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SCIENCE AND ARTS.

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PROFESSORS B. SILLIMAN AND B. SILLIMAN, JR.,

AND

JAMES D. DANA.

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SCIENTIFIC INTELLIGENCE.

ERRATA AND ALTERATIONS.

P. 22, l. 14 from bottom, and p. 24, line 17 from top, for "longioribus," *read* "superantibus."—P. 64, line 16 from top, for "bright," *read* "light."—P. 74, line 5 from top, for "Class II," *read* "Class I."—P. 114, after note at bottom, insert Eds.

P. 28, l. 16 from top, for "one hundred and twenty," *read* "twenty."
P. 93, l. 2 from bottom, for "practical relation," *read* "particular reaction."
P. 95, l. 17 from top, insert "the" before "action."
P. 96, l. 2 " " read first formula "O" for "O_2."
P. 96, l. 28 " " for "these," *read* "their."
P. 97, l. 15 from bottom, for "CH_2O," *read* "CH_4O."
P. 99, Note, l. 2 from bottom, for "copsic" *read* "capric."
P. 100, l. 9 from top, for "formics," *read* "formic."
P. 177, l. 7 " " " ("$2+0)-0=1$," *read* "$2+0-1=1$."
P. 177, l. 13 " " " "acids are often found," *read* "acid are often formed."
P. 177, l. 17 " " " "heat," *read* "treat."
P. 177, l. 2 from bottom, for "$C_6(NHO_2)_3{=}O$," *read* $C_6(NHO_2)3O$.
P. 178, l. 7 from bottom, insert "a" before "compound."
P. 180, l. 5 from top, for "hydride," *read* "anhydride."
P. 180, l. 6 " " insert "the" before "anhydride."
P. 181, l. 8 " " insert "an" before "amide."
P. 181, l. 14 " " insert O_2 after H_2.
P. 181, l. 18 " " for "sulphamephylane," *read* "sulphamethylane."
P. 181, l. 18 from bottom, after similarity, *insert* "a."
P. 182, l. 1, after derivatives, *insert* "of."
P. 182, l. 10 from top, insert "this" before "ether."
P. 184, *dele from* "Urea" *in* 4*th line to* "artificially" *in the* 6*th.*
P. 184, l. 10 from top, for "acesenic," *read* "arsenic."
P. 184, l. 13 " " " "chlorainline" and "bichlorainline," *read* "chloraniline" and "bichloraniline."

Vol. iii, p. 295, in the formula of pyroxyline, dele 8HO.

Henry Hall Esq
11½ Tremont

Vol. IV. JULY, 1847. No. 10.

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[SECOND SERIES.]

ART. I.—*On Terrestrial Magnetism;* by WILLIAM A. NORTON, Professor of Mathematics and Natural Philosophy in Delaware College.

I PROPOSE in the present article to show that, adopting certain fundamental conceptions with respect to the terrestrial magnetic forces, the magnetic may be deduced from the thermal elements of the earth. The first investigations tending to establish the existence of a physical connection between the heat and magnetism of the earth, seem to have been made by Sir David Brewster. In 1820 he announced the "discovery of two poles of maximum cold on opposite sides of the north pole of the earth," and in the vicinity of the two magnetic poles; and maintained the probability of some physical connection between the poles of maximum cold, and the magnetic poles. He also proved "that the circle of maximum heat, like the magnetic equator, did not coincide with the equinoctial line; that the isothermal lines and the lines of equal magnetic intensity, had the same general form surrounding and enclosing the magnetic poles and those of maximum cold; and that, by the same formula, *mutatis mutandis,* we could calculate the temperature and the magnetic intensity of any point of the globe." This subject has since been studied by several philosophers; and particularly by Captain Duperrey, and M. Kupffer of Kasan. The original memoirs of these authors I have not seen. The following is the substance of the account which Sir David Brewster gives of their investigations. In the years 1822–1825, Captain Duperrey made an extended system of magnetic observations in the vicinity of the equator, by which he was enabled to trace the magnetic equator, with peculiar accuracy, through an extent of 247° of longitude. In his paper on the magnetic equator, subsequently published, he announced that he had discovered that "the points of this great circle, or those where the magnetic intensity is a minimum, are also the warmest points of each meridian," and thus that "the thermal and magnetic equator are connected, as Sir David Brewster had already proved to be the case with the thermal and magnetic poles;" also, "that in comparing the isothermal and isodynamic lines, he had found a remarkable analogy in their curvatures and particularly in the direction of their concavities, and convexities." M. Kupffer, in certain memoirs read before the Russian Academy about the year 1829, attempted to establish that terrestrial magnetism resides at the surface of the globe, and thence inferred the existence of a connection between the magnetic and thermal phenomena of the earth: conceiving that the intensity of the earth's magnetism would vary directly or inversely as the temperature, according as it was of the nature of permanent or induced magnetism.

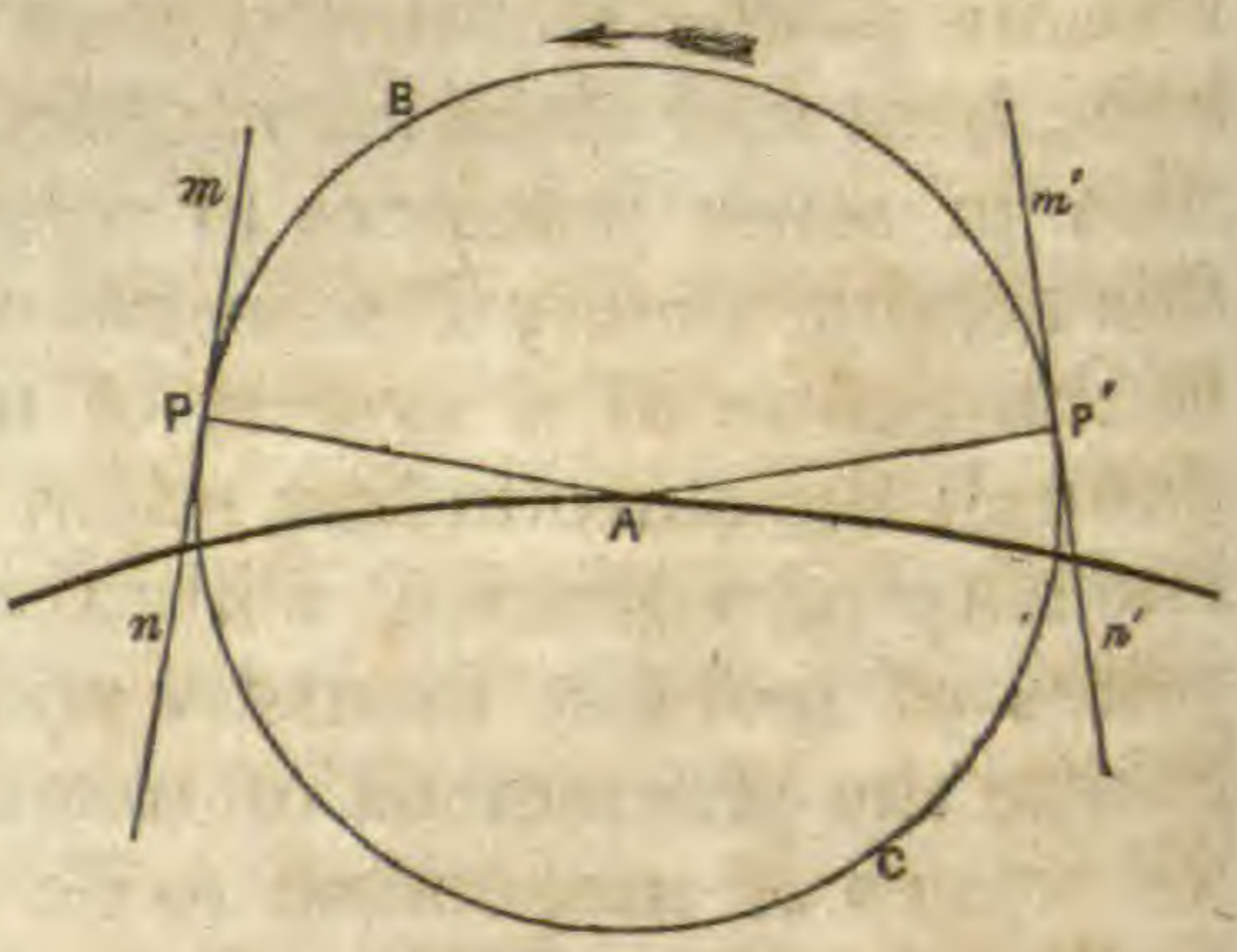
Several conjectures have been formed as to the nature of the connection between the temperature and magnetism of the earth. Dr. Traill has expressed the opinion that "the disturbance of the equilibrium of the temperature of our planet, by the continual action of the sun's rays on its intertropical regions, and by the polar ices, must convert the earth into a vast thermo-magnetic apparatus." Christie has suggested that "difference of temperature may be the primary cause of the polarity of the earth, though its influences may be modified by other circumstances." Œrsted conceives that the sun, by producing evaporation, deoxydation, &c., as well as by increasing the temperature, is the exciting cause of electrical currents, which perpetually traversing the earth's surface in a direction nearly parallel to the equator, give to the earth "a constant magnetic polarity." Perhaps the more generally received theory of the present day concerning the physical nature of the earth's magnetism, is that it consists of thermo-electric currents circulating at or near the earth's surface, induced by the heat of the sun. Prof. Barlow, who adopts this view, conceives that only one link is wanting to complete the explanation of terrestrial magnetism, viz. the discovery of the metallic thermo-magnetic apparatus. Brewster remarks upon this, that "if it could be shown that the action of solar heat is capable of developing magnetism in particles such as those which are known to constitute our globe, the great difficulty would be removed."

In seeking for the explanation of the connection between the magnetic and thermal phenomena of the earth, philosophers seem hitherto to have regarded the heat as only modifying in some in-explicable manner the intensity of the magnetism of the terrestrial particles; or as bearing towards it the relation of cause and effect. But there is another view to be taken of the matter. We may regard the two principles of heat and magnetism as similar in their ultimate physical nature, as every where subsisting together, and that the causes which produce a variation of temperature at the surface of the earth, as we pass from one point to another, occasion at the same time and in like manner a variation of the magnetic intensity of the particles. So that the temperature at each particular place may be taken as the approximate measure of the molecular magnetic intensity there. The conception that I have formed of the probable physical nature of the imponderables, of which I have given an exposition in a paper read before the American Philosophical Society in December last, has led me to take this view of the physical relations subsisting between the heat and magnetism of the earth. This conception is, essentially, that all the phenomena of the imponderables are but different effects of different vibratory motions of the particles of matter, and of the ethereal undulations produced by these vibrations;—the vibrations answering to the different principles of light, heat and electricity, differing in time and intensity, and possibly in some instances in direction, of vibration. Agreeably to this general theory I conceive each particle of the earth's mass to be the centre of a system of undulatory movements propagated through the surrounding ether, and of every variety of time and intensity of vibration within certain limits. To the waves or pulses of feeblest intensity and shortest time of vibration I attribute the phenomena of magnetism; or, at all events, I suppose the waves of magnetism to lie at the opposite extreme from the waves of heat. It thus happens that all the particles of the magnetic needle receive the impulsive actions of the waves of magnetism propagated from the particles of matter at the earth's surface, and at certain depths below the surface;—from how great a depth will depend upon the degree of transparency, to these waves, of the matter of the earth. That the principle of magnetism is incoercible, or that it passes freely through opake bodies of ordinary thickness, has been fully established by the experiments of M. Haldat: and that all the particles of the magnetic needle are subject to the action of the magnetic force of the earth, is evident from the fact that the directive force of the needle is proportional to its mass. Why it is that magnets alone are sensibly influenced by the impulsive actions of the ethereal pulses, I cannot now stop to consider. These theoretical views, I do not here present for the purpose of advocating them, but simply because they furnish a simple and comprehensive conception of the terrestrial magnetic forces and of their relations to the earth's temperature. The mechanical theory of terrestrial magnetism which it is the main design of the present article to exhibit, and apply, although suggested by these views, is not necessarily dependent upon them. The quantitative results arrived at, simply establish the existence of the forces supposed and of the relations conceived to subsist between them and the temperature of the earth. Different views may be entertained of the physical origin of these forces; or, we may rest upon the forces themselves as so many primary properties of matter.

The mechanical theory of the magnetism of the earth, of which I propose to give an exposition, is based upon the following fundamental principles. These were obtained inferentially from the physical theory of terrestrial magnetism which has been briefly explained: but for our present purpose, they may be regarded as mere assumptions, to be tested by the conclusions and results to which they lead.

1. Every particle of matter at the earth's surface, and to a certain depth below the surface, is the centre of a magnetic force exerted tangentially to the circumference of every vertical circle that may be conceived to be traced around it. Thus, if A, fig. 1, be a particle of the earth's mass at or near the surface, P a particle of a magnetic needle, and BPC a circle traced in a vertical plane around A as a centre and passing through P, P will be urged by a force whose line of direction is the tangent *m*P*n*. Whether there are probably tangential forces lying also in oblique planes, I do not here consider. If there are such forces it appears from the results of the investigation that they may be disregarded in the present inquiry. According to the views which have been offered of the probable physical nature of magnetism, the tangential forces here supposed are due to the transversal vibrations of the ethereal waves of magnetism propagated from the point A, and originated by certain vibratory movements of the particle at A.

Fig. 1.



2. The direction of this force will be different according as it solicits the north or south end of the needle; and it is always such, that to the north of the acting particle the north end of the needle is urged downwards and the south end upwards, and that to the south of the same particle the north end is urged upwards and the south end downward. Thus, in fig. 1, if P be to the north of A and P′ to the south of it, at P the north end of a magnetic needle will be solicited to move in the direction P*n*, and the south end in the direction P*m*; and at P′ the north end will be solicited in the direction P′*m*′, and the south end in the

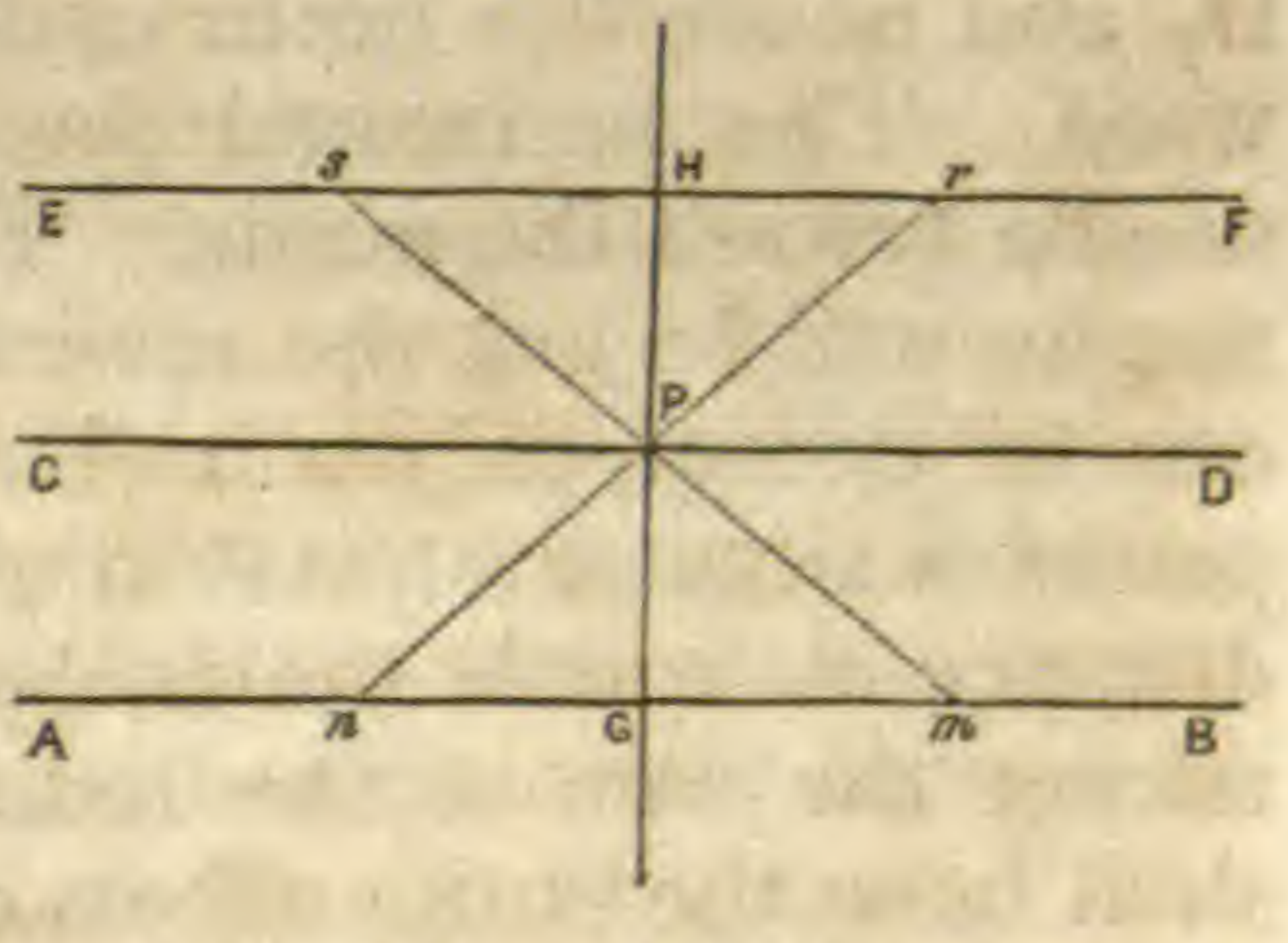
direction P′*n*′. This amounts to saying that the magnetic force of A in its action upon the north end of the needle is directed tangentially in the circle from right to left, as shown by the arrow, and in its action upon the south end of the needle is directed from left to right.

Upon the undulatory theory of magnetism these differences of action are attributable to ethereal waves whose transversal forces of vibration lie in opposite directions, and to certain differences in the magnetic states of the two ends of the needle.

3. The intensity of the magnetic force of a particle of the earth, at a given distance, is assumed to be approximately proportional to its temperature, or amount of sensible heat. This assumption was made under the idea that the sun was the source, at the same time of waves of heat, light and magnetism, and that the molecular forces of vibration due to the different kinds of waves would probably vary according to the same law in passing from one point to another on the earth's surface.

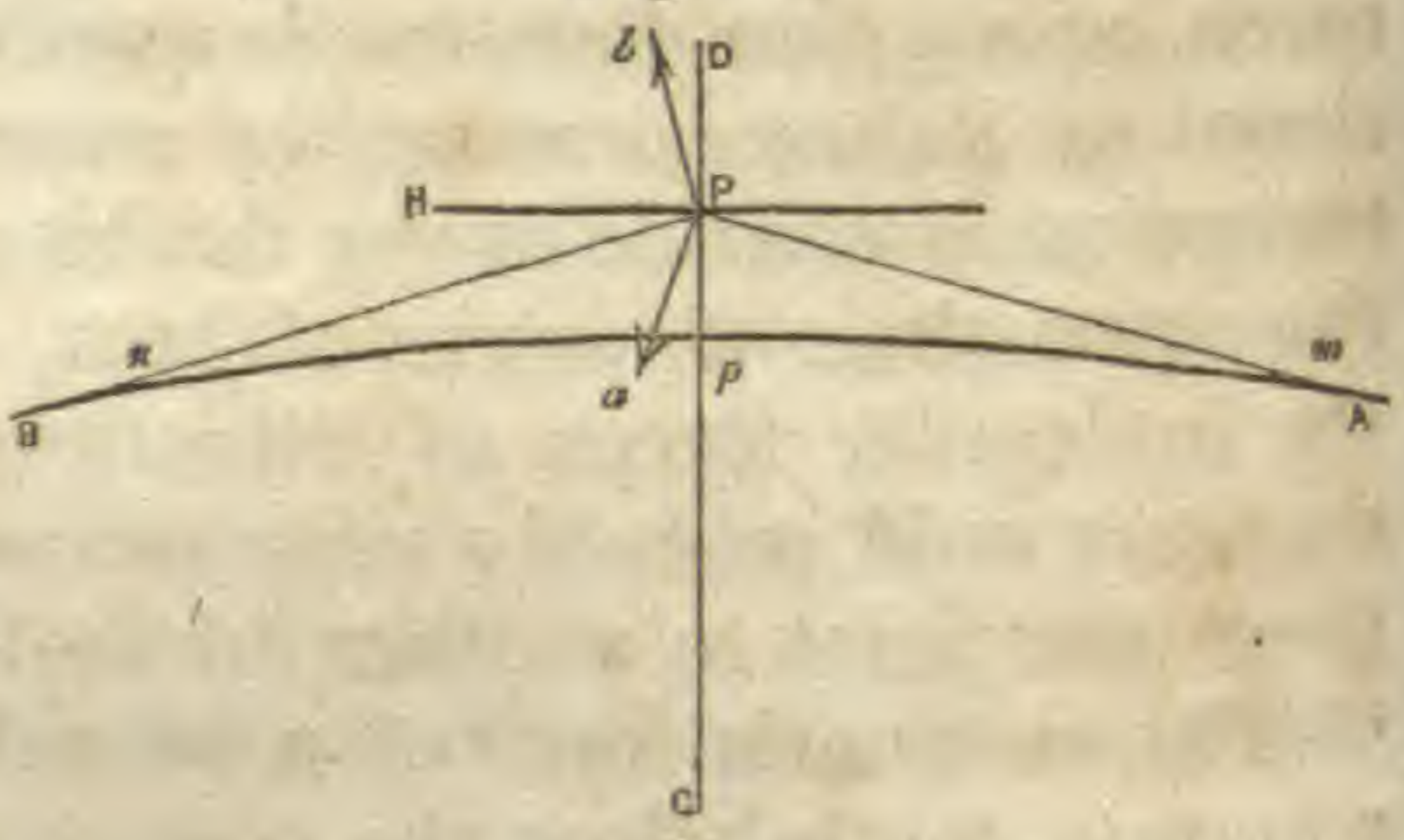
The magnetic force of a particle at the earth's surface, and for a certain depth below the surface, will have a certain mean intensity about which the actual intensity will vary during the day and year, by an amount decreasing with the depth. Beyond a certain depth, the magnetic intensity, like the temperature, will remain the same throughout the year, and will have a value greater than the surface mean in proportion as we descend lower. Lines conceived to be traced on the earth's surface connecting the points where the annual mean magnetic intensity of the particles near the surface is the same, will, according to the present view, coincide with the isogeothermal lines, and very nearly therefore with the isothermal lines. Let then, AB, CD, EF, fig. 2, represent portions of three isogeothermal lines, regarded as parallel to each other, and GPH an arc of a great circle crossing these lines perpendicularly. If we take four points *m*, *n*, *r*, *s*, similarly situated with respect to GPH, the action of the particle *m* upon the north end of a magnetic needle will be perpendicular to *m*P and directed obliquely downward. The action of the particle *n* will be perpendicular to *n*P and also directed obliquely downward. The magnetic forces of the particles *r*, *s*, will be respectively perpendicular to *r*P and *s*P and directed obliquely upward. Now it is evident that while one effect of the action of *m* will be to urge the north end of the needle toward C, the particle *n* will have an equal tendency to urge it toward D. In like manner, the components of the forces of *r* and *s*, which solicit the north end of the needle in the directions PC

Fig. 2.



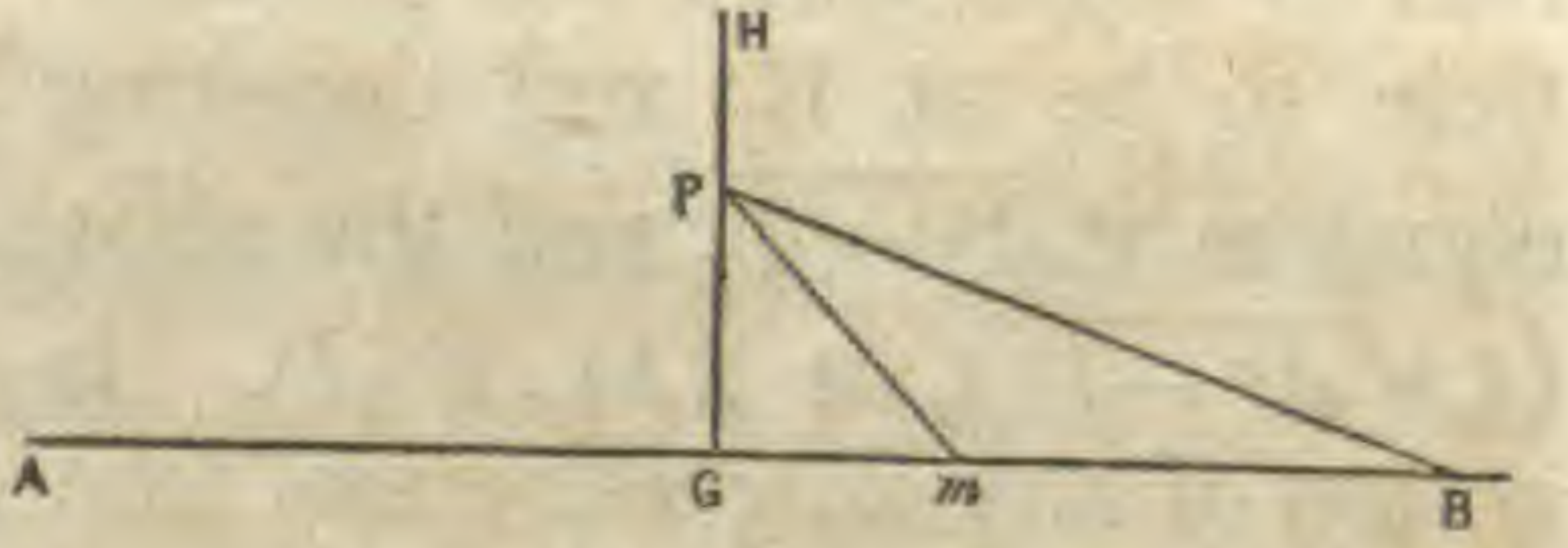
and PD, destroy each other. The same may be shown with regard to the actions upon the south end of the needle. It follows, therefore, that the needle will place itself at right angles to CPD, the isogeothermal line passing through P the station of the needle. This is a consequence from our theory which, like the formulæ soon to be investigated, is to be tested by making comparisons with observations.

Fig. 3.



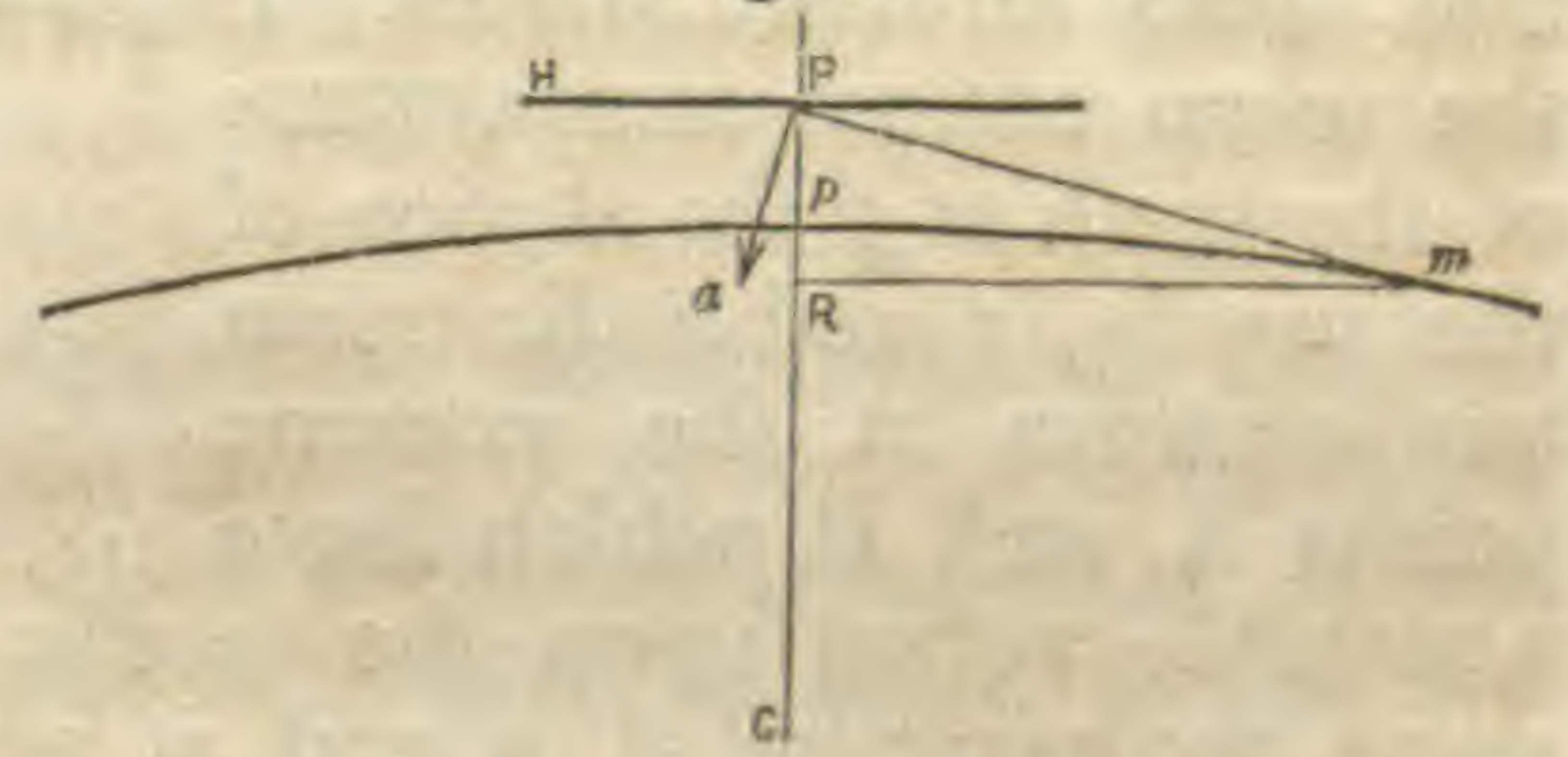
Let us now deduce from the general principles which have been laid down, the horizontal and vertical components of the directive force of the needle. Let ApB, fig. 3, represent a great circle of the earth, answering to mPs, or nPr in fig. 2, Cp its radius, P the north end of a magnetic needle, and m n two particles of the earth situated at equal distances to the north and south of P. The action of m situated to the south of P, will be in the direction Pa perpendicular to mP, and that of n will have the direction Pb perpendicular to nP. The force Pa may be decomposed into two forces having the directions PC and PH; and the force Pb may be decomposed into two having the directions PD and PH. The sum of the two horizontal components will be the effective horizontal force due to the actions of m and n, and the difference of the two vertical components will be the effective vertical force due to the action of the same particles. Since the temperature of m is higher than that of n, the component directed from P to C is greater than that directed from P to D, and hence the north end of the needle will be urged downward. The horizontal force will solicit the north end of the needle toward the north. The actions upon the south end of the needle will be just the reverse. Now if we suppose the same process of decomposition to be gone through with for each pair of particles situated on AB at equal distances from P, up to a certain distance at which the molecular actions become insensible, by taking the sum of the individual forces along PC and PH, we shall have the entire effects of the arc AB in these two directions. In the same manner we may obtain the effects of any arc below AB and situated in the same plane; and thus the entire effect of all the matter situated in this plane which exerts any action upon the needle. Since the curvature of the arc AB is very slight, and P is very near to it, it is only the particles situated quite near to p that will have any material action in the horizontal direction. For arcs below the earth's surface the portion that furnishes the horizontal force will be greater as the depth increases, but will still, doubtless, be small in comparison with the more distant parts which act nearly in the vertical direction upon the needle. If, as we have supposed, the principle of magnetism be analogous in its nature to light and heat, then it must be more or less absorbed in its passage from the lower arcs to the surface; and there may be a gradual decrease in the extent of the arc which exerts a sensible action upon the needle, as the depth of the arc increases, until at the lower surface of the stratum of sensible action it becomes reduced to zero.

Fig. 4.



Formulas for the horizontal and vertical components of the directive force suited to our present enquiry, may be easily investigated. Let AB, fig. 4, be an isogeothermal line, and GH an arc of a great circle crossing this line perpendicularly and passing through P the station of the needle. The magnetic intensity of the particles of AB is every where the same. Take any particle *m* and designate the distance P*m*, in a right line, by *r*. Either end of a needle at P will be solicited by a force perpendicular to P*m*, and in the vertical plane through P*m*. This force will be, for different isogeothermal lines, directly proportional to the magnetic intensity of *m*, and therefore to its mean annual temperature (t); and will, for the same isogeothermal line, vary from one particle to another with the distance *r*. Its expression will therefore be of the form $At\,.\,\varphi$[*](r); A being an indeterminate constant. Now, let *mp*, fig. 5, represent the great circle immediately below *m*P in fig. 4, and lying either on the earth's surface or beneath it. We shall have force P*a*(due to *m*) $= At\,.\,\varphi(r)$. The component of P*a* in the direction of the radius or vertical PC will be equal to $Pa\,.\cos aPC = Pa\,.\sin mPR = Pa\,.\,\varphi'(r, h, R)$; R being the radius of the circle, which may be taken equal to the radius of the earth, and *h* the height P*p* of the needle above the circle. We have therefore for the action of *m* in the direction of the vertical PC, the expression $At\,.\,\varphi(r)\,.\,\varphi'(r, h)$; and when the height *h* is regarded as constant, we have $At\,.\,\varphi(r)\,.\,\varphi'(r)$, or $At\,.\,f(r)$. To obtain the entire effect in the vertical direction of all the particles in the line GB, fig. 4, let GB be denoted by *k*, any portion G*m* of it by *x*, and PG by *l*. The action of an elementary portion of GB will have for its expression $At\,.\,f(r)dx$

Fig. 5.



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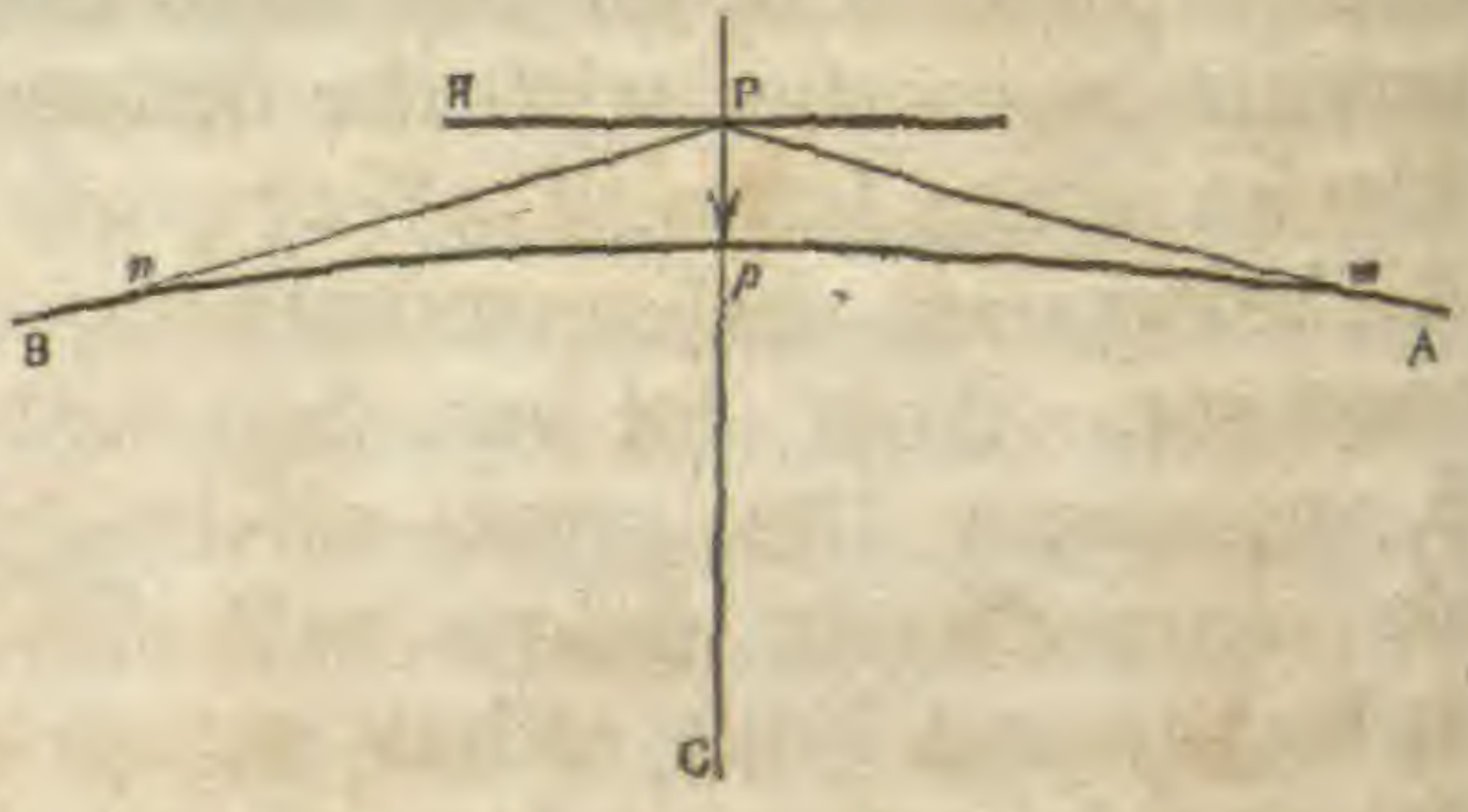
[*] The letters φ, *f*, F, with and without accents, are used in these investigations to designate different functions, and are therefore to be read "a function of."

$=\mathrm{A}tf(\sqrt{l^2+x^2})dx$. Integrating this between the limits 0 and k, we have, vertical action of GB$=\mathrm{A}t\,.\,\mathrm{F}(l, k)$. Whence, vertical action of AB$=2\mathrm{A}t\,.\,\mathrm{F}(l, k)$. If k may be taken sensibly the same for different isogeothermal lines, this expression will become $2\mathrm{A}t\,.\,\mathrm{F}(l)$. It is to be supposed, however, that the last particle of GB, which has a sensible action upon the needle at P, is at the same distance from this point whatever may be the distance of AB from it. The value of k will therefore be less, in proportion as the distance l is greater. Supposing the most remote particle to be at B, and denoting its distance PB by d, k will be equal to $\sqrt{d^2-l^2}$, and the above expression will become $2\mathrm{A}t\,.\,\mathrm{F}(l, \sqrt{d^2-l^2})$, or $2\mathrm{A}t\,.\,\mathrm{F}'(l)$. It follows therefore that the entire action of any isogeothermal line AB in the vertical direction upon a needle at P, may be reduced to a single force, proportional to the temperature, and varying from one isogeothermal line to another, with the distance PG of this line from the station of the needle. The entire effect of any single lamina of matter will therefore be the same as if the action was confined to the particles lying in the arc GPH; the effective force of each particle being proportional to its temperature, and also a certain function of its distance from the needle.

Fig. 6.



This being understood, let AB, fig. 6, represent an arc crossing the parallel isogeothermal lines at right angles, T the mean annual temperature of the earth at p the station of the needle, t and t' the mean temperatures at the extreme points A and B which have a sensible action upon the needle, u the difference between the mean temperature at p and at any point m, y the arc pm, a the arc pA, and r the distance Pm. pm or y may be regarded as depending for its value upon Pm, Pp, and Cp; of which Pp and Cp are constant for the same arc. Thus for any one arc, (representing, according to what has been shown, a single lamina,) $y=\varphi(r)$. If we regard the variation of temperature as uniform for the extent of the arc AB

$$u : t-\mathrm{T} : : y : a \therefore u=(t-\mathrm{T})\frac{y}{a}=(t-\mathrm{T})\frac{\varphi(r)}{a}.$$

Thus, temperature at $m=\mathrm{T}+(t-\mathrm{T})\dfrac{\varphi(r)}{a}$.

Whence, putting $v=$ vertical force due to an element dy at m, and taking the expression for the action of an isogeothermal line, and incorporating the 2 with the constant A,

$$dv = \mathrm{A}\left(\mathrm{T}+(t-\mathrm{T})\frac{\varphi(r)}{a}\right)\mathrm{F}'(r)dy = \mathrm{A}\left(\mathrm{T}+(t-\mathrm{T})\frac{\varphi(r)}{a}\right)\mathrm{F}'(r)d\varphi(r)$$

$$= \mathrm{AT}\,.\,\mathrm{F}'(r)d\varphi(r)+\mathrm{A}(t-\mathrm{T})\frac{\varphi(r)}{a}\mathrm{F}'(r)d\varphi(r).$$

Integrating, $v = \mathrm{AT}\int \mathrm{F}'(r)d\varphi(r)+\mathrm{A}(t-\mathrm{T})\int\frac{\varphi r}{a}\mathrm{F}'(r)d\varphi(r).$

Integrating between the limits Pp and PA, to obtain the force due to the arc pA, the two integrals will become two functions of Pp and PA. Now, for any supposed value of Pp, PA will be the same at every different place on the earth, and therefore the values of these integrals will be every where the same. If we denote them by M and N, we have

$$v = \mathrm{ATM}+\mathrm{A}(t-\mathrm{T})\mathrm{N} = \mathrm{AM}\,.\,\mathrm{T}+\mathrm{AN}(t-\mathrm{T}).$$

By the same process we obtain for the vertical force due to the arc pB $v' = \mathrm{AM}\,.\,\mathrm{T}+\mathrm{AN}(t'-\mathrm{T})$.

Hence the expression for the effect of the whole arc, AB, is

$$v-v' = \mathrm{AN}(t-t') = c(t-t') \quad . \quad . \quad . \quad (1.)$$

If we consider the action of a second lamina, the value of c may be different, but $t-t'$ will remain very nearly the same, except at considerable depths where the rate of variation of the temperature may be different, or the arc AB may be diminished by the absorption of the ethereal waves in their passage to the surface. If we neglect these possible variations of $t-t'$, and add together the actions of the different laminæ, we obtain for the actual vertical force

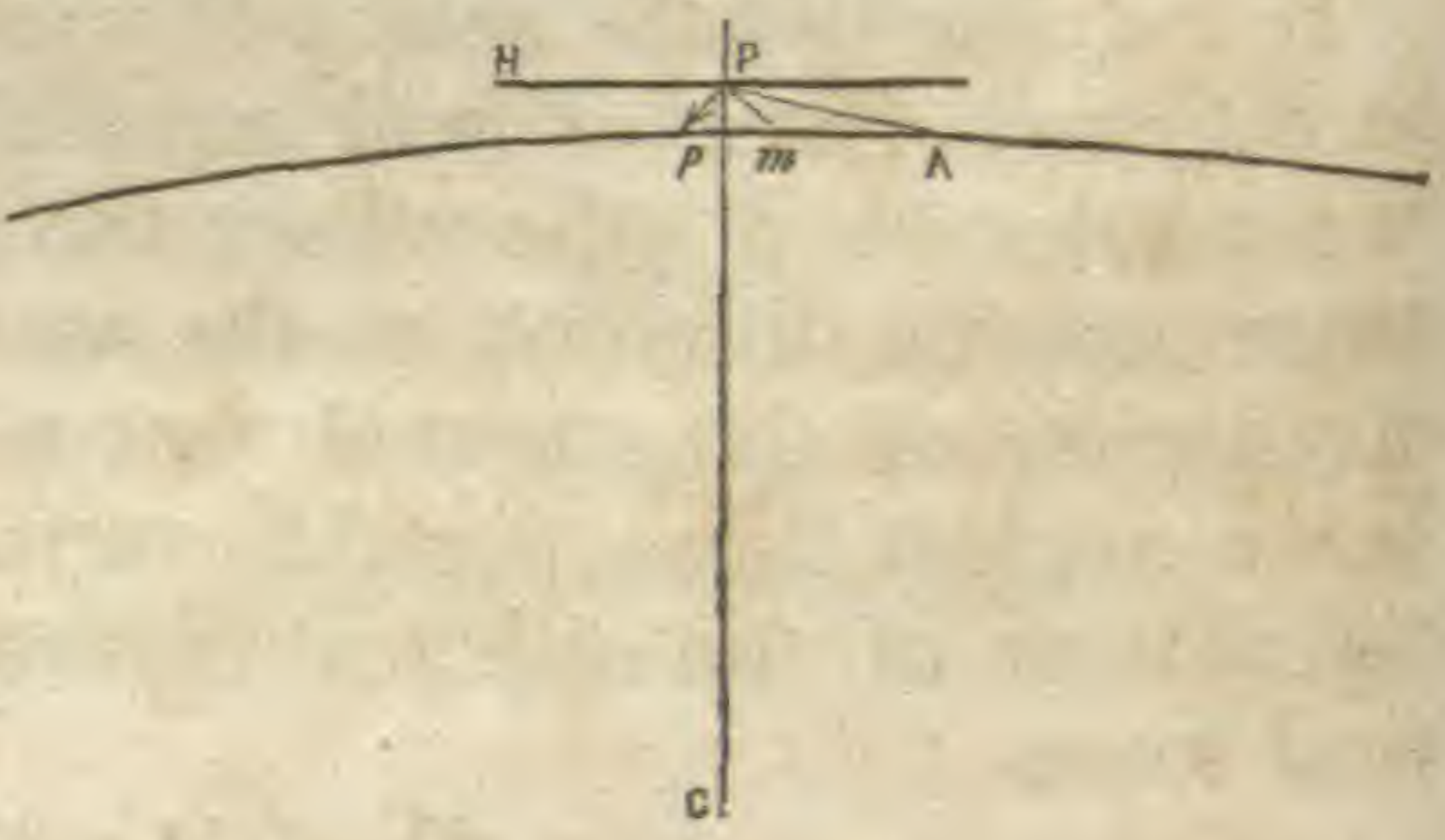
$$\mathrm{V} = \mathrm{C}(t-t') \quad . \quad . \quad . \quad (2.)$$

in which C is the sum of the values of c for the different laminæ. If we take account of the variations of $t-t'$, we shall have the actual force equal to the sum of a series of expressions of the form $c(t-t')$ in which both c and $t-t'$ will be more or less different. It would seem, however, that the changes in the value of $t-t'$, from absorption or other causes, must be very slight. In fact if the absorption be always a certain fractional amount of the intensity, there will be no change of $t-t'$ from this cause. It will only be necessary to regard c as varying. And if the absorption be always the same fractional amount whatever may be the intensity, c and therefore C will have the same value at different places.

