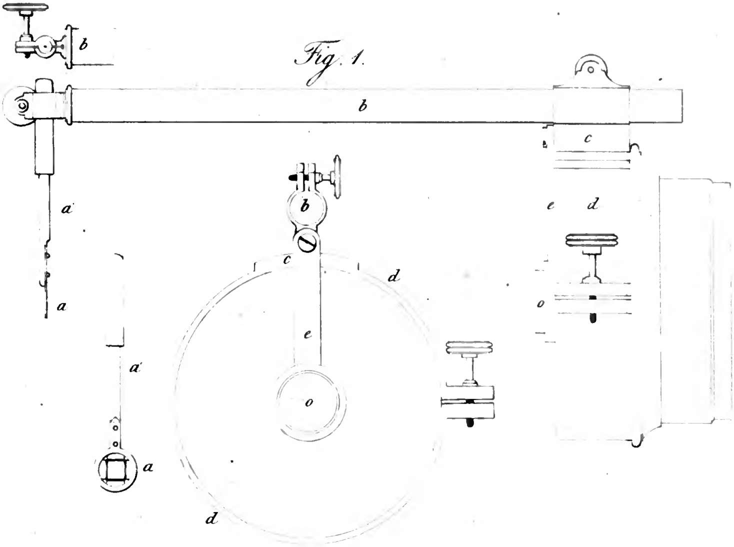
Fig. 1.

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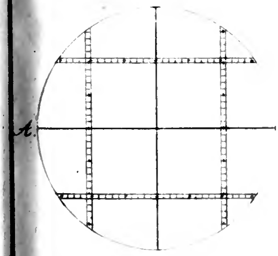

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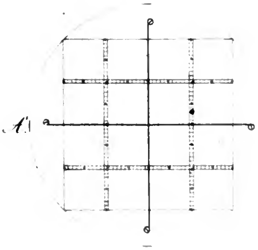

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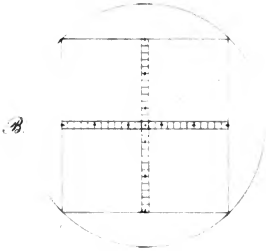
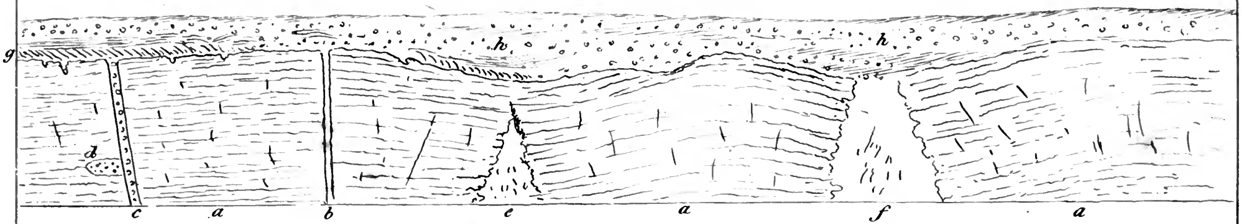
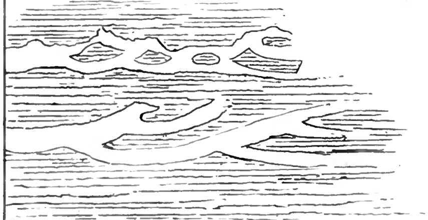


S. Porter sc.



General Appearance of the Quarries at Brotherton

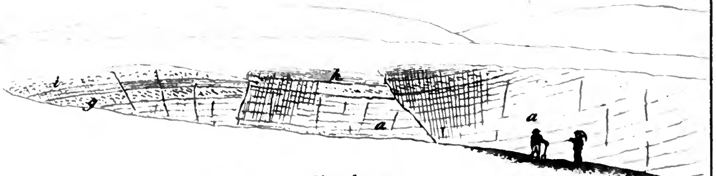
1



Layers of Gypsum in No. 5

3

2



Quarry at Brotherton

J. P. del. 1828.

S. Porter sculp.

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