The supposition made in the investigation of formula (2), that the variation of temperature is uniform for the extent of the arc AB, is not strictly true. From the equator to the latitude 45°, and even beyond this, the rate of diminution of the temperature for every degree of latitude continually increases. The effect of this will be to make the vertical component somewhat greater, except in the higher latitudes, than formula (2) would give it, (that is, supposing C to be determined à priori. If C be determined from observations made at the point of maximum variation of temperature, the values of V given by equation (2) will be too small south of this point and too great north of it.)

To obtain a formula for the horizontal component of the directive force, we may proceed in the same manner as for the vertical component, except that we now multiply the force Pa, fig. 5, by the cosine of the angle aPH instead of aPC. We shall therefore have for the entire action of the isogeothermal line AB, fig. 4, the expression $A't \,.\, F''(l)$. Hence, that of all the isogeothermal lines, or of the whole acting surface, will be reduced to that of the single arc which crosses these lines at right angles; the magnetic intensity of the different points of this arc being proportional to the temperature, and the effective forces upon the needle varying according to some function of the distance. Now, as in the present enquiry all the active particles lie quite near to P, their temperatures may be considered the same and equal to that of the earth at the station of the needle: or, if there is a sensible variation at the lower layers, the augmentation towards the south will be compensated for by an equal diminution towards the north. Hence, designating the arc pm, fig. 7, by y, and the distance Pm by r, the expression for the horizontal force due to this arc is

Fig. 7.



$$\int dh = \int A'T \,.\, F''(r)dy = A'T \int F''(r)d\varphi(r).$$

Integrating between the limits $r = \mathrm{P}p$ and $r = \mathrm{PA}$, and designating the value of the integral by P, we have

$$H' = A'T \,.\, P;\ 2H' = 2A'P \,.\, T$$

and thus finally the total horizontal force

$$H = C'T \qquad . \quad . \quad . \qquad (3.)$$

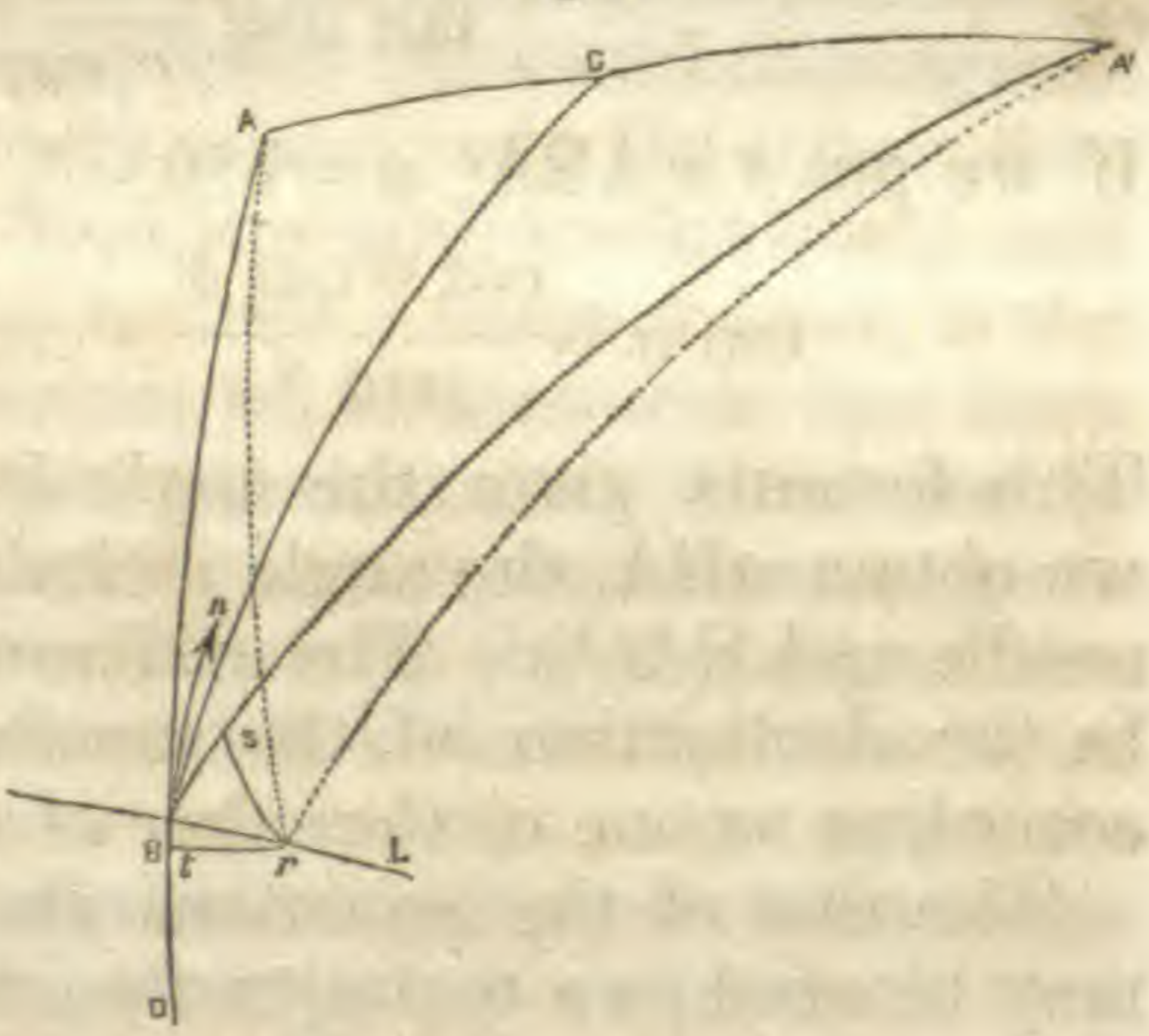
This is the expression for the entire effect of a single lamina. For different laminæ C′ may be different; and beyond a certain depth T will increase. If the supposed absorption of the magnetic emanations be a certain constant fractional amount of the magnetic intensity of the molecules, C′ will be every where the same. If we take the sum of all the equations (3) answering to the different laminæ, we shall have an equation of the same form for the horizontal component of the directive force, or the horizontal intensity at P. It is only by comparing the results furnished by this equation, with observations, that we can ascertain with certainty whether T is to be taken sensibly different from the mean surface temperature, and whether C′ may be regarded as truly constant for all places.

It remains to investigate a formula for the declination of the needle. We have already seen that the magnetic needle is every where at right angles to the line of equal molecular magnetic intensity traced upon the earth through its station; which line we have assumed to be the same as the isogeothermal line passing through the same point. We have therefore only to seek for a formula which shall make known the direction of the isogeothermal line at a given place and place the needle at right angles to this line of direction. Such a formula may be derived from Brewster's formula for the determination of the mean annual temperature of a place. This is

$$T=(t-\tau)(\sin^n\delta\,.\,\sin^n\delta')+\tau \quad . \quad . \quad (4.)$$

where t is the maximum equatorial temperature, τ the minimum temperature at each of the two poles of maximum cold, and δ, δ' the distances of the place from the two cold poles. Let C, fig. 8, represent the north pole of the earth, A and A′ the two poles of greatest cold, B a given place, BL the direction of the isogeothermal line through B. $BA=\delta$, and $BA'=\delta'$. For the isogeothermal line, since T is constant, $dT=0$. Hence, if we differentiate equation (4), and put the differential equal to zero, we shall have a relation between $d\delta$ and $d\delta'$, the variations of δ and δ' in passing from the point B to its consecutive point r on the isogeothermal line. Thus, putting $t-\tau=c$, we have

Fig. 8.



$$dT=c(n\sin^{n-1}\delta\cos\delta\sin^n\delta' d\delta+n\sin^{n-1}\delta'\cos\delta'\sin^n\delta d\delta').$$

Multiplying and dividing by $\sin^{-n+1}\delta\sin^{-n+1}\delta'$,

$$dT=\frac{c(n\cos\delta\sin\delta' d\delta+n\cos\delta'\sin\delta d\delta')}{\sin^{-n+1}\delta\sin^{-n+1}\delta'}=0.$$

Hence, $$\cos\delta\sin\delta' d\delta+\cos\delta'\sin\delta d\delta'=0$$

And, $$\frac{d\delta}{d\delta'}=-\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} \quad . \quad . \quad . \quad (5.)$$

If we drop the perpendiculars rs and rt upon BA′ and BA produced, we have $Bt=d\delta$, and $Bs=d\delta'$. Put $Br=k$, angle $rBt=a$, and angle $rBs=a'$. If in the angle A′BD we conceive two arcs to be drawn through B respectively perpendicular to BA′ and BD, the isogeothermal line will lie some where between these two perpendiculars; for it is only in this situation that in passing from

B to r it can happen that δ will be increased and δ' diminished, and therefore that $\sin^n\delta \sin^n\delta'$, in formula (4), can remain the same. Now $Bs = Br \cos rBs$, or $d\delta' = k \cos a'$; and $Bt = Br \cos rBt$, or $d\delta = k \cos a$. Hence $\frac{d\delta}{d\delta'} = \frac{\cos a}{\cos a'}$; and, by equation (5), neglecting the minus sign; putting also u=angle A′BD,

$$\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} = \frac{\cos a}{\cos a'} = \frac{\cos a}{\cos(u-a)},$$

or,

$$\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} = \frac{\cos a}{\cos u\cos a + \sin u\sin a} = \frac{1}{\cos u + \sin u\tan a}.$$

Whence,

$$\tan a = \frac{\sin\delta'\cos\delta - \sin\delta\cos\delta'\cos u}{\sin\delta\cos\delta'\sin u},$$

or,

$$\tan a = \frac{\cot\delta\tan\delta'}{\sin u} - \cot u.$$

If we put β=ABA′ $u = 180 - \beta$, and

$$\tan a = \frac{\cot\delta\tan\delta'}{\sin\beta} + \cot\beta \quad . \quad . \quad . \quad (6.)$$

This formula gives the angle DBL. Subtracting this from 90° we obtain nBA, the angle included between the direction of the needle and BA(δ). The difference between this and ABC will be the declination of the needle, which will be east or west, according as one or the other of these angles is the greater.

The first of the equations above gives the following, which may be used as a tentative formula in place of equation (6):—

$$\frac{\cos a}{\cos(u-a)} = \frac{\tan\delta}{\tan\delta'} \quad . \quad . \quad . \quad . \quad (7.)$$

To make use of formula (6) we must know δ, δ', and β. These may be obtained by solving the two spherical triangles ACB, A′CB. The latitude and longitude of the place B, and the latitudes and longitudes of the two poles A and A′ being given, we readily find CB, AC, and A′C, and the angles ACB, A′CB.

The formulæ which have now been investigated, viz. (2), (3), and (6), serve for the determination of the vertical and horizontal intensities at any place, and the declination of the needle. By taking the square root of the sum of the squares of the horizontal and vertical intensities, we shall have the directive force or total magnetic intensity of the place; and by dividing the vertical by the horizontal intensity we shall have the tangent of the dip.

These formulæ I have compared with a large number of observations made in various parts of the northern hemisphere, and will proceed to give an exposition of the details of the calculations, and of the results obtained.

(*To be continued.*)

ART. II.—*General Geological Distribution and probable Food and Climate of the Mammoth;* by Prof. R. OWEN.[*]

THE remains of the Mammoth occur on the Continent, as in England, in the superficial deposits of sand, gravel, and loam, which are strewed over all parts of Europe; and they are found in still greater abundance in the same formations of Asia, especially in the higher latitudes, where the soil which forms their matrix is perennially frozen.[†] Remains of the Mammoth have been found in great abundance in the cliffs of frozen mud on the east side of Behring's Straits, in Eschscholtz's Bay, in Russian America, 66° N. lat.; and they have been traced, but in scantier quantities, as far south as the states of Ohio, Kentucky, Missouri, and South Carolina. But no authentic relics of the Elephas primigenius have yet been discovered in tropical latitudes,[‡] or in any part of the southern hemisphere. It would thus appear that the primeval Elephants formerly ranged over the whole northern hemisphere of the globe, from the 40th to the 60th, and possibly to near the 70th degree of latitude. Here at least, at the mouth of the river Lena, the carcass of a Mammoth has been discovered, preserved entire, in the icy cliffs and frozen soil of that coast. To account for this extraordinary phenomenon, geologists and naturalists, biased more or less by the analogy of the existing Elephants, which are restricted to climes where the trees flourish with perennial foliage, have had recourse to the hypothesis of a change of climate in the northern hemisphere, either sudden, and due to a great geological cataclysm,[§] or gradual, and brought about by progressive alterations of land and sea.[‖]

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[*] Extracted from Prof. Owen's British Fossil Mammalia, 8vo. London, 1846.

[†] Hedenström, in his "Survey of the Laechow Islands," on the north-eastern coast of Siberia, remarks, "that the first of these islands is little more than one mass of these bones; and that although the Siberian traders have been in the habit of bringing over large cargoes of them (tusks) for upwards of sixty years, yet there appears to be no sensible diminution."

[‡] The fossil elephantine remains discovered in India, belong to a species more nearly allied to the Elephas indicus.

[§] Cuvier, "Discours sur les Révolutions de la Surface du Globe." It is obvious that the frozen Mammoth at the mouth of the Lena, forms one of the strongest, as well as the most striking, of the celebrated anatomist's assumed "proofs that the revolutions on the earth's surface had been sudden." Cuvier affirms that the Mammoth could not have maintained its existence in the low temperature of the region where its carcass was arrested, and that at the moment when the beast was destroyed, the land which it trod became glacial. "Cette gelée éternelle n'occupait pas auparavant les lieux où ils out été saisis; car ils n'auraient pas pu vivre sous une pareille température. C'est donc le même instant qui a fait périr les animaux, et qui a rendu glacial le pays qu'ils habitaient. Cet événement a été subis, instantané, sans aucune gradation, &c."—*Ossemens Fossiles*, 8vo, ed. 1834, tom. i, p. 108.

[‖] Lyell, "Principles of Geology," in which the phenomena that had been supposed "to have banished for ever all idea of a slow and gradual revolution,"[*] were first attempted to be accounted for by the gradual operation of ordinary and existing causes.

[*] Jameson's "Cuvier's Theory of the Earth," 8vo, p. 16, 1813.

I am far from believing that such changes in the external world were the cause of the ultimate extinction of the Elephas primigenius; but I am convinced that the peculiarities in its ascertained organization, are such as to render it quite possible for the animal to have existed as near the pole as is compatible with the growth of hardy trees or shrubs. The fact seems to have been generally overlooked, that an animal organized to gain its subsistence from the branches or woody fibre of trees, is thereby rendered independent of the seasons which regulate the development of leaves and fruit; the forest food of such a species becomes as perennial as the lichens that flourish beneath the winter snows of Lapland; and, were such a quadruped to be clothed, like the Reindeer, with a natural garment capable of resisting the rigors of an arctic winter, its adaptation for such a climate would be complete. Had our knowledge of the Mammoth, indeed, been restricted, as in the case of almost every other extinct animal, to its bones and teeth, it would have been deemed a hazardous speculation to have conceived, a priori, that the extinct ancient Elephant, whose remains were so abundant in the frozen soil of Siberia, had been clad, like most existing quadrupeds adapted for such a climate, with a double garment of close fur and coarse hair; seeing that both the existing species of Elephants are almost naked, or, at least, scantily provided when young with scattered coarse hairs of one kind only.

The wonderful and unlooked for discovery of an entire Mammoth, demonstrating the arctic character of its natural clothing, has, however, confirmed the deductions which might have been legitimately founded upon the localities of its most abundant remains, as well as upon the structure of its teeth, viz., that, like the Reindeer and Musk Ox of the present day, it was capable of existing in high northern latitudes.

The circumstances of this discovery have been recorded by Mr. Adams in the 'Journal du Nord,' printed at Petersburg in 1807, and in the 5th volume of the 'Memoirs of the Imperial Academy of Sciences at St. Petersburg,' of which an excellent English translation was published in 1819.

Schumachoff, a Tungusian hunter and collector of fossil ivory, who had migrated in 1799 to the peninsula of Tamut, at the mouth of the river Lena, one day perceived amongst the blocks of ice a shapeless mass, not at all resembling the large pieces of floating wood which are commonly found there. To observe it nearer, he landed, climbed up a rock, and examined this new object on all sides, but without being able to discover what it was. The following year he perceived that the mass was more disengaged from the blocks of ice, and had two projecting parts. Towards the end of the next year, (1801,) the entire side of the animal and one its tusks were quite free from the ice. On his return to the borders of the Lake Oncoul, he communicated this extraordinary discovery to his wife and some of his friends, but their reception of the news filled him with grief. The old men related how they had heard their fathers say, that a similar monster had been formerly discovered on the same peninsula, and that all the family of the person who had discovered it had died soon afterwards. The Mammoth was consequently regarded as an augury of future calamity, and the Tungusian was so much alarmed that he fell seriously ill; but becoming convalescent, his first idea was the profit he might obtain by selling the tusks of the animal, which were of extraordinary size and beauty. The summer of 1802 was less warm and more stormy than usual, and the icy shroud of the Mammoth had scarcely melted at all. At length, towards the end of the fifth year, (1803,) the desires of the Tungusian were fulfilled; for, the parts of the ice between the earth and the Mammoth having melted more rapidly than the rest, the plane of its support became inclined, and the enormous mass fell by its own weight on a bank of sand. Of this, two Tungusians who accompanied Mr. Adams were witnesses. In the month of March, 1804, Schumachoff came to his Mammoth, and having cut off the tusks, exchanged them with a merchant, called Bultunoff, for goods of the value of fifty rubles.

Two years afterwards, or the seventh after the discovery of the Mammoth, Mr. Adams visited the spot, and "found the Mammoth still in the same place, but altogether mutilated. The prejudices being dissipated because the Tungusian chief had recovered his health, there was no obstacle to prevent approach to the carcass of the Mammoth; the proprietor was content with his profit from the tusks; and the Jakutski of the neighborhood had cut off the flesh, with which they fed their dogs during the scarcity. Wild beasts, such as white bears, wolves, wolverines, and foxes, also fed upon it, and the traces of their footsteps were seen around." The skeleton, almost entirely cleared of its flesh, remained whole with the exception of one foreleg, (probably dragged off by the bears.) The spine, from the skull to the os coccygis, one scapula, the pelvis, and the three remaining extremities, were still held together by the ligaments and by parts of the skin. The head was covered with a dry skin; one of the ears, well preserved, was furnished with a tuft of hair. The point of the lower lip had been gnawed; and the upper one, with the proboscis, having been devoured, the molar teeth could be perceived. The brain was still in the cranium, but appeared dried up: the parts least injured were one forefoot and one hindfoot: they were covered with skin, and still had the sole attached. According to the assertion of the Tungusian discoverer, the animal was so fat, that its belly hung down below the joints of the knees. This Mammoth was a male, with a long mane on the neck; the tail was much mutilated, only eight, out of twenty-eight or thirty caudal vertebræ, remaining; the proboscis was gone, but the places of the insertion of its muscles were visible on the skull. The skin, of which about three-fourths were saved, was of a dark grey color, covered with a reddish wool, and coarse long black hairs. The dampness of the spot where the animal had lain so long, had in some degree destroyed the hair. The entire skeleton, from the fore part of the skull to the end of the mutilated tail, measured sixteen feet four inches; its height was nine feet four inches. The tusks measured along the curve nine feet six inches, and in a straight line from the base to the point, three feet seven inches.

Mr. Adams collected the bones, and had the satisfaction to find the other scapula, which had remained, not far off. He next detached the skin on the side on which the animal had lain, which was well preserved; the weight of the skin was such, that ten persons found great difficulty in transporting it to the shore. After this, the ground was dug in different places to ascertain whether any of its bones were buried, but principally to collect all the hairs which the white bears had trod into the ground while devouring the flesh; and more than thirty-six pounds' weight of hair were thus recovered. The tusks were repurchased at Jatusk, and the whole expedited thence to St. Petersburg; the skeleton is now mounted in the museum of the Petropolitan Academy.[*]

It might have been expected that the physiological consequences deducible from the organization of the extinct species, which was thus in so unusual a degree brought to light, would have been at once pursued to their utmost legitimate boundary, in proof of the adaptation of the Mammoth to a Siberian climate; but, save the remark that the hairy covering of the Mammoth must have adapted it for a more temperate zone than that assigned to existing Elephants,[†] no further investigations of the relation of its organization to its habits, climate, and mode of life,

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[*] A part of the skin and some of the hair of this animal, were sent by Mr. Adams to Sir Joseph Banks, who presented them to the Museum of the Royal College of Surgeons. The hair is entirely separated from the skin, excepting in one small part, where it still remains firmly attached. It consists of two sorts, common hair and bristles; and of each there are several varieties, differing in length and thickness. That remaining fixed on the skin is thick-set and crisply curled; it is interspersed with a few bristles, about three inches long, of a dark reddish color. Among the separate parcels of hair are some rather redder than the short hair just mentioned, about four inches long, and some bristles nearly black, much thicker than horse-hair, and from twelve to eighteen inches long. The skin when first brought to the Museum, was offensive to the smell. It is now quite dry and hard, and where most compact is half an inch thick. Its color is the dull black of the living Elephant.

[†] "La longue toison dont cet animal était convert semblerait même démontrer, qu'il était organisé pour supporter un degré de froid plus grand que celui qui convient à l'éléphant de l'Inde."—*Pictet, Paleontologie*, 8vo, tom. i, p. 71, 1844.

appear to have been instituted; they have in some instances, indeed, been rather checked than promoted.

Dr. Fleming has observed, that "no one acquainted with the gramineous character of the food of our Fallow-deer, Stag, or Roe, would have assigned a lichen to the Reindeer." But we may readily believe that any one cognizant of the food of the Elk, might be likely to have suspected cryptogamic vegetation to have entered more largely into the food of a still more northern species of the deer tribe. And I can by no means subscribe to another proposition by the same eminent naturalist, that "the kind of food which the existing species of Elephant prefers, will not enable us to determine, or even to offer a probable conjecture concerning that of the extinct species." The molar teeth of the Elephant possess, as we have seen, a highly complicated and a very peculiar structure, and there are no other quadrupeds that derive so great a proportion of their food from the woody fibre of the branches of trees. Many mammals browse the leaves; some small rodents gnaw the bark; the Elephants alone tear down and craunch the branches, the vertical enamel plates of their huge grinders enabling then to pound the tough vegetable tissue and fit it for deglutition. No doubt the foliage is the most tempting, as it is the most succulent part of the boughs devoured; but the relation of complex molars to the comminution of the coarser vegetable substance is unmistakeable. Now if we find in an extinct Elephant the same peculiar principle of construction in the molar teeth, but with augmented complexity, arising from a greater number of the triturating plates and a greater proportion of the dense enamel, the inference is plain that the ligneous fibre must have entered in a larger proportion into the food of such extinct species. Forests of hardy trees and shrubs still grow upon the frozen soil of Siberia, and skirt the banks of the Lena as far north as latitude 60°. In Europe, arboreal vegetation extends ten degrees nearer the pole, and the dental organization of the Mammoth proves that it might have derived subsistence from the leafless branches of trees, in regions covered during a great part of the year with snow.

We may therefore safely infer from physiological grounds, that the Mammoth would have found the requisite means of subsistence at the present day, and at all seasons, in the sixtieth parallel of latitude; and relying on the body of evidence adduced by Mr. Lyell in proof of increased severity in the climate of the northern hemisphere, we may assume that the Mammoth habitually frequented still higher latitudes at the period of its actual existence. "It has been suggested," observes the same philosophic writer, "that, as in our own times, the northern animals migrate, so the Siberian Elephant and Rhinoceros may have wandered towards the north in summer." In making such excursions during the heat of that brief season, the Mammoths would be arrested in their northern progress by a condition to which the Reindeer and Musk Ox are not subject, viz. the limits of arboreal vegetation, which, however, as represented by the dominating shrubs of Polar lands, would allow them to reach the seventieth degree of latitude.* But, with this limitation, if the physiological inferences regarding the food of the Mammoth from the structure of its teeth be adequately appreciated and connected with those which may be legitimately deduced from the ascertained nature of its integument, the necessity of recurring to the forces of mighty rivers hurrying along a carcass through a devious course, extending through an entire degree of latitude, in order to account for its ultimate entombment in ice, whilst so little decomposed as to have retained the cuticle and hair, will disappear. And it can no longer be regarded as impossible for herds of Mammoth to have obtained subsistence in a country like the southern part of Siberia where trees abound, notwithstanding it is covered during a great part of the year with snow, seeing that the leafless state of such trees during even a long and severe Siberian winter, would not necessarily unfit their branches for yielding sustenance to the well-clothed Mammoth.

With regard to the extension of the geographical range of the Elephas primigenius into temperate latitudes, the distribution of its fossil remains, teaches that it reached the fortieth degree north of the equator. History, in like manner, records that the Reindeer had formerly a more extensive distribution in the temperate latitudes of Europe than it now enjoys. The hairy covering of the Mammoth concurs, however, with the localities of its most abundant remains, in showing that, like the Reindeer, the northern extreme of the temperate zone was its metropolis.

Attempts have been made to account for the extinction of the race of northern Elephants, by alterations in the climate of their hemisphere, or by violent geological catastrophes, and the like extraneous physical causes. When we seek to apply the same hypothesis to explain the apparently contemporaneous extinction of the gigantic leaf-eating Megatherian of South America, the geological phenomena of that continent appear to negative the occurrence of such destructive changes. Our comparatively brief experience of the progress and duration of species within the historical period, is surely insufficient to justify, in every case of extinction, the verdict of violent death. With regard to many of the larger Mammalia, especially those which have passed away from the American and Australian continents, the absence of suffi-

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* In the extreme points of Lapland, in 70° north latitude, the pines attain the height of sixty feet; and at Enontekessi, in Lapland, in 68° 30′ north latitude, von Buch found corn, orchards, and a rich vegetation at an elevation of 1356 feet above the sea.—*Lindley, Intr. to Botany*, pp. 435, 490.

cient signs of extrinsic extirpating change or convulsion, makes it almost as reasonable to speculate with Brocchi,[*] on the possibility that species like individuals may have had the cause of their death inherent in their original constitution, independently of changes in the external world, and that the term of their existence, or the period of exhaustion of the prolific force, may have been ordained from the commencement of each species.

ART. III.—*Note upon Carex loliacea,* Linn., *and C. gracilis,* Ehrh.; by A. GRAY.

UNDER the name of *Carex loliacea,* two distinct species have long been confounded, which, although they have been of late to some extent distinguished, yet their history and synonymy still require elucidation.

Linnæus established his *C. loliacea* upon a Swedish plant, indicated in the *Flora Suecica,* No. 840, to which the specific name was first applied in the *Species Plantarum,* with the phrase: "C. spiculis subovatis sessilibus remotis androgynis, capsulis ovatis teretiusculis muticis divaricatis." He further describes it as having from four to eight small ovate spikelets scattering at the apex of the culm, and the perigynia "ovate, obtuse, pointless, and rounded on the lower side;" and proceeds to compare it with C. muricata, (which as to the *Flora Suecica,* is stated by Wahlenberg to be the C. stellulata, *Good.,*) from which it is said to differ in its smaller size, and in the less divaricate obtuse fruit. I suppose that there is no authentic specimen preserved in the Linnæan herbarium.

In the year 1802, Schkuhr figured[†] and described what he, with much hesitation, took for C. loliacea, remarking however that this Linnæan species was a very doubtful plant, and that what he had taken for it was probably only a variety of C. muricata; which seems to have been the case.

In the next year the real C. loliacea was, as I suppose, correctly taken up by Wahlenberg, a botanist most likely to know the Linnæan plant, who well characterized it as follows: "C. spiculis *basi masculis* subdistantibus ternis paucifloris, squamis brevibus, *capsulis subovali-ellipticis utrinque convexiusculis obtusis obtusangulis* divaricatis, ore integerrimo, bracteolis setigeris, foliis angustissimis."[‡]

In 1805, Willdenow gave a new phrase, viz. "C. spica androgyna composita, spiculis subquaternis inferne masculis subapproximatis, stigmatibus binis, *fructibus ellipticis obtusis nervosis com-*

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[*] Cited by Lyell, "Principles of Geology," (1835,) vol. iii, p. 104.

[†] Reidgr. t. Ee, No. 91.

[‡] Wahlenb. in Act. Holm. 1803. p. 147.

pressis erectis."* This character was evidently drawn from the specimen in his herbarium marked fol. 2, the source of which is not recorded, and from which Kunth has also recently derived an additional description of C. loliacea; while the fol. 1, holds a Swedish specimen of a different plant, sent by Swartz under the name of C. loliacea, which (judging from a memorandum made on inspection several years ago) is most probably the C. tenella of *Schkuhr.* This C. tenella, Willdenow remarks, is the same as C. loliacea, but is incorrectly delineated and described by Schkuhr as having the spikelets masculine at the summit. Here is the beginning of the confusion, soon further complicated by Schkuhr himself, in which these two very distinct species have ever since been involved.

Schkuhr established and figured his *C. tenella*, in the first part of his work on Carices, in 1802, (No. 15, t. Pp, f. 104,) upon a plant which he found in the herbarium of a friend, who was entirely ignorant of its source, or even whether he had collected it himself or received it from a correspondent. This friend, as he elsewhere states, was Hedwig. Schkuhr's herbarium shows that he subsequently received the same species from Sweden, through Thunberg, ticketed "C. loliacea, *Linn.* In Nordlandia Norvegiæ rarius, per Nordlandiam Sueciæ copiose." In the same work, Schkuhr also figured (t. E, f. 24) a plant of unrecorded origin, which he took for the C. gracilis of "*Ehrhart, Gram.* [*Phytophylac?*] 78." The specimen which Schkuhr figured is not preserved in his herbarium; but in a paper fixed to the folio under this name, marked "Saamen," I found the very perigynium and achenium (*i. e.*) separately delineated in his figure. The perigynium is distinctly beaked, the staminate flowers are plainly depicted as occupying the summit of the spikelets, and the whole figure so nearly agrees with the smaller states of *C. rosea*, that I can scarcely doubt it was derived from that plant. In place of the specimen actually figured, the herbarium of Schkuhr contains one with a printed ticket, "C. gracilis, *Ehrh.:* Upsal," which is probably an authentic specimen from Ehrhart's original collection, but which, as it certainly is not the plant which Schkuhr has depicted, I suppose to have been received at a later period, and that the specimen which served for the figure in question was then discarded.

On obtaining possession of this authentic specimen (as I take it to be) of Ehrhart's *C. gracilis*, Schkuhr could not fail to perceive that it was precisely the same species with his own C. tenella, and with what had already been sent him from Sweden under the name of C. loliacea. Accordingly, in his Supplement, (1806,) he united the two, (but without explaining the

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* Wild. Sp. Pl. 4, p. 237.

mistake he had made in figuring as C. gracilis, something different from the Ehrhartian plant;) and, following the cue which had been given him by Swartz, Willdenow, and Thunberg, erroneously referred them both to C. loliacea, *Linn.* Under that species, consequently, these two synonyms have been generally cited ever since, notwithstanding the discrepancy in the position of the staminate flowers, which in C. gracilis, *Ehrh.*, (C. tenella, *Schk.*,) are *correctly* described by Schkuhr as at the apex; while those of C. loliacea are rightly characterized by Wahlenberg and Willdenow, and indeed by all succeeding writers, as occupying the base of the spikelets: and the difference in the perigynia, &c. of the two species is not less decisive. Yet even Wahlenberg has unguardedly adduced the synonym in his Flora Lapponica; where he has given a further and most excellent account of the genuine C. loliacea, particularly contrasting it with his own C. tenuiflora, which is indeed the nearest related species. He notices the "*squamæ albicantes, omnium tenuissimæ*," and well describes the perigynia as follows: "Capsulæ in singula spicula 3 vel 4, ita obtusæ ut apice fere rotundatæ, utrinque convexiusculæ nervosæ, ob formam suam seminibus *Lolii temulenti* haud dissimiles, ut nomen omnino bonum."*

While the C. loliacea, *Linn.*, is, so far as I am aware, restricted to the north of Europe, the C. gracilis, *Ehrh.* has apparently a wider range and is much more abundant in the new world than in the old. It is the well-known *C. disperma*, of Dewey; who, while he noted its resemblance to C. loliacea, *Schk.*, (tenella, *Schk.*,) conceived it to be distinct by its terminal staminate flowers—a point in which it does indeed differ from the true C. loliacea, but not from the plant which Schkuhr mistook for it.

The two plants are so distinct in appearance and character, that the wonder is they should have been so long confounded. But I know of only two botanists who have distinguished them, namely, Nylander and Mr. Tuckerman. As to the former, my information is indirect. Ruprecht, in his recent critical enumeration of the plants which grow around St. Petersburg, has a "*Carex tenella*, Schkuhr, et Fl. Petropol. Bene diversa est a C. loliacea, L., utrasque exposuit cl. Nylander in *Spic. Fl. Fenn.*, ii, No. 92 et 93."† I have no acquaintance with the work of Nylander here cited, nor do I know its date; but I possess, through the kindness of Dr. Fischer, specimens ticketed "*Carex pulchella*, Nylander: ad oppidum Sardavalæ, Finlandiæ," which exactly accord with the American C. disperma, and, so far as recollection

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* Wahl. Fl. Lapp., p. 232.—In his Flora Suecica, he further adds, that the "capsules are a line and a half long," which is fully one-third longer than are those of C. gracilis.

† In Historiam Stirp. Fl. Petropol. Diatribæ, p. 84. 1845.

and memoranda may be trusted, with the "C. gracilis, *Ehrh.*, Upsal," in Schkuhr's herbarium.

Mr. Tuckerman, in his *Enumeratio Caricum*, (1843,) p. 19, rightly remarks, that the C. loliacea of Schkuhr is scarcely that of Wahlenberg and Fries; and he inclines to the opinion, that the specimen from which Schkuhr figured his C. tenella, out of Hedwig's herbarium, was received by Hedwig from Muhlenberg, and therefore may directly represent the American plant. This is not unlikely; but Mr. Tuckerman does not appear to have been aware that this species is also a native of the north of Europe, and had been gathered at least as early as the year 1780. He justly remarks, also, that it is scarcely credible that Schkuhr's figures 24 and 104, can belong to the same species. I have already given what I believe to be the explanation of this incongruity.

It would therefore appear that the synonymy of the two species in question should stand as follows:

1. C. LOLIACEA, *Linn.; Wahl.; Fl. Dan.*, t. 1403; *Kunth*, (excl. syn. C. tenella and C. gracilis, *Schk.*,) not of *Schk. Car. No.* 14, f. 91, nor *Suppl. No.* 47, p. 18.

2. C. GRACILIS, Ehrh.; not of *Schk. Car.*, f. 24, nor of *R. Br.* C. tenella, Schk. Car., f. 104. C. loliacea, *Schk. Car. Suppl.*, p. 18; not of *Linn., etc.* C. disperma, *Dewey;* not of *Kunze, Car.*, t. 33.*

ART. IV.—*Description of Three New Carices, and a New Species of Rhynchospora;* by JOHN CAREY.

CAREX GRAYII: spica mascula solitaria pedunculata; spicis fœmineis 2 globosis densi-(25–30-) floris exserte pedunculatis; stigmatibus 3; perigyniis deflexo-patentibus ovatis ventricosis multi-nervosis rostratis ore bifidis squamam ovatam hyalinam mucronatam triplo longioribus.—C. intumescens, var. β. globularis, *A. Gray, in Ann. Lyc. Nat. Hist. N. Y.*, iii, 236.

Hab. Ad ripas fluminum "Mohawk" et "Wood-creek," Nov. Ebor. occident. detexit cl. A. Gray, M.D.

Culm 3 feet high, robust, triquetrous, smooth and leafy. Leaves taller than the culm, 4–5 lines broad, rough on the margin. Sterile spike 1½–2 inches long: fertile spikes globular, occasionally single, but generally 2, quite distinct and separate, 1½ inch in diam-

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* The figure which Prof. Kunze has given as *C. disperma*, from specimens gathered on the Black Mountain of North Carolina by Rugel, is an entirely different species; namely, the C. rosea, var. radiata, *Dewey*, (C. neglecta, *Tuckerm.*,) or very near it—a plant which I have myself gathered on the mountains of Carolina, very far south of the known range of the species for which this excellent Caricologist has unaccountably mistaken it.

eter. Perigynia crowded, deflexed, smooth and shining, 9 lines in length, 25–30 nerved, tapering into a long perfectly glabrous beak. Achenium obtusely triangular, minutely dotted under a lens, crowned with the long continuous style.

Dr. Gray, who first detected this plant on the banks of the Mohawk at Utica, and described it as a variety of C. intumescens, *Rudge*, remarks, that it "is characterized by its larger and coarser habit, and by its globose, many-flowered pistillate spikes. It flowers a month later than the ordinary form of the species, and when young might readily be mistaken for C. lupulina." To this may be added, that C. intumescens, owing to the scarcely exserted peduncles, has the loose, few- (5–8-) flowered spikes closely approximate, so as to be almost indistinguishable; and the perigynia are erect, much shorter, (6–7 lines long,) slightly serrulate towards the apex of the beak, and only 15–20-nerved. Though closely resembling C. intumescens, these constant characters and a marked difference in aspect, appear to entitle this plant to rank as a species.*

Carex platyphylla: spicis 4; mascula 1 erecta gracili pedunculata; fœmineis 3 erectis filiformibus laxe 3–4-floris incluse pedunculatis, suprema masculæ approximata, cæteris remotis folioso-bracteatis; bracteis spicas paulo superantibus; stigmatibus 3; perigyniis triquetris ovalibus striatis brevissime rostellatis squamam ovatam hyalinam acutam vel mucronatam subæquantibus, ore obliquo integro.

Hab. In declivibus umbrosis, Nov. Angl. et Nov. Ebor.

Culms numerous, leafless, 8–12 inches long, slender, somewhat ancipital, smooth, diffusely spreading and prostrate in fruit. Leaves all radical, $\frac{1}{2}$–1 inch in breadth, 4–6 inches long, flat, pale green or whitish, striate throughout with very fine and close nerves, three of them more conspicuous. Fertile spikes generally 3, erect, $\frac{1}{2}$–$\frac{3}{4}$ of an inch in length, with a few distant alternate flowers, subtended by leafy sheathing bracts, which are not much longer than the spikes. Perigynia triquetrous, finely striate, narrowed at the apex, with a minute oblique point: scale of a light chestnut color, with a green keel and scarious margins.

This plant, though not uncommon in shady ravines, has been hitherto confounded either with the large leaved form of C. anceps, *Muhl.*, or with C. retrocurva, *Dew.*, from both of which, however, it is quite distinct. It forms, with C. plantaginea, *Lam.*, and C. Careyana, *Dew.*, a well marked subsection, (*Plantagineæ*,) which may be characterized by the few-flowered, erect fertile spikes, the upper usually close to the barren one, all on

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* Since the foregoing description was in type, I have seen specimens from Columbus, Ohio, collected by Mr. Sullivant.

short peduncles nearly included within the small sheathing bracts, or the lower partly exserted; and by the triquetrous fruit; numerous, leafless, diffuse, and at length prostrate culms; and broad radical leaves. In the varying forms of C. anceps, the perigynium is constantly more obtuse on the angles, and more obovate in outline; and the bracts are always long and leafy, the upper exceeding the culm. In C. digitalis, *Willd.*, and the closely allied C. retrocurva, the leaves and bracts are also long and grassy, commonly exceeding the culms, and the lower spikes are generally on much-exserted, filiform, more or less pendulous peduncles. The perigynium of the present species, the smallest of the group here indicated, closely resembles that of C. digitalis.

CAREX SYCHNOCEPHALA: spicis androgynis inferne masculis crebris arcte capitato-aggregatis folioso-bracteatis; stigmatibus 2; perigyniis compressis e basi ovato-lanceolata abrupte contracta subsessili longe sensimque rostratis apice bifidis margine scabris squamam hyalinam lanceolatam abrupte mucronatam paulo longioribus.—C. cyperoides, *Dew., in Am. Jour. of Sc. and Arts*, iii, 171, non *L.*

Hab. In Nov. Ebor. Comitat. "Jefferson," ubi legerunt cl. I. B. Crawe, M.D., et cl. W. A. Wood, M.D.

Culm about a foot high, leafy, smooth; spikes sessile, densely clustered, forming a compound capitate spike subtended by 3 long unequal foliaceous bracts much exceeding the spike. Perigynium tapering from an abruptly contracted ovate base into a long and slender scabrous bifid beak, a little exceeding the lanceolate abruptly mucronate scale. Achenium ovate, compressed, crowned with the lengthened style.

This plant, which has a great resemblance to C. cyperoides, *Linn.*, differs from that species in the nearly sessile perigynium, which tapers from a much wider and contracted (not attenuated) base into a shorter beak, of which the teeth are also shorter than in the European plant. The perigynia are more crowded on the rachis than in C. cyperoides, the spikes of which, owing to the greater length of the beaks, have a more comose appearance than in our plant. The scale is shorter, abruptly mucronate, and not gradually tapering as in C. cyperoides; and the achenium is ovate, not ovate-oblong, as in that species.

I may here mention that, amongst the undetermined species of Carex in the rich herbarium of my friend, Prof. Gray, I find C. vulpina, *L.*, collected at, or near Columbus, Ohio, by Mr. Sullivant; and also a single specimen from Illinois, communicated by Dr. Engelmann of St. Louis. They correspond perfectly with the European plant, and the species may possibly be common in the Western States, where it may have been hitherto confounded with the nearly allied, though very distinct, C. stipata, *Muhl.*

Rhynchospora Knieskernii: culmo trigono gracili; spicis numerosis in glomerulis 4–6 distantibus aggregatis; nuce lævi obovata substipitata setas 6 retrorsum hispidas æquante tuberculo triangulari subduplo longiore.

Hab. In pinetis Nov-Cæsar., detexit cl. P. D. Knieskern, M.D.

Culm 12–18 inches high, branching from the base, slender, nearly smooth: leaves short and narrow. Spikes small, setaceously bracteate, forming small distant clusters throughout the entire length of the culm, each subtended by a long foliaceous bract. Nut obovate, lenticular, attenuate at the base. Tubercle compressed, broad at the base, about half the length of the nut.

In its characters this species is closely allied to R. capillacea, *Torr.*, from which, however, it is readily distinguished by the shorter and more numerous aggregated spikes, and the much smaller nut and short bristles. In general appearance it more nearly approaches to R. gracilenta, *Gray*, but the nut is quite different, and the bristles are not antrorsely hispid as in that species. I learn from Dr. Knieskern, that it grows exclusively on banks of iron ore in the Pine barrens of New Jersey. He distributed it, as new, under the name of R. Grayana, which name being preoccupied by Kunth for the R. Elliottii, *Gr. Mon. Rhynch.*, I dedicate it to the discoverer.

Art. V.—*Observations on the Whirlpool, and on the Rapids, below the Falls of Niagara; designed by illustrations to account for the origin of both;* by R. Bakewell, New Haven.

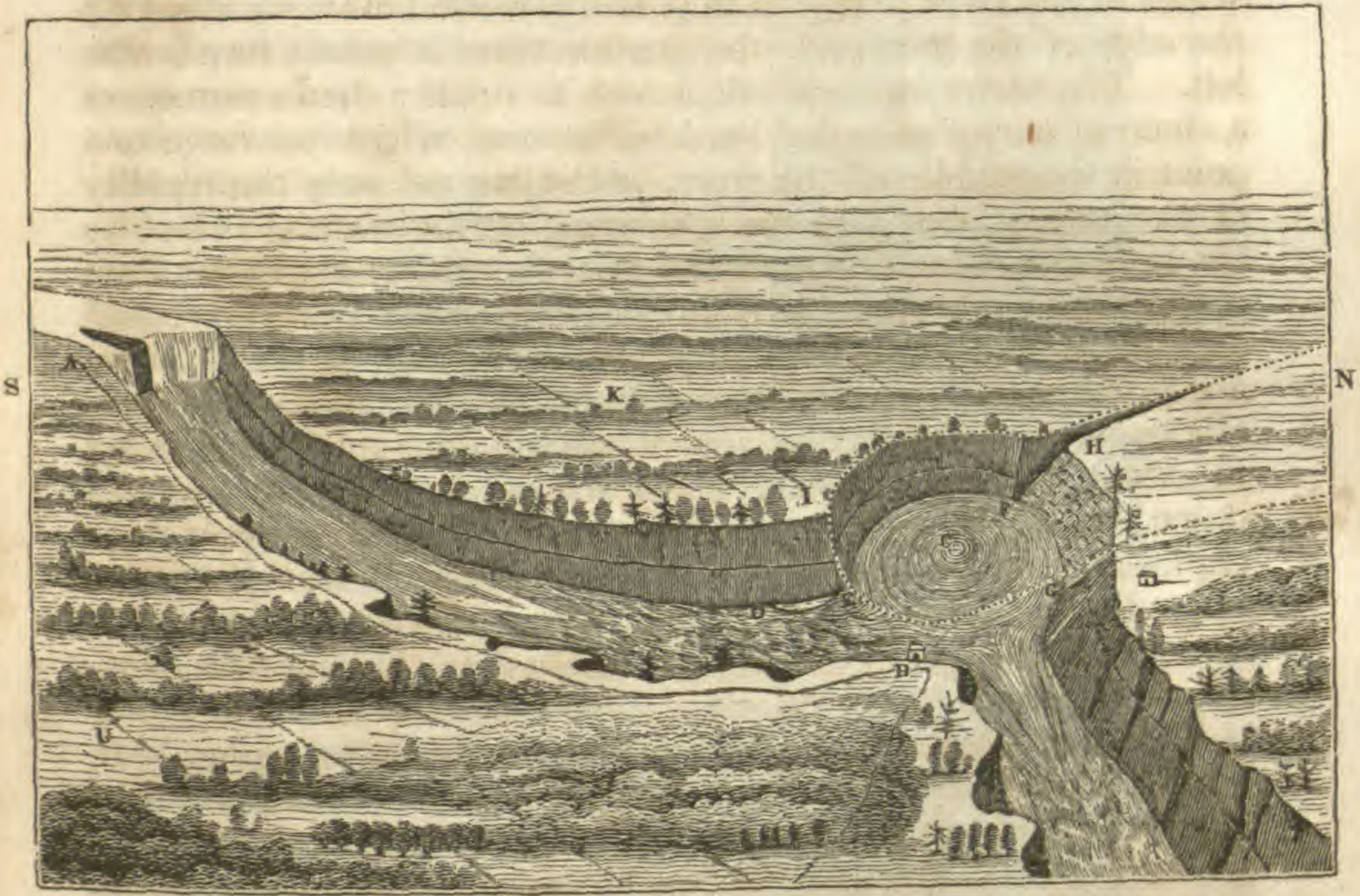
On my return to England soon after visiting the Falls of Niagara in the year 1829, I published in Loudon's Magazine a short memoir illustrated by drawings, exhibiting the physical structure of the country along the river Niagara, with special reference to the retrograde movement of the falls; in the course of my remarks I endeavored to prove from the conformation of the strata, and the erosive action of water, that the falls were once at Queenston. During the six days that I remained there, I made several sketches of the falls and the surrounding scenery, little expecting at the time that I should ever see the cataract again. I returned to America to reside in the summer of 1830, and in the autumn of 1846, I spent eight days at Niagara, taking with me the sketches which I had made seventeen years before. After a lapse of so many years, I was sensibly impressed with the change, which had taken place, particularly in the Canada fall. The waters had receded from the American side of the Horse-shoe fall towards the centre; parts of the precipice were bare which in 1827 were entirely hid by the descending flood. The water which then flowed over these projecting bare rocks, in descending, spread out into magnificent festoons. The beautiful feature which I formerly saw has disappeared. To this it may be said, that the waters of Lake Erie were unusually low in 1846, and this may account for the retreat. But I would reply, that no diminution was indicated by the banks of the river. I was told in 1829, by one who had resided there forty years, that a difference of level was perceptible only when a strong southwest wind sweeps over the wide expanse of Lake Erie, driving its waters into the mouth of the river. Not having made a very careful outline of the edge of the American fall, I am not prepared to say, whether any material change had taken place, with the exception of its being apparently more broken in the centre, where the cutting process appears to go on with great activity. It is stated by residents there, that a considerable alteration had taken place, from the falling of masses of limestone rock from the middle of the cataract. That a constant change is in progress no one can doubt who carefully examines for himself as he wanders over this wonderful scene. I was particularly impressed with its magnificence while making a drawing of what is called the cave, situated half a mile below the ferry on the American side. This cave or ledge of bare rock, has just the appearance that the rocks over which the American falls are now precipitated, would present, if the *waters were suddenly withdrawn.* The same broken outline appears in both instances, giving evidence that in each case the most violent action had been in the centre. When the cataract was here, the space between the American fall and the commencement of the 'cave', was in all probability, an island, presenting a similar appearance to what the falls now have. There is still a small stream flowing down the precipice where once a mighty torrent fell.

What surprised me much on my second visit, was the comparative stillness in which the mighty work of discharging the surplus waters of so many inland seas down a precipice of one hundred and eighty feet was carried on. In father Hennepin's curiously interesting description of this "vast and prodigious cadence of water," he represents himself or his friends as being so overcome by the noise, that the hands were applied to the ears by way of dampers. The marvel to me is, that they make so little noise. It cannot be denied, however, that the state of the atmosphere and direction of wind, have much to do in regulating the sound produced by the fall of this immense body of water.

After these preliminary remarks, I will now confine myself more particularly to the object for which this communication was undertaken, which was to offer some observations on the whirlpool, as well as on the rapids below the falls, and to assign a probable cause for their existence. If in doing this I should be able to add any thing to the interest which will ever be felt by those who visit the falls, and its vicinity, my labor will not be altogether in vain.

Fig. 1.

A Birds-eye View, or Map of the Ravine from the Falls of Niagara to the Whirlpool.



K. Canada.—U. United States.—The dotted lines represent the outline of the ancient valley, partly filled with drift, H.—F. Ravine.—C. Whirlpool.—B. Summer-house.—D, E. Quartzose rock seen below the surface of the water.

Having made several visits to the whirlpool, taking sketches from points which I thought most desirable, I found that each visit increased my admiration and wonder. A general idea of its situation may be had by reference to the drawing, fig. 1, giving a birds-eye view of the country from the falls to the whirlpool, a distance of three miles. Perhaps I shall make myself better understood by giving a description of the ravine from A to B. The width of the river at the ferry is about eleven hundred and forty feet. The height of the rocks, one hundred and eighty feet. On the verge of the precipice, a little below the American falls, there is a path which leads directly to the Summer-house, B, situated immediately above the whirlpool; this path continues close to the edge of the precipice. About half a mile down, we come to the 'cave' before alluded to—a bare rock on which nothing grows—a place of deep interest to the traveller as he stands upon this ancient bed of a former lateral torrent.

The river below the falls moves majestically along without a ripple, having the appearance of dark bottle-green marble, varying at times into blue, with yellowish and greenish veins, the latter due to the foam which seems as if imbedded as it streams down in long wavy lines. This solid representation of water, gave an additional novelty to the scene. About one mile from the falls the sides of the ravine gradually converge, diminishing of course the width of the river. Half a mile still lower,* following along by the edge of the precipice, the stream takes a gentle turn to the left. The water on each side is seen to ripple; then commences a chain of waves preceded by deep furrows, which converge to a point in the middle of the river, indicating not only the rapidity of the current, but also the upheaving of the waters, rising, as has been ascertained by measurement, eleven feet above the level at the sides; after this, it is broken into foam and spray, and dashing on with impetuous fury, pursues its wild career for about a mile, then rushes with the swiftness and violence of an avalanche into a wide circular area of one hundred and twenty acres in extent. Then, suddenly, as by an unseen power, it is calmed down, and in silence sweeps round in eddying circles; these circles glide into curves which swell round this vast amphitheatre in gentle undulations, as if gathering strength for its last conflict through the narrow portal which leads to its oblivion in the waters of Ontario.

While standing on the precipice at the Summer-house, (B, fig. 1,) which overlooks the whirlpool, my attention was particularly directed to the place where the waters enter the whirlpool, where I could distinctly see the rocks projecting for a considerable distance from the Canada side towards the centre of the current, not many feet below the surface of the water, contracting very considerably the space through which the waters apparently escape. The curved line, DE, indicates this projection. There was something impressively grand in the whole scene as contemplated from this point. The drainage of four great lakes covering an area of about 135,000 square miles, escapes at the northern extremity of Lake Erie through a channel, (as stated by Mr. Allen, from measurements by Mr. E. R. Blackwell,) seventeen hundred feet in width, thirty-two feet in depth, running at the rate of six miles an hour, equal to 22,440,000 cubit feet, weighing 701,250 tons, flowing every minute;†—here the whole is confined to a breadth not exceeding two hundred and twenty-five feet! the distance from rock to rock, as I was informed by the proprietor

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* I observed a steamboat intended to ply between a landing place, which had been constructed at great expense down the precipice to the water's edge, at the base of the falls, &c.; but on trial, the engine had not power sufficient to contend with the current. It is to be hoped the project will be forever abandoned. In case of accident to the machinery, there is nothing to prevent the destruction of the boat in the rapids.

† Am. Jour. of Sci., Vol. xlvi, p. 71.

of the grounds. The question naturally arises, how is it possible for this immense volume of water to escape through so narrow a defile, and then suddenly to become comparatively sluggish in the whirlpool. On referring to Mr. Lyell's admirable work on America which I had with me, and examining the section of the strata from Niagara to the whirlpool, which Mr. L. had taken from Mr. Hall's geological Report on the Geology of New York, it occurred to me that a satisfactory explanation might be given. The projecting rock under the water is unquestionably the hard quartzose sandstone, and underneath this lies a very thick bed of soft red shale. A short distance before the waters enter the whirlpool, this floor of hard sandstone rock is broken through, and the resistless torrent has made itself a passage underneath this rock, on each side of the ravine, and it is by this excavation that the waters escape. This perhaps will be made more apparent, when explaining in the sequel the supposed origin of the whirlpool.

The section, fig. 2, is principally from Lyell, in which I have introduced the river, whirlpool, and the ancient lateral valley, (H,) filled with drift. In the following remarks, great stress is laid on the relative hardness of the rocks which compose the Niagara group: consisting as it does, of hard limestone, calcareous shale, soft shaly sandstone, and of quartzose sandstone. Had all the strata consisted of solid limestone, as I remarked in the communication before re-

Fig. 2.

A Section of the Strata on the Canada side of the Niagara River, from the Falls to Queenston.

F, G. Compact limestone resting on soft beds of shales.—3. Red shaly sandstone—very friable drift.—2. Quartzose sandstone extremely hard.—1. Thick bed of shale, very soft.—H. Valley filled up with drift, marked H in fig. 1.—W. Whirlpool, which forms the terminus to the deep lateral valley as represented by W in fig. 4, and by the dotted lines, I, F, G, in fig. 1.

ferred to, 'there is great reason to believe that the erosive action of the water would have been very slow, and many generations might have passed without any sensible change; but the vast mass of waters breaking with inconceivable force on the softer shale which forms the base of the hard rock, the foundation is thus undermined, the harder rocks fall down for want of support,' thus causing the various changes between turbulence and tranquillity which take place in the river in its course from the falls to the outlet at Queenston.

Taking it for granted that the cataract was once at the precipice at Queenston, it will be seen by reference to the section, fig. 2, that, owing to the inclination of the strata, the falls would be considerably higher than they are at present; thus exposing to view several beds of shale, limestones, and sandstones not found at the falls. The lowest (No. 1) is a very thick stratum of friable shaly red sandstone, through which the river ploughs its way. The river at Queenston, as we are informed by Mr. Allen, before referred to, is one hundred and sixty feet in depth. This depth is sufficient to entomb the huge fragments of the harder rocks, as they would gradually fall down by the erosive, undermining process continually going on by the descending flood, without causing any agitation of the surface. It will be seen from the dip of the strata, that as the falls retrograde, the hard quartzose rock would be at the base of the falls, and in time cease to be broken through by the cataract; as the retrocession advanced, the waters would have to flow *over* this hard rock. The superincumbent limestone falling on this hard pavement would cause a great impediment to the escape of the water, which would give rise to the rapids.

From the whirlpool to what is called the Devil's hole, and for a considerable distance below, the river rushes with great impetuosity, when it gradually subsides, and then moves on in silent grandeur towards the lake. On crossing the river at Lewiston, and ascending the hill near Brock's monument, I was agreeably surprised on beholding the singular and furrowed appearance of the ground. It was smooth on the surface, but shaped into knolls and ravines, having the appearance of a mountainous country in miniature—hills and valleys—but without water; and this all excavated out of the hard limestone rock. This appearance gave me satisfactory evidence that the waters of the lakes once rushed over the ground on which I was walking.

The whirlpool as seen on the Canada side of the river, presents many more points of interest than on the American, independently of the curiosity excited by Mr. Lyell's discovery of a deep lateral valley filled with drift, which he traced from the whirlpool to St. David's; Mr. Hall having first suggested the idea that it might be connected with the opening at that place.

Fig. 3.

Sketch of the Whirlpool taken on the Canada side near the ravine which forms part of the lateral valley marked F G, on the map fig. 1.

On the Canada side, more than three-fourths of this magnificent amphitheatre of rock may be explored along the margin of the pool which it incloses. One reason why so few comparatively visit the whirlpool on this side, is the want of enterprise in the individual who owns the land, in not making the descent more practicable. On visiting the place last summer, it was not only very difficult but dangerous to descend, particularly so after rain. Having reached the base of the precipice and scrambled over rocks and through dense masses of roots, decayed branches and foliage of trees, for about the space of two hundred yards, the entanglement suddenly disappears, and a clear open space is left along the margin of the pool, on which it is a great pleasure to rest and admire the sublime scene. The shore is uninterrupted for near two hundred yards; after which it is obstructed as before, by huge fragments of rocks, &c. The foreground of the sketch, fig. 3, from A to B, represents this open space, which also indicates the extent of the base of the cliff of drift lying between the rocks F and G, in figs. 1 and 2. The cliff is less precipitous than the rocks which enclose it; its debris consists of sand with boulders of conglomerate or igneous rocks, and affords easy access to the water's edge.

At the northern extremity of the whirlpool, there is by far the most comprehensive view of the high perpendicular wall of rocks which encloses this deep, dark, circling pool. Here we are brought to the immediate confines of the whirling vortex. On its surface are seen the ruins of a forest, floating round, marking out to the eye the outline of that fatal circle. These yellow logs and trunks, grinding against each other, dip and rise, following on in ceaseless round until they waste away in this their winding sheet. Occasionally, some are thrown out and are borne along in a circuitous route to the rapids which commence at the outlet of the whirlpool; a few find a resting place on the beach, where they present many very grotesque forms, some resembling the boomareng of the New Hollander, others cimiters, rolling-pins, and the like.

The sketch, fig. 3, was taken at the northern extremity near the gorge, marked F, fig. 1. In going up this narrow gorge, through which a small stream flows, I was very much interested in noticing that the high perpendicular rocks which form part of the Niagara group on my left, presented the same wall-like appearance as in the ravine through which the river flows, from the falls to Queenston. Fragments of limestone rock which once crowned the summit of the precipice, lay in confusion at its base. On my right rose the steep cliff of drift, H, with its motley group of boulders extending from F to G. As I was exploring this wild picturesque gorge, formed at the western extremity of the lateral valley by the descending rains washing away the sand into the whirlpool, I was led to think that in all probability, there was a time when the cataract thundered through this channel, now nearly filled with drift, and its waters emptied into the lake or sea, through the opening at St. David's. That this assertion may not appear altogether visionary, I would state that it is an ascertained fact, that this ancient valley extends from the whirlpool to St. David's, about six miles from Queenston, as was first suggested by Mr. Hall to Mr. Lyell, when the latter having called Mr. Hall's attention to this bed of drift at the whirlpool. "Ascending," says Mr. Lyell, "the steep bank formed of these materials, we soon reach the general level of the table land and pass over it for two miles before we begin to enter the depression, which deepening gradually, carries us down to St. David's. This valley is entirely excavated in the boulder formation, and we may infer that the latter maintains its full depth between St. David's and the whirlpool, from sections obtained in sinking a well in the intervening township of Stamford, where a great thickness of drift was passed through."*

It is perhaps worthy of remark that the direction of this valley from the falls to St. David's, does not materially differ from a straight line. The width of this valley, at the whirlpool, (FG, fig. 1,) which is deserving of particular attention, Mr. Lyell gives at about one hundred and seventy yards. Now this width, whether more or less than one hundred and seventy yards, agrees so nearly with the width of the ravine at the entrance into the whirlpool, IB, that it is difficult to resist the conclusion that they had both one origin, but at periods of time immeasurably remote from each other. The continuous appearance now presented is accidental. The origin of this valley and its termination at the whirlpool may, I think, be explained on the supposition that ages anterior to the commencement of the ravine at Queenston, this valley or channel was hewn out by the floods which drained the inland lakes or sea. The width of the valley at St. David's, which is about two miles, militates nothing against the assumption that the waters once rushed over the precipice at St. David's. It is reasonable to infer that its volume was immeasurably greater than at present, and that in process of time the valley would contract, as the waters were concentrated and were brought to act with greater energy on a given point on the various strata of hard and soft rocks; this increased erosive action of the waters would go on until the cataract would finally assume a wall-like appearance as is now seen at the falls. This process appears to have gone on from the time when the river first fell over the precipice at Queenston, and thus the falls have continued to advance on their retrograde journey south. This I think is very evident from what

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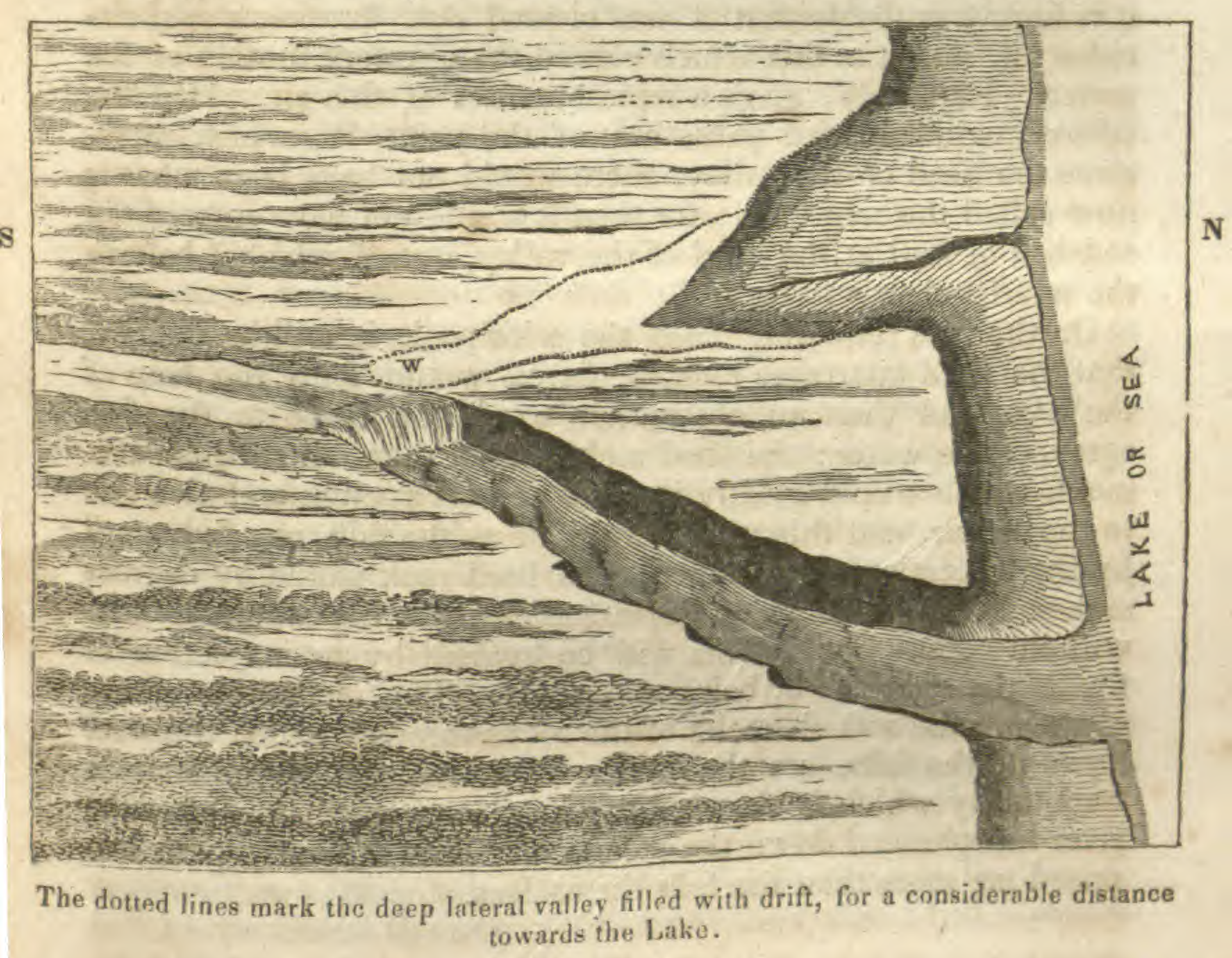
* Lyell's America, Vol. ii.

is now seen on the sides of the declivity near Brock's monument. The smooth, scooped out appearance in the solid limestone rock, as before alluded to, indicates that long before the waters were concentrated at the ravine at Queenston, they were for ages sweeping over the precipice on each side of the present opening. When the falls had retrograded as far as is represented by the dotted lines in fig. 4, their further progress was arrested by physical changes constantly but slowly going on, according to Mr. Lyell, which have so materially changed the surface and condition of the globe. This was chiefly the submergence of the whole table-land, which, Mr. Lyell, in his work before referred to, says, caused the valley to be filled up and also covered the table-land itself with drift, which in some places is three hundred feet deep. After a long interval of time the country was again elevated, or the sea retired, exposing the precipice over which the waters would rush. But their direction, from the great inequalities of the surface arising from the accumulations of drift, might be changed, and instead of continuing to plough out for itself a passage in its former channel, might finally be concentrated about

Fig. 4.

The supposed situation of the Falls when near what is now called the Whirlpool.



The dotted lines mark the deep lateral valley filled with drift, for a considerable distance towards the Lake.

the precipice at Queenston, and there commence anew its great work of retrocession. It will be seen by reference to fig. 4, that the ravine at Queenston and onward, to the whirlpool, is not parallel to the lateral valley, (represented by dotted lines,) but makes an angle, the apex of which is the head of the valley. When the falls advance to the dotted lines, W, which mark the boundary of this valley of drift, and had broken and cut its way through the hard limestones, &c., into this soft and very thick bed, a violent and rapid excavation would go on by the mighty force exerted from the falling cataract on the soft material, most of which would be carried away in the form of mud. As this drift descended far into the soft shale below the quartzose rock, it is highly probable that it was cleared out, forming a vast *circular* pit, and it is this which caused the gyratory motion of the water. Fig. 2, W, gives a representation of this pit. Had the falls retrograded a few yards east of the point, W, which represents the head of the valley, there would not have been what is now called the whirlpool; for then it would not have entered the soft bed of drift at the head of the valley, out of which I believe the whirlpool was formed.

On the falls retreating from the whirlpool, it will be noticed, that the hard quartzose rock, 2; fig. 2, would form the base of the falls, and then an obstruction would be made to the free egress of the water; the hard rocks would then fall *on* this pavement, which would greatly increase the obstruction and give rise to the rapids, and this would continue as the falls receded, until by the indication of the strata, this hard rock would by degrees sink so low as to allow a depth sufficient for the waters to flow without commotion. This will be evident by an inspection of fig. 2, the stratum, 3, being soft shale. The inclination of the strata and the soft character of the rocks through which the river flows at the falls, are the causes of that apparently miraculous tranquillity which is observed to take place immediately after the river has plunged down the precipice. This sudden repose surprised me more than the falls themselves.

Art. VI.—*On certain Improvements in the Construction and Supply of the Hydro-oxygen Blowpipe, by which Rhodium, Iridium, or the Osmiuret of Iridium, also Platinum in the large way, have been fused;* by Robert Hare, M.D., Professor of Chemistry in the University of Pennsylvania. (Communicated by the Author.)

Having observed while I was a pupil of my predecessor, Dr. Woodhouse, in the year 1801, that a jet of hydrogen when inflamed in atmospheric air, of which only one-fifth is oxygen, produced a heat of pre-eminent intensity, I was led to infer that in combining with pure oxygen, the gas in question ought to produce a temperature at least five times as great. This led to the contrivance of two modes of producing a jet consisting of a mixture of hydrogen with oxygen. Agreeably to one mode, the gaseous currents meeting like the branches of a river, were made analogously to form a common stream. This object was accomplished by means of perforations drilled in a conical frustum of pure silver, so as to converge until met by another shorter perforation, commencing at the opposite surface, and so extended as to join them at the point of their meeting. The other mode was that of causing one tube to be within another, so as to be concentric; the outer tube being a little the longer of the two, the latter being employed for hydrogen, the former for oxygen.

In the year 1814, this last mentioned mode was improved, so as to have the means of securing, by adjusting screws, the concentricity of the tubes, and varying the distance of the orifice of efflux of the inner tube from that of the other.

The constructions employed in 1801, were described and published in a pamphlet, and afterwards republished in Tilloch's Philosophical Magazine, Vol. xiv, and in Annales de Chimie, Vol. xlv. At the same time an account was given of the fusion of pure lime and magnesia, and of the fusion of platinum. Subsequently in a paper published in the Transactions of the American Philosophical Society, it was mentioned that I had volatilized platinum.

About the year 1811, Professor Silliman, in a memoir read before the Connecticut Academy of Sciences, gave an account of a series of experiments, in which the experiments which I had performed were repeated, and many additional fusions made. I had adverted to the intensity of the light produced during the exposure of lime to the flame. Alluding to the heat and light, my words were, "the eyes could not sustain the one, nor the most refractory substances resist the other." The intensity of the light was still more insisted upon by Silliman.

My experiments were also repeated by Mr. Rubens Peale, during many successive years, at the Philadelphia Museum, for the amusement of visitors.

About the year 1813–14, it was ascertained, at the laboratory of Dr. Parrish, that a bladder being supplied with a mixture of hydrogen and oxygen, in due proportion, and punctured by a pin, while subjected to compression, on igniting the resulting jet, the gas within the bladder did not explode. Of course a burning jet of flame thus created, was found competent to produce, while it lasted, the same effect as when otherwise generated by the same gaseous mixture.

Soon after this result was obtained, Sir Humphrey Davy discovered, that if a lamp flame be completely surrounded by a gauze of fine wire, it may be introduced into an inflammable gaseous mixture without causing it to explode. This was ascribed to the refrigerating influence of the metal, keeping the gaseous mixture below the temperature requisite for inflammation. Hence it was inferred, that if a mixture of hydrogen and oxygen, while condensed within a suitable receiver, were allowed to escape through a capillary metallic tube, so as to form a jet, this might be made to burn without communicating ignition to the portion remaining in the receiver.

By means of an apparatus contrived agreeably to this idea, Dr. Clark of Cambridge, England, repeated the experiments, made many years before by Silliman and myself, without any other reference to ours, than such as was of a nature to do injustice. An exposition of the invalidity of Dr. Clark's pretensions to originality was made in Silliman's Journal for 1820, vol. ii, and in Tilloch's Philosophical Magazine, for 1821, vol. lvii.

The light produced by the hydro-oxygen flame with lime having been observed by Lieutenant Drummond, of the British navy, was ingeniously proposed by him, as the means of illumination in light-houses, and in consequence, has been subsequently used as a substitute for the solar rays, in an instrument known as the hydro-oxygen microscope, which is a modification of that which has been called the solar microscope. The name of Drummond light has consequently been given to a mode of illuation, which I originally produced as above stated.

The instrument which was used by Professor Silliman and by Rubens Peale, was that above described as having two perforations meeting in one. In this form it was, I believe, employed by Dr. Hope, of Edinburgh, and Dr. Thompson of Glasgow, who both treated it as my contrivance, anteriorly to the publication of Dr. Clark's memoir.

The other form, consisting of two concentric pipes, was modified by a Mr. Maungham, with the view of producing a lime light for the microscope above alluded to. When I saw Mr.

Maungham at the Adelaide gallery in 1836, he treated this instrument as mine, in another form. I was surprised afterwards to learn that he had obtained a premium for this modification from the British Society for the Encouragement of Arts, without any allusion to the original inventor.

After my return from Europe in 1836, I was very much in want of a piece of platinum of a certain weight, while many more scraps than were adequate to form such a piece were in my possession. This induced new efforts to extend the power of my blowpipe; and after many experiments, I succeeded so as to fuse twenty-eight ounces of platinum into one mass.

Although small lumps of platinum had been fused by many operators, with the hydro-oxygen blowpipe, as well as myself, it had not, up to the year 1837, been found sufficiently competent to enable artists to resort to this process. I am informed by Mr. Saxton, that some efforts which were made while he was in London were so little successful, that the project was abandoned. There was an impression that the metal was rendered less malleable when fused upon charcoal, as in the experiments alluded to. This is contradicted by my experiments, agreeably to which fused platinum is as malleable as the best specimens obtained by the Wollaston process, and is less liable to flake. The celebrated Dr. Ure, on seeing the platinum in the form of wire, of leaf, and plate, said that there was no one in Europe who could fuse platinum in such masses. He also alledged that it had been found so difficult to weld platinum, that no resort was had to that process. In this I concur, having had the welding tried by a skillful smith, both with a forge heat, and with a heat given by the hydro-oxygen blowpipe. An incorporation of two ingots was effected on their being hammered together, when heated nearly to fusion; but on hammering the resulting mass cold, a separation took place along the joint by which the ingots were united.

The difficulty seems to arise from the rapidity with which the platinum becomes refrigerated. It seems to have a less capacity for heat than iron, and, not burning in the air as iron does, has not the benefit of the heat acquired by iron from its own combustion with atmospheric oxygen.

Lately, by means of the instrument and process which it is my object here to describe, I have been enabled to obtain malleable platinum directly from the ore, by the continued application of the flame. From some specimens of platinum I have procured as much as ninety per cent. of malleable metal. The malleability is not inferior to that of the best specimens obtained by reducing it to the state of sponge, through the agency of aqua-regia and sal-ammoniac. There is, however, a greater liability to tarnish, arising, probably, from the presence of a minute portion of palladium.

Of the fusion of iridium and rhodium, I have already given an account in the Bulletin of the American Philosophical Society, which was subsequently embodied in an article in this Journal for October last, 1846.*

It remains now to give an account of the apparatus employed in the fusion of platina on a large scale.

Fig. 1 represents the association of fifteen jet pipes of platinum with one large pipe, B, D, at their upper ends, so that their bores communicate, by means of an appropriate brass casting, with that of the large pipe, the joints secured by hard solder. Their lower extremities are made to protrude about half an inch from a box, A, of cast brass, their junctures, with the appropriate perforations severally made for them, being secured by silver solder. They come out obliquely in a line along one corner of the box, an interval of about a quarter of an inch alternating with each orifice. By means of flanges, the brass box is secured to a conical frustum of copper, fig. 2, so as to form the bottom thereof, while the pipe, extending above the copper case, is screwed to a hollow cylinder of brass, A, fig. 3, provided with two nozzles and gallows screws, *g*, *g*, for the attachment of appropriate hollow knobs, to which pipes are soldered, proceeding from the reservoirs of oxygen and hydrogen. Cocks are interposed by which to regulate the emission of the gases in due proportion.

In connecting the pipes conveying the gases with the brass cylinder, A, fig. 3, care should be taken to attach that conveying oxygen to the upper nozzle, while the other, conveying hydrogen, should be attached to the lower nozzle; since, by these means their great difference in density tends to promote admixture, which, evidently, it must be advantageous to effect.

The object of surrounding the jet pipes with water, by means of the copper box,† is to secure them against being heated to such a degree as to cause the flame to retrocede and burn within them, so as finally to explode within the cylinder, A, *g*, *g*, fig. 3. It is preferable to add ice or snow to the water, in order to prevent undue heat.

Fig. 4 represents a movable platform, A, of cast iron, wholly supported upon the point of the iron lever, D, B, which is curved towards the extremity under the platform, so as to point upwards, and to enter a small central conical cavity made for its

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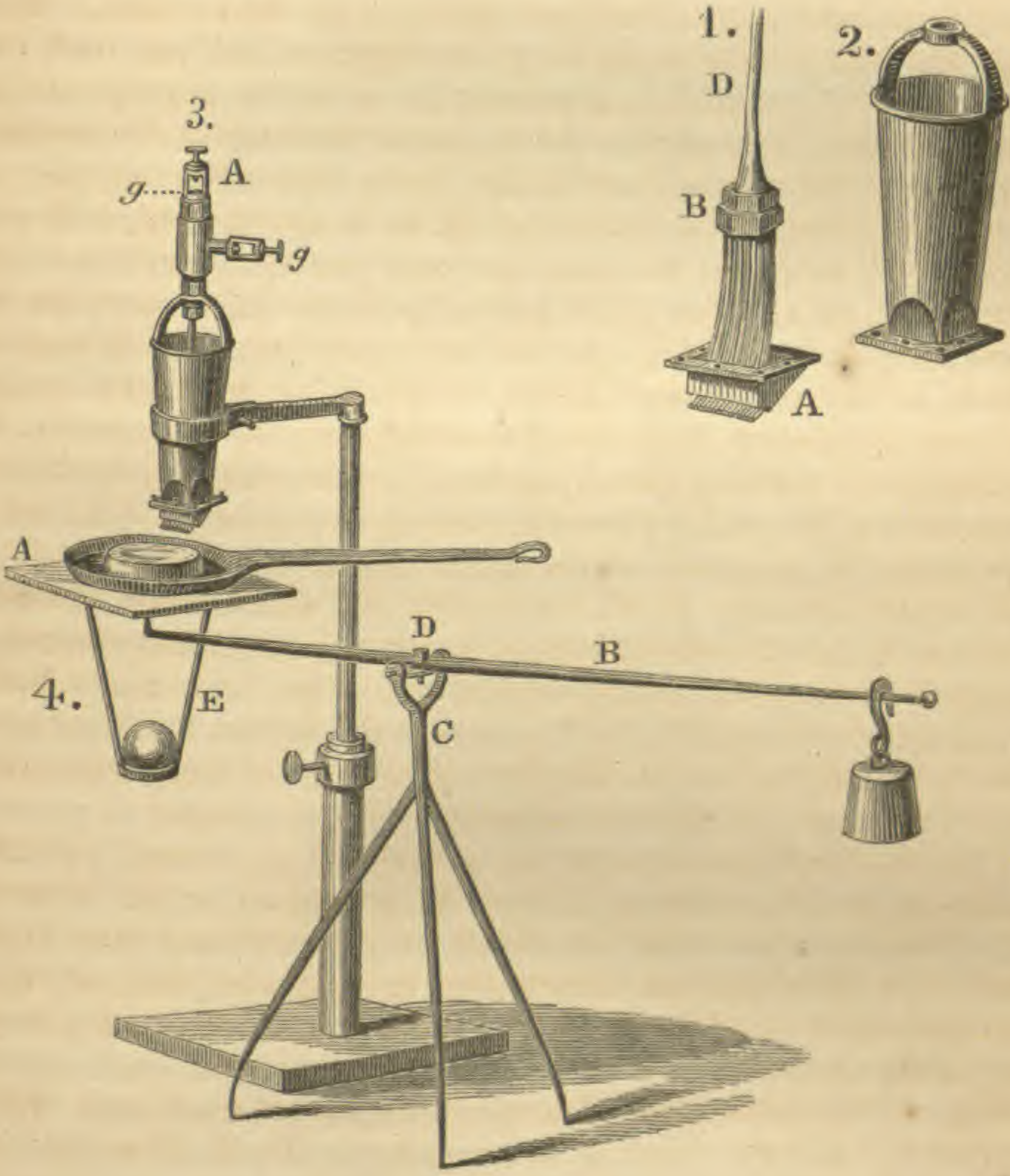
* Since published in the Revue Scientifique at Paris.

† Since the engraving was made, I have preferred to use water-tight boxes, with gallows screws and nozzles, situated one near the bottom on one side, the other on the opposite side near the top. By means of the lower nozzle, a pipe is attached, communicating with a head of cold water, the other being so situated as to carry the water into a waste pipe, or large tub; a circulation may be kept up during the whole time that the operation is going on.

As a support, a brick kaolin is used, having an oblong ellipsoidal depression on the upper face for the reception of the metal to be fused.



1.

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3.

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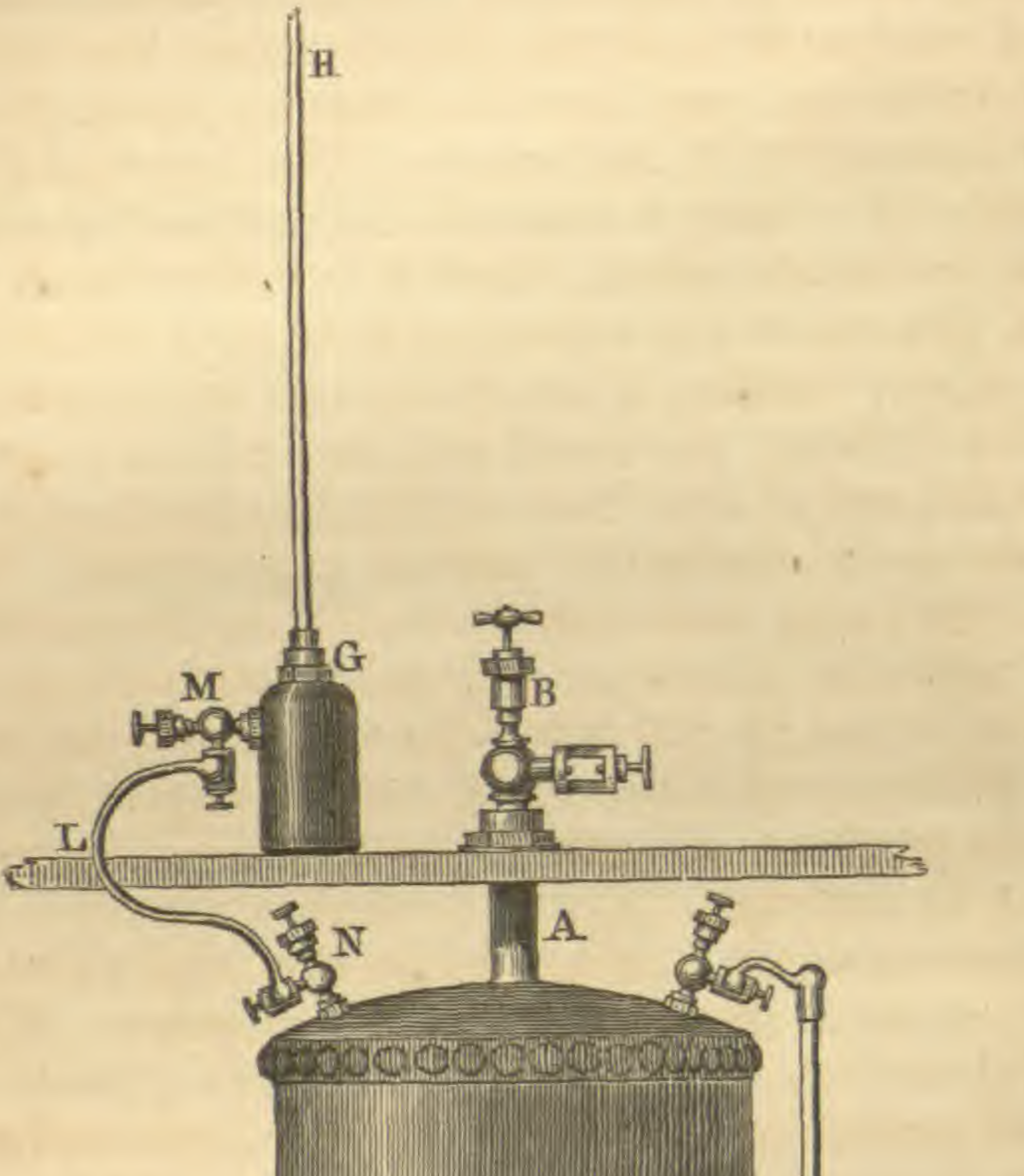


5.

reception. The lever is supported by a universal joint upon the fulcrum, C, so that by means of a sliding weight at one end, the platform and its appurtenances are counterpoised at the other. The platform is kept in a horizontal position by the cannon ball, supported in a sort of iron stirrup terminating in a ring, in which the ball is placed. Upon the platform is situated an iron pan with a handle, holding the brick, on a cavity in which as already mentioned, the metal is supported. The apparatus being duly prepared, and connected with the supply pipes, the hydrogen is first allowed to escape, and then the oxygen, until the ignition has attained apparently a maximum. The accomplishment of this object may, of course, require the adjustment of either cock several times, especially where there is any decline in the pressure either of the one or the other gas in its appropriate reservoir.

By means of the handles of the lever and of the pan, the operator is enabled to bring the metal into the position most favorable for the influence of the heat, while his hands and face are sufficiently remote to render the process supportable. In fusing any quantity, not being more than four ounces, the platform may be dispensed with, the handle of the pan being held in one hand of the operator, while by the other, the cocks may be adjusted.

When the blowpipe of fifteen jets, or any larger, may be employed, and the platform is necessarily resorted to, the cocks must be adjusted by an assistant.

Fig. 5 represents a cask made of boiler iron, three-sixteenths of an inch thick, so as to resist an enormous pressure. The joints are secured by riveting, as in constructing high pressure boilers.

This cask communicates with the hydrant pipes, so called, by which our city is supplied with water, of which the pressure varies from a half to more than two atmospheres, say from seven to thirty pounds per square inch, according to the number and bore of the cocks from which the water may be flowing at the time, for the consumption of the community. Hence, experiments, while using this head, are best made towards bed-time, or between that time and sunrise. The vessel is filled with water by opening a cock, F, on one side of the pipe, C, and allowing the air to escape through the valve-cock, B. Being thus supplied, the cock, F, closed, and a communication with a bell glass, into which oxygen is proceeding from a generating apparatus, being made by means of a flexible leaden tube, on opening the valve cock, B, and the cock, E, the water will run out, and be replaced by gas from the bell. This process being continued till the iron cask is sufficiently supplied with gas, the cock, E, must be shut. Whenever the gas is wanted for the supply of the blowpipe, it is only necessary to establish a communication between the valve-cock, B, and the upper gallows screw, fig. 3, of the cylinder, A, and to open the cock, F, so as to admit the water to press upon the gas, the efflux being regulated by B, or preferable by a cock of the ordinary construction, one of which kind should be interposed at a convenient position between the valve-cock, B, and cylinder, A.

T, represents a glass tube, which, by due communication with the interior, shews the height of the water, and consequently the quantity of gas in the vessel.

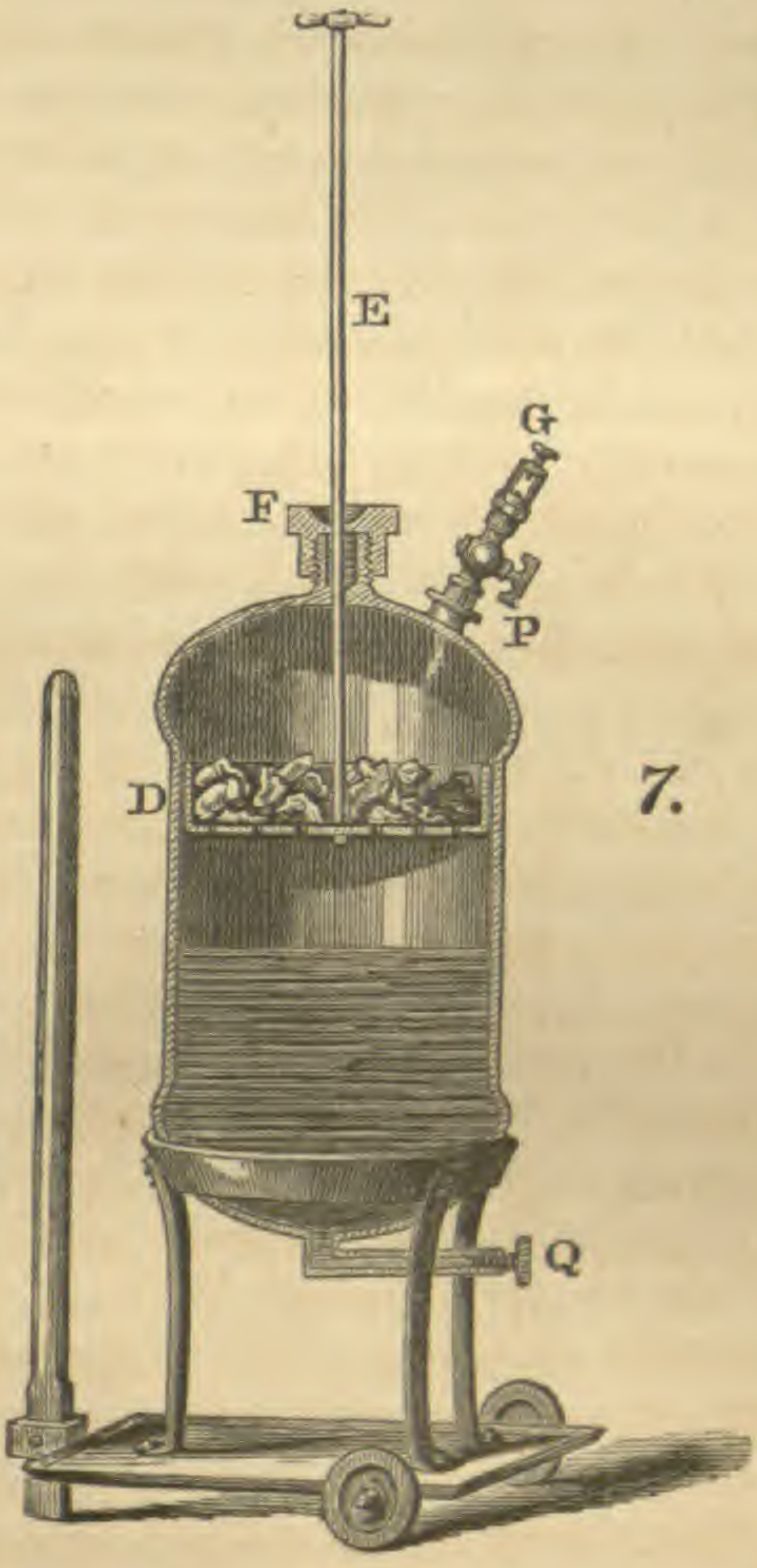
G, H, represents a gauging apparatus, consisting of a cast iron flask, of about a half a pint in content, and a glass tube of about a quarter of an inch in bore, which should be at least five feet in height. The tube is secured air-tight into the neck of the flask, so as to reach nearly to the bottom within. The flask is nearly full of mercury. Under these circumstances, when a communication is made, by a leaden pipe between the cavity of the flask and that of the reservoir, an equilibrium of presure resulting, the extent of the pressure is indicated by the rise of the mercury in the tube.

In order to generate hydrogen for the supply of a reservoir like that represented by the preceding figure, I have employed the vessel represented by fig. 7. This vessel, by means of a suitable aperture, susceptible of being closed by a screw plug, is half filled with diluted sulphuric acid. Being furnished with a tray of sheet coper, D, punctured like a coal sieve, and supported by a copper sliding rod, E, strips of zinc are introduced in quantity equal to the capacity of the tray. The sliding rod passes through a stuffing-box, F, at top of the reservoir, so that the operator may, by lowering or raising the tray, regulate or suspend the reaction between the zinc and its solvent, accordingly as the supply of hydrogen is to be produced, suspended, increased, or diminished.

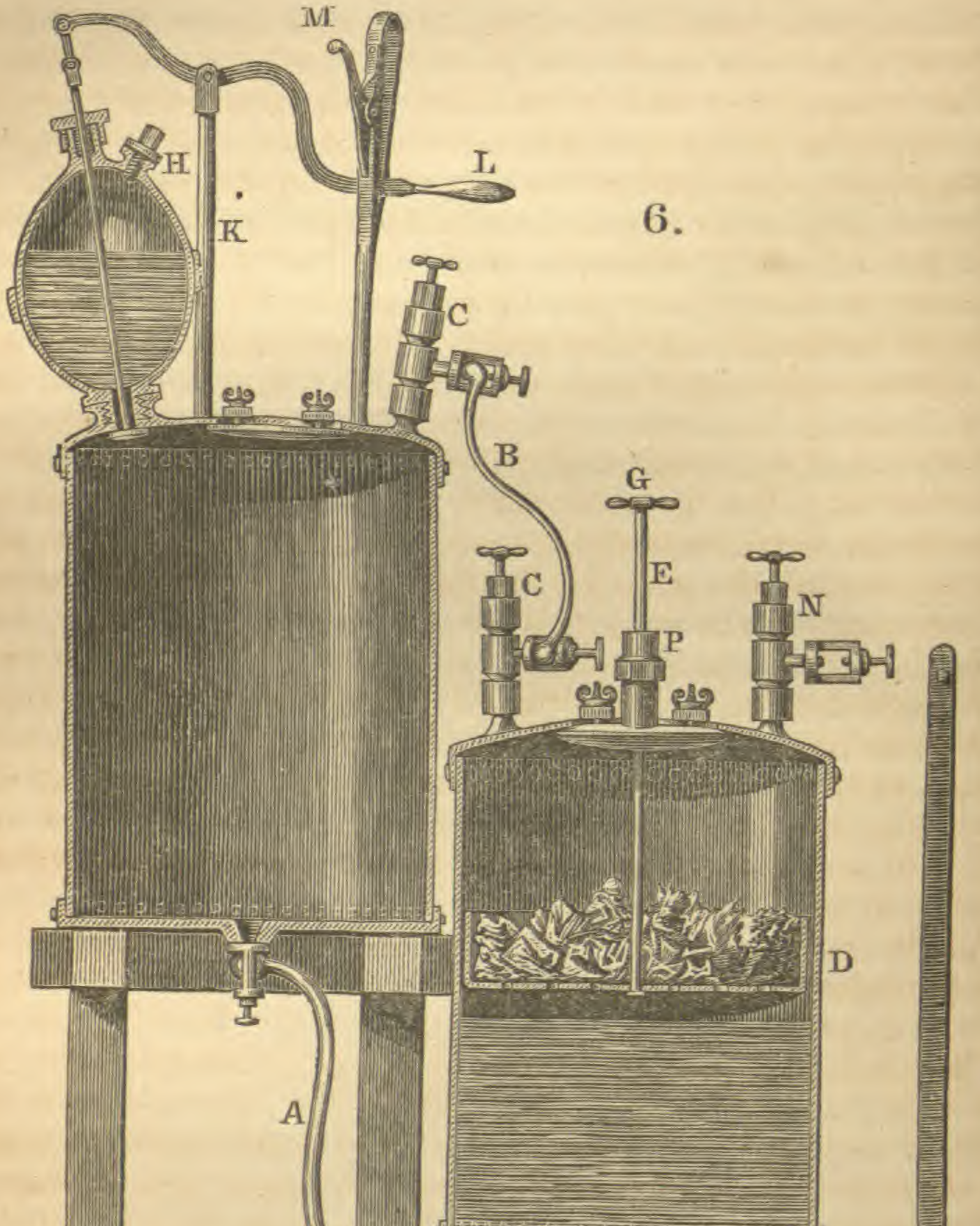
The communication with the reservoir is open and regulated by means of a cock, P, furnished with a gallows screw, G, for the attachment of a leaden pipe, as above described, in the process for supplying the reservoir with oxygen.

Another apparatus for producing a supply of hydrogen, is represented in fig. 6. It consists of two similar vessels of boiler iron, each capable of holding forty gallons. They are lined internally with copper, being situated upon a wooden frame, so that the bottom of one is two-thirds as high as the top of the other. The upper portions of these vessels communicate by a leaden pipe, B, of about half an inch bore, furnished with a cock, while the lower portions communicate by another leaden pipe of a bore of one and a half inches.

The upper vessel is surmounted by a globular copper vessel, of about twelve inches in diameter, which, from its construction, renders it possible to introduce an additional supply of concentrated acid, while the apparatus is in operation, without reducing the pressure within the reservoir, by permitting the excess above the pressure of the atmosphere to escape. This object is accomplished as follows:—



7.



6.

The valve at the end of the rod, attached to the lever, L, being kept shut by the catch, M, the screw plug, H, removed, the acid is introduced through the aperture thus opened. In the next place, the plug being replaced, and the valve depressed by means of the lever and rod, so as no longer to close the opening, which it had occupied, the acid descends from the chamber into the cavity of the vessel beneath it. The valve is of course restored to its previous position as soon as the acid has effected its descent.

The lowermost vessel is furnished with a perforated copper tray, supported by a copper sliding rod, in a way quite analogous to that already described in the case of the copper reservoir. It is also supplied with zinc and its solvent in like manner, being made half full of the diluted sulphuric acid. Of course, on contact being produced between the zinc and its solvent, the generation of hydrogen will take place. So long as the communication between the upper portions of the two vessels is open, the gas will extend itself into both, occupying the whole of the upper vessel, and that half of the lower one which is unoccupied by the liquid, But if, in this way, the pressure reaches to two atmospheres, as indicated by the gauge,* on shutting the communication through the pipe, B, the pressure in the inferior vessel will augment, that in the superior vessel remaining as before, but the liquid will consequently begin to pass out of the inferior vessel through the pipe A, and thus may lessen the contact between the acid and zinc, and finally suspend it altogether. Meanwhile the gas in the upper vessel being condensed to nearly half its previous bulk, the pressure will be nearly four atmospheres. It will, in fact, always be nearly double that which existed before the pipe, B, was closed.

In order that nearly the whole of the acid shall be expelled from the inferior vessel, the tray must be depressed till it touches the bottom of that vessel.

The pressure being four atmospheres at commencement, as soon as, by means of a pipe attached to the valve-cock, N, an escape of gas is allowed, the acid is forced again upon the zinc, and thus prevents a decline of pressure to any extent sufficient to interfere with the process.

The gases may be used from a receiver in which they exist, in due proportion, safely by the following means:—

Two safety tubes are to be made, not by Hemming's process exactly, but as follows:

A copper tube, silver soldered, of which the metal is about the eighth of an inch in thickness, is stuffed with the finest copper wire, great care being taken to have the filaments straight and

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* I have used for a gauge an instrument like G, fig. 5, the tube being about two feet in length, and sealed at the upper end.

parallel. The tube is then to be subjected to the wire-drawing apparatus, so as to compress the tube on its contents until the draught becomes so hard, as that it cannot be pushed farther without annealing. The stuffed tube thus made is to be cut into segments, in lengths about equal to the diameter, by a fine saw. The surfaces of the sections are to be filed gently with a smooth file. By these means, they appear to the naked eye like the superficies of a solid metallic cylinder. Brass caps being fitted on these sections, they are to be interposed by soldering, at the distance of a foot or more, into the pipe for supplying the jet. Under these circumstances, the posterior section becoming hot, may allow the flame to retrocede; but the anterior section being beyond the reach of any possible combustion, and remaining cold, will not allow of the retrocession; and as soon as the flame passes the first section, the operator, being warned, will, of course, close the cock, and subject the posterior section to refrigeration before proceeding again.

But this plan of operating may be rendered still more secure by interposing a mercury bottle, or other suitable iron vessel, half full of oil of turpentine, between the reservoir and safety tubes, as in the arrangement of a Woulfe's bottle. A leaden pipe proceeding from the reservoir is, by a gallows screw, attached to an iron tube which descends into the bottle, so as that its orifice may be near the bottom. The leaden pipe communicating through the safety tubes with the jet-pipe, is attached to the neck of the bottle. Thus the gaseous mixture has to bubble through the oil of turpentine in order to proceed through the safety tubes to the jet-pipe. If, while this process is going on, the flame should, by retrocession, reach the cavity of the bottle, exploding in contact with the turpentine, a compound is formed, which is, *per se*, inexplosive from the excess of carbonaceous matter. Meanwhile the shock, acting on the surface of the oil, drives it into the bore of the iron tube, and thus, both by its chemical and mechanical influence, renders it utterly impossible that the flame should reach the cavity of the reservoir.

Apparatus for the Fusion of Iridium or Rhodium or masses of Platinum less than five ounces in weight.

For the fusion of either Iridium or Rhodium or masses of Platinum not exceeding the weight of half an ounce, an instrument with three jets has been employed, the bore of each jet pipe being such as not to admit a wire larger than the $\frac{1}{32}$ of an inch in diameter. The flame produced by these means was quite sufficient to envelope the mass to which it was applied.

In fusing any lumps or congeries of platinum, not exceeding five ounces, an instrument has been used capable of giving seven jets of gas, issuing of course, from as many pipes. Of these pipes, six protrude through the brass casting forming the bottom of the copper case constituting the refrigerator, so as to be equidistant from each other upon a circumference of three-fourths of an inch in diameter, the seventh protruding from the centre. The bores of these jets are such as not to admit a wire larger than $\frac{1}{32}$ of an inch in thickness. Those of the larger instruments represented by the accompanying engravings were such as to admit wires of $\frac{1}{24}$th of an inch in thickness.

The jet-pipes may be made by the following process:—A thin strip of sheet metal, somewhat wider than the length of the circumference required in the proposed pipe, after being roughly turned about a wire so as to form an imperfect tube, is drawn through several suitable holes in a steel plate, as in the wire-drawer's process. Under this treatment the strip becomes converted into a hollow wire; the edges of the strip being brought into contact reciprocally, so as to leave only an almost imperceptible crevice. Having drawn one strip of platina in this way, another strip sufficiently wide nearly to enclose it, is to be drawn over that first drawn, care being taken to have the crevices left at the meeting of the edges on contrary sides. The compound hollow wire or tube thus fabricated, is finally to be drawn upon a steel wire of the diameter of the requisite bore.

The following method of making jet-pipes, though more difficult, is preferable; as there is less liability of the water of the refrigerator leaking into the bore.

Select a very sound and malleable cylinder of platina, of about three-eighths of an inch in thickness, perforate it by drilling in a lathe, so that the perforation may be concentric with the axis. A drill between $\frac{1}{16}$th and $\frac{1}{8}$th of an inch in diameter may be employed. In the next place the cylinder may be elongated by the wire-drawing process, until the proper reduction of metallic thickness is effected, the diameter of the bore being prevented from undergoing an undue diminution, by the timely introduction of a steel wire.

Of course, the metal must be annealed as often as it hardens, by drawing. For this purpose, a much higher temperature is necessary in the case of platinum, than in that of either copper, silver, or gold.

The annealing is best performed by the hydro-oxygen flame. If charcoal be used, the greatest care must be taken to have the fireplace clean.

Agreeably to a trial made last spring, palladium may be used as a solder for platinum; and as it is nearly as difficult to fuse as this metal, it is of course, for that purpose, preferable to gold where great heat is to be resisted. No doubt, by employing palladium to solder the exterior juncture of the double drawn tubes above mentioned, they might answer as well nearly as when constructed of solid platinum.

Art. VII.—*Description of Two New Species of Fossil Footmarks found in Massachusetts and Connecticut, or, of the Animals that made them;* by Rev. Edward Hitchcock, President of Amherst College, and Professor of Natural Theology and Geology.

I have long wished to describe several new and peculiar fossil footmarks which have been brought to light in the sandstone of the Connecticut Valley in Massachusetts and Connecticut. But a constant pressure of more important duties has delayed the work, not months merely, but years. I have determined, however, to begin it; hoping that time and health may allow me to prosecute the descriptions in future numbers of the American Journal of Science. For the present I content myself with describing two species; one of them, if I rightly understand it, of most extraordinary dimensions and character.

Before the Association of American Geologists and Naturalists, at their meeting in New Haven, in 1845, I communicated a paper, in which, instead of naming the tracks, as I had formerly done, I attempted to name the animals that made them. That paper I have never found time to get ready for the press; though a list of names was given in the Proceedings of that Society. I am more and more satisfied that this principle, suggested to me by my friend, Mr. James D. Dana, is the true one by which these singular relics should be described.

I have been surprised, however, to learn that some object to giving scientific names, either to these footmarks, or to the animals that impressed them; because they think the characters by which they must be described too indefinite for distinguishing species, or even genera. My reasons for a contrary opinion are briefly as follows.

1. The existence of these tracks demonstrates the existence of certain animals that made them during the triassic period. 2. The facts well known concerning organic remains, render it almost certain, that these animals have never been described, either in the living or fossil fauna of any country. 3. All who have seen a good collection of these tracks, will be satisfied that they were made by several species of animals. Now this conviction must result from some diversity of character, which we witness in these footmarks. And if that diversity could produce such a conviction, it can be expressed in words; and thus the different species, at least many of them, be distinguished from one another. If they cannot thus be distinguished, then they must be regarded as only varieties of the same species. But no comparative anatomist will admit this to be possible. 4. Comparative anatomy teaches us that some of the surest and most constant characters by which animals are distinguished, are derived

from their feet. This is eminently true of birds. "Indeed," says Duméril, "it is by the form and the length of the feet, and the disposition of the toes, that birds are divided into six orders," &c.* 5. Living animals could to a great extent be divided correctly into families, genera, and species, by their tracks. 6. If no fossil animal is to be named until we obtain a complete description of it, then a large part of those already named, should be stricken from the list of organic remains, since only fragments of their skeletons have been found; and we have the authority of Cuvier for saying, that sometimes even the whole skeleton is insufficient to distinguish species from species. "The difference," he remarks, "between two species is sometimes entirely inappreciable from the skeleton. Even the genera cannot always be distinguished by osteological characters."† My conviction is, that not a few fossil animals have been described from characters much more uncertain than those derived from well preserved tracks. 7. We have the highest authority for naming animals from their tracks alone. This was done by Professor Kaup, in the case of the *Chirotherium;* and by Professor Owen, in the case of the *Festudo Duncani;* the only evidence of whose existence is the tracks on the sandstone of Scotland.‡ 8. Convenience in writing or conversing about different kinds of these relics, demands that scientific names should be attached, either to the tracks or the animals that made them. In making attempts to describe them without names, I have sometimes been reminded of the *house that Jack built*, in an old nursery story: Ex gr., "this is the dog that worried the cat, that killed the rat, that ate the malt, that lay in the house that Jack built."

Upon the whole, I cannot see why it is not as desirable, and as consonant to the laws of zoology and comparative anatomy, to derive the name of an extinct animal from its tracks, as from a fragment of a skeleton. Admit that in most cases there may be more danger of mistake in the former than in the latter instance: yet in the first case there is almost every possible degree of uncertainty as to the exact place which the animal ought to occupy. But if well assured of its former existence, why should it not have a name assigned it, among the preadamite inhabitants of the earth, according to the rules of nomenclature derived from zoology and comparative anatomy? So far as these sciences will justify distinctions, and no farther, do I contend for the erection of genera and species. In the present instance, I have so constructed the generic and specific names that they will hold good, though future researches should prove the animals to have been very different in nature from what we now suppose. Fur-

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* Elemens des Sciences Naturelles, Tome ii, p. 258, fourth edition.

† Ossemens Fossiles, Tome troisième, p. 524, third edition.

‡ Rep. of Brit. Assoc. for Advancement of Science, for 1841, p. 160.

ther reflection and new discoveries have led me to alter somewhat the names which I presented to the Geological Association. But as I offered at that time no descriptions, I suppose such changes are lawful, according to the rules of zoological nomenclature.

My present object, however, is not to present a complete view of this subject, but only to describe two new species recently discovered in South Hadley. They were brought to light by Pliny Moody, Esq., the same individual, who, about forty-six years ago, discovered near the same spot, the first specimen of footmarks ever noticed as an object of interest in the valley of the Connecticut. That specimen, described and figured in my final Report on the Geology of Massachusetts, plate 48, fig. 55, and now in my cabinet, was turned up by Mr. Moody, then a boy, while ploughing upon his father's farm, and recognized as a row of tracks made by a bird. While he was absent at college, it passed into the hands of Dr. Dwight, of South Hadley. Yet now, after the lapse of nearly half a century, Mr. Moody has found, within ten rods of his house, perhaps the largest and most extraordinary track yet brought to light in this valley. It is but an act of justice, therefore, it seems to me, to affix his name to this most remarkable species, which would have been destroyed by the quarryman had he not rescued it. The slab containing it, is, indeed, considerably mutilated, and only one very distinct track remains. But three others of the same animal are obvious, and enable me to give its characters with considerable confidence. This interesting slab is about ten feet long, six or eight inches thick, and weighs more than half a ton. It is broken open lengthwise, as shown in the drawing, fig. 1: and some smaller fragments are broken off, some of which are lost. Mr. Moody having allowed me to deposit this slab in the Cabinet of Amherst College, I have brought the fragments together, and am gratified to find so much remaining. Besides the large tracks, several rows of smaller species are exhibited almost without any loss. Of the large tracks, four remain. The second (A, fig. 1,) is the most perfect, being deficient in nothing but the extremities of the two middle toes, and a confusion at the end of the shortest lateral toe.* So peculiar is the shape of this track, and so different its phalangeal impressions from those of the feet of any living animal with which I am acquainted, that I should hardly have dared to describe it from a single specimen, had I not found its essential features exhibited in the other tracks. Some of these are badly broken, and others are indistinct, owing apparently to the peculiar state of the mud when they were made. Yet enough remains to identify them with the most perfect one just described. It is clear, also, that they were

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* Pres. Hitchcock sent for this Journal an outline sketch of this remarkable track, of full size, (twenty inches in length,) which from the magnitude of the plate required for it, is not inserted.

made by the right and left feet of the animal: and hence I was forced, contrary to my first impressions, to regard the animal as a biped. In attempting to trace its analogies to living animals, however, I have been less successful than in respect to any other animal of the thirty or forty species that impressed the forming new red sandstone of New England. Indeed, the enquiry has recurred to me more forcibly than ever, whether some of these animals may not have combined in their structure, characters now found in several distinct races; as seems to have been the case with some of the Saurians. But this suggestion can be judged of better after describing the footmarks under consideration.

On the same slab with the large tracks, are those of two other species of thick toed bipeds; one of which is the *Brontozoum Sillimanium*, (Ornithoidichnites Sillimani of my Report,) and the other a new species which I have denominated *B. parallelum*, on account of the slight divergence of the lateral toes. I shall first describe the genus Brontozoum, and then this new species, in the manner in which I propose in future to describe all the species known to me.

Fig. 1. Reduced 18 diameters.

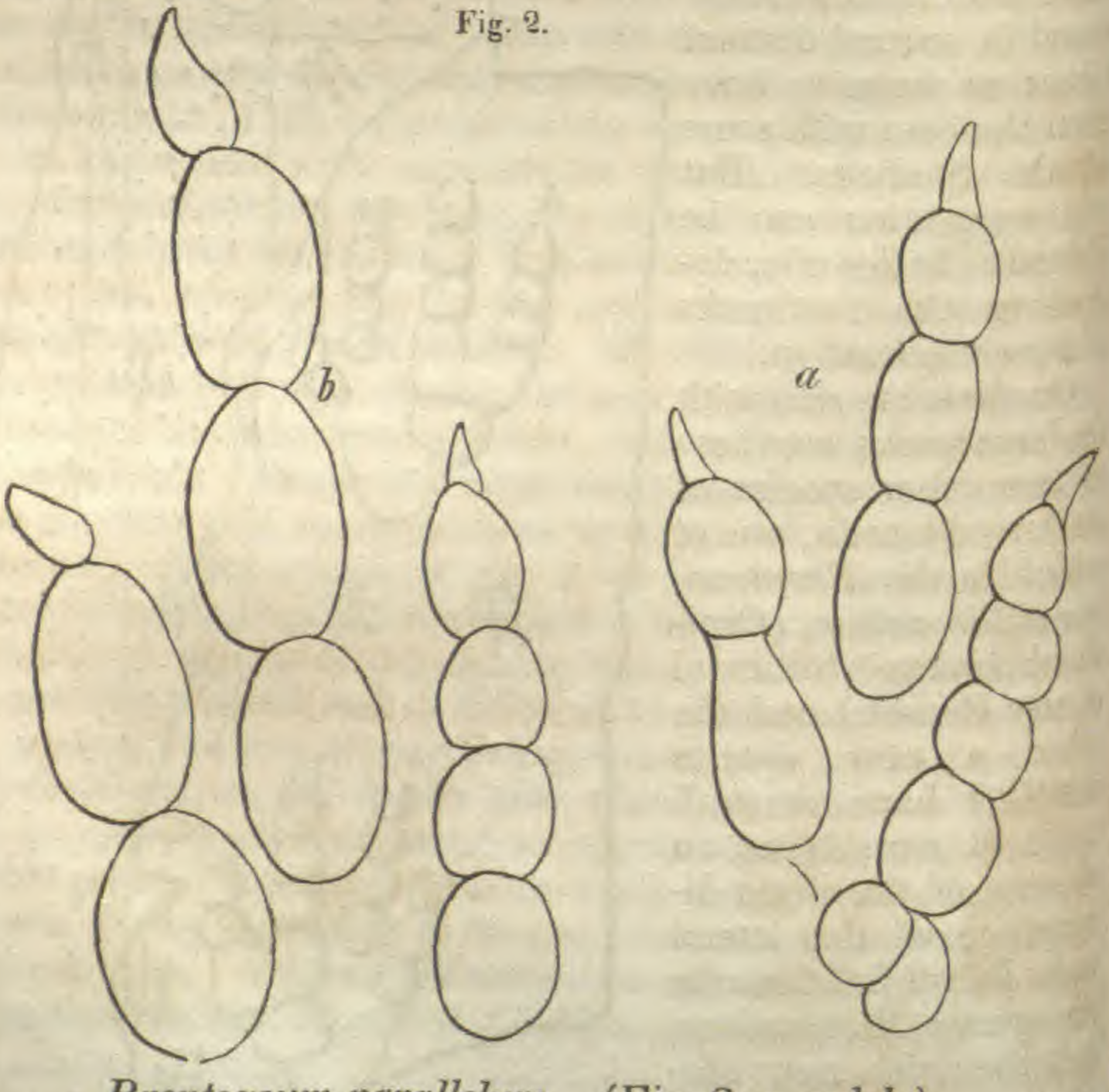
Genus **Brontozoum**, (βϱοντης, a giant, and Ζωον, an animal.)

Foot tridactylous, pachydactylous, the toes making strong tubercle-like phalangeal impressions; having claws, which in the lateral toes proceed from the outer side, and in the middle toe from the inner side; inner toe shortest: all of them directed forward. Tubercular swellings or phalanges of the inner toe, two; of the middle toe, three; of the outer toe, four. The distal extremity of the tarso-metatarsal bone double-headed; yet rarely reaching the ground: the cushion beneath it, making an impression, which slopes upward posteriorly. Animals bipedal, gregarious.

Five species known: one of them of great size,—with a foot eighteen inches long.

Affinities.—The number and position of the toes, and of the phalanges of the several toes, as well as the manner in which the steps succeeded one another, ally the animals to birds. The deficiency of the hind toe, and the great length of most of the steps, ally them to Grallæ. The great thickness of the toes, and the great size of the feet in some instances, suggest a relation to the Struthionidæ.

Fig. 2.



Brontozoum parallelum. (Fig. 2, *a* and *b*.)

Divarication of the lateral toes, 15° to 20°; do. of the inner and middle toe, 5° to 6°; do. of the outer and middle toe, 8° to

15°. Length of the middle toe, 2 to 3 inches; do. of the inner toe, 1·5 to 2 inches; do. of the outer toe, 1·8 to 2·3 inches; do. of the claw of the middle toe, 0·4 inch; do. of the foot, 3 to 3·5 inches; do. of the step, 13 to 29 inches. Width of the toes, 0·33 to 0·5 inch; do. of the posterior part of the foot, 1 to 1·4 inch. Longest diameter of the double-headed lower extremity of the tarso-metatarsal bone, 0·5; shortest do., 0·27 inch. Length of the middle toe beyond the outer ones, 1·2 to 1·4 inch. Distance between the tips of the lateral toes, 1·5 to 1·6 inch; do. between the inner and middle toe, 1·37 to 1·64 inch; do. between the outer and middle toe, 1·2 to 1·65 inch. Length of the first phalanx of the inner toe, 0·65 to 0·8 inch; do. of the second and third, (supposed to make but one impression,) 0·6 to 0·8 inch; do. of the first of the middle toe, 0·64 to 0·8 inch; do. of the second phalanx, 0·53 to 0·8 inch; do. of third and fourth, 0·4 to 0·8 inch; do. of the first of the outer toe, 0·4 to 0·54 inch; do. of the second, 0·3 to 0·4 inch; do. of the third, 0·26 to 0·35 inch; do. of the two last, 0·33 to 0·45 inch. Tracks in a right line, and the axis of the foot coincident with that line.

Distinctive Characters.—The most striking characters by which the tracks of this animal are marked off from all others, are the near approach to parallelism of the lateral toes, and the great length of the step compared with the size of the foot. This is particularly the fact in respect to the smaller of the outline tracks given on Fig. 2, *a;* for the animal by which this was made, had a stride of two feet: nor is this confined to a single specimen; so that the idea that the animal was running, is not probable. The great disparity between the step in the large specimen (fig. 2, *b*) and the small one (fig. 2, *a*), has led me to suspect that in the above description I may have embraced two species: but their form coincides too exactly to allow of a separation: and yet the large track shows a stride of only 13 inches, while that of the smaller one is 24 inches. The former is from Turner's Falls in Gill, and the latter from South Hadley. I am more disposed to this opinion, from the fact, that I find another row of tracks on the same slab from South Hadley, that contains fig. 2, *a*, running in the opposite direction, and about as large as fig. 2, *b*, yet exhibiting a stride of 29 inches. See the two rows on Fig. 1, *a*, *a*, *a*, *a*, and *b*, *b*, *b*, *b*.

The ratio between the length of the foot and the step in this species, (taking the two examples on fig. 1 as our guide,) is much greater than that of any other animal whose footmarks I have found. That ratio is 8 for the smaller track, and 8·3 for the larger: that is, the step is eight times larger than the foot. Applying the rule which I have suggested for ascertaining from these numbers the length of this bird's leg,* we find it to be 39

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* See Final Report by the writer on the Geology of Massachusetts, vol. ii, p. 522.

inches for the smaller animal, and 47 inches for the larger one; that is, from the hip joint to the ground. This is rather more than the length of the leg of the Red Flamingo of this country, which I think also has a larger foot than the fossil bird.

I now proceed to describe the large and extraordinary animal whose tracks occur on the same slab with the B. parallelum, (fig. 1,) but whose affinities to any existing animal are far less obvious. For this remarkable animal I have selected the generic name of *Otozoum*, from that of Otus, one of the fabled præadamic giants. The meaning of Otozoum is, *an animal Otus, or giant.*

The description of the foot of this animal, as we learn it from its footmarks, will depend to a considerable extent upon the zoological class to which we refer it. The protuberances exhibited on the footmark may be all the result of phalangeal impressions; or a part of them may be produced by carpal or metacarpal, or if by the hind foot, by tarsal or metatarsal bones: or if the animal were a bird, by the distal extremity of its tarso-metatarsal bone. Can we then discover to what class of animals these tracks are to be referred?

In the first place, the proof seems quite strong that they must have been made by a biped. This evidence is shown on fig. 1; where it will be seen that the feet regularly alternate as those of a biped would do. But if made by a quadruped, there ought to be two rows, or at least two tracks, near to each other, separated by a longer interval from two others in close proximity: for in one or the other of these modes do most quadrupeds (except those that leap, and those that bring up the hind foot exactly into the place impressed by the fore foot) advance. Besides, the distance of the tracks to the right and left of the animal's general course, is no greater than a biped so large would exhibit: whereas if it were a quadruped, that distance must have been much larger, and the axes of the feet would probably be more divaricate.

When I saw that these tracks were four-toed, it occurred to me that they might have been made by the hind foot of the crocodile. But their biped character forbids the supposition: and besides, the phalangeal impressions do not agree at all with the phalanges of that animal, which are two in the inner toe of the hind foot, three in the second, and four in the third and fourth.* This latter reason, as well as the number of toes, affords strong evidence against the supposition that this animal was a bird. Some slight resemblance may be noticed between the accompanying drawing, fig. 2, and the feet of the Armadillos, as given in the *Ossemens Fossiles, tome cinquième, Pl. XI, figs.* 10 *to* 14; yet I doubt whether the resemblance is real.

On showing a drawing of this track to Professor Agassiz, he made a suggestion as to the nature of the animal that im-

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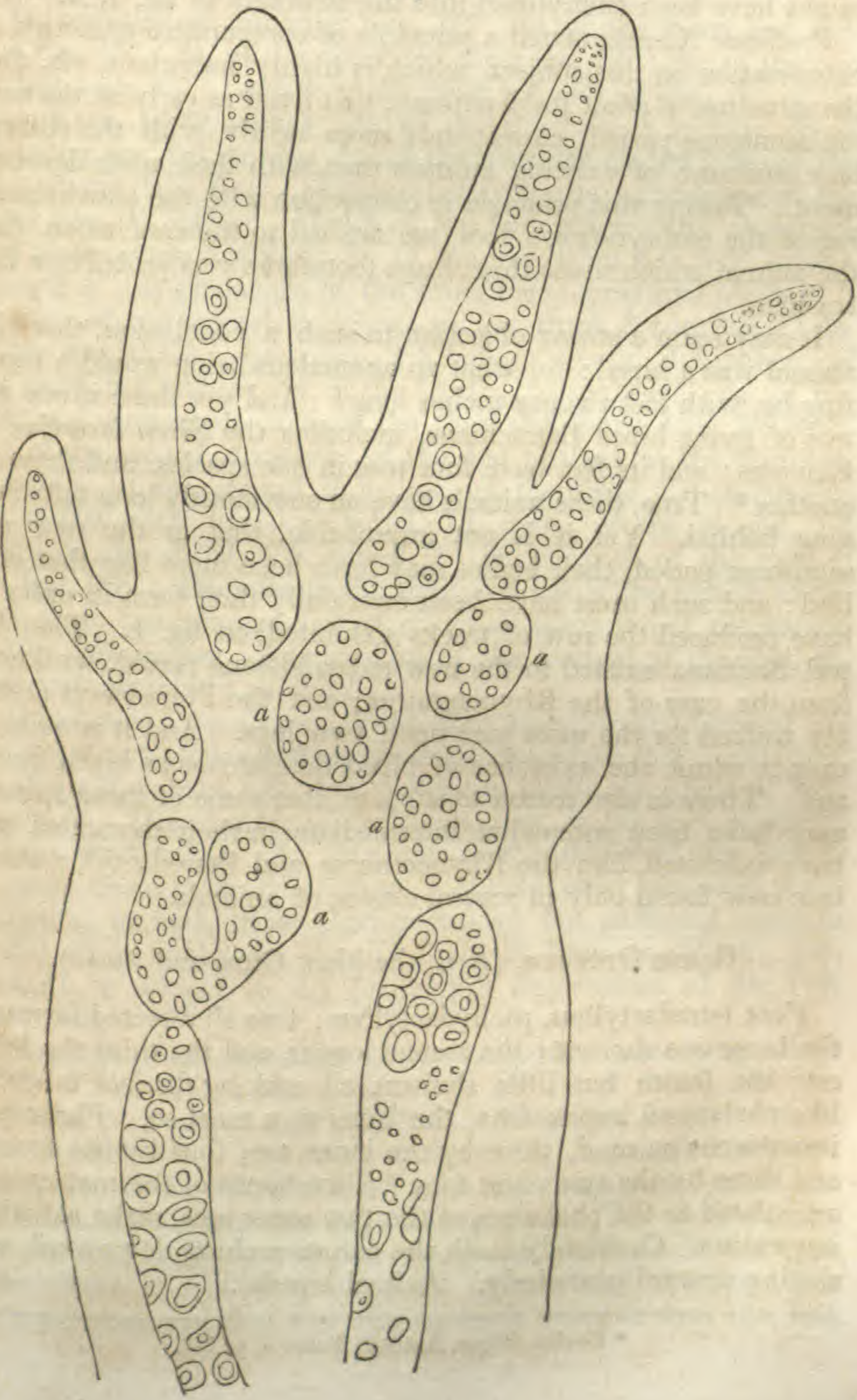
* Cuvier, Ossemens Fossiles, Tome cinquième, p. 104.

pressed it, which I regard as very important. He at once exhibited to me a drawing of the foot of a recent Batrachian, the *Alytis obstetricans*, in a paper by Dr. Carl. Vogt, while the animal was in an embryo state. This drawing, which I have copied on fig. 3, shows the condition of the forefoot while yet ossification

Fig. 3.



was in an incipient state, or had not begun. The resemblance is certainly rather striking between this sketch and that on fig. 1: and it leads to the suspicion that some of the tubercular impressions of the track may have been made by the metacarpal bones. Such I suppose to be the character of *a*, *a*, *a*, *a*, fig. 3; and when these were fully ossified, it is easy to conceive that they might have been anchylosed into the structure in fig. 1, A.

Professor Agassiz stated a principle of comparative anatomy, in conversation on this subject, which is highly important, viz. that the structure of adult fossil animals, that lived as early as the new red sandstone period, corresponds more nearly with the embryonic structure of existing animals than with their adult development. Taking this principle in connection with the above drawing of the embryo-frog's foot, we are led to the conclusion, that the animal which made these huge footmarks was probably a Batrachian.

It may seem a strong objection to such a conclusion, that the animal was a biped: for what an anomalous being would a biped frog be, with feet twenty inches long! And yet there is one genus of living biped Batrachians, including the *Siren lacertina* of Linnæus; and its feet have four toes in one species, and three in another.* True, these animals have an enormously long tail dragging behind. Yet it is not improbable, that in the new red sandstone period, their bodies may have been more like that of a bird: and such must have been essentially their form in order to have produced the row of tracks exhibited on fig. 1. That biped Saurians existed in the new red sandstone period, we know from the case of the Rhyncosaurus: and the Pterodactyl probably walked for the most part upon two legs. And it is quite as easy to admit the existence of biped Batrachians as biped Saurians. There is also reason to suppose, that some of these animals may have been somewhat intermediate in their characters, and have exhibited, like the Rhyncosaurus and Pterodactyl, a structure now found only in several classes of animals.

Genus OTOZOUM, (Ωτος, the giant Otus, and Ζωον.)

Foot tetradactylous, pachydactylous; toes all directed forward: the inner one shortest; the second longer, and the third the longest; the fourth but little shorter: all making distinct tubercle-like phalangeal impressions, the inner toes most so. Phalangeal impressions on mud, three by the inner toe, four by the second, and three by the two outer toes. Two bones of the metacarpus, articulated to the phalanges of the two outer toes, make a distinct impression. Cushion beneath the carpus arching downward, and sloping upward posteriorly. Animal bipedal.

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* Cuvier, Règne Animal, Tome ii, p. 120.

Remarks.—It may be that what I have reckoned as the first phalangeal impression on the two inner toes was made by metacarpal bones: and it is also possible, on the other hand, that both the impressions which I have described as having a metacarpal origin on the two outer toes, may have been phalangeal.

Otozoum Moodii. (Fig. 1, A.)

Divarication of the outer toes, 35°; do. of the inner and second toe, 15°; do. of the outer and third toe, 12°; do. of the two middle toes, 5°. Length of the inner toe, 8·5 inches; do. of the second toe, 10·25 inches; do. of the third toe, 8 inches; do. of the outer toe, 8·5 inches; do. of the foot, 20 inches; do. of the step, about three feet. Distance between the extremities of the outer toes, 13 inches. Width of the foot behind the phalanges and metacarpus, 5 inches; do. of the toes, from 2 to 3·25 inches. Length of the phalanges of the inner toe:—proximal phalanx, 3 inches; of the second, 2 inches; of the third, 3·4 inches (?) do. of the second toe:—proximal, 2·4 inches; second, 2·5 inches; of the third, 2·9 inches; do. of the fourth, 2·6 inches (?); do. of the proximal metacarpal bone of the third and fourth toes, 3·5 inches; of the second, 4 inches: of the first phalanx of the third toe, 2 inches; of the second, 2 inches; of the distal, 3·8 inches (?); do. of the outer toe:—proximal, 1·6 inch; of the second, 1·6 inch; of the distal, 5·4 inches (?) Divarication of the axes of the feet, 30°. Distance to the right and left of the middle of the heel, from the average line of direction along which the animal moved, 2·5 inches. Integuments of the bottom of the foot, rugose and irregularly papillose.

Distinctive Characters.—Four thick toes directed forward and making strong phalangeal impressions, distinguish this animal from all others that have left their footprints in the sandstone of New England. The number of phalanges, also, in the toes, separates it from every other. As only one of the tracks of the animal is entire enough for description, I should have suspected some deception in both these characteristics; but sufficient remains of the other tracks, to identify them by their repetition; particularly in respect to the phalangeal impressions of the two outer toes.

Situation and character of the Deposits containing these tracks.—The tracks above described are all in relief, and the rock is a very coarse gray sandstone, the grains being often as large as buckshot. Yet every thing is exhibited most distinctly. Nearly the whole slab is covered with rain drops most beautifully exhibited, and shown upon the drawing, fig. 1. The tracks appear to have been made upon a fine micaceous sand, which has little more coherence now than when the animals trod upon it. But the coarse material that was subsequently brought over this fine stratum, seems to have adapted itself to every irregularity, and now presents us with perfect casts of the original tracks, while the subjacent rock, which seems to have been a good moulding sand, does not hold together enough to show a single entire track.

It seems that the rows of tracks at this locality were parallel to the edges of the water. They run nearly east and west, and in the direction of the strike of the strata; and in one or two places upon the slab figured above, we can see where the water acted by gentle undulations upon the fine micaceous sand, and upon the coarse grit, partially wearing them both away, or intermixing them; and some of the large tracks look as if the sand had been so wet that the impressions were partly filled up by the sand sliding into them. Only the second track exhibits the outlines of the parts entire. On that, the protuberances rise from one to two inches above the general surface. The extremities of this track have been broken off accidentally, except the inner one which is obscured by lying too near the edge of the water. It is obvious however how far it extended. As I have before mentioned, the second large track on fig. 1, forms the type by which I have restored the others, or rather, completed them; for some of the toes remain in all cases, and so far as they go, they confirm the characters exhibited by the second. It is only a part of the phalangeal impressions that shows the rugosities or papillæ of the skin: yet I can hardly doubt but we have them exhibited on some of the protuberances.

All the left-hand side of the slab, represented on fig. 1, for about half its length, embracing the first two of the large tracks, has been split off an inch or two lower than the other part of the slab. This makes no difference in the large tracks, except to make them stand out in higher relief; but it brings to light several of the smaller tracks, which, although of the same species, must have been impressed at a later period—probably one or two years later—than those scattered among the rain drops.

I have not been able to find any certain example of claws upon the large tracks. Most of the toes are somewhat mutilated at their extremities; and in general, the sides converge rapidly on the last phalanx, so that if claws existed on the foot—and I think they did—they must have been short and blunt.

Circumstances under which the tracks of these animals were made.—Have we any facts in this case indicating the circumstances under which these tracks were made and preserved? It is difficult, without a sketch of the topography of the region, to convey an adequate idea of their situation. The spot is on the south side of Mount Holyoke, which here runs nearly east and west. It curves southerly, however, as it crosses the river, and on the west we have Mount Tom, as the continuation of Holyoke is called. On the east we have a primary range at a short distance, against which the east end of Holyoke abuts, with only a narrow space between. It is obvious then, that this locality must have been the north shore of an estuary, opening southerly, and extending to what is now Long Island Sound. That it was salt-water is evident from the occurrence of fucoids in the same basin, a few miles south. Now we know that the current through this estuary was either north or south, for the ripple marks have an east and west direction, and in size they correspond with those made by the waters of the Connecticut on the sand in the same region. The direction of that stream also is south; and some have thought that the floods of that stream may have brought in the sand which filled the tracks. But the locality must have been defended from a northerly current by Mount Holyoke, whose elevation doubtless formed the shore on which the animals trod. Indeed, it would be exposed to no current that I can conceive of, sufficiently powerful to move such coarse materials, except the waves and tides from the south. And yet, a deposit at least six inches thick of coarse sand, was brought in over the tracks. It seems difficult to conceive how any river floods should have raised the waters of an estuary enough for this purpose; and more difficult to show how these coarse materials could have been thus brought over this spot. I have hence been rather inclined to suppose that they were silted in by the waves and the tides:—not the daily tides, but the spring tides. Suppose the animals walked along the shore during neap tide, and that no rain fell till the return of spring tide. By that time the mud might have become so indurated, that even such coarse materials might have been brought in by moderate waves, without erasing the impressions. It might be also that the river, which doubtless flowed into this estuary, answering to the present Connecticut, was at the same time swollen; and perhaps also we must resort to the supposition of a subsidence of the locality—an occurrence not uncommon during igneous eruptions: and we know from other circumstances, that the tracks were made about the same period in which Holyoke was erupted. We have evidence also that this period, including some precursory outbursts of the igneous matter, was quite long.

Should time and health permit, I hope to send another communication ere long, describing other new species of tracks in the Connecticut valley. I have no others, however, that are so remarkable as the large one herein described. This, indeed, seems to eclipse that of the *Brontozoum* (Ornithoidichnites) *giganteum*, figured in the Journal of Science for 1836, being even of greater dimensions. I had thought that we had reached nearly the end of this ancient volume; but it may be, that many new chapters will yet be brought to light, when its stony leaves shall be still farther opened.

ART. VIII.—*Glycocoll (Gelatine Sugar) and some of its Products of Decomposition;* by Prof. E. N. HORSFORD.

(Continued from Vol. iii, p. 381.)

COMPOUNDS of glycocoll and sulphuric acid are even more remarkable than those with hydrochloric acid. As little success attended the effort to ascertain the precise conditions under which some of them are formed, as rewarded the labors with the compounds already described. Of these, two, the double sulphate of glycocoll and oxyd of ammonium, and the anhydrous sulphate of glycocoll, have especial interest, as they throw much light over the constitution and nature of this body.

Anhydrous Sulphate of Glycocoll.

$$\mathrm{Gl, SO_3}.$$

By dissolving glycocoll in hot spirits of wine, cooling, adding sulphuric acid drop by drop, and setting aside in a quiet place, after a day or two there are formed beautiful elongated thin flat prisms with right angled terminal planes. From another portion the salt crystallized in the most delicate attenuated tables of the greatest brilliancy. It is soluble in water and hot diluted alcohol, and quite insoluble in absolute alcohol and ether. It tastes sour and reddens litmus paper, does not change upon exposure to the air, and loses no weight by 100° C. (212° F.)

Combustion with chromate of lead gave the following results:

I. 0·5147 grm. gave 0·4257 carbonic acid and 0·2509 water.
II. 0·3134 " " 0·2574 " " " 0·1616 "
III. 0·1541 " " 0·1260 " "
IV. 0·3397 " " 0·7039 platin-salammoniac.
V. 0·4248 " " with chlorid of barium 0·4673 grm. sulphate of baryta.

In per cent. expressed agreeing with,

	I.	II.	III.	IV.	V.
Carbon,	22·55	22·40	22·30	. .	. .
Hydrogen,	5·41	5·72	. .	. .	. .
Nitrogen,	. .	. .	. .	13·05	. .
Sulphuric acid,	. .	. .	. .	. .	37·97

Which give the formula

$$\mathrm{C_4\,H_4\,NO_3,\,SO_3},$$

as the comparison of estimated and analytical results shows.

		Theory.	Experiment.
Carbon, - - - - -	4 equiv. = 24	22·66	22·42
Hydrogen, - - - -	4 " = 4	3·77	5·56
Nitrogen, - - - -	1 " = 14	13·20	13·05
Oxygen, - - - -	3 " = 24	22·64	21·00
Sulphuric acid, - - -	1 " = 40	37·73	37·97
	106	100·00	100·00

Repeated combustions did not enable us to lessen the per-centage of hydrogen. The variation from the theory is, doubtless, to be attributed to the absorption in the chlorid of calcium tube, of a small quantity of sulphurous acid, which escaped from the combustion tube. This explanation unfortunately occurred after repeated analyses had consumed the stock of salt.

This constitution is remarkable in the field of organic chemistry. On its borders we have a similar instance in anhydrous sulphate of ammonia, NH_3+SO_3.

Sulphate of Hydrate of Glycocoll.

$Gl, SO_3, HO.$

This salt was obtained from a solution similarly prepared to that which yielded the anhydrous salt, except that the solution was boiled with sulphuric acid, instead of the latter being added to the cold solution. It crystallizes in short prisms, reminding one of sulphate of copper, and the crystals, though small, are of exceeding beauty and perfection of form. They do not change upon exposure to the air.

A single determination only was made, and *that* of the nitrogen. The other determinations were not made, from want of substance, all subsequent efforts to form the salt having failed.

By Varrentrapp and Will's method:—

0·3367 grm. gave 0·2943 grm. platin-salammoniac.

In per cent. expressed, Nitrogen 12·37.

This corresponds with the formula

$C_4\ H_4\ NO_3, SO_3, HO,$

which requires 12·17 per cent. of nitrogen.

Basic Sulphate of Glycocoll.

(a.) $3Gl\ HO, 2SO_3, 2HO.$

If to a solution of glycocoll in diluted spirits of wine, sulphuric acid in excess be added, and set aside, in twenty-four hours long rectangular prismatic crystals form upon the bottom of the containing vessel. A very considerable excess of sulphuric acid did not change the constitution of the crystals.

They taste and react acid, and like the salts already described suffer nothing from exposure to the air.

Combustion with chromate of lead gave the following results:

I. 0·4199 grm. gave 0·3528 carbonic acid and 0·2149 water.
II. 0·3944 " " 0·3219 " " " 0·1974 "
III. 0·2399 " " by Varrentrapp and Will's method, 0·5067 grm. platin-salammoniac.
IV. 0·6866 grm. gave 0·4928 sulphate of baryta.
V. 0·5808 " " 0·4170 " "
VI. 0·4532 " " 0·3225 " "
VII. 0·4960 " " 0·3500 " "

In per cent. expressed the above determinations correspond with

	I.	II.	III.	IV.	V.	VI.	VII.
Carbon,	22·91	22·25					
Hydrogen,	5·68	5·56					
Nitrogen,			13·31				
Sulphuric acid,				24·62	24·62	24 20	24·40

These numbers give the formula,

$$3(C_4\,H_4\,NO_3, HO)+2(SO_3, HO).$$

The juxtaposition of the estimated per cents. and analytical results follows:—

		Theory.	Experiment.
Carbon,	12 equiv. = 72	22·29	22·58
Hydrogen,	17 " = 17	5·26	5·62
Nitrogen,	3 " = 42	13·00	13·31
Oxygen,	14 " = 112	34·69	34·03
Sulphuric acid,	2 " = 80	24·76	24 46
	323	100·00	100·00

The following formula is submitted as expressing the rational constitution of this salt:—

$$(\mathrm{Gl\,HO}, SO_3\,HO+\mathrm{Gl\,HO})+(\mathrm{Gl\,HO}, SO_3\,HO).$$

The following sulphuric acid compounds were none of them completely analyzed. They were prepared in small portions while seeking to obtain a neutral sulphate of hydrate of glycocoll; and it was not until the capacity of this body to combine with others of such different nature, and in such varied proportions became fully apparent, that the existence of so complex and unusual compounds was believed.

The crystallized salts were for the most part groups of elongated prisms.

Basic Sulphate of Glycocoll.

(b.) $3\mathrm{Gl}, 2SO_3, HO$.

The constitution of this salt differs from that of the preceding in the amount of water. As both of them were dried in the air over sulphuric acid, and suffered no change, this difference is attributable doubtless to the degree of concentration, or difference of temperature. It will be observed that it corresponds precisely with a basic hydrochlorate (d), whose constitution is given on page 380 of the last volume.

With chlorid of barium, 0·2182 grm. of crystals, gave 0·1940 grm. sulphate of baryta.

In per cent. sulphuric acid 27·74.

This corresponds with the formula

$$3(C_4\,H_4\,NO_3)+2SO_3+HO,$$

which requires 27·87 parts in 100. As the probable rational constitution of this salt the following is submitted:

$$(\mathrm{Gl}, SO_3+\mathrm{Gl}, HO)+\mathrm{Gl}, SO_3.$$

Basic Sulphate of Glycocoll.

(c.) $3(\mathrm{Gl, HO})2\mathrm{SO}_3, \mathrm{HO}$.

A mixture of the salt (b) with the previously described one (a), doubtless gave the crystals for the following determination:

0·3076 grm. gave 0·2300 grm. sulphate of baryta, which gives in per cent. expressed, sulphuric acid 25·65; corresponding with the above formula. The following is more rational.

$$(\mathrm{Gl, SO}_3, \mathrm{HO+Gl, HO})+(\mathrm{Gl, HO+SO}_3\ \mathrm{HO}).$$

This requires 25·47 parts of sulphuric acid in 100.

(d.) $2(\mathrm{Gl, HO})+\mathrm{SO}_3$.

Another salt gave by combustion with chromate of lead,—

From 0·3039 grm., 0·2872 grm. carbonic acid, and 0·1680 grm. water; which expressed in per cent., give carbon 25·77, hydrogen 6·01. These numbers correspond with the formula

$$2(\mathrm{C}_4\ \mathrm{H}_4\ \mathrm{NO}_3, \mathrm{HO})+\mathrm{SO}_3,$$

which requires carbon 25·26, and hydrogen 5·26.

Glycocoll and Sulphate of Oxyd of Ethyl.

$\mathrm{Gl, HO, AeO, SO}_3$.

The particular circumstances of the formation of this salt, beyond those already given, viz. a solution in hot spirits of wine, or in water to which absolute alcohol was added, are not ascertained.

With chlorid of barium, 0·6470 grm. gave 0·3036 grm. sulphate of baryta; which in per cent. give of sulphuric acid 17·27. This quantity of acid corresponds with the formula

$$\mathrm{C}_4\ \mathrm{H}_4\ \mathrm{NO}_3, \mathrm{HO+C}_4\ \mathrm{H}_5\ \mathrm{O, SO}_3,$$

which requires 17·62 per cent. of sulphuric acid.

Nitrate of Glycocoll.

$\mathrm{Gl, HO+NO}_5, \mathrm{HO}$.

The capability which this compound possesses of uniting with bases enveloped the earlier conceptions of the nature of glycocoll in obscurity:—an obscurity from which the changes the nitrate of copper salt experienced upon subjection to heat, and the simple combinations with the oxyds of silver, copper and lead, did not in any degree relieve it. It was then suggested that the glycocoll played the part of the water of crystallization in the salts that were formed. From the analysis below, it will be seen that the salts were double salts, in which glycocoll with or without water, as a *base*, united with hydrated nitric acid, or as a salt with nitrates of metallic oxyds.

Braconnot obtained this compound by direct combination of nitric acid with glycocoll prepared from isinglass. Dessaigne procured it directly from hippuric acid, employing nitric instead of hydrochloric acid for its decomposition.

We prepared it by dissolving glycocoll in strong nitric acid, and setting the solution over sulphuric acid to crystallize. Occasionally large tabular crystals, apparently belonging to the monoclinate system, are formed. Not unfrequently, however, the salt crystallizes in needles, especially if the fluid has been warmed.

They do not deliquesce upon exposure to the air. They taste and react acid. They were dried over sulphuric acid. Combustion with chromate of lead gave the following results:—

I. 0·4509 grm. substance gave 0·2954 grm. carbonic acid, and 0·1963 grm. water.

II. 0·4968 grm. substance gave 0·3122 grm. carbonic acid and 0·2054 grm. water.

Two analyses, according to Varrentrapp and Will's method, gave respectively 10·04 per cent. and 10·64 per cent. of nitrogen. From this it is evident that this method cannot here be employed:—a fact with regard to nitrates, to which attention has already been drawn by the chemists just mentioned.

Failing in this, a determination was made by the quantitative method of Prof. v. Liebig.

The proportions of carbonic acid to nitrogen in four tubes, were: 17 : 9, 14 : 7, 10 : 5, 24 : 11; or, together 65 : 32 = 2 : 1.

In per cent. expressed the above determinations give

	I.	II.	III.
Carbon, - - -	17·86	17·15	. .
Hydrogen, - - -	4·83	4·59	. .
Nitrogen, - - -	. .	. .	20·50

These correspond with the formula

$$C_4\ H_4\ NO_3,\ HO+NO_5\ HO,$$

as will be seen by the annexed estimates and results of analysis.

		Theory.	Experiment.
Carbon, - - - - -	4 equiv. = 24	17·38	17·49
Hydrogen, - - - -	6 " = 6	4·32	4·71
Nitrogen, - - - -	2 " = 28	20·29	20·50
Oxygen, - - - -	10 " = 80	58·01	57·30
	138	100·00	100·00

Boussingault by drying the salt at 110° C. (230° F.) obtained as already noticed the anhydrous compound $C_4\ H_4\ NO_3,\ NO_5$.

Oxalate of Glycocoll.

$Gl,\ \bar{O},\ HO.$

An aqueous solution of glycocoll with oxalic acid, evaporated upon a watch glass, crystallizes in rays reminding one of a cross section of wavellite. If alcohol be added to a solution of glycocoll in oxalic acid, the latter in excess, the solution becomes milky, with the separation of oxalate of glycocoll. If added in small quantities and successively, it crystallizes with the beauty that characterizes all or nearly all the compounds of this body. Dessaigne obtained the salt directly from hippuric acid by employing oxalic instead of a stronger acid, to effect the decomposition. It does not alter upon exposure to the air.

Combustion with chromate of lead gave the following :—0·3600 grm. gave 0·4227 grm. carbonic acid, which in per cent. expressed, gives carbon 32·02, corresponding with the formula

$$C_4\ H_4\ NO_3,\ C_2\ O_3,\ HO,$$

which requires 32·43 per cent. of carbon.

Acetate of Glycocoll.

$$\text{Gl, HO, }\bar{\text{A}}\text{, 2HO.}$$

This salt is readily prepared by dissolving glycocoll in acetic acid, and adding absolute alcohol drop by drop, till the solution becomes turbid, and then afterward at intervals, as the crystallization proceeds. The salt analyzed was prepared by adding absolute alcohol in excess to a concentrated solution of glycocoll in acetic acid, (the latter in excess,) by which the salt was thrown down. It was then redissolved by heat, and set aside to cool and crystallize, by which slender prismatic crystals of great beauty were obtained.

On combustion with chromate of lead, 0·2981 grm. gave 0·3644 grm. carbonic acid and 0·2031 grm. water, which in per cent. expressed correspond with carbon 33·33, hydrogen 7·57. The formula

$$C_4\ H_4\ NO_3,\ HO+C_4\ H_3\ O_3+2HO,$$

requires of carbon 33·33 per cent. and of hydrogen 6·94 per cent.

Tartrate of Glycocoll.

By dissolving glycocoll in tartaric acid and adding absolute alcohol in excess to the solution, an oily appearing liquid separates and settles to the bottom. Repeated and protracted agitation with alcohol and ether effect no change. This liquid dried upon a watch glass gave a gummy mass which was not further investigated.

Palmatinate of Glycocoll.

By dissolving palmitinic acid and glycocoll in hot spirits of wine, and setting aside to cool, the excess of acid rises to the surface in the form of an oil, while the salt crystallizes in white, thin, silky, radiating scales or blades of the greatest brilliancy. The oily layer, above, which with the whole mass becomes solid, may be readily removed, and the remainder pressed in silk and dried in the air over sulphuric acid. Combustion with chromate of lead gave the following results:

	I.	II.	III.
Carbon, -	51·30	51·23	50·84
Hydrogen, -	9·45	. .	9·44

With these, no formula embracing palmitinic acid and glycocoll has been found. The formula

$$C_4H_4NO_3, C_{32}H_{31}O_3+12HO,$$

requires 51·31 per cent. of carbon and 11·16 per cent. hydrogen, which would correspond with the carbon, but not with the hydrogen determinations.

Glycocoll and Bi-chlorid of Platinum.

$$Gl, PtCl_2, 2HO.$$

When to a concentrated solution of glycocoll in water, a concentrated solution of bi-chlorid of platinum is added, and then absolute alcohol drop by drop, the solution becomes turbid, and in a very short time, regular cherry-red crystals attach themselves to the sides of the vessel. Or if the concentrated aqueous solution be evaporated over sulphuric acid, after a time, groups of prismatic crystals are formed.

They become instantly covered with a bright colored crust upon exposure to the air, manifestly with the loss of water.

0·3679 grm. substance gave 0·0872 grm. platinum.

In per cent. expressed = 33·03, which corresponds with the formula $C_4H_4NO_3, PtCl_2+2HO$, which requires 33·26 per cent. of platinum.

Glycocoll and Chlorid of Barium.

$$Gl, BaCl, 2HO.$$

To obtain this salt, equivalents of crystallized chlorid of barium ($=BaCl+2HO$) and glycocoll were dissolved in the least quantity of hot water, and suffered to crystallize quietly in the cold. In a few moments the salt crystallized in groups of short prisms of extreme beauty. None were sufficiently perfect to admit of measurement. They appeared to belong to the rhombic system, of the combination $\infty P . \breve{P}\infty . \infty\breve{P}\infty$.

The addition of alcohol to the solution changed the form to that of slender flat needles.

The salt is soluble in water, more so in hot than in cold, tastes bitter, gives neither acid nor alkaline reaction, does not deliquesce or change upon exposure to the air.

Dried over sulphuric acid, 0·6715 grm. substance gave 0·3833 grm. sulphate of baryta, =55·34 per cent. of chlorid of barium, giving the formula $C_4H_4NO_3$, BaCl, 2HO, which requires 55·31 per cent. of chlorid of barium.

Glycocoll and Chlorid of Potassium.

$$Gl, KCl.$$

This compound was prepared by dissolving glycocoll and chlorid of potassium in water, and evaporating over sulphuric acid.

When the solution had become very concentrated, fine needle-formed crystals filled the whole mass. They deliquesce readily in the air.

A single combustion with chromate of lead, gave from 0·4992 grm., 0·3055 grm. carbonic acid = 16·58 per cent. of carbon.

The formula $C_4 H_4 NO_3$, KCl, requires 16·92 per cent. of carbon.

Glycocoll and Chlorid of Sodium.

A concentrated solution of glycocoll and chlorid of sodium in water, gave upon addition of absolute alcohol and standing a length of time, crystals containing both of the above mentioned ingredients. A quantitative examination was not made.

Glycocoll and Bi-chlorid of Tin.

By dissolving glycocoll in the least quantity of water, and adding bi-chlorid of tin, after a time, crystals containing both ingredients of the solution are formed. They were not more particularly examined.

Glycocoll and Hydrochlorate of Berberin.

Gl, Ber, HCl.

This salt is obtained by adding a hot solution of hydrochlorate of berberin in spirits of wine, to a concentrated solution, in excess, of glycocoll in the same menstruum. Upon cooling, the whole mass becomes solid, and consists of myriads of the most delicate needles, of a brilliant orange color and bitter taste. The salt may be washed with water, as glycocoll is therein readily soluble, while the salt of berberin is not.

The salt dried at 100° C. [212° Fah.] and burned with chromate of lead, gave the following results:

0·1563 grm. substance gave 0·3485 grm. carbonic acid and 0·0826 grm. water, which expressed in per cent. give carbon 60·80, hydrogen 5·87. These correspond with the formula

$$C_4 H_4 NO_3 + C_{42} H_{18} NO_9, HCl,$$

which, containing berberin with the constitution given by Fleitmann,* requires 60·21 per cent. of carbon and 5·03 per cent. of hydrogen.

Glycocoll and Potash.

By dissolving glycocoll in diluted caustic potash and evaporating to syrup consistence over a water bath, crystals in the form of long delicate needles, containing the two ingredients, are formed. They may be rapidly washed with spirits of wine. They deliquesce rapidly in the air, even over sulphuric acid. Dissolved in water, the salt gives a very strong alkaline reaction. It was not further examined.

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* Liebig's Annalen, Bd. lix, s. 166.

Glycocoll and Hydrate of Baryta.

It has already been mentioned, that glycocoll rubbed with pulverized hydrate of baryta, in a mortar, becomes almost instantaneously semifluid. Upon diluting the solution, and setting aside, after a time crystals containing both baryta and glycocoll were deposited. The salt was not analyzed. Its composition, in all probability, corresponds with that of the oxyd of copper, silver and lead, noticed below, and there exist, doubtless, similar salts of strontia, lime and magnesia.

Glycocoll and Oxyd of Copper.

Gl, CuO, HO.

This salt may be prepared by adding to a solution of glycocoll sulphate of copper and caustic potash—and addition of absolute alcohol,—or by dissolving hydrated oxyd of copper, with the aid of heat, in a solution of glycocoll, and adding absolute alcohol:—or lastly by boiling the anhydrous oxyd of copper, in excess, with glycocoll. If the latter be concentrated it must be filtered hot. In this case, the filtrate in a few moments is resolved into a solid mass of the most exquisite cerulean blue color. More carefully examined, it is found to consist of exceedingly delicate needles. The addition of absolute alcohol to the concentrated solution precipitates the whole salt; to the diluted, less perfectly.

At 100° C. [212° F.] 0·5443 grm., at the conclusion of several days, had lost 0·0438 grm. =8·04 per cent. =one atom of water.

With this loss the color passed through a light green to a shade in which a lavender or violet tint is discernible.

The analysis was made with the substance dried in the air over sulphuric acid.

Combustion with chromate of lead gave the following results:—

I. 0·2030 grm. of substance gave 0·1538 grm. carbonic acid and 0·0912 grm. water.

II. 0·2373 grm. by the method of Varrentrapp and Will, gave 0·4762 grm. platin-salammoniac.

III. 0·1745 grm. gave 0·0592 grm. oxyd of copper.

IV. 0·2871 grm. gave 0·0972 grm. oxyd of copper.

Which expressed in per cent. give

	I.	II.	III.	IV.
Carbon,	20·66	. .	. .	. .
Hydrogen,	4·99	. .	. .	. .
Nitrogen,	. .	12·65	. .	. .
Oxyd of copper,		. .	33·85	33·92

These give the formula $C_4H_4NO_3$, CuO, HO, as will be seen by comparing the theoretical and analytical results.

		Theory.	Experiment.
Carbon, - - - -	4 equiv. = 24	20·92	20·66
Hydrogen, - - -	5 “ = 5	4·35	4·99
Nitrogen, - - -	1 “ = 14	12·20	12·65
Oxygen, - - -	4 “ = 32	27·92	27·81
Oxyd of copper, - -	1 “ = 39·7	34·61	33·89
	114·7	100·00	100·00

With the loss of an atom of water, we have the salt

$$C_4H_4NO_3, CuO,$$

which it will be seen is precisely the composition derived from Boussingault's analysis of the salt dried at 120° C. = [248° F.] See page 373.

Glycocoll and Protoxyd of Lead.

Gl, PbO, HO.

This salt was prepared by dissolving with the aid of heat, protoxyd of lead (obtained from the peroxyd by long continued heat) in a concentrated aqueous solution of glycocoll, and the addition of alcohol till it began to be turbid. In a few hours it separated in prismatic crystals that slowly increased in size for several days, particularly with successive additions of absolute alcohol. The crystals remind one of cyanid of mercury.

A single combustion with chromate of lead gave from 1·3967 grm. substance, 0·6182 grm. carbonic acid, equal to 12·07 per cent. of carbon, corresponding with the formula derived from Boussingault's analysis with the addition of an atom of water,

$$C_4H_4NO_3, PbO, HO,$$

which requires 12·83 per cent. of carbon.

Boussingault's analysis was made from the salt, dried at 120° C., [248° F.,] leaving $C_4H_4NO_3$, PbO.

Glycocoll and Oxyd of Silver.

Gl, AgO, HO.

If oxyd of silver be added to a solution of glycocoll, it readily dissolves with the application of heat. With the addition of alcohol the above compound crystallizes in wartform crystals, which become dark upon exposure to light.

This salt was not analyzed, as Boussingault's analysis of it, dried at 110° C. [230° F.] as already noticed, gave the formula

$$C_4H_4NO_3, AgO.$$

There is scarcely a doubt that corresponding compounds of cobalt, nickel, manganese and iron protoxyds with glycocoll, might with nearly equal facility be prepared.

These compounds are perhaps analogous to those of ammonia with copper and nickel oxyds, when the latter are dissolved in the volatile alkali.

Glycocoll and Nitrate of Silver.

Gl, AgO, NO_5.

If the filtrate from a chlorine determination of the hydrochlorate of glycocoll be evaporated to concentration, and set aside over sulphuric acid, in a little time tolerably regular crystals of the above salt may be obtained.

It may be procured by dissolving glycocoll in nitrate of silver: or by dissolving oxyd of silver in the solution of the nitrate of glycocoll.

Upon melting, it explodes with violence. When exposed to moist air it deliquesces; though it remains unchanged over sulphuric acid.

The salt dried over sulphuric acid, on combustion with chromate of lead:—

I. 0·9300 grm. of substance gave 0·3550 grm. carbonic acid and 0·1880 grm. water.

II. 0·7840 grm. of the same gave 0·2950 grm. carbonic acid and 0·1560 grm. water.

III. 0·6469 grm. of the same gave 0·0258 grm. chlorid of silver.

In per cent. expressed,

	I.	II.	III.
Carbon,	10·11	10·26	. .
Hydrogen,	2·24	2·21	. .
Silver,	. .	. .	49·83

giving the formula $C_4 H_4 NO_3, AgO, NO_5$,
as the annexed estimates and results of analysis will show:

		Theory.	Experiment.
Carbon, - - - -	4 equiv. = 24	10·16	10·18
Hydrogen, - - -	4 " = 4	1·69	2·22
Nitrogen, - - -	2 " = 28	11·86	. .
Oxygen, - - -	8 " = 64	26·76	. .
Ox. silver, - - -	1 " = 116	49·53	49·83
	236	100·00	

Glycocoll and Nitrate of Copper.

$Gl, HO. CuO, NO_5, CuO, HO$.

This salt was analyzed by Boussingault, and may be considered as a compound of hydrate of glycocoll with nitrate of copper, united to hydrate of oxyd of copper.

$$(Gl, HO + CuO\,NO_5) + CuO, HO.$$

Glycocoll and Nitrate of Potash.

Gl, KO, NO_5.

This salt forms readily from a solution of glycocoll in nitrate of potash, upon the addition of absolute alcohol. No quantitative analysis of it was made. The above formula is derived from the analyses on page 373.

Glycocoll and Bi-sulphate of Potash.

$$Gl, SO_3+Gl, KO, SO_3.$$

By dissolving bi-sulphate of potash in water and adding a solution of glycocoll, throwing the whole down with alcohol, redissolving by heat and setting aside to cool and crystallize, the above salt is obtained in semi-opaque prismatic crystals.

A single determination from the salt dried over sulphuric acid gave from 0·6873 grm. of substance 0·6200 grm. sulph. baryta. In per cent. giving sulphuric acid =30·94. The formula

$$C_4 H_4 NO_3, SO_3+C_4 H_4 NO_3, KO, SO_3,$$

requires of sulphuric acid 30·83 per cent.

Glycocoll and Bi-chromate of Potash.

If glycocoll be dissolved in an aqueous solution of bi-chromate of potash, and absolute alcohol be added till the liquid becomes turbid, and the whole set aside, in a little time crystals will be formed.

These, even under the liquid, in a few days become decomposed, with the deposition of carbon. They were not further examined.

Glycocoll and Urate of Ammonia.

$$Gl, \bar{U}, AmO, \bar{U}.$$

When to a hot filtered solution of urate of ammonia, glycocoll is added, in a little time as the liquid cools, long semi-opaque needles shoot out from the sides of the vessel. The addition of alcohol after the first crystallization, causes the separation of a second portion.

Upon dissolving in hot water equivalents of glycocoll and urate of ammonia, and cooling, a flocculent mass was thrown down, which the addition of alcohol increased, and which, when examined with the microscope, proved to consist of exceedingly minute prisms.

The salt dried over sulphuric acid and burned with chromate of lead, gave from 0·2926 grm. substance, 0·3463 grm. carbonic acid and 0·1144 grm. water, which equal carbon 32·46, hydrogen 4·40. The formula

$$C_4 H_4 NO_3, C_5 N_2 H_2 O_3+NH_4 O, C_5 N_2 H_2 O_3,$$

requires carbon 32·30, hydrogen 4·61.

Similar flocculent precipitates were obtained from solutions of glycocoll in both urates of potash and soda.

Glycocoll and Uric Acid.

The importance of finding a compound of uric acid that would readily dissolve in water, suggested the effort to combine it with glycocoll.

Two atoms of glycocoll united to two of uric acid would equal three atoms of cyanate of glycocoll:

$$C_3\,H_8\,N_2\,O_6 + C_{10}\,N_4\,H_4\,O_6 = 3(C_4\,H_4\,NO_3,\,C_2\,NO),$$

a compound that may be presumed readily to dissolve in water.

All effort to this end, however, proved unsuccessful. Uric acid remained unchanged in the most concentrated solution of glycocoll, even with the long continued application of heat.

Glycocoll and Benzoic Acid.

As these two bodies exist in combination in hippuric acid, it was to be presumed that a reunion might be effected. To this end, solutions of the two in spirits of wine were made and poured together. After a time the glycocoll on the one hand and the benzoic acid on the other crystallized out.

The same result attended the effort to combine cinnamic acid, cane sugar and neutral phosphate of lime with glycocoll.

(To be continued.)

Art. IX.—*On the Potato Disease.*

Recherches sur la Nature et les Causes de la Maladie des Pommes de Terre, en 1845; par P. Harting, Professeur à l'Université d'Utrecht. Amsterdam, 1846.

De Ziekten der Aardappelen in het Algemeen, door Prof. von Martius. Of de Aardappel Epidemie der Laatste Jaren. Berigten en Meddeelingen door het Genootschap voor Landbouw en Kruidkunde te Utrecht.

The above are the titles of two of the most extended scientific investigations of this subject that have yet appeared. The work of Prof. Harting is particularly valuable, as containing a methodical and extensive series of microscopic observations which seem to have been made with much care and accuracy. It is illustrated by colored plates, showing the tissues, the cells, &c., of the potato in its healthy state, and proceeding through the commencement and various stages of disease.

Prof. Harting is clearly of the opinion that the disease is not to be ascribed to a parasitic fungus; but that the fungus is an effect only, as in the commencement it is never visible and sometimes is wholly absent during the whole progress of the malady. He has distinguished and figured no less than six varieties of these singular plants. The greater part of them belong to the genus Fusisporium of Link. One of them Fusisporium Solani is also described and figured by von Martius. Its characters are:

Floccis fertilibus erectis ramosissimis parce septatis, ramis patentibus, sporidiis terminalibus arcuatis, 4-5 septatis, facile decidentibus.

Another species Spicaria Solani, is thus described.

Floccis albis, decumbentibus dense intertextis, ramulis fertilibus vulgo quatuor erectis, sporidiis minimis ovalibus concoloribus.

Some of these species are only found in the internal cavities caused by disease, others in cavities under the skin through which they eventually pierce and then expand to a very considerable comparative bulk. In one instance and one alone Prof. Harting has perceived the formation of a particular fungus within the sac of a perfect cell; ordinarily their commencement is on the edges of internal cavities among the remnants of destroyed cells. In this instance the potatoes were of a particular variety from the vicinity of Coblence. The fungus belonged to the genus Oidium, (Link,) or Oospora, (Wallworth,) and was named by Prof. H. Oidium violaceum. Its characters are:

Floccis ramosis violaceis, fertilibus in sporidia subglobosa secedentibus. It is therefore quite different from any of the others. Von Martius does not appear to have met with this, but he describes several other distinct varieties. Payen mentions one of the same nature, but of an orange color.

These fungi seem not to be capable of spreading by infection. A large number of experiments were made upon this point; some of their sporules were placed in contact with freshly cut potatoes and allowed to remain in contact under favorable circumstances for many days; in no case was a fungus of the same species reproduced. This would appear to be conclusive, but von Martius and Payen, both obtained results of a different character. In any case we may conclude that it is not a very easy matter to spread infection in this way.

When the brown or black liquid matter, which appearing in the *sacs* of the cells, is the *first* visible proof of disease, is placed in contact with a freshly cut surface, the disease is readily communicated, but not if the skin of the tuber be perfectly sound and unwounded. A very curious additional fact is, that in this way the disease may be communicated to apples, pears, &c.

Both Harting and Martius agree that the disease is not to be ascribed to insects. During the early stages of the disease nothing is to be seen of them or their larvæ. They usually appear at about the same time as the fungi. Ordinarily two species are observed, Glyciphagus fecularum and Tyrogliphus feculæ. Later in the disease, a species of Rhabditis sometimes appears of the same class as those which are found in vinegar, &c. These are only some of the more common varieties which occur.

Prof. Harting has made a partial chemical investigation of the difference between the sound and the diseased portions of the tubers. The reaction of the sound portions was acid, that of the diseased alkaline, with an evolution of ammonia. As might be supposed from this, the quantity of nitrogenous compounds was reduced in the unsound portions, disappearing at last almost entirely. The brown and black parts contain a greatly increased proportion of insoluble matter; the increase is chiefly owing to the deposition of brownish granular matter, in the cells. This matter is insoluble in water, in ether, in boiling alcohol, in acids or alkalies, and exhibits most of the properties of ulmin, resulting from the composition of the substance contained in the cellular liquids. We will here quote Prof. Harting's words.

"Cette matiére est le resultat des transmutations qu'ont subies l'albumine et la dextrine dissoutes dans le suc cellulaire, et de la fécule, que, après s'être transformée en dextrine, y contribue aussi.

"Il est três-vraisemblable que c'est l'albumine, qui soit transformée la première, puis la dextrine, enfin la fécule, qui résiste le plus long-temps, et dont l'alteration est encore peu visible même à un état trés-avancé de la maladie.

"Tontes ces transformations chimiques, appartiennent à cette grande série de phénomènes, comprise sous le nom général de fermentation, et qu'on pourrait désigner ici plus particulièrement par le nom *d'humification*, or *d'ulmification*."

He thinks that we may observe the same things every year in apples, pears, &c. The same granular brown matter is shown by the microscope in the cells, and by chemical analysis is proved to be identical with the brown matter of the potatoes.

Prof. Harting, led on by these facts, sought to find in the temperature of the air and earth, the cause of this disease. He has collected a large number of observations upon this point. The winter of 1844–1845 was long and rigorous, and the cold especially severe during March. The équilibrium between the air and the surface of the earth, when a change took place, was thus disturbed, the earth becoming warm much more slowly than the air. The early planted potatoes then found the ground in an unfavorable state. The year 1845 is compared with the preceding years as far back as 1838. The month of March was excessively cold as noticed above, the month of April was a little warmer than the mean of the preceding Aprils; May was very rainy, and the temperature below the *minimum* of preceding years. June, on the contrary, was very hot, above the former maximum, July was also very warm with much rain, so that the potatoes grew with much rapidity. The variations of the barometer were not greater than ordinary, but the case was far otherwise as to the humidity of the air and the pressure of vapor. During the months of July and August, the relative humidity was above the maximum of the same months in preceding years; in those years also the pressure of vapor was less at two in the afternoon than at eight in the morning, but in 1845 this rule was reversed. The malady in Holland ended in the month of July, and after the middle of that month the above differences were not more perceptible. The great heat of the air and excessive moisture caused a rapid developement of the plant, and of course an increased transpiration was necessary, but was always checked by the increased pressure of vapor in the middle of the day; this of course deranged the circulation and caused the liquids in the circulation to begin to ferment. This view is supported by the fact that in Holland the parts first attacked were the leaves and stalks, the parts more directly in contact with the air. In Scotland and some parts of Prussia the disease made its appearance in September, for the most part; the temperature of the earth was then higher than that of the air, and accordingly the disease generally attacked the tubers first. But when we acknowledge all of these extraordinary facts, we still are forced to look for some special predisposition to disease among the potatoes themselves. In what this special predisposition consists, it is not easy to say.

It has not been the same in all species of potatoes, some have almost escaped while others of another kind in the same neighborhood have been almost utterly destroyed; it must reside in the plant itself, either in the structure of its tissues, or in the chemical state of its juices. It has been noticed that the potatoes of late years have had a much greater tendency than usual to germinate. This indicates an unusual molecular movement in the juices, which under the influence of moisture and the atmosphere, in place of changing the starch into dextrine and dextrine into cellulose, ferments and causes the disease.

Potatoes planted during the early morning have in some instances been almost entirely free from the malady, while those of the same variety planted in the afternoon, after lying in the sun sometime, were almost all destroyed. In this case, it seems possible that the heat of the sun gave a movement to the juices and prepared the way for the subsequent attack.

Von Martius describes two distinct kinds of disease, De Drooge kankerachtige Ziekte der Aardappelen, the dry canker disease of the potatoe, Gangræna tuberum Solani; and "De schurftachtige Ziekte der Aardappelen," the scabby disease of the potatoe, Porrigo tuberum Solani.

Prof. Harting's results and suggestions certainly furnish ample ground for very probable theories as to the cause of this disease, and indicate the course to be taken in future investigation. If, as seems possible, atmospheric influences induce such chemical changes in our growing crops, though we have found a cause, we have not found a remedy; to guard field crops from atmospheric changes is not an easy matter.

Such changes may occur only at long intervals of years, but the fact of their occurring at all, will be a warning to the nations not to place their sole dependence on a single crop. Unhappy Ireland and the north of Scotland are mournful examples of this mistake. J. P. N.

Utrecht, April 25, 1847.

ART. X.—*Report on Meteorites;* by CHARLES UPHAM SHEPARD, M.D., Professor of Chemistry in the Medical College of South Carolina, and in Amherst College, Mass.

(Continued from Vol. ii, ii Ser., p. 392.)

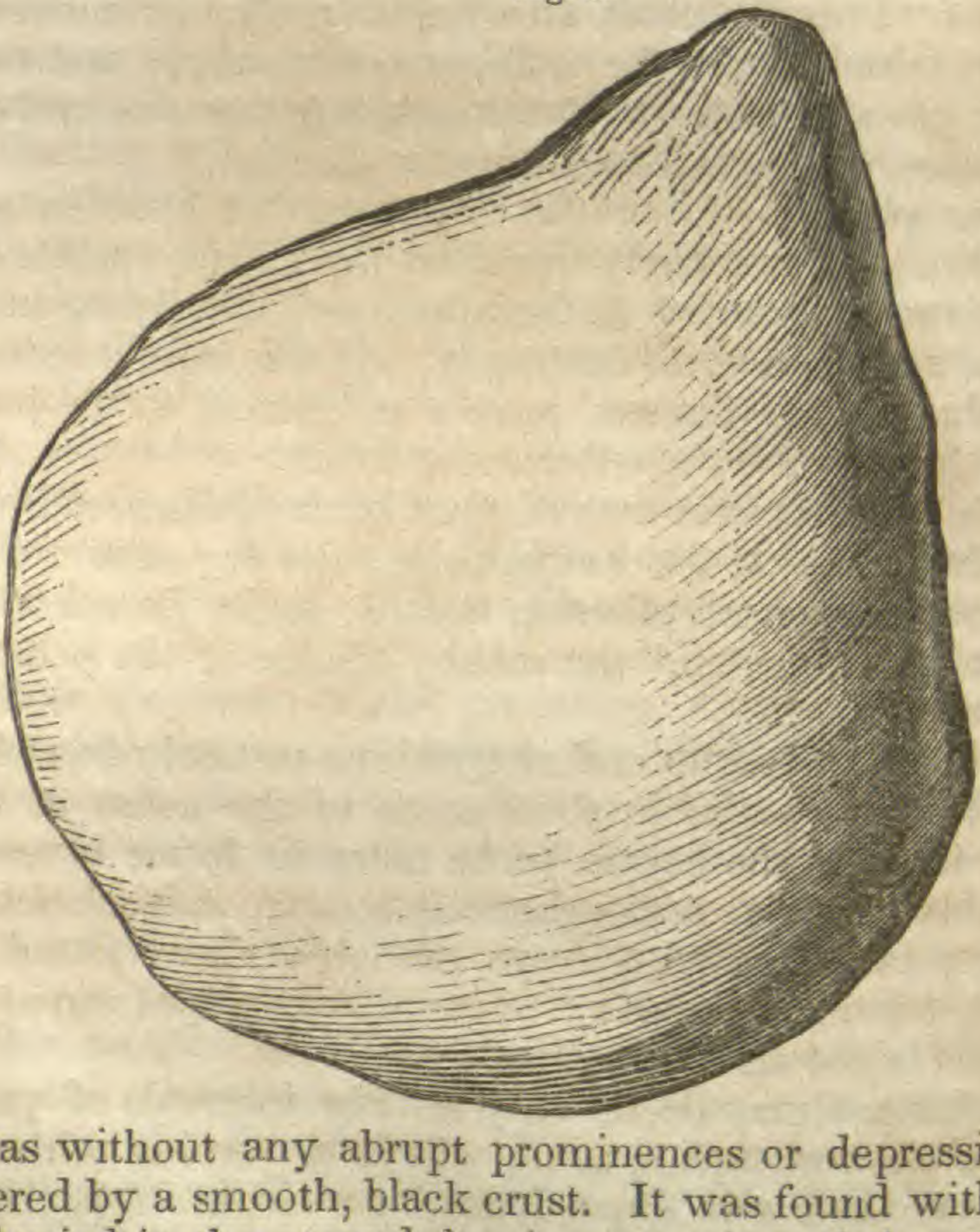
CLASS II. METALLIC.

ORDER FIRST. *Malleable, homogeneous.*

Section 1*st.* PURE.

1. *Walker county, Alabama.*—This mass was described by Dr. TROOST in Vol. xlix, p. 344, (1845.) Through the assistance of Dr. I. F. SOWELL, of Athens, Ala., I am able to supply a few additional details, concerning the occurrence of this unusually interesting specimen. Dr. Sowell observes, that "the existence of this iron was made known to me in 1839 or '40; and I was in treaty for it during two or three years, before being able to obtain possession of it. The original mass was irregularly oval, resembling the figure here sketched.

Fig. 6.



"It was without any abrupt prominences or depressions, and was covered by a smooth, black crust. It was found with the larger end buried in the ground, leaving a portion of the smaller extremity projecting above the soil,—suggesting the idea, that it was driven into the ground by the force of its fall. Upon this smaller end, the finder (Mr. Speaks) placed his foot to rest, while abroad on a hunting excursion. Its unusual appearance attracted his attention, and led him to remove it to his house as something valuable. The mass was found remote from any settlement, in an uncultivated and rather unfrequented region. Its weight was one hundred and sixty-five pounds."

This iron does not afford by etching, the Widmannstättian figures; although it exhibits glistening freckles, or angular spots of the size of fine-grained gunpowder, which are occasionally intermingled with shining lines and fibres. Sp. gr. = 7·265.

It consists of iron 99·89, with traces of calcium, magnesium and aluminium, in the order, as to quantity, in which they are enumerated,—the calcium being most abundant.

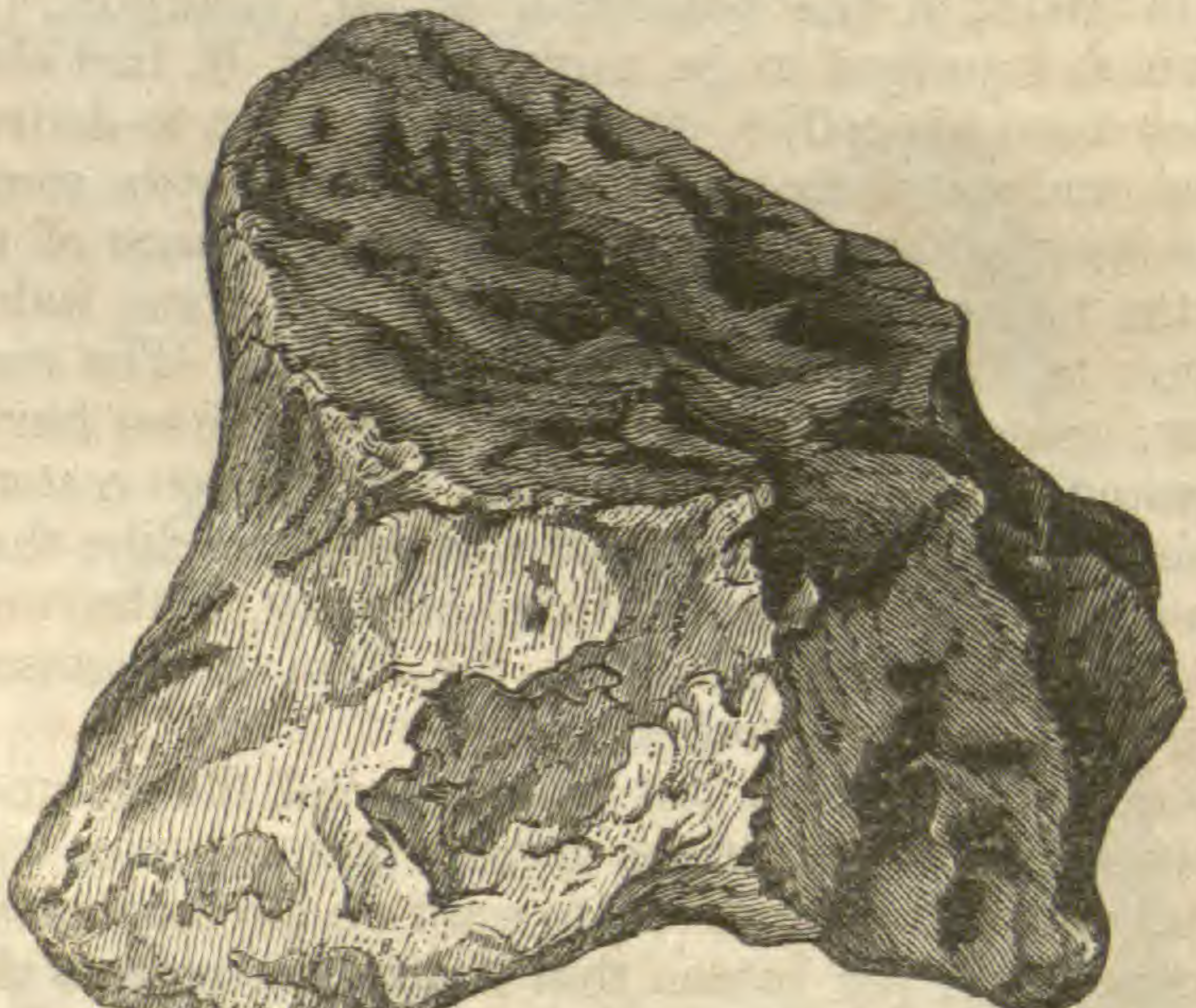
2. *Scriba*, (*Oswego*,) *N. Y.*—My description of this mass was published in Vol. xl, p. 366, (1841.) To that account may now be added the statement of Mr. John G. Pendergast, communicated to me in a letter dated July 15, 1846. "I saw a mass of iron at Oswego in 1834, in the possession of Mr. Rathbun, (a blacksmith,) which I judged to be meteoric. Mr. R. had obtained it on that day from his collier, who had been down to deliver a load of charcoal, and stated that he found it in the woods, some where in the vicinity of his coal-pit. The circumstance of its being found in the forest, together with its size and form, induced me at the time to believe it to be meteoric iron. The mass in all probability, was originally globular in form, but from having been highly ignited, and striking the earth (perhaps on a stone) with great force, a flattening in its shape was produced, like that which would be occasioned in a round lump of putty, if thrown against a board. I was fully satisfied that the form it possessed, could have been imparted in no other way."

The foregoing contains but little beyond the testimony of a second witness, to the conditions under which the mass was found. It appeared important however, to omit no circumstance relative to its discovery, for the reason that it does not possess that peculiar chemical composition, which has heretofore been regarded as confirmatory of the extra-terrestrial origin of similar productions, and on which account, I hesitated in my first notice to include it among undoubted meteoric irons. Its resemblance however, to the Walker county, Ala., iron, not only in composition, but in the generally smooth surface and black color of its crust, and still more, in the freckled figures developed upon its polished sections by nitric acid, establishes an analogy of the most marked kind between the two bodies. And as it seems unreasonable to ascribe the large drop-shaped mass of Alabama, either to a terrestrial or an artificial source, I feel authorized in claiming a meteoric origin for them both.

Section 2d. ALLOYED. *Sub-section*, CLOSELY CRYSTALLINE.

3. *Babb's Mill*, 10 *miles north of Greenville, Green county, Tennessee.*—This mass was described by Dr. TROOST in Vol. xlix, p. 342, (1845.) Judge PECK has afforded me (under date of Dec. 14, 1845) some additional particulars, relating to the locality, from whence he had obtained a specimen, in its natural condition. His remarks are as follows: "Of the two masses found in Green county, the first, as well as I can recollect, weighed twelve or thirteen pounds; the other which I have, weighs upwards of six pounds. The former was injured by having been heated and cut. It exhibited however, a crystalline structure, when small portions were torn or broken asunder, though the grains were very small. It was homogeneous; and formed as malleable and tough an iron, as I have ever seen. The second mass (of about six pounds) I was fortunate enough to obtain, just as it was found."

Fig. 7.



This specimen was in the most obliging manner transferred to me, in exchange, by Judge Peck; and with the exception of a few hundred grains taken from an angle, has been preserved precisely in its original shape. It exhibits in the most perfect manner that peculiar moulding (consisting of somewhat irregular basin-shaped depressions of various sizes, connected with blunt rounded angles and edges) which marks so many of these productions.* A wood-cut does but inadequately render these appa-

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* Having observed that this kind of surface occurs in masses of artificial iron, both cast and malleable, if it have been a long time exposed to the action of weather, (as in iron palings and posts, as well as in old cannon,) I cannot avoid attributing the pitted, indented outside of the meteoric irons, in part, to terrestrial influ-

rent. The black coating of oxyd of iron, so often investing meteoric iron, is here nearly replaced by broad patches of a thin, yellowish, ochrey brown incrustation.

Sp. gr. =7·548. It is close grained and perfectly compact, taking a very high polish, and exhibiting at the same time, a color rather whiter than that of steel. It shows no crystalline figures on being corroded with nitric acid; although on very close inspection, minute, whitish spots, (isolated and collected into patches,) may be seen here and there, scattered without order over the surface. When broken, it presents a fine granular texture, attended by a high silvery lustre.

Dr. Troost found the mass he obtained to contain, iron 87·58, nickel 12·42, remarking however that the ratio of the nickel given was probably too high, and that the compound might contain other ingredients. My own specimen affords me, iron 85·30, nickel 14·70, with traces of calcium, magnesium and aluminium.

4. *Claiborne, Alabama.*—Vol. xxxiv, p. 332, (1838.) Vol. xlviii, p. 145, (1845.)

5. *Livingston county, Kentucky.*—Vol. ii, ii Ser., p. 357, (1846.)

6. *Dickson county, Tennessee.*—Vol. xlix, p. 337, (1845.)

7. *Texas*, (*Red River.*)—Vol. iii, p. 44, (1821.) Vol. viii, p. 218, (1824.) Vol. xvi, p. 217, (1830.) Vol. xxvii, p. 382, (1835.) Vol. xxxiii, p. 257, (1838.) Vol. xliii, p. 358, (1842.) Vol. ii, ii Ser., p. 372, (1846.)

8. *Burlington, Otsego county, N. Y.*—This mass (originally 150 lbs. in weight) was described by Prof. Silliman, Jr., in Vol. xlvi, p. 401, (1844.) It was ploughed up by a farmer, near the north line of the town, sometime prior to 1819. Portions were cut from it, from time to time, by the discoverer's blacksmith, for agricultural uses; until its weight was diminished to about a dozen pounds, when it fortunately fell into the hands of Prof. Hadley, of Geneva, N. Y., to whom I am indebted for a conical lump, (weighing nine pounds,) which must have formed a somewhat pointed extremity of the original mass. From the base of this, a slice was taken, leaving a lump of five pounds of the annexed form. Its sides show for the most part, the natural crust of the iron; but where this is not the case, the surface has been cut and polished, or is coarsely crystalline with large tetrahedral and sub-hackley faces, occasioned by the breaking off of what were apparently projecting prongs. Its polished faces show a very high lustre, with a color of nearly the same whiteness as German silver. Held at a proper angle, they discover very distinctly the same crystalline characters, which are still more distinctly brought out by the ac-

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ences, which have acted upon masses not perfectly homogeneous either in composition or in density. For this reason perhaps, the Lockport iron, which is very much charged with amygdaloidal kernels of magnetic iron pyrites, presents an uncommonly pitted and jagged surface.

tion of acids. The etched surface is illustrated in the accompanying figure. The pattern is strikingly peculiar, as well as beautiful. The bright shining veins, which resist the action of the acid, are rarely nearer together than the $\frac{1}{15}$th or $\frac{1}{20}$th of an inch; and these in place of being continuous, are interrupted at frequent intervals. In their course also, they frequently exhibit little triangular enlargements, the sides of the triangles curving inwards. The surface included between the shining lines, and which forms at least $\frac{9}{10}$ths of the whole, is every where finely freckled as if depending upon a granular texture, and even bears some analogy to what is familiarly known as crystallized tin, or *Moiree metallique.*

Fig. 8.

Its hardness is very unusual, no iron with which I am acquainted offering on the whole, so much resistance to the operation of slitting. Mr. Rockwell gives as its composition, iron 92·291, and nickel 8·146. My own result in a single analysis, is as follows:

Iron,	95·200
Nickel,	2·125
Insoluble,	·500
Sulphur and loss,	2·175
	100·000

Sub-section, COARSELY CRYSTALLINE.

9. *De Kalb county, Tennessee.*—Vol. xlix, p. 341, (1845.)

10. *Asheville, (Baird's plantation, near French Broad River, six miles north of Asheville,) Buncombe county, North Carolina.*—Vol. xxxvi, p. 81, (1839,) and Die Meteoriten, von P. PARTSCH, Wien, 1843, s. 116.

As this county has of late afforded two other localities of meteoric iron, I have taken pains to ascertain as nearly as possible the exact position of each. The Hon. T. J. Clingman informs me, that this locality is six miles north of Asheville, on the estate of Col. Baird, who is of opinion that other fragments may there be found, as he has within two years observed small pieces of rusty iron in the same field from which Dr. Hardy's mass was obtained.

Farther experiments on the composition of this iron, enable me to add to what was before made known, that it contains cobalt, magnesium and phosphorus; and that the nickel is sometimes present in a ratio as high as 5 p. c., while the silicon is considerably below 0·5 p. c., as formerly quoted.

11. *Guildford county, North Carolina.*—Vol. xl, p. 369, (1841,) and Die Meteoriten, von P. PARTSCH, s. 114.

12. *Carthage, Tennessee.*—Vol. ii, ii Ser., p. 356, (1846.)

13. *Jackson county, Tennessee.*—Vol. ii, ii Ser., p. 357, (1846.)

ORDER SECOND. *Malleable, heterogeneous.*

Section 1st. AMYGDALOIDAL.*

14. *Hommoney Creek, near base of Pisgah Mountain, (ten miles west of Asheville,) Buncombe county, North Carolina.*

The present iron was brought to light through the perseverance of the Hon. T. J. CLINGMAN, of Asheville, to whose liberality I am indebted also for the possession of so interesting an object. He informed me in March, 1846, that while in the adjoining county of Haywood, he had accidentally been told by a Mr. Clarke, that his son had a mass of ore, five or six pounds in weight, that was very black and heavy, and which they could not break with a sledge-hammer, though they were able to indent its surface. Mr. C. was disappointed, on visiting the son, to find the piece had been mislaid and probably lost. His description however, agreed closely with that given by the father. He learned also from the young man, that the mass had the appearance of

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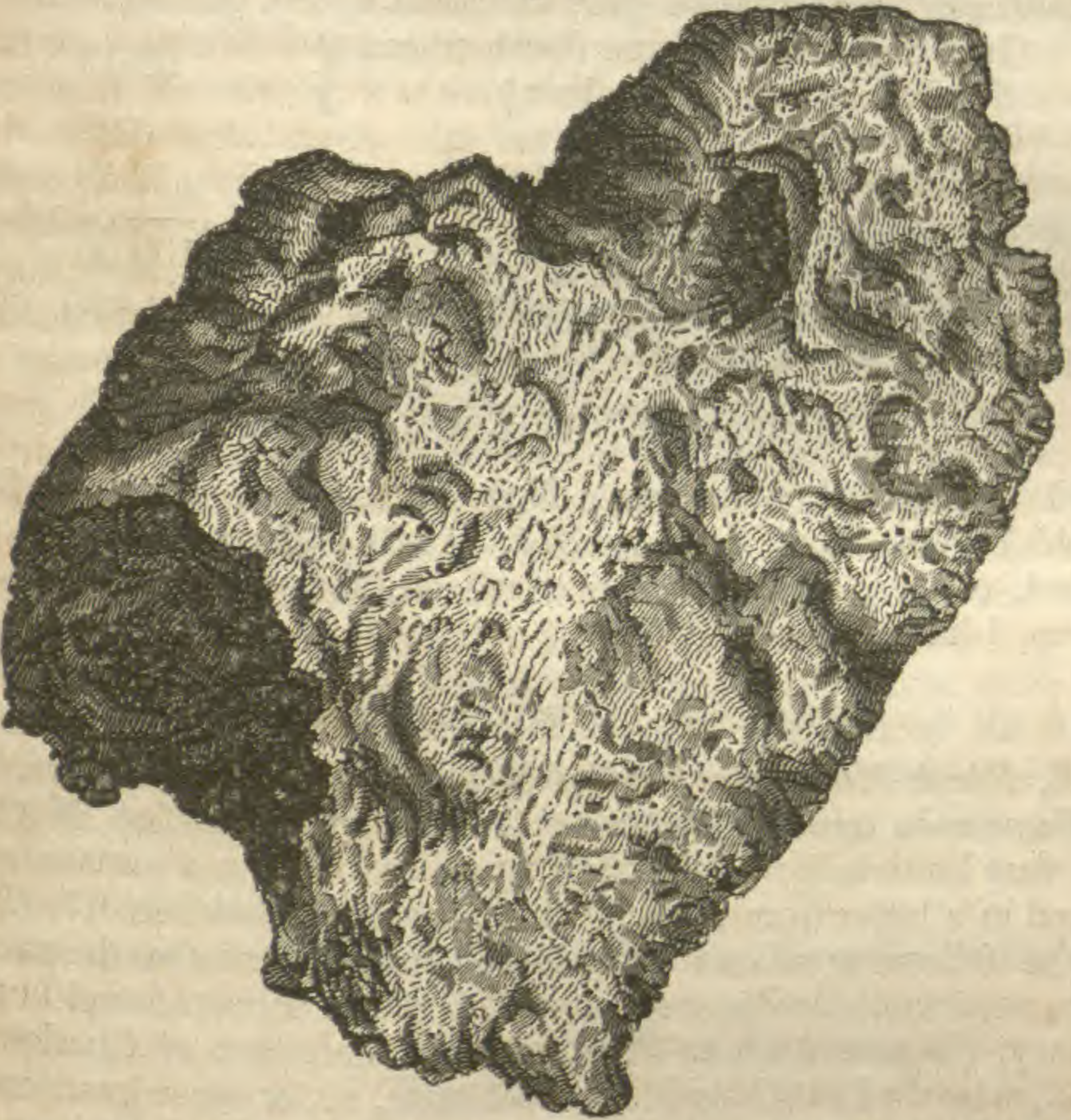
* The present mass having been discovered since the classification of the previous paper was made, it becomes necessary to create a new section for the reception of this remarkable variety. In some respects, it resembles the amygdalo-peridotic species from Siberia and Atacama. It differs however, from them both, in the more diminutive cavities, and still more in this, that these cavities are almost completely empty. The term amygdaloidal therefore, is here applied, in analogy with its use in geology, for describing the vesicular traps.

having been melted, one side being flattened, while from other parts of it, there were projections ("spurs") as long as a man's finger, which he could batter down with a stroke of the hammer. He said he obtained it a year before in Buncombe county, in a field, where he was of opinion that more of the same might be found. Mr. C. afterwards visited the neighborhood in which the specimen occurred; and was there assured by a young man, that he had seen the piece that the Clarkes had described, and that he knew of another much larger piece, similar to it, at an old house on the Clarke farm, where the smaller had been found.

On procuring the mass, (which weighed nearly twenty-seven pounds,) Mr. C. communicated to me the following particulars respecting it, which may perhaps be given in this place as generally descriptive of its aspect. "It is rather flat on one side, as though it had been laid when semi-fluid on a somewhat plane surface, while its other sides are irregular, with cavities and various inequalities. It has no appearance of ever having been hammered, and externally looks like a cinder from a blacksmith's fire." (At first, from not having seen any vesicular meteoric iron, Mr. C. was led to question its genuineness.) "But it is too large, and much too heavy to be compared with cinder. It has some malleability, though it may be broken if struck on its thinner projections and edges. Its knotted appearance, toughness and malleability, together with the peculiar form of the broad side, or bottom, and that of the large end, indicating that a greater than human force must have been applied to the mass, and evincing that it was cleft by an explosion from some large body, lead me on the whole, to rest in the inference, that it is of foreign origin." Mr. C. likewise remarked, that its external appearance would be well conceived of, if we supposed an ordinary mass of meteoric iron to be thrown into a forge-fire, and when thoroughly fused at its surface, suddenly to be withdrawn and cooled.

Its shape may be judged of by the figure on the opposite page. As frequently happens with these productions, a general conception may best be obtained by likening them to some familiar objects: this specimen strikingly reminds one of the head of a reptile. As figured, it reposes on its flat and broad side, and the dark shadow at the left, is in the place of the nearly vertical section, supposed to represent the junction of the animal's head with its body. It measures eleven inches in length, by seven in breadth; and is four in thickness at the thicker end, while at the upper extremity of our figure, it is not above two and a half, and on the right and lower edge, it thins down to little above one inch. Its surface is rather tuberose and jagged, than pitted with regular depressions. Color various shades of brown to black, and somewhat variegated (especially in the bottoms of the cavities) with an ash colored earthy matter. This last was undoubtedly derived from the circumstance, that the mass was for a considerable time employed as a support for fuel in the fireplace of a farmer's kitchen. Upon the under side, there adheres over a few inches,

Fig. 9.



a crust of an earthy, black amygdaloid, scarcely distinguishable, unless freshly broken, from the iron itself; and in one spot, nearly buried within the substance of the iron, a few grains of a dull, yellowish, gray olivine were noticed, similar to those found in the Bitburg iron. Near the surface, and especially upon the thinner edge and at the small extremity of the mass, its structure is eminently vesicular, the cavities being from one-fourth to one-twentieth of an inch in diameter, sometimes distinct, at others running together, and generally lined with a black powder. But as the distance increases to an inch from the surface, the cavities grow smaller and more remote from one another. No deeper section than one inch has yet been made in the mass; it is therefore possible, that the central portions may be nearly compact. The fresh fracture has a color and lustre, intermediate between steel and magnetic iron-pyrites. Etched surfaces, excepting where the structure is highly vesicular, exhibit the most delicate Widmannstättian figures, consisting of very minute and thickly interspersed triangular figures, distinct enough to be easily seen with the naked eye, but under a microscope exceedingly beautiful. They resemble somewhat in this respect, the Bitburg iron, to which it also approximates in the tuberose conformation of the exterior surface.

Hardness about that of grey cast iron. Sp. gr. = 7·32.

It is composed of iron, (with traces of chromium and cobalt,)	98·19
Nickel, ...	0·23
Carbonaceous, insoluble matter and loss,	1·58
	100·00

The yellowish, olivine-like grains consist of silicic acid, lime, magnesia, and oxyd of iron.

Section 3d. AMYGDALO-PYRITIC.

15. *Lockport, (Cambria,) New York.*—Vol. xlviii, p. 388, (1845.) Vol. ii, ii Ser., p. 374, (1846.) In addition to the nickel, copper, phosphorus and silicon, found in this iron by others, I have detected cobalt.

Section 4th. PYRITO-PLUMBAGINOUS.

16. *Black Mountain, head of Swannanoah River, eastern line of Buncombe county, (fifteen miles east of Asheville,) N. C.*—My first knowledge of this iron was derived from a remark, contained in a letter from Hon. T. J. Clingman, dated Feb. 17, 1846, to the following effect: "Dr. Hardy informs me that he gave a very remarkable looking specimen of meteoric iron found in this county, (Buncombe,) to the late Col. Nicholson of Charleston, S. C., who died at Abbeville in that state, six or seven years ago." Being in Charleston, I applied to the executors of Col. N. for information respecting that portion of his effects, which would be likely to include this specimen; but my inquiries were without success. Previous to this date however, I had been informed by Prof. Tuomey, who was then the state geologist, that he had seen a specimen of malleable iron in the cabinet of Dr. Barratt of Abbeville, which led me to address a letter to this gentleman, relative to the subject, from whom I received the following note, dated June 1, 1846, accompanied by the specimen itself. "I can furnish you with little that is definite concerning its history. The year Col. Nicholson, of Charleston, died, he had obtained it in Pendleton or Greenville District. It was given to him by some person, who had picked it up as a meteorite. Col. N. gave it to me, as I was the only person in this part of the country who preserved such objects. I believe it to be meteoric in its origin, and as such it has had a place in my cabinet. To yourself and to science, it is most cheerfully tendered."

On communicating a description of the mass to Dr. Hardy, he replied, "I have no doubt that the specimen referred to is the same which I gave Col. Nicholson. It was found at the head of Swanannoah river, near the base of Black mountain, towards the eastern side of Buncombe county."

The fragment weighs only twenty-one ounces; and, judging from the size and shape of that side which still exhibits the natural outside of the meteor, it is evidently a portion of a mass that must have been much larger. Its texture is throughout, highly crystalline, having all the laminæ (which are unusually thick) arranged conformably to the octahedral faces of a single individual. These layers, which commonly have a thickness of one-tenth of an inch, adhere to one another with much tenacity, so as not to be separable by any ordinary force. They manifest a slight tendency however, as the result of weathering, to separate into granular portions of the thickness of the layers themselves; the particles being somewhat oval in form—a result which seems to flow from the existence of very minute veins of magnetic iron-pyrites: for when a surface of the iron is polished, it exhibits the appearance of being mapped off into rounded patches by thin veins of the pyrites; and on the application of nitric acid this structure is still farther developed by the corrosion of the veins. Within these areas, the structure of the iron, when etched, scarcely seems crystalline; at most, exhibiting a few faintly marked crossing lines. A somewhat similar structure is visible in the Cocke county iron.

The mass contains several rounded and irregular nodules of plumbaginous matter, (from half to one inch in diameter,) with which again (and often situated in the midst of the kernels) are found large pieces of foliated, magnetic iron-pyrites. In this respect also, the present iron is closely related to the Cocke county iron.

Its sp. gr. = 7·261.

It consists of nickel, (with traces of cobalt,) .	2·52
Iron, ...	96·04
Insoluble matter, sulphur and loss, . .	1·44
	100·00

17. *Cocke county, Cosby's Creek, Tennessee.*—For our earliest notice of this truly wonderful locality of meteoric iron, we are indebted to Dr. Troost, (see Vol. xxxviii, p. 250, 1840,) and for an additional account of its composition by myself, see Vol. xliii, p. 354, (1842.) The history of this locality is still farther illustrated by the following particulars, derived from two letters from Judge Jacob Peck of Jefferson county, Tennessee, the one dated July, 1845, and the other December, of the same year.—Extract from the former, which was addressed to

Dr. J. H. Kain of this city: "The large mass of meteoric iron found some years ago in Cocke county, (on a creek called Cosby's,) fell into the hands of some persons who tried to break it with sledge-hammers, but not succeeding, they placed it upon what is here called a 'log-heap,' where after roasting for some time, it developed certain natural joints, of which advantage was taken with cold chisels and spikes, for its separation into fragments. These were put into a mountain waggon, and transported thirty or forty miles to a sort of forge, and there hammered into 'gun-scalps,' and other articles of more common use. Some remnants of the mass fell into the hands of Dr. Troost. The original mass was one of rare character, and ought to have been preserved entire. Much of it was composed of large and perfect octahedral crystals. Its weight was about a ton. Another mass weighing one hundred and twelve pounds, was found near the locality of the larger one. This also was malleable, very white, and easily cut with a sharp instrument. It was picked up by a mountaineer, who supposing it to be silver, asked fifteen hundred dollars for it. After retaining it for some years, he finally sold it to a friend of mine for a small sum, who transferred it to Dr. Troost."

Extract from the letter of December, 1845, to myself: "The weight of the mass has been variously estimated; but I am certain it was never weighed, prior to its being broken up. It was probably about two thousand pounds. In figure, it was an oblong, square block. I saw several very regular octahedral crystals that had been detached from the exterior angles of the mass. I had formerly supposed that the whole of it had been taken to Lary's forge, in Sevier county, and the greater part of it there wrought into 'gun-scalps;' but very recently, I have been informed, that part of it was taken to the forge of Peter Brown, in Green county, and there forged. I understand that a man by the name of McCoy, had a neat bar forged from it for making a gun-barrel, which, to use the expression of Brown's son, 'was as bright as silver.' In the conversation, young Brown informed me that he thought a piece of the iron in its natural state still remained. On searching, it was found by a little girl of the family. It weighs rather more than a pound, and had been preserved by the family as a nut-cracker.*

"The great mass was found on a hill, or rather on an offset of an eminence, at about one hundred feet above the bed of Cosby's creek. I was at the place after the mass was taken away. The formation was a hard clay-slate, and very little impression was left at the spot, except some stains of red oxyd of iron. McCoy,

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[*] This specimen I owe to the kindness of Judge Peck.

who claimed to be the owner of the land, took me there, under the impression that I should be able to aid him in discovering a mine of pure iron near the spot, especially, as the mass of one hundred and twelve pounds was found in the same immediate vicinity. The search of course was to no purpose. The mass of one hundred and twelve pounds appeared to me to be identical in character with the fragments I have seen of that supposed to weigh a ton."

The sp. gr. of this iron, as given by Partsch, (Die Meteoriten, p. 151,) is 7·26. I have found that of the included magnetic iron-pyrites, to be 4·454.

ORDER THIRD. *Brittle.*

Section 1st. PURE.

18. *Randolph county, North Carolina.*—This mass (originally two pounds in weight) was described by me in Vol. xvii, p. 140, (1830,) as native iron. It had been previously mentioned in Vol. v, p. 262, (1822,) by Prof. D. OLMSTED, in a descriptive catalogue of rocks and minerals collected by him, during his geological survey of North Carolina. It is spoken of by Prof. O., as occurring in the vicinity of a bed of argillaceous iron ore. It is distinctly foliated, the laminæ being thin and much interlaced. Color and lustre resembling those of mispickel. When etched, it presents very fine, almost invisible, feathery lines, much resembling hoar frost on a window pane. Hardness equal to that of the best tempered steel. Sp. gr. = 7·618. The only metal I have been able to detect in this steel, is cobalt, and this only in traces. A reddish brown powder, not soluble in nitro-hydrochloric acid, did not communicate any color to a bead of borax, which led to the suspicion that it was silicon.

19. *Bedford county, Pennsylvania.*—This variety was described in Vol. xiv, p. 183, (1828,) as native iron, slightly arsenietted. It closely resembles the Randolph county specimen, in structure, color, hardness and lustre. Its sp. gr. = 6·915. In the few grains at my command for its examination, I have been unsuccessful in verifying the existence of arsenic, or of detecting the presence of any other metal, besides iron. Still, its greater analogy to the Randolph iron than to any other terrestrial production, either natural or artificial, induces me to retain it in the category of meteorites.

Section 2d. ALLOYED.

20. *Otsego county, New York.*—The precise locality of this very curious iron cannot at present be given. It came into my possession under the following circumstances. Two or three persons from Otsego county submitted a number of specimens to

Dr. James R. Chilton, practical chemist of New York, for determination, stating that they had collected them in that region. Among the collection was the iron in question, which they described as having been picked up by them in the soil. They were of opinion, that it was some valuable metal; and were only satisfied that it was iron, by being shown by Dr. C., that it adhered strongly to the magnet. Dr. C. was at once led to suspect that it was a meteoric production, from the peculiarity of its shape; and induced the proprietors to exchange it for several specimens of silver ores, which they were desirous of procuring, to enable them to prosecute their mining researches with more intelligence. By paying Dr. C. the value of the specimens he had given for it, he very kindly transferred it into my hands.

Its weight was 276 grs., and its figure almost spherical or drop-like, as represented in the margin. It was covered with a black coating, save on one side, where it had been partially polished. The application of a drop of dilute nitric acid to this side, brought into view the most beautiful, raised lines, closely compacted together, and crossing each other in every direction. Its hardness was too great to allow of its being sawn; it was therefore broken upon an anvil (within a closed ring of iron) by means of heavy blows with a sledge. Its structure within, is foliated, or foliated-columnar, the individuals radiating from the centre to the circumference. Its color when first broken, was a light steel-grey, with a faint yellowish or reddish tinge, somewhat analogous to magnetic iron-pyrites. Interspersed through the mass, a close inspection discovers very minute, perfectly round globules of magnetic iron-pyrites, the number of which is much increased by the aid of the microscope. These globules are easily detached, and leave behind cavities with smooth, silvery colored walls. A polished surface of its interior, on being etched, exhibits a very exquisitely beautiful crystallization, consisting of innumerable, closely compacted, silvery lines, crossing each other in various directions, but rarely forming regular triangles, as in the malleable irons, (but more resembling the brittle irons of North Carolina and Pennsylvania,) more or less spotted with black globules of pyrites.

Fig. 10.

Being anxious to preserve as much as possible of this smallest of all the known meteoric iron-masses, I have contented myself with such inferences as a solution of less than twenty grains, enabled me to make respecting its composition. It dissolves with difficulty in nitro-hydrochloric acid, at the same time evolving sulphuretted hydrogen, leaving behind minutely divided carbon (plumbago) and a heavy whitish powder. This latter, fused with carbonate of soda on charcoal, gave what appeared to be metallic tin. The clear solution saturated with ammonia, afforded peroxyd of iron that corresponded to 94·57 per cent. of metallic iron; and the solution possessed an intensely azure blue color, which I ascertained to proceed chiefly from the presence of copper, though nickel and cobalt were also both detected in the liquid. This little meteorite, therefore, contains the following elements:—iron, copper, nickel, cobalt, sulphur, carbon, tin? and possibly chromium.

Notwithstanding this specimen comes from the same county with the Burlington iron, still its peculiar physical and chemical properties, leave no doubt of it having formed a totally independent body; and for aught that yet appears, two hundred and seventy-six grains in weight constitutes the totality of the fall!

APPENDIX TO CLASS I.

a. Grayson county, Virginia.—A meteoric iron is referred to by Prof. J. W. ROGERS, as existing in this county, and in which he found 6·15 per cent. of nickel. Vol xliii, p. 169, (1842.)

b. Roanoke county, Virginia.—A meteoric iron is mentioned by Prof. W. B. ROGERS as existing in Roanoke county, in which he detected the presence of chlorine. Vol. xliii, p. 169, (1842.)

c. Franconia, New Hampshire.—The following note from ROBERT GILMORE, Esq. of Baltimore, leads me to believe that a mass of meteoric iron was obtained by this gentleman, ten or twelve years ago in New Hampshire. "It was supposed by Dr. J. F. Dana (late Prof. of Chemistry in Dartmouth College) to be native iron. I purchased it at a village about twelve miles this side of the notch of the White mountains, of a person who told me, that it was found under the roots of a large tree, which was overturned upon the banks of a small stream in his neighborhood. He informed me that the blacksmith who had tried it, found it to be pure iron, and that he had refused to dispose of it to Dr. Dana, who was desirous of purchasing it. I tempted him, however, by a proposal of a higher offer than he had before had made for it, and obtained the mass. The tree, under whose roots it was found, must have been fifty or one hundred years old. I had presented the mass (whose weight was about fifteen pounds) to the Baltimore Academy of Science, in whose keeping it was lost sight of, during the destruction of their building by fire."

(To be continued.)

Art. XI.—*A General Review of the Geological Effects of the Earth's Cooling from a state of Igneous Fusion;* by James D. Dana.

In former papers in this Journal,* the writer has endeavored to illustrate the origin of many of the earth's features, by reference to the necessary consequences of cooling from a state of igneous fusion. In conclusion, a summary of the results arrived at is here offered, in order to aid the reader in a cautious and comprehensive revision of the subject; for its bearing upon the history of our globe is so important and of so universal a character, that it cannot receive too close attention. If there has been a state of igneous fluidity, the cause appealed to has acted; and to reason rightly on many points in geological dynamics, the effects of this prime cause should be first ascertained. Whatever the fact under consideration, be it an elevation, a subsidence, a fracture, earthquakes, igneous ejections, or any of the like operations or their consequences, we cannot be sure of assigning the true explanation, until it is shown whether this grand agency—which commenced with the very beginning of solidification, to end only with cooling itself,—has operated or not in producing or modifying the result. It is much to be desired that mathematical science may give definiteness to our views on this fundamental point in geological theory.†

The hypothesis of the former fluidity of the earth, we have not deemed it necessary to discuss. The proofs of an approximate uniformity of trend in the earth's features, and consequently of a prevailing structure in the very nature of the crust of our globe, place the question almost, if not quite, beyond doubt. The investigations of W. Hopkins, Esq., showing on astronomical data, that the whole is not now solid, afford still stronger confirmation of the hypothesis, and fully authorize the adoption of it as a basis of reasoning.

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* Vol. ii, ii Ser., p. 335, and iii, 94, 176. 381, 1846, 1847.

† In this branch of investigation, principles of the highest importance to science have already been deduced, with great ability, by W. Hopkins, Esq., F.R.S. We alluded to his researches on the systems of fissures consequent on elevations, in the last volume of this Journal, pp. 395, 396; and we mention here what escaped us till too late for insertion in that place, that his "Researches in Physical Geology," are continued in a series of articles in the Transactions of the Royal Society, for the year 1839, p. 381, for 1840, p. 193, and for 1842, p. 43, treating especially of the bearing of the amount of precession and nutation on the question of the fluidity of the interior of the earth and the thickness of the crust. Mr. Hopkins argues that the earth could not have cooled at the surface as long as there was perfect freedom of motion in the igneous fluid, and concludes that "the minimum thickness of the crust of the globe, which can be deemed consistent with the observed amount of precession, cannot be less than one-fourth of the earth's radius;" also, that the mean inclination of the earth's axis to the place of the ecliptic, can never have changed since solidification commenced.

It should be remarked, that in the following summary the causes alluded to are not presented as the only source of the effects enumerated, though a legitimate and sufficient source. The causes have acted conjointly with the wide-spread agency of water, yet they may have been less dependent on the latter for many results, than has often been urged. We mention no authorities for any of the conclusions stated, as they are already given, as far as known to the author, in the previous articles alluded to.*

General Review of the Consequences of the Earth's Cooling.

I. Solidification of the surface after the fluid material had lost its perfect fluidity.

a. The change inconceivably slow, and hence the rock formed having a coarsely crystalline texture :—the subsequent progress of solidification *beneath* the crust still more gradual, and therefore producing at all periods of the globe a coarsely crystalline texture :—the whole the result of a single immeasurably prolonged operation.†

b. Hence, probably, a general uniformity in the crystalline structure, sufficient to give the crust apparently two directions of easiest fracture, whose mean courses are N.W. b. W. and N.E. b. N. ; yet varying much, being probably dependent to a great degree on the early direction of isothermal and isodynamic lines, (this Journal, iii, 392.)

c. In the progress of this cooling, commencing with its first beginning, the surface necessarily presenting large circular or elliptical areas that continued open as centres of fluidity and eruptive action,‡ (ii, 345 ; iii, 395.) Subsequently, a gradual reduction in size of these centres of igneous action and their frequent extinction.

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* We add here a reference to the valuable memoirs on slaty cleavage, by W. Sharpe, Esq., in the Quart. Jour. Geol. Soc., No. 7, p. 309, and No. 9, pp. 74–105. See also this Journal, last volume, p. 430, and p. 110, in this number.

See also on the effects of cooling, De la Beche's Report on Cornwall, Devon and W. Somerset, 8vo, London, 1839, p. 33, and elsewhere.

† Long sustained heat of a requisite and scarcely varying temperature, is the essential circumstance demanded for the distinct crystallization of most minerals from fusion. It is well known that lava streams after becoming incrusted over, are often years in cooling. Yet they pass to the cold state too rapidly or irregularly, for a coarse crystallization of all the several ingredients of the rock, and thus illustrate the absolute necessity of the condition stated. We have observed elsewhere, that a granite-like structure is seldom produced about a volcanic vent except in its central mass of lavas where they finally cool, shut out from the air by thick beds of non-conducting rock. (ii, 349.)

We remark farther, that a long-continued uniform temperature, of some specific degree, is a condition of the greatest importance in chemical combination. It is a condition which the Author of nature has established in the animal structure, where the most complex compositions take place. And when the requisite degree of heat in specific cases is ascertained, and the means of sustaining an unvarying temperature are at hand, we may predict that some chemical compositions will be made to take place directly, which now require indirect processes. The reason for this is obvious, if we consider that with difference of temperature is connected difference of size, and difference of attracting power both cohesive and chemical.

‡ Well illustrated on the surface of the moon, as also are many of the points here mentioned, (ii, 335.) See Beer and Mädler's charts.

d. A boiling movement or circulation (up at centre and down around the sides) in the vast circular areas of igneous action, owing to escaping vapors, and dependent mainly on the temperature being greatest below at centre and least at the surface and laterally.* As this circulatory or cyclosis movement occurs in material whose mineral ingredients or products differ in the temperature of solidification or of formation, it determines to some extent the distribution of these mineral constituents, and of the rocks which are formed. In later periods, this cause producing a feldspathic centre to volcanic mountains having basaltic sides, (ii, 343.)

e. As refrigeration went on, the centres of eruption becoming mostly extinct over large areas, and remaining still active over other areas of as great or greater extent:—for cooling, wherever commenced, would extend somewhat radiately from the centre where begun, (yet with some relation to the structural lines,) and so gradually enlarge the solidifying area and encroach upon the more igneous portions.

II. Contraction, as a consequence of solidification, attended by a diminution of the earth's oblateness.

a. Rate of contraction in different parts unequal, according to the progress of refrigeration; and after the formation of a crust, greater beneath the crust than in the crust itself, (iii, 96, 181.)

b. Contraction beneath the crust causing a subsidence of the surface.

c. Subsidence greatest where the crust was thinnest or most yielding, and least in those parts which were thickest from having been first stiffened by cooling;—the large areas that continued to abound in igneous action therefore becoming in process of time more depressed than those areas that were early free (or mostly so) from such action, (ii, 352; iii, 181.)

d. Subsidence of the surface progressive; or, if the arched crust resisted subsidence, a cessation, until the tension was such as to cause fractures, and then a more or less abrupt subsiding, (iii, 96.)

e. Frequent changes and oscillations in the water level, either gradual or abrupt, arising from the unequal progress of subsidence in different parts, and also in early periods from extensive igneous action, (iii, 95, 181.)

III. Fissures and displacements of the crust, owing to the contraction below it drawing it down into a smaller and smaller arc; also, from a change in the earth's oblateness.

a. Fissures influenced in direction by the structure of the earth's crust,—because of the existence of such a structure, and also because

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* The boiling action in Kilauea, Hawaii, appears in general character, closely like that of boiling water. In the great lake, 1500 feet in diameter, there is an active play of jets over the surface precisely as in a boiling fluid, with no sounds ordinarily but the grum murmur of ebullition. A constant flow is seen in the liquid, (well shown in the jets that move with the current,) from the hottest part, near the northeast side, towards the southwest part of the lake; and this flow is so remarkable that it was formerly accounted for by supposing that a submarine stream of fire here came to the surface, and disappeared again after being for a short distance visible.

the tension causing fractures would be exerted with some reference to the structural lines, the tension and the structure being both a simultaneous consequence of cooling, (iii, 394.)

b. Direction of fissures modified by the relative positions of the large areas of unequal contraction, and whatever the actual course, frequently attended by transverse fractures, (iii, 395, 396.)

c. As the force of tension acts tangentially in a great degree, (like the pressure of stone against stone in an arch, and that of the whole arch against the supporting or confining abutments,) the effects will appear either over the subsiding area, or on its borders; and they will be confined to the latter position whenever the surface is strong enough to resist fracture, (iii, 96, 97, 181, 395.)

d. The borders of large subsiding areas sooner or later experiencing deep fissurings and extensive upliftings through the tension or horizontal force of the subsiding crust; these upliftings frequently in parallel series, of successive formation, or constituting a series of immense parallel folds; *that* side of the fold in general steepest which is most remote from the subsiding area, (iii, 98, 182, 186.)

e. Fissures formed having the character of a series of linear rents either in interrupted lines or parallel ranges, instead of being single unbroken lines of great length, and this owing to the brittle nature and structure of the earth's crust; ranges sometimes curved, either from having a general conformity to the outlines of contracting areas, or because proceeding from an inequality of force along parallel lines of tension over a subsiding area,* (iii, 185, 385.)

IV. Escape of heat and eruptions of melted matter from below through opened fissures.

a. Igneous ejection of dikes an *effect* and not a cause of displacements, (iii, 99, 185.)

b. Some points in the wider fissures continuing open as vents of eruption. The outlines of large contracting areas being liable from the cause just stated to deep fissurings, these therefore likely to abound most in volcanic vents, (iii, 98, 186.)

c. Heat from many fissures giving origin to hot springs.

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* The writer would remark here, in order not to be misunderstood, that in accounting for curving ranges of elevations, or courses of fissures, by the lateral force of a subsiding crust, (iii, 395,) he has considered the smaller circular areas of igneous action alluded to, as producing scarcely appreciable results, except when combined in large compound areas which subside as a whole. The great curves on the east and northeast of Asia, in the mountains of the continent, as well as in the ranges of islands, are not necessarily due to each being the outline of a circular area of contraction, although we cannot deny that instances of this are possible; but rather to the subsidence that deepened the Pacific depression, and its unequal amount in different transverse lines, connected with the structural character of the crust or its courses of easiest fracture, (iii, 185:)—for these curves are all *convex* alike *towards the ocean*, and similar also are the subordinate curves in the East Indies, (such as that by Negros, West Mindanao and the Sooloo Sea to North Borneo, and that by East Mindanao, Sangir and North Celebes,) as well as the curves in the mountains of Eastern Australia, (iii, 388.)

d. Distribution of the heat attending submarine action, causing metamorphic changes.*

V. Earthquakes, or a vibration of the earth's crust, consequent on a rupture, internal or external, and causing vibrations of the sea besides other effects, (iii, 181.)

VI. Epochs in geological history, (iii, 187.)

VII. Courses of mountains and coast lines, and general form of continents, determined to a great extent by the general direction of the earth's cleavage structure, and the position of the large areas of greatest contraction.

Continents (or areas of comparatively slight contraction) often therefore present ranges of mountains near their borders, and these mountains are highest and abound most in volcanoes around the *largest* ocean, (the Pacific, iii, 398.) Thus the existence of such continental areas determined the existence of the mountains they contain; and also the mountains in their turn, determined to some extent the position and nature of subsequent deposits formed around them, effecting this either directly, or by influencing the courses of ocean currents during partial or entire submergences, or by determining the outlines of ancient seas of different epochs. According to this view, the general forms of continents, and those of the seas, however modified afterward, were to a great extent fixed in the earliest periods by the condition and nature of the earth's crust. They have had their laws of growth, involving consequent features, as much as organic structures. In this remark, we refer not, under the term continent, to the surfaces of land bounded by the water line; for these, by slight subsidences, are greatly varied in form and size:—but to those extended areas, which, were there no water, would stand raised far above the intermediate oceanic depressions.

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* In this Journal, Vol. xlv, p. 111, (1843,) the writer has supported the principle that metamorphic changes require no other cause but what attends submarine igneous action, and that the word *hypogene* applied to such rocks is inadmissible. The views there presented properly include not only the heat from submarine volcanic action and fissure ejections, but that escape of heat, going on for ages, through the fractures attending the gradual folding and uplifting of strata while beneath the sea. Similar views, of earlier date, are offered by De la Beche, in his very able Report on Cornwall, Devon and W. Somerset, 8vo, 1839. The de-bituminization of the anthracite coal of the Appalachians appears to be attributed by Prof. Rogers essentially to this cause. (Trans. Assoc. Amer. Geol. and Nat., 1840-1842, p. 473.)

ART. XII.—*Review of the Organic Chemistry of* M. CHARLES GERHARDT.*

THIS book appeals with peculiar claims to the notice of all interested in the progress of chemical science. Organic chemistry has made great progress during the last few years; but until the publication of the Précis, with the exception of Liebig's excellent Traité de Chimie Organique, no systematic work embracing the results of the last decade had appeared. This is to be ascribed to the great difficulty of classifying the immense array of facts, and harmonizing the various conflicting theories—a task indispensable as a preparation for such a work and at the same time exceedingly delicate.

Liebig in his Traité assumed as the basis of his system, the theory of compound radicals, and commences with the assertion, that "organic chemistry is the chemistry of compound radicals." This was a most ingenious application of the electro-chemical philosophy of Berzelius to the investigation of this class of compounds, and was supported by so many analogies as to render it very probable; at the same time it admitted the application of the received nomenclature to these bodies. These radicals are generally however purely hypothetical, and when we are able to isolate substances having the composition assigned to them, they are found to possess none of the properties which theory would require. Recent experiments have shown that mellon and mellonids have not the composition ascribed to them by Liebig, and that mellon cannot be regarded as a compound radical. Cyanogen and kakodyle must however be excepted, as compounds which comport themselves in many respects like elementary bodies.

The progress of discovery has shown, that this hypothesis is but poorly adapted to form the basis of a system of classification, for the discovery of nearly every new body requires the assumption of an imaginary compound to explain its reactions in accordance with the theory of radicals; and so uncertain are the principles which are to direct us in the application of this theory, that different chemists often assign very different *rational formulas* to the same compound. There have been not less than seven different formulas proposed, to express the arrangement of the elements in alcohol; each author seeking by his own to explain some practical relation. Thus Dumas regards it as the bi-hydrate of olefiant gas; Liebig as the hydrated protoxyd of ethyle,

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* Précis de Chimie Organique; par M. CHARLES GERHARDT, Professeur à la Faculté des Sciences de Montpellier. 2 vols. 8vo. Paris, (Fortin, Masson et Cie.) 1845.—We are indebted for this review and abstract of M. Gerhardt's valuable work, to Mr. THOMAS S. HUNT, lately from the Laboratory of Yale College, and now Chemist to the geological survey of the Canadas.

C_4H_5; Berzelius as the bin-oxyd of C_4H_6, and Zeise as a hydruret of $C_4H_5O_2$. The inconvenience of this system arises not only from the fact that the radicals are hypothetical, but that their very existence in the compounds is alternately claimed and denied, and the elements are arranged and re-arranged like the letters in an anagram, as the case may require. M. Liebig seems to have felt its deficiencies, for after describing in the first volume of his Traité, a number of bodies as derivatives of compound radicals, in the succeeding portions of the work he returns to the old divisions of acids, alkalies, essential oils, etc.

This mode of viewing organic compounds resulted from the idea of dualism in chemical compositions, which had found advocates in the great majority of chemists since the days of Lavoisier, and has been perpetuated by the received system of nomenclature. And although there have been at different times those who have seen the difficulties of the binary system, it is only within a few years that a different philosophy has gained partisans.* This new system is distinguished as that of the *French school*, and ranks among its adherents the most distinguished chemists of France. It rejects entirely the idea of a binary arrangement in the composition of bodies, and regards their atoms as constituting a system, in which one or more molecules may be exchanged for others without altering the chemical constitution or type of the arrangement.

M. Gerhardt, who has been long known as one of the most distinguished chemists of France, has attempted the task of systematizing the great accumulation of facts which organic chemistry presents, and framing a classification that shall embrace all those substances whose composition is accurately determined, and in the present work he has given us the result of his labors.

Researches in organic chemistry have shown that we can produce artificially many products of the vegetable and animal organisms. Thus sugar yields by different processes, butyric, oxalic and formic acids; the first of these is one of the acids of butter, the second exists in the fluids of many plants, the last is a secretion of ants. Again bee's wax, when fused with caustic potash, forms stearic acid, one of the acids of animal tallow; by the action of nitric acid, it yields a number of new compounds among which is succinic acid, which exists in amber. These products are less complex in their constitution than the original substances; sugar by the action of oxydizing agents yields, besides formic acid, carbonic acid gas and water, and wax when converted into succinic acid, undergoes a similar decomposition.

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* Mr. J. D. Whelpley attempted some years since, to show from the electro-chemical decomposition of the metallic salts of the mineral acids, that they must be regarded not as binary compounds of an acid with an oxyd, but as ternary combinations of the metal, oxygen, and the other element. This principle was made by him the basis of a beautiful and ingenious classification of all saline compounds.

We cannot retrace this process and bringing together the formic acid, carbonic acid and water, by a process of dexoydation reproduce the sugar. These products were formed by a combustion in which a part of the carbon and hydrogen is converted into carbonic acid and water, and the power of reducing them belongs to the vegetable organism, where the chemical affinities are controlled and directed in a peculiar way by the vital force. It is thus that in these operations, we commence with a complex body and by a process in which its carbon and hydrogen are gradually oxydized, reduce it to simpler and simpler forms.

There are however some exceptions to this law; a few synthetical processes are known by which we can unite the elements of simpler compounds to form one more complex. Two polymeric bodies are known which are formed by a grouping together of several molecules of aldehyde; and many of the essential oils undergo a similar change by action of sulphuric acid. The decomposition of organic substances by heat offers some remarkable instances of this kind; in the dry distillation of wax $C_{19}H_{38}O$, we obtain paraffine, which is $C_{24}H_{50}$.

In view of these relations, observes our author, "we may consider all organic substances as the result of the combustion of others more rich in carbon and hydrogen, or reciprocally as the products of the reduction or complication of other bodies containing less carbon and hydrogen."

"In considering from this point of view the whole of organic substances, we observe that they offer successive and almost insensible gradations, in such a manner as *to form an immense scale*, the two extremities of which are occupied, the one at the summit, by the cerebral substance, albumen, fibrine and other bodies still more complex; and on the other at the bottom by carbonic acid, water and ammonia, preceded by wood-spirit with formic acid and the other bodies derived from it."

"The chemist in applying the agents of combustion to substances, *descends the scale*, that is to say, he gradually simplifies these substances by burning successively, portions of their carbon and hydrogen. On the contrary, *he remounts the scale* in applying to organic substances the processes of reduction. These considerations conduct us to an exact appreciation of the principles upon which we may classify all organic substances in a simple and complete manner, which does not have recourse to hypothesis, but confines itself strictly to the limits of experience." pp. 21, 22.

In the examination of organic substances, we observe that those which correspond in their chemical characteristics, present a similarity of relation in the proportions of their constituent elements. The alcohols, embracing wood-spirit, spirit of wine, potato-oil and ethal, are examples; their composition is respectively CH_4O_2, C_2H_6O, $C_5H_{12}O$ and $C_{16}H_{34}O$.*

If the single equivalent of oxygen which each of them contains, were united with two equivalents of the hydrogen to form water, the carbon and hydrogen in the residue of each would be in the proportion of 1 to 2. By oxydizing agents the alcohols lose two equivalents of hydrogen and gain one of oxygen, giving rise to the formic, acetic, valerianic and ethalic acids, in each of which the carbon and hydrogen are in the proportion of one to two; and in all the products of the transformation of these bodies, the proportions of these elements still bear a similar relation to each other. Hence if we know the composition of any derivative of spirit of wine, we can at once foresee that of a similar product derived from any other body of the group.

Substances like these having a likeness in characters depending upon a similarity of constitution are denominated *homologues;* and are to be carefully distinguished from those which resemble each other merely in physical characters, and which are called *analogues.* For example, wood-spirit resembles acetone in being inflammable, odorous, very volatile, and soluble in water, while ethal is allied to stearine in being solid at ordinary temperatures, insoluble in water and having other properties common to the fatty bodies; but their resemblances are only analogies, and when we examine wood-spirit and ethal in relation to their constitution and the products of their decomposition, we find that they are closely related to each other and are homologues.

In homologous bodies, the combustible elements, carbon and hydrogen vary exceedingly in their proportions, while the oxygen and azote are always atomically the same. Two bodies therefore which contain the one O_2 and the other O_3, or one N and the other N_2, cannot be homologues, while bodies containing C_2, or C_5 and H_{12} or H_{34}, may very well be so, as in the alcohols already mentioned. M. Gerhardt has adopted some general formulas to express these relations; R, representing the carburets of hydrogen; RO, those bodies which like alcohol, contain one equivalent of oxygen; while other oxygenized compounds are designated as RO_2, RO_3, &c. Those containing nitrogen are represented in a similar manner, thus RN, RN_2O_3.

In order that two or more bodies may be homologues, it is not sufficient that they can be represented by the same general formula; the equivalent ratio between the proportions of carbon and hydrogen must also be identical. Formic acid CH_2O_2, acetic acid $C_2H_4O_2$, valerianic acid $C_5H_{10}O_2$, and ethalic acid $C_{16}H_{32}O_2$ are designated by the general formula RO_2, and in

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* In these formulas it will be observed that our author divides the equivalent of hydrogen, representing water by H_2O. The equivalent of most of organic compounds is taken at one-half the number usually adopted, for reasons which will be explained farther on.

each of them R represents a compound in which the carbon and hydrogen are in the proportion of 1 : 2. These bodies are homologues, and the relation of their elements is such that they may evidently be derived from each other by the abstraction of equal equivalents of carbonic acid CO_2 and water H_2O. This is then the most simple ratio, and is selected as the term of comparison. It is not however the most frequent; generally the hydrogen is less than two, and when it exceeds it, the excess is seldom more than two equivalents.

"When homologous bodies are decomposed into other homologues, they lose or fix atomically the same quantities of carbonic acid, water, oxygen, &c." This principle is illustrated by the group of alcohols so often referred to; when converted into hydrocarbons, they give up one equivalent of water, and in the formation of acids they severally lose H_2 and fix O. From this it follows that a geometrical ratio between the elements of homologous substances is not necessary; bodies having the following proportions of C and H may be homologues:

C H	C H
$1 : 4 = 1 : (2+2)$	$4 : 4 = 4 : (8-4)$
$2 : 6 = 2 : (4+2)$	$6 : 8 = 6 : (12-4)$
$5 : 12 = 5 : (10+2)$	$8 : 12 = 8 : (16-4)$
$16 : 34 = 16 : (32+2)$	$16 : 28 = 16 : (32-4)$

and the same principle applies to any other proportions of these elements. In the first group, each compound by losing in equivalents of hydrogen is reduced to the normal ratio, and in the second, the addition of four is required.

To express these relations, the symbol R is preserved for the ratio of 1 : 2; for those bodies in which the proportion of hydrogen is greater, the number of equivalents is indicated by an exponent preceded by the sign plus (+), and when its proportion is less it is expressed by a similar exponent with the sign minus (−).

Wood-spirit CH_2O, alcohol C_2H_6O, potato-oil $C_5H_{12}O$ and ethal $C_{16}H_{34}O$, are by this notation, homologues of the form $R^{+2}O$, and the acids derived from them by the abstraction of two equivalents of hydrogen and the addition of one of oxygen are expressed by the formula RO_2. The acids, oxalic $C_2H_2O_4$, succinic $C_4H_6O_4$, pimelic $C_7H_{12}O_4$ and suberic $C_8H_{14}O_4$ are homologues of the form $R^{-2}O_4$; oxamid $C_2H_4N_2O_2$ and succinamid $C_4H_8N_2O_2$, are homologous bodies of the form RN_2O_2; benzene C_6H_6 and cumene C_9H_{12} are expressed by R^{-6}, and so on. To determine whether two bodies having the same amount of oxygen, can be homologues, we assume a number of equivalents of hydrogen equal to twice that of the carbon, (this being the proportion of 1 : 2,) and observe whether the excess or deficiency of hydrogen is the same in both; and consequently whether they can be expressed by the same formula.

The salicylic acid $C_7H_6O_3$, and the anisic $C_8H_8O_3$, are monobasic and contain three equivalents of oxygen; in the first, the deficiency of hydrogen is $14-6=8$, and the second $=16-8=8$. These acids may then be represented by the formula $R^{-8}O_3$.

This proportion between the elements of a compound does not, however, necessarily imply a homology; there are some exceptions which depend in some way upon the peculiar grouping of the elements. Thus ordinary ether $C_4H_{10}O$, is represented by the same general formula as alcohol $R^{+2}O$, but the chemical characters of the two are entirely different and do not allow us to consider them homologues. It is then necessary to add as a condition of homology, a similarity of chemical characters, dependent upon a like arrangement of the molecules. Vol. i, pp. 29–35.

This notation expresses in a beautiful and simple manner, the relations of homology which exist between different compounds. It is the peculiarity of this system that it is based upon the natural affinities of bodies and not upon analogies; this is the only arrangement which will always be correct, because it is founded in the constitution of the substances themselves.

The important relations which the combustible elements sustain, appear "to permit us to class homologous bodies according to their carbon," and M. Gerhardt has accordingly constructed upon this basis a classification in which all organic substances are arranged in a tabular form. Those containing the same atomical proportion of carbon constitute a family which is designated by the number of equivalents of that substance. Each family is divided into the carburets of hydrogen and those containing oxygen and nitrogen, so that we have R, RO_2, RN, &c. These divisions are found on the left of the table, while at the top are marked at the head of their respective columns, the proportions of hydrogen. This will be better understood by a view of a part of the 1st and 2d families.

Family.	Gen. formula.	R^{+2}	R	R^{-2}
2.	R	C_2H_6, acetene.	C_2H_4, olefiant gas.	
	RO	C_2H_6O, (*a*) alcohol. (*b*) metl. ether.	C_2H_4O, aldehyde.	
	RO_2	. . . .	$C_2H_4O_2$, acetic acid.	
	RO_4	. . . .	. . .	$C_2H_2O_4$, oxalic acid.
1.	R	CH_4, marsh gas.		
	RO	CH_4O, wood-spirit.	. . .	CO, oxyd of carbon.
	RO_2	. . . .	CH_2O_2, formic acid.	CO_2, carbonic acid gas.

By this arrangement we are able at once to give a new substance a place, and to determine its relation to other series of compounds; those bodies which are homologues are always found in the same vertical column, and hence in looking over the table, we see at once in what families homologues of any particular form exist, and how these may be formed from other bodies of the same family. This may be illustrated by an extensive class of homologous acids of the form RO_2, which are here given with their families and formulas.

1.	Formic,	$C\,H_2\,O_2$
2.	Acetic,	$C_2\,H_4\,O_2$
3.	Metacetonic,	$C_3\,H_6\,O_2$
4.	Butyric,	$C_4\,H_8\,O_2$
5.	Valerianic,	$C_5\,H_{10}\,O_2$
6.	Caproic,	$C_6\,H_{12}\,O_2$
7.	Enanthylic,	$C_7\,H_{14}\,O_2$
8.	Caprylic,	$C_8\,H_{16}\,O_2$
9.	Pelargonic,	$C_9\,H_{18}\,O_2$
10.	Capric,	$C_{10}\,H_{20}\,O_2$
11.		
12.	Lauric,	$C_{12}\,H_{24}\,O_2$
13.	Cocinic,	$C_{13}\,H_{26}\,O_2$
14.	Myristic,	$C_{14}\,H_{28}\,O_2$
15.		
16.	Ethalic,	$C_{16}\,H_{32}\,O_2$
17.	Margaric,	$C_{17}\,H_{34}\,O_2$
18.	Anamiritic,	$C_{18}\,H_{36}\,O_2$
19.	Stearic,	$C_{19}\,H_{38}\,O_2$

The acids of the 1st, 2d, 5th, and 16th families are derived directly from alcohols of the formula $R^{+2}O$; and in the 2d we find aldehyde $C_2\,H_4\,O$, a derivative of alcohol, which fixes one equivalent of oxygen to form the acid. Spermaceti in the 16th family has the formula $C_{16}\,H_{32}\,O$, and forms ethalic acid by combining with an equivalent of oxygen; it is consequently a homologue of aldehyde. No homologues of alcohol are known in the other families; but in butyral $C_4\,H_8\,O$, and beeswax $C_{19}\,H_{38}\,O$, we have bodies corresponding to aldehyde, and enanthole and menthol are probably the aldehydes of the 7th and 10th families. We may anticipate that future researches will discover an aldehyde and alcohol for each of these acids, and fill up the 11th and 15th families by a similar series. Four acids of this group have been added to the list within the last two years,[*] and butyral was but recently discovered as a product of the destructive distillation of butyrate of lime. It will be remembered that ethal, an alcohol, is formed by the action of potash upon spermaceti its corresponding aldehyde. We can thus obtain aldehydes from alcohols and acids, and alcohols from aldehydes.

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[*] They are, the metacetonic, discovered by Gottlieb; the enanthylic or azoleic, which was formerly considered as a bibasic acid; and the pelargonic, observed by Redtenbacher among the products of the oxydation of oleic, and supposed to be identical with the acid of the *pelargonium roseum*. This occupies the place formerly assigned to the copsic acid of Chevreul, which the observations of Lerch have shown to be a mixture of capric with a new acid, the caprylic.

In this series we observe a regular gradation from the volatile and soluble formic and acetic acids to the solid fatty acids at the other extremity of the scale. Those from the 4th to the 10th inclusive are oily and sparingly soluble, and present a regular increase of about 20° Centigrade in their boiling points; higher in the scale they are solid at the ordinary temperature, and the stearic and margaric cannot be distilled without decomposition. Redtenbacher has recently shown that all the liquid acids of this group, with the exception of the formics, are produced in the oxydation of oleic acid by nitric acid.* Stearic acid by the action of the nitric loses two equivalents of carbon and four of hydrogen in the form of water and carbonic acid; and yields the margaric; which by a farther oxydation affords several of the volatile acids of the series. The other solid acids yield the same results, and are perhaps intermediate products in the oxydation of the margaric by nitric acid.

By the action of nitric acid upon wax, we oxydize a portion of its carbon and hydrogen, and obtain a series of bodies lower in the scale; among these are the succinic, pimelic, and suberic acids, which, as we have already seen, are homologues of the form $R^{-2} O_4$. Spermaceti yields the same products as wax, but if we expose its homologue of the 2d family, aldehyde, to this process, it cannot yield succinic acid, which belongs to the 4th family, but we obtain instead its homologue in the 2d family, oxalic acid.

The results of science are continually demonstrating the universality of the maxim of Linnæus, *Natura non facit saltum.* We see bodies possessing the most dissimilar physical characters, but agreeing in constitution, when arranged acccording to their chemical relations exhibiting such a gradation that it is difficult to say where the seeming dissimilarity begins or ends, and we may expect that future discoveries will show many bodies of which but one or two homologues are now known to be members of a complete series.

The examples which we have given, will illustrate the features of this classification; which founded as it is upon the natural affinities of bodies and the numerical relations of their elements, must necessarily be permanent.

(*To be continued.*)

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* This Journal, ii Ser., Vol. iii, No. 8.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Congelation of Mercury in three seconds, by virtue of the spheroidal state, in an incandescent crucible*, (Letter from M. Faraday to Boutigny, Ann. de Chim. et de Phys., xix, May, 1847, p. 383.)—In producing congelation of mercury by virtue of the spheroidal state, I first heated a crucible to redness and maintained it at this temperature; I then introduced some ether, and then solid carbonic acid; into this mixture in a spheroidal state, I inserted a metallic capsule containing about 31 grammes of mercury, and in two or three seconds it was solidified. It seemed strange indeed that mercury put into a red hot crucible should come out congealed.

2. *On a new Test for Prussic Acid, and on a simple Method of preparing the Sulphocyanid of Ammonium;* by Prof. Liebig, (Liebig's Annalen, Jan., 1847; Chem. Gaz., April, 1847.)—When some sulphuret of ammonium and caustic ammonia are added to a concentrated aqueous solution of prussic acid, and the mixture heated with the addition of pure flowers of sulphur, the prussic acid is converted in a few minutes into sulphocyanid of ammonium. This metamorphosis depends on the circumstance, that the higher sulphurets of ammonium are instantly deprived by the cyanid of ammonium of the excess of sulphur they contain above the monosulphuret; for instance, if a mixture of prussic acid and ammonia be added to the pentasulphuret of ammonium, the solution of which is of a deep yellow color, and the whole gently heated, the sulphuret of ammonium is soon decolorized; and when the clear colorless liquid is evaporated, and the admixture of sulphuret of ammonium expelled, a white saline mass is obtained which dissolves entirely in alcohol. The solution yields, on cooling or evaporation, colorless crystals of pure sulphocyanid of ammonium. Only a small quantity of sulphuret of ammonium is requisite to convert, in the presence of an excess of sulphur, unlimited quantities of cyanid of ammonium into sulphocyanid; because the sulphuret of ammonium, when reduced to the state of monosulphuret, constantly reacquires its powers of dissolving sulphur and transferring it to the cyanid of ammonium. The following proportions will be found to be advantageous:—2 oz. of solution of caustic ammonia of 0·95 spec. grav. are saturated with sulphuretted hydrogen gas; the hydrosulphuret of ammonium thus obtained is mixed with 6 oz. of the same solution of ammonia, and to this mixture 2 oz. of flowers of sulphur are added; and then the product resulting from the distillation of 6 oz. prussiate of potash, 3 oz. of the hydrate of sulphuric acid, and 18 oz. water. This mixture is digested in the water-bath until the sulphur is seen to be no longer altered and the liquid has assumed a yellow color; it is then heated to boiling, and kept at this temperature until the sulphuret of ammonium has been expelled and the liquid has again become colorless. The deposited, or excess of, sulphur is now removed by filtration, and the liquid evaporated to crystallization. In this way from 3⅓ to 3½ oz.

of dazzling white dry sulphocyanid of ammonium are obtained, which may be employed as a reagent, and for the same purpose as the sulphocyanid of potassium. Of the 2 oz. of sulphur added, ½ an oz. is left undissolved.

The behavior of the higher sulphurets of ammonium towards prussic acid furnishes an admirable test for this acid. A couple of drops of a prussic acid, which has been diluted with so much water that it no longer gives any certain reaction with salts of iron by the formation of prussian blue, when mixed with a drop of sulphuret of ammonium and heated upon a watch-glass until the mixture is become colorless, yields a liquid containing sulphocyanid of ammonium, which produces with persalts of iron a very deep blood-red color, and with persalts of copper, in the presence of sulphurous acid, a perceptible white precipitate of the sulphocyanid of copper.

3. *Separation of Alumina from Oxyd of Iron.*—Dr. W. Kuop (Jour. für Prakt. Chem., Oct. 9, 1846,) states that he has effected a complete separation of these two oxyds by precipitating with sulphuret of ammonium, washing the precipitate with water containing a little free sulphuret of ammonium, and then extracting the alumina by a solution of potash which also must have a little sulphuret of ammonium in it. In this way the alumina, on subsequent precipitation, is obtained on slow desiccation as a transparent mass, and on quickly drying and calcining it has so perfectly a white color as to leave no doubt of its being extremely pure.

4. *Detection of minute traces of Alcohol;* (Monthly Jour. Med. Sci., Dec., 1846.)—Dr. R. D. Thomson proposes in place of the distillation of a liquid suspected to contain alcohol, and trusting to the odor of alcohol in the product, which is the usual mode, to resort to the use of chromic acid, which as is well known, produces a characteristic emerald green solution of oxyd of chromium, in fluids containing alcohol. The characteristic odor of aldehyde given off from the dehydrogenation of the alcohol by the chromic acid, also aids materially in detecting minute quantities of spirits of wine. For this purpose a small quantity of bichromate of potash is placed in the bottom of a conical glass containing a portion of the suspected fluid, and sulphuric acid is poured on it by means of a tube funnel. If alcohol is present, the green oxyd will soon be observed on the surface of the undissolved salt, and the characteristic odor of aldehyde will speedily be perceptible.

5. *On the Acid Reaction of the Gastric Juice;* by Prof. C. G. Lehmann, (Bericht der Gesellschaft der Wissenschaften in Leipzig, p. 100–105; Chem. Gaz., March, 1847.)—Pelouze, and especially Bernard and Barreswil, have shown with certainty the absence of free muriatic acid in the gastric juice. The author has obtained the same result, and at the same time he has indisputably proved the presence of free lactic acid. To obtain the gastric juice of dogs in the greatest state of purity possible, these animals were kept without food for from twelve to sixteen hours, and then fed from ten to twenty-five minutes before death with bones freed as perfectly as possible from skin and fat. Immediately after they were killed, the stomach was tied at the cardia and pylorus, and removed from the body. It was then opened by an oblique incision near the pylorus, and the fluid poured out, without the stomach being at

the same time much moved. The gastric juice thus obtained was almost perfectly clear, scarcely opalescent. The stomach of a dog of the size of a poodle contained from fifteen to forty grms. of a liquid, which flowed out spontaneously; that of a large pointer, from thirty to ninety grms. The fresh gastric juice was poured into a shallow broad flask, the mouth of which was closed by a cork, and through this, a glass tube, bent four times at a right angle, was passed; the latter was covered with nitrate of silver on its inner side. The apparatus was placed under the air-pump with dry hydrate of potash, and exhaustion then applied. When the gastric juice had been evaporated until it was of a syrupy consistence, vapors of muriatic acid were evolved somewhat suddenly, so that the chlorid of silver formed could be determined qualitatively and quantitatively. Treated in this manner, a gastric juice which was but slightly opalescent for instance, yielded 1·808 per cent. of solid residue, 0·125 per cent. muriatic acid, and 98·067 per cent. of water. This muriatic acid is formed by the decomposing action of the lactic acid at a certain degree of concentration, even in the cold, upon many chlorids, especially those of calcium and magnesium, but not the chlorids of potassium and sodium. To prove the presence of the lactic acid itself with certainty, the gastric juice was concentrated *in vacuo* to one-twelfth its volume, the residue mixed with alcohol of 0·85 spec. grav., the spirituous solutions from several stomachs evaporated to the consistence of a syrup, and the residue exhausted with absolute alcohol. The residue of this was exhausted with ether, and the ethereal extract mixed with water to remove the fat, and filtered. On further concentration, more drops of oil separated from the filtrate; moreover, the fluid about to be tested still contained muriate of ammonia. The liquid was partly saturated with lime, partly with magnesia, and the salts formed were purified by several recrystallizations from alcohol and water. The magnesian salt, dried at 266° F., and then incinerated, gave 16·666 per cent. of magnesia, 61·906 per cent. lactic acid, and 21·428 per cent. water; the formula $MgO, \overline{La}+3HO$ requires 16·085 per cent. magnesia, 62·936 per cent. lactic acid, and 20·979 per cent. water. In some other experiments, fasting dogs were fed from twenty to forty-five minutes before death with horse-flesh containing but little fat. The fluid which flowed spontaneously from the stomach, when filtered, left 5·602 per cent. of residue, and thus contained nutritive matters already in solution, which were detected by the copious precipitate produced by alcohol, or the formation of yellowish-brown films on evaporation. The gastric fluid thus obtained yielded no muriatic acid under the air-pump. From this fluid a magnesian salt was also obtained. I. gave 16·666 per cent. of magnesia, 62·122 $\overline{La}$, and 21·212 HO; II., which was obtained by exhausting the contents of the stomach with water, gave 15·966 per cent. MgO, 62·026 $\overline{La}$, and 21·008 per cent. of HO.

6. *Equivalent number of Titanium*, (L'Institut, March 10, 1847.)—The equivalent of titanium has been determined from the bichlorid of titanium by M. Isidore Pierre, Professor at Bordeaux. He obtained, in a series of five experiments, the numbers 314·76, 314·37, 314·94, 311·84, 309·88; in a second series, 313·41, 311·30, and in a third 311·58, 309·41. Operating with the greatest care, some small pro-

portion of the chlorid is supposed to decompose during the experiment, through the humidity of the air; and in this way M. Pierre accounts for the variation in the above results. Believing that the first three results are most correct, he adopts the number 314·69 (or on the hydrogen scale, 25·13) for the equivalent.

7. *On the compounds of Iron with Carbon;* by M. KARSTEN, (Bericht Berlin Akad., Nov. 5, 1846; Chem. Gaz., March, 1847.)—The determination of the amount of carbon in the different kinds of bar iron, steel and pig iron, are still variable and uncertain, partly owing to the estimation of the amount of carbon being very tedious if not difficult, and partly because the limits between bar iron and steel, as well as between steel and pig iron, are wholly undetermined, and are merely assumed conventionally from certain physical properties of the product. Combinations in definite proportions between iron and carbon are not to be met with in the carburets of iron; for the union of these two substances takes place in indefinite proportions, uninterruptedly, from 0 to the maximum amount of carbon, which is about 5·93 per cent. The classification of the carburets of iron in three divisions, bar iron, steel, and pig iron, is consequently not necessary, i. e., not required, by the combining proportions, but wholly arbitrary.

To determine the amount of carbon, the best methods of separating the carbon from iron were employed; but in order to ascertain the degree of trust-worthiness belonging to each, white pig iron, with a bright metallic surface, smelted with charcoal from sparry iron ore at the Sayner works near Bendorf on the Rhine, was submitted to experiment. This pig iron contains no uncombined carbon (graphite), or at least but mere traces; and the amount of combined carbon approaches closely to the maximum amount which iron is capable of taking up.

The amount of carbon of this pig iron was found, by different methods of analysis, as follows:—

	Per cent.
By elementary analysis with oxyd of copper, the carbon being calculated from the carbonic acid gas,	4·2835
By elementary analysis with chlorate of potash and chromate of lead,	5·7046
2d experiment,	5·6987
By decomposition of chlorid of copper,	5·5523
2d experiment,	5·6978
By decomposition of perchlorid of iron:—	
1. Experiment with sublimed chlorid of iron,	5·4232
2. With perchlorid prepared in the moist way,	5·2867
By decomposition of chlorid of silver,	5·6056
2d experiment,	5·7234

As all bar iron contains more or less carbon, some decision should be made as to the limits up to which it should be called bar iron, and below which steel. If the limits are fixed by calling that bar iron steel which becomes so hard by cooling in water after having been hardened that it gives sparks with quartz, this effect occurs only when the iron has taken up 0·5 of carbon. Iron which is perfectly free from foreign ingredients may even combine with 0·65 per cent. of carbon before attaining the above degree of hardness. The purer the iron and the less foreign substances (silicium, sulphur, phosphorus) it contains, the greater amount of carbon will it require in order to become much harder after the process of hardening than previous to it.

Iron which contains 0·5 to 0·65 per cent. of carbon is very soft steel; the hardness and tenacity of the steel increase with the amount of the carbon. From 1·4 to 1·5 per cent. appears to be the limit at which steel exhibits after hardening the greatest hardness with the greatest tenacity; with more carbon the hardness increases, but the malleability and tenacity of the steel are diminished; when it amounts to 1·75 per cent. the steel is very slightly malleable; with 1·9 it can scarcely be welded red-hot, and with 2 per cent. it breaks to pieces under the hammer. In this state the steel might already be called *pig iron*; but it may be beaten in the cold, and does not possess the property of separating a portion of its carbon in the form of graphite when allowed to cool very slowly after fusion. This occurs only when the carbon amounts to 2·25 or 2·3 per cent. If, therefore, a line of demarcation were to be drawn between steel and pig iron, which should be founded upon the combining proportions, 2·3 would characterize this limit.

The more carbon the pig iron takes up, from that minimum to the maximum of 5·93 per cent., the lighter does the color become, and the greater the hardness of the white variety, which is analogous to hardened steel. The gray variety, with an equal amount of carbon, which is analogous to unhardened steel, will be softer, that is, will separate the more graphite on solidification, the slower the cooling. The gray pig iron, which contains the same amount of carbon as the corresponding white kind, may consequently be sometimes a mixture of white pig iron with graphite, sometimes of soft steel or of hard bar iron and graphite, according as the solidification resulted more or less slowly, and the solidified mixture retained more or less carbon in the combined state. When the solidification is sudden, gray iron is scarcely formed, because the entire amount of carbon remains chemically combined with the iron, and is not separated as graphite.

In preparing cast steel, the process is purely empirical, the eye of the workmen being the weight and balance in determining the amount of carbon in the material to be employed. To manufacture cast steel with certain properties, those materials must be selected in which the amount of carbon is known, and which, by being fused together in accurately calculated proportions, produce a cast steel containing that amount of carbon which corresponds with the properties required of the cast steel to be prepared.

8. *Note on the Action of a Solution of Caustic Soda upon a Stoneware Jar;* by Mr. TRENHAM REEKS, (Chem. Gaz., April, 1847.)—The author's attention was drawn to this subject from the presence of a large quantity of alumina in the analyses of some bronzes and iron ores. On examining the reagents employed, it was found that it originated in the soda, which had been kept for some time in a stoneware jar, the alumina of which had been dissolved out by the soda, and a thick coating of silica left closely adhering to its surface.

9. *On the Detection of Cotton in Linen;* by G. C. Kindt, (Liebig's Annalen, Feb., 1846; Chem. Gaz., April, 1847.)—This subject has frequently engaged the attention of commercial and scientific men; many experiments have been made in order to detect cotton thread in linen; many processes have been recommended, but none have hitherto proved satisfactory. I was therefore much surprised when a stranger, a few weeks ago, showed me a sample of linen from the one-half of which all the cotton filaments had been eaten away. He had obtained it in Hamburg, and asked me whether I could give him a process for effecting this purpose. Now since, as far as I am aware, nothing has been published on this subject, and it is of very general interest, I consider it a duty to communicate the results of my experiments. I had already observed, in experimenting with explosive cotton, flax, &c., that these two substances behave somewhat differently towards concentrated acids; and although it has long been known that strong sulphuric acid converts all vegetable fibre into gum, and when the action is continued for a longer period, into sugar, I found that cotton was metamorphosed much more rapidly by the sulphuric acid than flax. It is therefore by means of *concentrated sulphuric acid* that cotton may be removed from linen when mixed with it; and this object may be effected by the following process:—

The sample to be examined must be freed as perfectly as possible from all dressing by repeated washing with hot rain or river-water, boiling for some length of time, and subsequent rinsing in the same water; and I may expressly observe, that its entire removal is requisite for the experiment to succeed. When it has been well dried, the sample is dipped for about half its length into common oil of vitriol, and kept there for about half a minute or to two minutes, according to the strength of the tissue. The immersed portion is seen to become transparent. It is now placed in water which dissolves out the gummy mass produced from the cotton; this solution may be expedited by a gentle rubbing with the fingers; but since it is not easy to remove the whole of the acid by repeated washing in fresh water, it is advisable to immerse the sample for a few instants in spirits of hartshorn, (purified potash or soda has the same effect,) and then to wash it again with water. After it has been freed from the greater portion of the moisture by gentle pressure between blotting-paper, it is dried. If it contained cotton, the cotton threads are found to be wanting in that portion which had been immersed in the acid; and by counting the threads of the two portions of the sample, its quantity may be very readily estimated.

If the sample has been allowed to remain too long in sulphuric acid, the linen threads likewise become brittle, or even eaten away; if it were not left a sufficient time in it, only a portion of the cotton threads have been removed; to make this sample useful, it must be washed, dried, and the immersion in the acid repeated. When the tissue under examination consists of pure linen, the portion immersed in the acid likewise becomes transparent, but more slowly and in a uniform manner, whereas in the mixed textures the cotton threads are already perfectly transparent, while the linen threads still continue white and opake. The sulphuric acid acts upon the flax thread of pure linen, and the sample is even somewhat transparent after drying as far as the acid acted upon it, but all the threads in the sample can be seen in their whole course.

Cotton stuffs containing no linen dissolve quickly and entirely in the acid; or if left but one instant in it, become so brittle and gummy that no one will fail to recognize it as cotton when treated in the above manner.

10. *Nitrification and the Fertilization of Soils;* by F. KUHLMANN, (Comptes Rendus, Nov., 1846.)—The researches of this author published in 1838 are well known. By these he demonstrated that all the gaseous or vaporizable compounds of nitrogen, were converted into ammonia by the hydrogen and hydrogenous gases in contact with heated spongy platinum, and that on the other hand, all these compounds were converted into nitric acid or peroxyd of nitrogen, by oxygen or oxydating gases.

Upon this foundation the following view is based. Animal substances exercise a beneficial effect only when carbonate of ammonia is disengaged by their decomposition; in like manner, according to Kuhlmann, the nitrates are effectual as manures, only when the nitric acid has been converted into ammonia by the deoxydizing influence of putrid fermentation.

Various recent experiments are brought to prove that this opinion is correct, and that similar conversions to those observed in gases take place in liquids. Nitre thrown into a mixture of zinc or iron and sulphuric or better dilute hydrochloric acid, retards or stops the disengagement of hydrogen until the whole of the nitric acid is converted into ammonia. Nascent sulphuretted hydrogen produces the same effect, with deposition of sulphur. A current of sulphuretted hydrogen passed through a solution of chlorid of antimony and a nitrate, in like manner transforms the nitric acid into ammonia.

The author entertains the opinion that the ammonia of the atmosphere or of manures, is converted at the surface of the soil into nitrates, and that this process of nitrification prevents the waste of ammonia; these nitrates are in their turn deoxydized by fermentation and afford ammonia to the plant.

The peroxyd of manganese is proposed as an agent for the perpetual transference of the oxygen of the air to ammonia, producing its conversion into nitric acid; MnO_2 being deoxydized by the ammonia and the resulting MnO being converted by the air into Mn_3O_4, which in its turn is deoxydated.

M. Kuhlmann considers it possible, in case of a deficient supply of nitre in Europe, to convert ammonia into nitric acid economically—and on the contrary with the nitrates from India and Chili to form ammonia, by turning to account the hydrogen or sulphuretted hydrogen, which is lost in many operations and is even a source of injury to health. He also proposes a new process for determining nitric acid, based upon the conversion of nitrates into ammonia, under the influence of nascent hydrogen.

G. C. S.

11. *Anhydrous Alcohol;* by M. CASORIA, (Phil. Mag., Nov., 1846, from Jour. de Chim. Med.)—Perfectly dry sulphate of copper is proposed as a means of rendering alcohol anhydrous, and as a test for the

presence of water in alcohol. The dry salt in combining with the water of the alcohol recovers its blue color, and when this color ceases to be produced, water is no longer present.

To obtain anhydrous alcohol, strong alcohol is to be saturated with chlorid of calcium, and the portion first distilled from it is to be treated with the dry sulphate until the blue color ceases to appear. These experiments should be performed in closed vessels, to prevent the interference of atmospheric moisture. G. C. S.

12. *On the Compounds of Phosphoric Acid with Aniline;* by Ed. C. Nicholson, (Phil. Mag., Jan., 1847.)—The facility with which the salts of aniline crystallize, led to the attempt to investigate its several phosphates, which might be supposed analogous to the phosphates of ammonia. Two tribasic phosphates were obtained, one being $2(HO, C_{12}H_7N)HO, PO_5$, the other $(HO, C_{12}H_7N,)\ 2HO, PO_5$, corresponding to the ammonia salts, and like them anhydrous. The attempt to form the salt with three equivalents of base or one containing soda (analogous to microcosmic salt) was unsuccessful. Two pyrophosphates were formed at the same time, acid and neutral; the latter could not be isolated; the former $(HO, C_{12}H_7N,)\ HO. PO_5$ corresponds to acid phyrophosphate of soda, but has no analogue in the ammonia series.

The metaphosphate was formed similar to the soda salt; the ammonia salt exists only in solution.

The conclusion is a natural one, that organic bases form series of salts with polybasic acids resembling those of the metallic oxyds.

G. C. S.

13. *On the relations of Glycocoll and Alcargene;* by Mr. Thomas S. Hunt.—We have received an interesting paper from Mr. Hunt on the relations of these two bodies, which we defer to our next number. He points out the fact that the formulas of the two bodies are the same, excepting the substitution of As for N, and instances some of the homologous compounds as follows:—

Glycocoll,	$C_4\,H_5\,NO_4$	Alcargene,	$C_4\,H_5\,AsO_4$
Argentic "	$C_4\,(H_4\,Ag)\,NO_4$	Argentic "	$C_4\,(H_4\,Ag)\,AsO_4$
Hydrochloric "	$C_4\,H_5\,NO_4, HCl$	Hydrochloric "	$C_4\,H_5\,AsO_4, HCl$

II. Mineralogy and Geology.

1. *Hauerite, a New Mineral Species;* by W. Haidinger, (Poggendorff's Annalen, Vol. lxx, p. 148.)—Hauerite belongs to Mohs's order of blende, and resembles very much several true brown zinc-blendes. Its crystals belong to the tessular system: they are partly perfect octahedrons, partly combinations of this form with faces of the hexahedron and other modifying planes.

One of the two crystals submitted to my examination by Mr. Berghofer, is a perfect and distinct octahedron, whose axis measures three quarters of an inch. The mineral cleaves with extreme facility parallel to the faces of the cube. Its lustre is between metallic adamantine and imperfectly metallic; the color ranges between dark reddish-brown and brownish-black, and in the thinnest films obtained by cleavage, it shows a low degree of brownish-red translucency; streak brownish-red; hardness =4·0, or that of fluor; specific gravity, according to von Hauer, 3·463.

In a glass tube before the blowpipe, an abundance of sulphur is given off, leaving a green residue soluble in acids with a disengagement of sulphuretted hydrogen. This residue when treated alone becomes superficially brown again, before the blowpipe. A fragment treated with salt of phosphorus does not (as is also true of manganese-blende from Nagyág) become of a violet color in the outer flame, until the whole of the sulphuret of manganese is decomposed. Upon platina foil with soda, it gives the reaction of manganese. In composition, it would therefore seem to be a higher grade of sulphuret of manganese; and guided by its isomorphism with iron pyrites, which is expressed by the formula $\mathrm{Fe\,S^2}$, we may infer that the formula of Hauerite is $\mathrm{Mn\,S^2}$.

According to the analysis of W. Adolphus Patera, the composition of the substance in question is as follows: sulphur 53·64, manganese 42·97, iron 1·30, silica 1·20 = 99·11, calculating the iron as sulphuret of iron, and deducting it, this would give, in one hundred parts,

	Analysis.	Calculation.
Sulphur,	54·801	53·7
Manganese,	45·198	46·3

It is remarkable that the form of the only sulphuret of manganese, with which we were hitherto acquainted, (manganese-blende, alabandine,) and whose composition is MnS, should likewise belong to the tessular system, and also show distinct cleavage parallel to the faces of the cube. Alabandine, however, is more semi-metallic in lustre, has a green streak, and gives off no sulphur in a glass tube before the blowpipe.

The writer first took the crystals from their color, form, streak, and manner of grouping, for weathered iron pyrites, when his attention was drawn by Mr. von Hauer to their perfect hexahedral cleavage; further investigation then established the distinctness of this beautiful species beyond a doubt.

Hauerite occurs at the sulphur-pits at Kalinka near Végles, in the neighborhood of Altsohl in Hungary. The crystals are met with in clay and in gypsum, occasionally associated with sulphur of a fine yellow tint, which is nearly transparent. They occur either insulated or grouped together like certain varieties of globular iron pyrites.

The name proposed was given this species as an acknowledgment of the high merits of his excellency the Privy Counsellor and Vice President, von Hauer, and because of the part which his son, Mr. F. von Hauer, took in the determination of the species. The substance was first noticed by Mr. C. v. Adler, at that time employed at Kalinka, and from this gentleman several persons received specimens. Hauerite will perhaps always remain a mineralogical rarity. The writer however looks forward with pleasure to the receipt of further specimens direct from the mining authorities of Lower Hungary.

2. *Coal and Iron in India*, (Mining Journal, April 10, 1847.)—As it has now been determined by the East India Company, and supported by government, that the railway system shall be extended to India, and a guarantee given for a dividend on the capital invested, any in-

formation respecting the localities from which supplies of fuel can be drawn, must prove interesting, and not less so the capabilities for the manufacture of iron. Hitherto the iron mines of India—though yielding iron in no respect inferior to the famous mines of Dannemora—have been scarcely opened, from the deficiency of the means of transport; and the coal-fields, though of great richness and extent, have lain neglected, principally from the same cause. The coal-fields of India are largely distributed over its surface; coal has been traced from Burdwan to the westward, across the valley of Palamow, through the district of Sohagpore to Jubulpore, the neighborhood of Sak, and the Towa River, in Nerbudda—four hundred and twenty miles from Burdwan. In the same parallel of latitude it is found in the province of Cutch, and is extended across the centre of India, to the northeast extremity of Assam, forming a zone, which stretches from 69° to 93° east longitude, and from 20° to 25° north latitude. There are also two situations where coal has been found distinct from this extensive and well-defined belt—Hurdwar and Attock—the first near the source of the Ganges; the latter, near that of the Indus. The Nerbudda river extends seven hundred miles along the very centre of the above zone; and coal in three situations has already been found on its banks. The Burdwan coal-field is of immense importance; the collieries at present opened are situated one hundred and forty miles from Calcutta, and the district is traversed by two rivers—the Damooda and the Adjii; the face of the country is undulating, presenting a difference of level between the heights and valleys of about sixty feet. The surface is composed of a yellow clay, supporting a good soil—both slightly calcareous; this clay rests on a grey sandstone, which effervesces with acids, seven feet in thickness; and where exposed to the air, in many places an efflorescence of soda is found upon it. Beneath this rock, an inferior coal is found, accompanied by shale, containing impressions of plants, bending over the low hills, and descending deep beneath the valleys; beneath these, good coals are found: and this portion of the deposit has been traced in a southwest direction eleven or twelve miles, and in a northwest line for seven miles—thus forming a curve. At a depth of about fifty feet, two beds of excellent coal occur—one, eight feet, and the other nine feet in thickness; below these, thirteen beds of sandstone and shales occur; and the greatest depth reached is eighty-eight feet, where the excavation is terminated by a hard grey sandstone. The whole district abounds in rich and valuable iron ores of various kinds; and it has been proved, by the erection of temporary furnaces at Sheargur, that immense quantities of iron can be made at little expense. The average of the ores produce fifty per cent. of iron. A prospectus, drawn up in 1828, pointing out the benefits likely to arise from establishing iron-works in India, led to the formation of the Porto Novo Works, near Madras, now in succesful operation; and, as the subject is one of immense importance to the construction of railroads in India, we shall, in a future number, give the substance of a report by Capt. Campbell, which will, doubtless, throw much light on the present position of the coal and iron districts.

3. *On Slaty Cleavage;* by Daniel Sharpe, (Quart. Jour. Geol. Soc., No. 9, p. 74.)—Mr. Sharpe commences his very valuable article

on slaty cleavage by describing the various distorted forms of certain species of shells in fissile rocks, showing that these forms depend on the positions of the shells with relation to the direction of cleavage. He observes that the same shells in rocks that are not fissile are not thus distorted ; and on a single slab or layer the various specimens are all distorted in the same direction. This observation led him to throw together many species which he had before considered distinct.

He illustrates the subject by figures of distorted forms of the *Spirifer giganteus* and *Sp. disjunctus* from Tintagel and South Petherwin, copies of which, reduced one-half, are here given. (We have collected together the several separate cuts of Mr. Sharpe for more convenient comparison.)

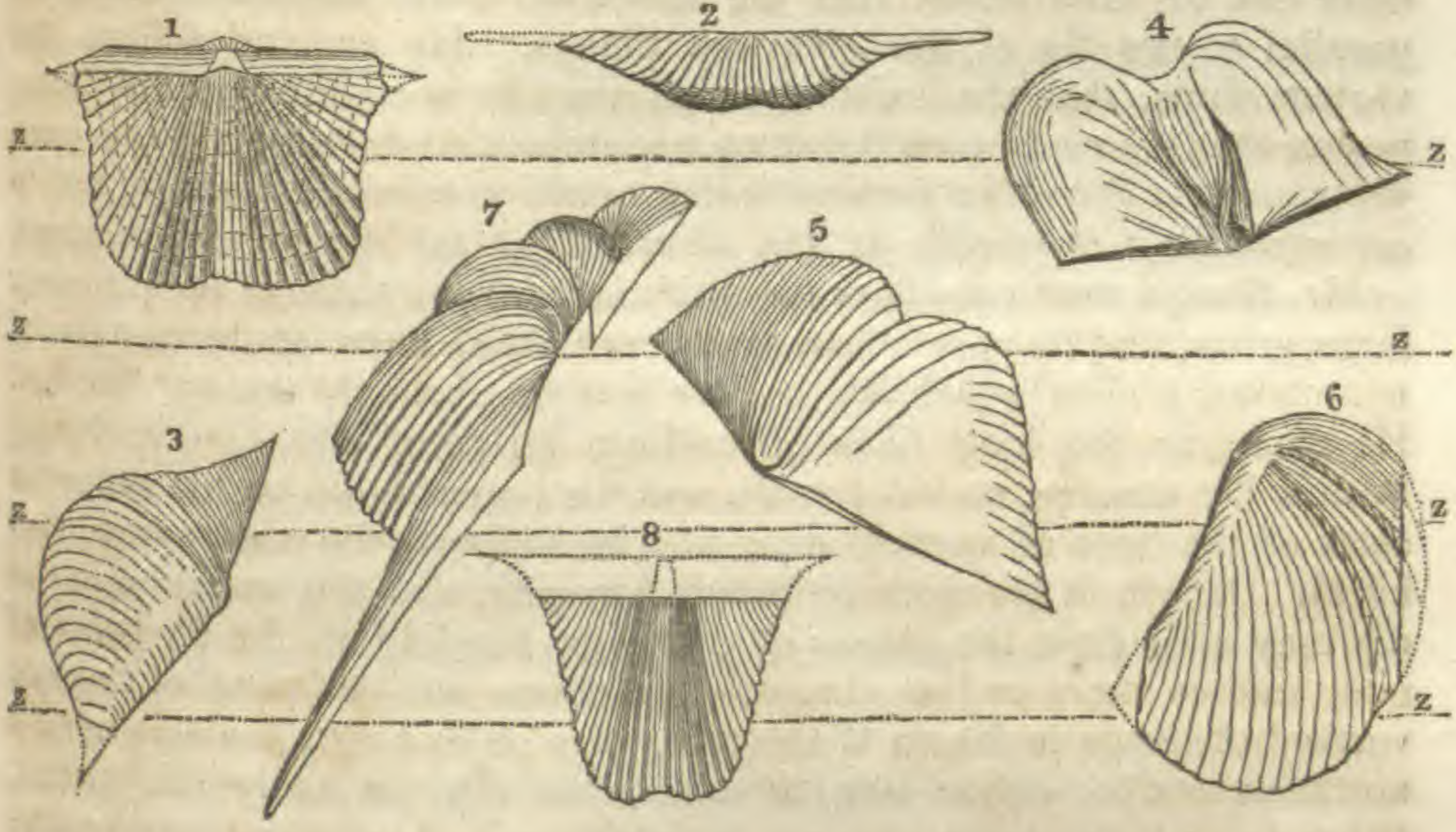
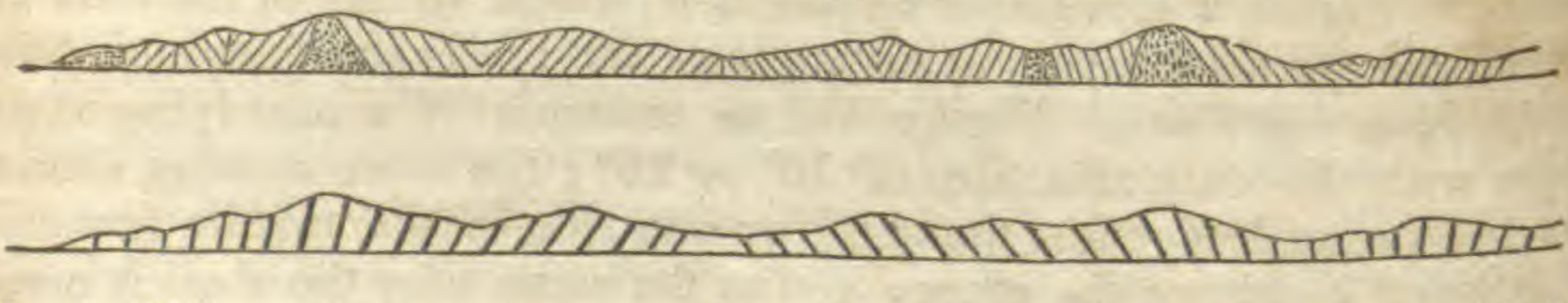


Figure 1 to 4, *Spirifer disjunctus ;* 5 to 8, *Spirifer giganteus.* All reduced one-half, except fig. 8, which is reduced two-thirds.

Fig. 1 represents the *S. disjunctus* of its proper form, and the following are distorted shells of this species and *giganteus.* The lines zz mark the direction of the lines of cleavage. These shells, he remarks, are usually flattened or narrowed in a direction *perpendicular* to the cleavage, and drawn out, or pressed out, in the direction of the dip of the cleavage planes. Figure 2 represents a specimen which so lay in the rock as to intersect the slate layers at an angle of 60° ; it is shortened one-half by the distorting force. Figure 3 is an example of a cast lying at an angle with the slaty structure of 10° or 15° ; the force causing distortion has pressed together the shell on one side of the middle line and lengthened it out on the other ; and at the same time the shell is compressed at right angles with the cleavage. Figure 4 represents another cast in a different position ; the large part of the shell is pressed under the other part and concealed, and at the same time the remainder is so expanded that the impressions of the hinge portion are nearly double their usual length, this expansion taking place "as usual in the direction of the dip of the cleavage." Figure 5 (a cast of *Spirifer giganteus*) represents a case nearly like figure 3, in which the plane of bedding of the shell made an angle of less than 5° with the cleavage ; the lower half is very much expanded in the plane of cleavage, and has lost thereby its radiations. In figure 6 there is the same angle between the plane of bedding and dip of cleavage, but a different position of the shell, in consequence of which one-half was extremely shortened, while the other was as remarkably widened. In figure 7 a still more singularly lengthened cast of *S. giganteus* is shown; it was from a bed where the cleavage intersected it at an angle of 1° only. The elongated half of the cast of the hinge is here three times the length of the other half, and the hinge area is singularly widened, while a great part of the cast of the body of the shell is lost. Figure 8 represents a specimen (imperfect in the hinge portion) expanded in the direction of its length; although not seen in place, Mr. Sharpe observes that there can be little doubt that the distortion took place in a direction parallel to the dip of the cleavage planes. He concludes from the various facts, that the existing forms may be accounted for by supposing that *the rocks* in which they are imbedded *have undergone compression in a direction perpendicular to the planes of cleavage, and a corresponding expansion in the direction of the dip of the cleavage.*

Mr. Sharpe next considers the uniformity of the strike of the dip over large areas, and its parallelism to the anticlinal axes or the ranges of mountains, a view which we believe was first brought out by Necker. He mentions the long lines of uniform strike of cleavage in North Wales, Devonshire, and Cornwall, and the opposite dip on the different sides of the lines of vertical dip; and he supports the view presented by Mr. Darwin in his work on South America, that this variation in the dip may arise from the planes of cleavage bending in the direction of great curves more or less abrupt. He points out two parallel lines of vertical cleavage in North Wales thirty-five miles apart, having a nearly northeast strike, either side of which the dip gradually diminishes. Other similar examples also are pointed out. A relation between the inclination of the cleavage planes and the elevation of the strata is apparent in the beds; the dip of the cleavage is greater the greater that of the bedding, though the two differ much. In North Wales the cleavage planes usually dip 20° or 30° more than the bedding; while in the middle of Devonshire and Cornwall they are less inclined than the bedding. In the following section (figure 9) in Carnarvonshire, North Wales, there are several anticlinal and synclinal axes of the stratification, yet, as shown in figure 10, only one axis of cleavage. The several anticlinal and synclinal axes, excepting the central one, have not influenced the cleavage, which follows uniformly its own direction through beds dipping in opposite directions. "Still there is so much relation between the direction of the cleavage planes and the position of the beds, that we might infer from this section alone, that the cause which produced the cleavage of the rocks had helped to determine the elevation of the beds."

Figs. 9 and 10.



In Devonshire he establishes two lines of vertical cleavage, sixty miles apart, one at Stoke Fleming the other at Bickington; and they bound a broad area over which the cleavage planes undulate in low flat waves, the axes of which bear between E. and E.N.E. The annexed cut represents the relation of the planes of bedding and cleavage in these undulations near Launcestown and on the coast near Tintagel. The continuous lines represent the bedding and the dotted lines the cleavage. After stating other similar facts from different districts in England, Mr. Sharpe remarks as follows, with regard to the relation of the cleavage planes to the bedding in Devonshire:—

Fig. 11.

> "Throughout the central area where the cleavage is nearly horizontal, the beds undulate in a succession of waves already described without offering any marked features. These undulations are sharper towards Bideford, where we may expect to find the cleavage highly inclined. At the Bickington limestone quarry, where the vertical line of cleavage passes, the beds are most violently contorted. Beyond this line is low ground at Barnstaple, in the band between the two lines of vertical cleavage. From Pilton to Ilfracombe, with cleavage highly inclined, the strata are elevated in high hills, and at Linton, where the inclination of the cleavage is only 35°, the beds seldom dip more than 5°. So again on the S. coast of Devonshire, disturbed and elevated strata occur in company with highly inclined cleavage. These observations are less complete than those relating to Carnarvonshire, but the theoretical conclusions to be derived from them are the same.
>
> "The regularity of the direction of the cleavage is not at all broken in the neighborhood of the granite of these counties, from which it is to be inferred that the granitic eruptions had taken place and become solid before the cleavage was produced: indeed some remarks of Sir H. T. De la Beche lead me to suppose that the cleavage is continued through the granite."

Mr. Sharpe having deduced from the distorted shells that "the slaty rocks had undergone compression in a direction perpendicular to the planes of cleavage," and "that this compression was compensated by an expansion in the direction of the dip of the cleavage," enters upon an explanation of the non-conformity of the bedding to the cleavage planes. Assuming that the elevation was produced by an elevating force beneath the area, he argues that there will result from such elevating action, besides a grand central arch or anticlinal axis, other subordinate fractures and dislocations either side; and that thus the various anticlinal axes in figure 9 were produced, while only the main or central one influenced the direction of the cleavage planes. With regard to the manner in which the cleavage structure has been occasioned, or the cause of this peculiar feature, Mr. Sharpe simply enumerates some of the views which have been presented, expressing at the same time the hope that the observations he has made may hasten its discovery: an end which must surely be promoted by observations of so great interest followed out with the care and discrimination exhibited in the important memoir, of which a brief abstract has been here presented.

4. *Geological Society of London*, April 14th, 1847.—A paper was read, entitled, "On the Structure and probable Age of the Coal Field of the James river, near Richmond, Virginia;" by CHARLES LYELL, F.R.S., V.P.G.S.

This coal field, which is about twenty miles long from north to south and from four to twelve in breadth from east to west, is situated twelve miles west of Richmond in Virginia, in the midst of a granitic region. The rocks consisting of quartzose grits, sandstones, and shales, precisely agree in character with the ordinary coal measures of Europe. Several rich seams of bituminous coal (the principal one being occasionally from thirty to forty feet thick) occur in the lower division of the strata, which are arranged in a trough and are much disturbed and dislocated on the margin of the basin, where they have a steep dip, while they are horizontal towards the centre.

The fossil plants which have been determined by Mr. Charles Bunbury, differ specifically, and most of them generically, from those found fossil in the older or palæozoic coal formation of Europe and North America, and resemble, as Prof. W. B. Rogers first truly remarked in 1840, the plants of the oolite of Whitby in Yorkshire, some few however being allied to fossils of the European trias.

From the upright position of the Calamites and Equisetæ Mr. Lyell infers that the vegetables which produced the coal grew on the spots where the coal is now found, and that the strata were formed during the continued subsidence and repeated submergence of this part of Virginia. The shells consist of countless individuals of a species of Possidonomya, much resembling *P. minuta* of the English trias. The fossil fish are homocercal and differ from those previously found in the new red sandstone (trias ?) of the United States. Two of them belong to a new genus and one to a Tetragonolepis, and they are considered by Prof. Agassiz and Sir P. Egerton to indicate the liassic period.

The analysis of the coal made by Dr. Percy and Mr. Henry, shows that it contains the same elements, carbon, oxygen, hydrogen and nitrogen, in the same proportions as the older bituminous coal of Europe and North America. Alternating layers of crystalline coal, and others like charcoal, are observed in many places, and in the charcoal, Dr. Hooker has detected vegetable structure not of Ferns or Zamites or any conifer, but perhaps of Calamites. The coal yields abundance of gas used for lighting the streets of New York and Philadelphia, and some fatal explosions have taken place in the mines, some of which are nine hundred feet deep.

Volcanic rocks (dikes and beds of intrusive greenstone) intersect the coal measures in several places, hardening the shale and altering the associated coal, the latter being in some places turned into a coke used largely for furnaces.

The author concludes by expressing his opinion that the evidence of the fossils, although some of them belong to forms usually found in the trias, preponderates upon the whole in favor of regarding the coal field of the James river as being of the age of the inferior oolite and lias.*

A paper was next read, entitled, "Descriptions of Fossil Plants from the Coal Field near Richmond, Virginia;" by **Charles J. F. Bunbury**, F.L.S., F.G.S.

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* For the memoir of Prof. Wm. B. Rogers, in which this conclusion was sustained by the same arguments in 1842, see Report Assoc. Amer. Geol. and Nat., 1840–1842, p. 298.

The author describes fifteen different forms of vegetable remains, of which, however, only nine or ten are sufficiently well preserved to be determined with any precision. Six are Ferns, of which three belong to *Pecopteris*, one to *Tæniopteris*, one to *Neuropteris*, and the sixth appears not to be referable to any genus hitherto described. The *Neuropteris*, and one of the species of *Pecopteris*, are new. One of the ferns is believed to be identical with *Pecopteris whitbiensis*, a species characteristic of the oolites of the Yorkshire coast. There is one species of *Equisetum*,—*E. columnare*—likewise characteristic of the Yorkshire oolites; one, or perhaps two of *Calamites;* two (which may possibly be mere varieties) of *Zamites;* the remainder are obscure impressions of an equivocal nature, but of which one has a certain degree of resemblance to a *Stigmaria*, and another to a *Lepidodendron.*

Five of these fossil plants had previously been determined and described by Prof. W. B. Rogers, namely, *Tæniopteris magnifolia*, *Pecopteris whitbiensis*, *Equisetum columnare*, *Calamites arenaceus*, and *Zamites obtusifolius*. Prof. Rogers described also a few other species, which do not occur in the collection made by Mr. Lyell.

From a comparison of these vegetable remains with those found in European strata, of which the geological position is well known, it may be concluded with tolerable certainty, that the Richmond coal-field is of later date than the great carboniferous system, and that it must be referred either to the lower part of the Jurassic, or the upper part of the Triassic series,—more probably to the former.

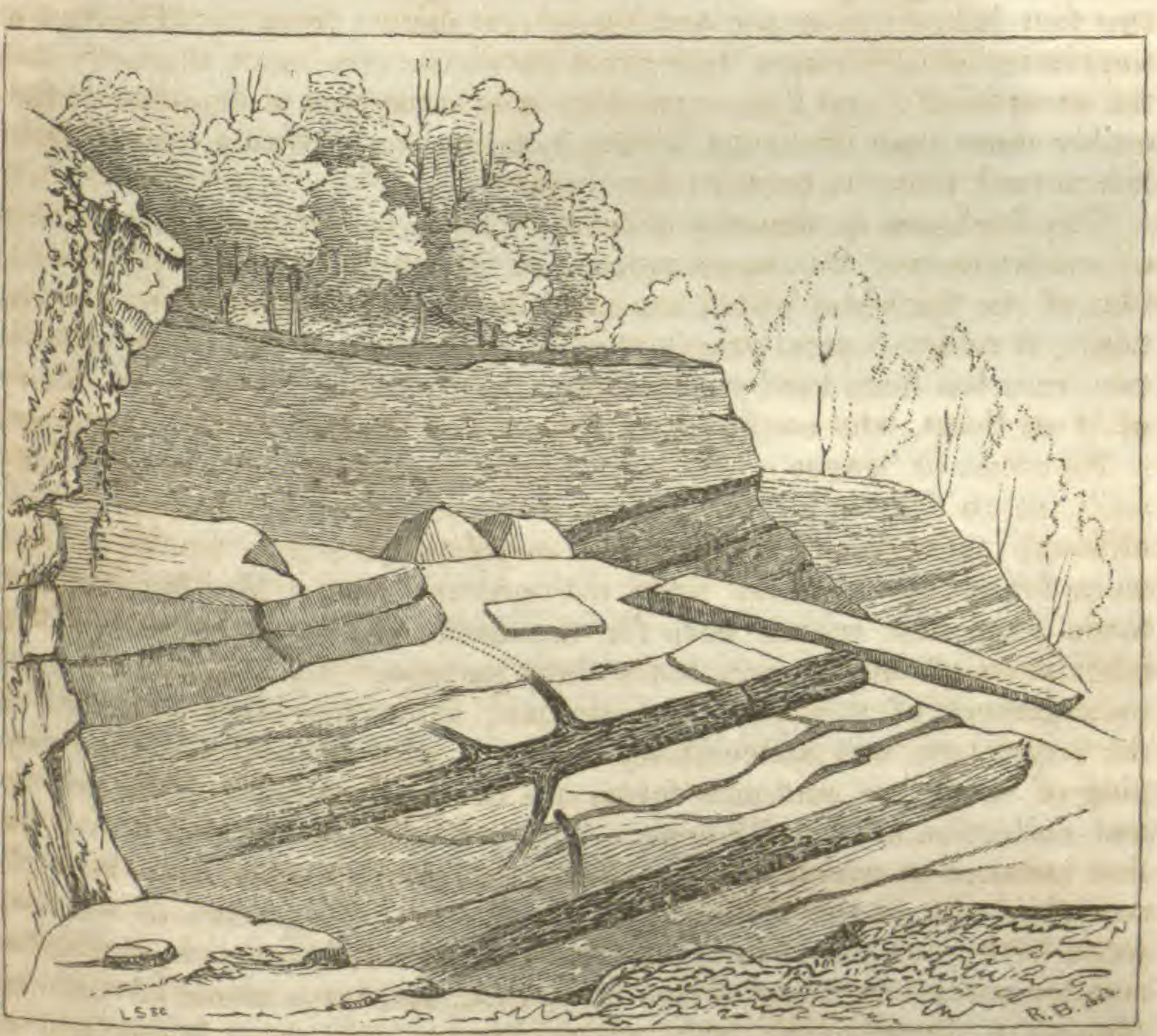
5. *Remarks on a Boulder Mass of Native Copper from the southern shore of Lake Superior;* by FORREST SHEPHERD, (communicated by request, to Prof. Silliman, for this Journal.)—The mass of native copper in my possession, was discovered on the southern shore of Lake Superior in July, 1845, by Tousant Piquette (an Indian of the Ojibwa tribe) in or near latitude 47° 5′ north, and longitude 88° 5′ west. It is composed almost entirely of pure native copper with spots of pure metallic silver upon its surface, together with a few water-worn pebbles of syenite, sandstone, &c., strongly imbedded and fastened in its cavities and sinuosities. Its length is about three feet and a half, its breadth two feet and a half, thickness from seven to eight inches, and its weight sixteen hundred and twenty-five pounds. As a specimen, its form and proportions could not well be better. One end is broader by a few inches than its opposite. One side discovers a slight natural rotundity and also a deep furrow cut obliquely into the solid metal, while the other side, nearly flat, appears much worn and polished in some places, whilst in other places it exhibits numerous grooves, scratches and broad longitudinal furrows, showing evidently that the mass has at some period been subject to great external violence. When found it was situated immediately upon the shore about three miles northeast of Elm river, not more than two or three feet above the water, and only about six feet from the broad side of the lake. It was standing on its smaller end, nearly in a perpendicular position, leaning slightly against a much larger boulder of sienite. The lower end was buried in the gravel of the shore about ten inches, and immediately underneath it were found pebbles and small boulders of porphyritic greenstone, syenite, sandstone, &c., and also an undecayed log of white cedar (arbor vitæ) on which it rested. Around it, both in the lake, and upon

the neighboring shore, and occupying a space of several acres, were seen in promiscuous assemblage, a multitude of boulders both large and small, composed chiefly of granite, syenite, greenstone, conglomerate, and red sandstone, apparently the companions of this extraordinary specimen. There is no stream of any magnitude or importance nearer than Elm river (three miles), which although called a river, is not more than twelve or fifteen feet in breadth. All along this coast and for many miles southward is a dense forest of large trees, such as white cedar, spruce, hemlock, pine, poplar, birch and maple; the growth of which, must have occupied four or five centuries.

The stratum of rock underneath this assemblage of boulders is red sandstone nearly horizontal, dipping northward into the lake at an angle of two or three degrees. About eight or ten miles southward is a ridge of stratified greenstone, generally called trap by explorers in this region. This ridge runs northeast and southwest nearly, and attains a height of five or six hundred feet. In this greenstone are numerous veins containing native copper with occasional spots of silver. These veins or lodes of copper, cut the above ridge at right angles and extend into a formation of conglomerate which reclines immediately upon the greenstone. Native copper is found also in the conglomerate. The red sandstone above mentioned reposes upon the conglomerate, so that there is a gradual descent from the summit of the greenstone ridge to the shore of the lake (a distance of eight or ten miles) where the copper boulder was discovered. From the adhesion of pebbles to the depressed and cavernous portions of this copper boulder, there is strong probability that it was derived from a vein in the conglomerate. But it could not have well been removed from the neighboring ridge, since the existence of the present forest; and it has evidently been deposited in the place where it was discovered, since the growth of the medium sized arbor vitæ on which it rested. The shore of the lake at this place is of moderate elevation varying from six to ten or twelve feet. The island of Isle Royal with its sandstone conglomerate, porphyry, and greenstone, is situated about fifty miles due north, and granite and syenite, similar to the boulders, accompanying the copper rock, exist in place on the northern shore of the lake, a distance of one hundred miles or upwards. No rocks of this description are known to exist nearer *in situ.*

6. *On Fossil Trees found at Bristol, Conn., in the New Red Sandstone.*—Two fossil trees have recently been discovered by the quarrymen who were excavating building stones in a sandstone quarry on the banks of the Pequabuck river in the town of Bristol, Connecticut. This town is on the western border of the greater secondary basin of Connecticut, and the locality where these fossil trees were found is not far from the junction of this deposit with the western primary ranges. The sandstone beds which crop out upon the banks of the Pequabuck, are fine grained, argillaceous and well adapted for many architectural purposes. No organic remains have before been observed in them, with the exception of a few ill characterized and obscure impressions of reed-like vegetation, upon the surface of a fissile stratum of argillaceous sandstone which is met with at a point about four feet above the bed containing the trees.

The writer's attention was called to these fossils by a letter from Mr. N. S. Manross of Bristol, (a member of the academical department of Yale College,) whose father owns the quarry where they were found. This gentleman had the consideration to preserve these interesting relics from destruction until they had been visited by the writer in company with R. Bakewell, Esq., to whom we are indebted for the accompanying sketch of the quarry with the two trees as they appeared, at the time of our visit.



It will be observed that the trunks are nearly parallel to each other in the plane of stratification of the beds, and nearly at right angles to the strike of the strata. Their buts point toward the river, while their heads are buried beneath the unopened sandstone. Several branches were to be traced from the principal trunk, one of which reached (in the dotted line) to the distance of eight or ten feet from the body and nearly at right angles with it. The bed in which these trunks were found is quite unlike the fine grained red deposits above and below them, being a rather coarse grained grey quartzose grit, sprinkled with mica and carbonaceous particles. It is very tender and friable when first exposed, and the trees which were imbedded in it were not properly petrified, but existed in the condition of soft lignite, in which the vegetable structure could be detected only on close observations. A rough exterior having the general appearance of the outer bark of the common yellow pine, was all the general character that could be observed. They were much flattened by the pressure of superincumbent rocks, not being over four inches thick in the thickest parts and thinning out to the edges. The greatest breadth of the trunk of the larger tree was about one foot, and it diminished from this very gradually for about fifteen feet, which is the extreme length to which they have been uncovered. The stem of the larger tree was divided transversely at nearly regular intervals of about fourteen inches by a cleft or notch, which corresponded to a similar ridge or prominence in the sandstone, both above and below. The two trees are not in the same plane, as may be seen in the sketch which correctly represents the smaller tree in the foreground as about two feet below the larger and three feet distant from it. The cast or impression of the larger tree gives its characters more distinctly than the stem itself: and this impression also measures in diameter considerably more than the trunk which it represents, showing that the latter has shrunk from its original dimensions.

The thickness of deposits over these trees is not more than six feet of sandstone and the same amount of diluvium; but this gives us no idea of the thickness which has undoubtedly been removed by denudation. A microscopical examination of specimens of the trunks of these two trees has been kindly undertaken by my friend, Prof. J. W. Bailey of West Point, who confirms the supposition that they were coniferous.

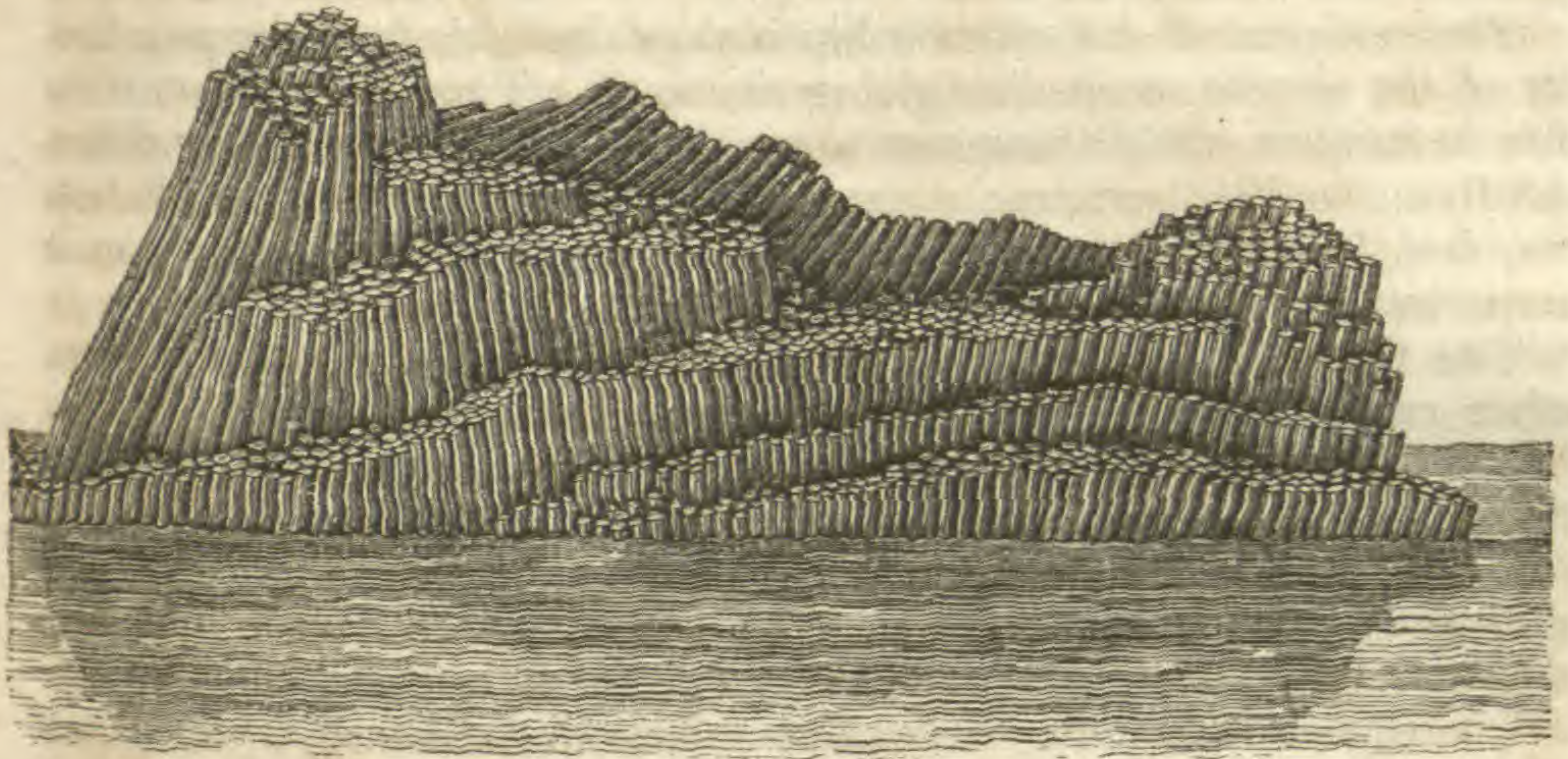
No cones or leaves could be detected in this locality, nor had any such, or in fact any other fossils, been obtained by the quarrymen, although there is a tradition that many years since, trunks of trees were found in a quarry near the present one. Mr. Manross has made particular search here for footmarks similar to those found in other parts of this deposit, but without success. By the zeal and good management of this young gentleman, about four feet in length of the larger tree was successfully removed with its corresponding capping of sandstone, and now forms one of the ornaments of the geological collection of Yale College. The writer supposes that this is the first instance in which the trunks of hard-wooded trees have been observed *in situ* in the Connecticut sandstone. Fragments of agatized wood have been found in Massachusetts by Prof. Hitchcock, and in the smaller secondary basin of Southbury, Ct., and large stems of reed-like plants are found in the beds which furnish the fish at Middlefield in the same state.

B. Silliman, Jr.

Yale College Laboratory, June 1, 1847.

7. *Observation on the Basaltic Formation on the northern shore of Lake Superior;* by T. R. Dutton, (communicated for this Journal.)—The display of igneous rocks on the north shore of Lake Superior is one of great interest to the geologist, both on account of the variety of the different formations, their relations to the adjacent slates, and the fact that some of them are the repositories of copper and silver.—Among these instructive rocks may be found, granite of a more recent date than the Devonian strata, sienite, porphyry, greenstone and trap, both compact, amygdaloidal and basaltic. It is of the last-mentioned formation that we now speak.

The numerous islands which occupy the most northern part of the lake are composed of trap and porphyry with underlying sandstone, and must be considered as one of the most important parts of the metalliferous region of the northern shore. On the southern shore of Simpson's Island and the southeastern of St. Ignace, the two largest of these islands, the trap presents the columnar form which is represented in the accompanying cut (drawn by Capt. Stannard) of a section forty feet long and twenty feet high.



The cliffs of this formation which extend for a distance of about three miles, are rarely more than sixty feet in height, and are composed of columns which are usually pentagonal or hexagonal in form, and which, though they are for the most part nearly perpendicular, are often inclined at different angles and sometimes bent. They are twenty or thirty feet long, and from six to eighteen inches in diameter; but they seldom present that distinctness in their columnar structure, and the transverse joints, which characterize the basalt of the Giant's Causeway.

III. Botany and Zoology.

1. *Notes on a Tour to Madeira, Teneriffe and Cape Verds, from the Journal of the Voyage of* Dr. J. R. T. Vogel *to the Niger*, (Lond. Jour. Bot., No. lxiii, March 1, 1847, p. 125.)—The Island of Madeira contains six hundred and seventy-two species of flowering plants and Ferns, of which eighty-five are absolutely peculiar, and four hundred and eighty common to Europe; two hundred and eighty are common to Madeira and the Azores (whose Flora is estimated at four hundred and twenty-five species); three hundred and twelve (or probably more) to Madeira and the Canaries; and one hundred and seventy to the neighborhood of Gibraltar (where four hundred and fifty-six have been collected).

It is remarkable that out of four hundred European (and these Mediterranean) species, indigenous to Madeira, not more than one hundred and seventy occur in Gibraltar; for it were natural to suppose that the majority of four hundred and eighty species which are very widely dispersed throughout the S. of Europe, should have migrated by way of Gibraltar, if transported across the ocean to Madeira. It is further worthy of observation, that the Azores, though very far to the westward, and the Canaries to the south, both contain many more of the Mediterranean plants seen in Madeira, than does Gibraltar.

A considerable number of the Madeira plants belong to genera not found in the adjacent continent, but in the Canaries, Azores, or Cape de Verd Islands; thus indicating a botanical affinity between these groups, and confined to them.

The evidence of this relationship is very decided, from the peculiarity of the genera or species giving rise to it. Though comparatively few in number, their characters are so prominent and so widely different from the Mediterranean plants which accompany them, that the latter, though numerically much the greatest, seem superadded, and, as it were, intruders on the former.

The Canaries and Madeira, from their central position and various other causes, are the centre of this botanical region, called by Mr. Webb the "Macronesian," and exhibit more peculiarity than the Cape de Verds, (as far as they are at present known,) or the Azores. There can be little doubt that Madeira was even more peculiar in its vegetation than now, previous to the destruction by fire of the luxuriant forests, which, according to historic evidence, clothed almost all the lower parts of the island. Not only would such a catastrophe destroy species, but their place would be afterwards occupied by strong-growing imported weeds, which would prevent the reappearance of the native plants by monopolizing the soil.

With very few exceptions, the Mediterranean are the only plants found in Madeira and the Canaries besides what are confined to those islands; in the Azores, on the other hand, some Northern European species are associated with them. In the Cape de Verds, far to the south, W. African and W. Indian plants replace those of the Mediterranean.

The Island of Madeira participates in the flora of the W. Indies to a much greater degree than does any part of the adjacent continent:—that this is in a great measure due to the dampness of its insular climate, is clear, from the plants in question being almost entirely Ferns, viz.:—Acrostichum squamosum, *Sw.* Aspidium molle, *Sw.* Asplenium monanthemum, *Sw.* Asplenium furcatum, *Sw.* Trichomanes radicans, *Sw.*, species found no where on the continent of Europe, nor in N. Africa. The presence of a plant belonging to the otherwise exclusively American genus, *Clethra*, is striking, because indicating a further relationship with the Flora of the New World, but of a very different character from the above.

The *Helichrysa* of Madeira are allied in rather a remarkable degree to the S. African species of that genus; a fact which reminds us that the *Myrsine Africana*, a Cape of Good Hope plant, is a native of the Azores, but of no intervening latitude on the West coast of Africa or the Atlantic Islands, or indeed any where else but Abyssinia. Though not a subject falling immediately within the province of the pure botanist, it may not be amiss here to state, that the four Island-groups in question have been conceived by my friend, Professor Forbes, to be the remains of one continuous and extended tract of land, which formed the western prolongation of the European and African shores. He points to the identity of species between these islands and Europe, as affording botanical evidence of this ingenious theory, which, however, he chiefly rests on geological grounds. Regarded in this light, the question will resolve itself, in the opinion of most botanists, into one, concerning the power of migration, and the probability of migration having taken place, to a very great extent, over the Atlantic Ocean, and against the prevailing direction of the winds. It may be contended that such a migration would have peopled these islands solely, or mainly, with certain of the more transportable classes of plants; and that the result must be, that the number of species belonging to each natural order would be great in proportion to the facility with which they bear transportation; while only those orders could be numerous, which possess that faculty in an eminent degree. But such are not the characteristics of the Mediterranean plants found in Madeira.

On the other hand, the existence of such a continent, during the period when these islands bore the plants which they now produce, would argue the former presence of a very large Flora belonging to the type which now distinguishes the islands in question from the Mediterranean, and of whose previous existence the remaining species, peculiar to them, are the indication. Against this theory it might be urged, that more specific identity between the plants of the several insular groups than now is seen, would then be the natural consequence; for the affinity of vegetation between the different islands consists, not in identical species, but in representatives. The same agent, in short, which effected the peopling of the several groups with the plants of continental Europe, would also have distributed more equally the non-European species over the same area.

It is, however, to the lofty peaks of Atlas that we must look, if any where, for the continental representatives of those peculiar plants which mark the North Atlantic Insular Floras. Thus, we expect to find the productions of the Galapagos Archipelago on the higher levels of the Cordillera; and the mountains of St. Thomas, Fernando Po and the Cameroons, on the west coast of tropical Africa, may yet exhibit to us the botanical features of St. Helena. Outlying and high islands commonly partake in the peculiar vegetation of a climate cooler than belongs to the low lands of the adjacent continent; though, in the case of Juan Fernandez, they sometimes exhibit genera equally isolated in botanical affinities as their habitats are in geographical position.

Teneriffe.—The next point visited by the Niger Expedition, after leaving Madeira, was the Island of Teneriffe, where the vessel in which Vogel had embarked remained but a few hours. The same island, and the same port, Santa Cruz, had been touched at by the Antarctic Expedition during the previous winter. Teneriffe is always held to be classic ground by the naturalist, as the opening scene of the labors of Humboldt, who there first appreciated in their full extent the laws governing the geographical distribution of plants. His lifelike pictures of the natural phenomena, observed during an ascent of the famous peak, have given an impulse to many succeeding scientific travellers, which has turned their thoughts and steps from closet studies and the pursuit of natural history at home, to seek far distant scenes, in the West, the East and the South.

The Peak itself is seldom descried: one hurried glimpse of its very apex, from upwards of sixty miles distance, was all we obtained: it then appeared like a little short and broad cone high in the clouds, or rather, as an opaque triangular spot on the firmament. It is difficult to imagine this, the culminant point, to be that mighty mass, at whose base the toil-worn traveller pauses; when, having surmounted four-fifths of the mountain, his heart quails at beholding a "Pelion upon Ossa piled" so sternly, so stony and so steep.

Much and deeply did the officers of Captain Ross and Trotter's Expeditions deplore the necessity of hurrying from this spot, so interesting to the sailor, it being the point to which every circumnavigator first steers, and from whence, with chronometers carefully corrected at its well-determined position, he takes his departure. For years, too, this was the prime meridian; distance in longitude at sea being reckoned from Teneriffe as zero, by all the seafaring nations of Europe at one period: and by some it is so still. From the days of the earliest circumnavigators, to the present, "we sighted the Peak of Teneriffe" marks that page in the narrative, at which all that is interesting in the voyage commences.

In the history of geology, the Canary Islands hold a conspicuous position: von Buch developed his theory of craters of elevation from what he there observed: his name too recalls, and most appropriately, that of his fellow-laborer in the same shores, Christian Smith, the amiable and gifted Swede, who first after Humboldt, explored their botany. Christian Smith returned to Europe to embark in the ill-fated Congo Expedition: when he again saw the Peak of Teneriffe, he welcomed it as a familiar object, and bade it adieu, rejoicing that a still more novel field of inquiry was opened to him, beyond this scene of his early exertions. A few short months terminated his life and hopes: like Vogel, he fell a victim to the dreaded fever of the pestilential coast of Africa: like him, too, he was a martyr in the cause of botanical science.

Possessed of so many and such touching associations, no naturalist-voyager can see the Fortunate Isles rising, one by one, on the horizon of the mighty Atlantic, without some feeling of melancholy, while reflecting on the fate of these his two predecessors, both most accomplished naturalists of their age and day; and whose prospects and hopes were in every respect as bright, perhaps brighter, than his own.

The excellent and beautiful work of Mr. Webb, on the Natural History of the Canaries, leaves little to be said, especially of their botany; and renders even an enumeration of the few species gathered by Vogel and the Botanist of the Antarctic Expedition unnecessary; for they were all collected within a few miles of Santa Cruz, during a very hurried walk, and scarcely include a dozen kinds. This locality is one of the most barren of the whole group, especially in the immediate neighborhood of the sea. The broad frontage of cliff and mountain, reaching upwards for several thousand feet above the town, and fore-shortened to the view from seaward, presents a progressive increase of verdure from the water's edge to the mountains. At this season, when the vines are out of leaf, nothing green meets the eye; the trees, either isolated or in very small clumps, only dot the alternate ridges and steep gullies with which the slopes are everywhere cut like the edge of a saw, producing that spotty effect in the landscape so admirably transferred to the phytographical illustrations of the work alluded to, and which is eminently characteristic both of the Canaries and Madeira.

The *Kleinia*, *Euphorbia* and *Plocama* are three plants which the voyager recognizes long before reaching the shore; and they are so singular, whether as regards habit, habitat, or botanical characters, that the opportunity of seeing them in a wild state, even from the sea, must be deemed a privilege by the botanist.

Cape de Verd Islands.—The voyage, from the Canaries to the Cape de Verd Islands, generally presents a hiatus in the journals of those sea-faring naturalists who have followed this route. Before arriving at the Canaries, landsmen have scarcely recovered from the novelty of ship-board and its effects; nor has there been time, since leaving these islands, to become thoroughly inured to the monotony of a sailing life. At first sight, the Cape de Verd Islands are very disappointing. It is true that we had passed from an extra-tropical latitude to far within the tropics; but the change in position was not accompanied with a corresponding difference, still less with luxuriance, in the vegetation and scenery. Yet these apparently barren islands have associations of great interest; and their examination yields both pleasure and profit. They afford us the first glimpses of the fever-smitten coast of Africa, and of slavery. Even the black man here, deprived of freedom, and an alien to the land in which, though guiltless, he is a prisoner for life, is apt to be regarded as a mere object of natural history by his Caucasian fellow-creature; who, before he has time for reflection, may perhaps be excused for pausing to consider, whether a being so different in features and social position, be really of the same origin as himself; whether, in short, the poor African is a race of the same stock, or a species apart.

There are many other circumstances, connected with these islands, calculated to keep the mind busy while in their neighborhood. They form the western extreme of the Old World, of what was the whole world to civilized man, till within the last very few hundred years; and hence these, the North Cape and Cape of Good Hope, constitute the three salient points in the geography of the eastern Atlantic. In many of their physical features, they form a continuation of the great Sahara desert; that mysterious blank on our maps, upon whose sea of sand so many of our venturesome countrymen have embarked, to be heard of no more. The hitherto unexplored mountains rise eight thousand feet and upwards above the sea, in serried ridges and isolated peaks, promising a rich harvest to some botanist, who may in these higher and cooler parts of the islands rely on immunity from disease and on a temperate climate. There he may expect to find new types of plants; for the Mountain Flora of Western Tropical Africa is wholly unknown; and of its probable nature even we can form no guess. To conclude, the Linnæan axiom of "semper aliquid novi ex Africa" has never yet proved false. A naturalist cannot see the shores of that continent without feeling that no other spur is required to exertion, in a field to which such a motto still applies with so much force.

2. *On the fundamental type and homologies of the Vertebrate Skeleton;* by Prof. Owen, (from the Literary Gazette; Ann. Mag. Nat. Hist., xix, 202, March, 1847.)—The Professor commenced by alluding

to the origin of anatomy in the investigation of the human structure, in relation to the relief and cure of disease and injuries; and to the consequent creation of an anatomical nomenclature, having reference solely to the forms, proportions, likenesses and supposed functions of the parts of the human body; which were originally studied from an insulated point of view, and irrespective of any other animal structure or any common type. So, likewise, the veterinary surgeon had begun the study of the anatomy of the horse in an equally independent manner, and had given as arbitrary names to the parts which he observed. Thus, in the head of a horse there was the "os quadratum;" and in the foot the "cannon-bone," the "great" and "small pastern-bones," the "coronet," and "coffin-bones," &c. When the naturalist first sought to penetrate beneath the superficial characters of the objects of his study, their anatomy had often been conducted in the same insulated and irrelative way. The ornithotomist, or dissector of birds, describes his "ossa homoidea," "ossa communicantia" seu "interarticularia," his "columella," his "os furcatorium" and "os quadratum," the latter being quite a distinct bone from the "os quadratum" of the hippotomist. The anatomizer of reptiles described "hatchet-bones" and "chevron-bones," an "os cinguliforme" or "os en ceinture," and an "os transversum;" he had also his "columella," but which was a bone distinct from that so called in the bird. The icthyotomist described the "os discoideum," "os transversum," "os cœnosteon," "os mystaceum," "ossa simplectica," "prima," "secunda," "tertia," "quarta," &c. Each at first viewed his subject independently and irrelatively; and finding, therefore, apparently new organs, created a new and arbitrary nomenclature for them.

After pointing out the impediments to a philosophical knowledge of anatomy, from such disconnected attempts to master its complexities, and the almost impossibility of retaining in the memory such an enormous load of names, many distinct ones signifying the same essential part, whilst different parts had received the same name, Prof. Owen proceeded to demonstrate the principal results of the philosophical researches of Cuvier, and other comparative anatomists, in tracing the same or homologous parts through the animal series, as they were exemplified in the osseous system, and principally in the bones of the head. When any bones in the human skull, for example, had been thus traced and determined in the skulls of the lower vertebrate animals, the same name was applied to it there as it bore in human anatomy, but understood in an arbitrary sense; and when the part had no name in human anatomy, but was indicated, as often happened, by a descriptive phrase, it received a name having a close relation to such phrase; and thus a uniform nomenclature had arisen out of the investigation of the homologies of the bones of the skeleton, applicable alike to the human subject, the quadruped, the bird, and the fish. The corresponding parts have been sometimes called *analogues*, and sometimes *homologues*; the latter being the appropriate term, since the parts are in fact namesakes. The essential difference between the relations of *analogy* and *homology* was illustrated by reference to a diagram of the skeletons of the ancient and modern flying dragons. The wings of the extinct pterodactyle were sustained by a modification of the bones of the fore-arm or pectoral limb, which bones were long and slender, like those of the bat; and one of the fingers, answering to our little finger, was enormously elongated. The wings of the little *Draco volans*, the species which now flits about the trees of the Indian tropics, were supported by its ribs, which were liberated from an attachment to a sternum, and were much elongated and attenuated for that purpose. The wing of the pterodactyle was *analogous* to the wing of the Draco, inasmuch as it had a similar relation of subserviency to flight; but it was not *homologous* with it, inasmuch as it was composed of distinct parts. The true homologue of the wing of the pterodactyle was the foreleg of the little *Draco volans.*

The recognition of the same part in different species, Prof. Owen called the "determination of a special homology;" the recognition of its relation to a primary segment of the typical skeleton of the vertebrata, he called the "determination of its general homology." Before entering upon the higher generalization involved in the consideration of the common or fundamental type, Prof. Owen gave many illustrations of the extent to which the determination of special homologies had been carried, dwelling upon those which explained the nature and signification of the separate points of ossification at which some of the single cranial bones in anthropotomy began to be formed; as in the so-called "occipital," "sphenoid," and "temporal" bones. More than ninety per cent. of the bones in the human skeleton had had their namesakes or homologues recognized by common consent in the skeletons of all vertebrate animals; and Prof. Owen believed the differences of opinion on the small residuum, capable with one or two exceptions, of satisfactory adjustment. The question then naturally arose in the philosophical mind, upon what cause or condition does the existence of these relations of *special homology* depend? Upon this point the anatomical world was divided. The majority of existing authors on comparative anatomy appeared either to have tacitly abandoned, or, with Cuvier and Agassiz had directly opposed, the idea of the law of special homologies being included in a higher and more general law of uniformity of type, such as has been illustrated by the theory of the cranium consisting of a series of false or anchylosed vertebræ. Profs. de Blainville and Grant, however, teach the vertebral theory of the skull; the one adopting the four vertebræ of Bojanus and the gifted propounder of the theory, Oken; the other regarding the hypothesis of Geoffroy St. Hilaire of the cranial vertebræ as more conformable to nature. Prof. Carus of Dresden has beautifully illustrated the poet Goethe's idea of the skull being composed of six vertebræ. But these authors had left the objections of Cuvier and Agassiz unrebutted; and judging from the recent works of Profs. Wagner, Müller, Stannius, Hallmann, and others of the modern German school, and those of Milne Edwards, the doctrine of unity of organization, as illustrated by the vertebral theory of the skull, seemed to be on the decline on the continent. To account for the law of special homologies on the hypothesis of the subserviency of the parts so determined to similar ends in different animals—to say that the same bones occur in them because they have to perform similar functions—involve many difficulties, and are opposed by numerous phenomena. Admitting that the multiplied points of ossification in the skull of the human fœtus facilitate, and were designed to facilitate, child-birth, yet something more than a final purpose lies beneath the fact, that all these points represent permanently distinct bones in the cold-blooded vertebrata. And again, the cranium of the bird, which is composed in the adult of a single bone, is ossified from the same number of points as the human embryo, without any possibility of a similar final purpose being subserved thereby. Moreover, in the bird, as in the human subject, the different points of ossification have the same relative position and plan of arrangement as in the skull of the young crocodile; in which animal they always, maintain, as in most fishes, their primitive distinctness. A few errors, some exaggerated transcendentalisms and metaphorical expressions of the earlier German homologists, and a too obvious tendency to *à-priori* assumptions and neglect of rigorous induction on the part of Geoffroy St. Hilaire, had afforded Cuvier apt subjects for the terse sarcasm and polished satire which he directed against the school of "Unity of Organization." The tone also which the discussions gradually assumed towards the latter period of the career of the two celebrated anatomists of the French Academy, seems to have led to a prejudice in the mind of Cuvier against the entire theory and transcendental views generally; and he finally withdrew, in the second edition of his 'Leçons d'Anatomie Comparée,' that small degree of countenance to the vertebral theory of the skull which he had given by the admission of the three successive bony cinctures of the cranial cavity in the 'Régne Animal.'

Prof. Owen then briefly alluded to the researches which he had undertaken, with a view to obtain conviction as to the existence or otherwise of one determinate plan or type of the skeletons of the vertebrata generally; and stated, that after many years' consideration given to the subject, he had convinced himself of the accuracy of the idea that the endo-skeleton of all vertebrate animals was arranged in a series of segments, succeeding each other in the direction of the axis of the body. For these segments or "osteocommata" of the endo-skeleton, he thought the term "vertebræ" might well be retained, although used in a somewhat wider sense than it is understood by a human anatomist. The parts of a typical vertebra were then defined, according to the views explained in the Professor's 'Lectures on Vertebrata;' and he proceeded to apply its characters to the four segments into which the cranial bones were naturally resolvable. The views of the lecturer were illustrated by diagrams of the disarticulated skulls of a fish, a bird, a marsupial quadruped, and the human fœtus. The common type was most closely adhered to in the fish, as belonging to that lower class of vertebrata in which "vegetative repetition"* most prevailed, and the type was least obscured by modifications and combinations of parts for mutual subservience to special functions. The bones of the skull were arranged into four segments or vertebræ, answering to the four primary divisions of the brain, and to the nerves

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* The general principle of animal organizations, which Prof. Owen has termed "the law of vegetative or irrelative repetition," is explained in the first volume of his 'Hunterian Lectures,—on the Invertebrate Animals.'

transmitted to the four organs of special sense seated in the head. Prof. Owen adopted the names which had been assigned to these vertebræ from the bones constituting their neural spines, viz., occipital, parietal, frontal, and nasal; and enumerated them from behind forwards, because, like the vertebræ of the tail, they lose their typical character as they recede from the common centre or trunk. The general results of the Professor's analysis may be thrown into the following tabular form :—

Primary Segments of the Skull-bones of the Endo-skeleton.

VERTEBRÆ.	OCCIPITAL.	PARIETAL.	FRONTAL.	NASAL.
Centrums.	Basioccipital.	Basisphenoid.	Presphenoid.	Vomer.
Neurapophyses.	Exoccipital.	Alisphenoid.	Orbitosphenoid.	Prefrontals.
Neural Spines.	Supraoccipital.	Parietal.	Frontal.	Nasal.
Parapophyses.	Paroccipital.	Mastoid.	Postfrontal.	None.
Pleurapophyses.	Scapula	Stylohyal.	Tympanic.	Palatal.
Hæmapophyses.	Coracoid.	Ceratohyal.	Articular.	Maxillary.
Hæmal Spines.	Episternum.	Basihyal.	Dentary.	Premaxillary.
Diverging appendage.	Fore-limb or fin.	Branchiostegals.	Operculum.	Pterygoids &Zygoma.

The upper or neural arch of the occipital vertebra protected the *epencephalon*, or medulla oblongata and cerebellum; that of the parietal vertebra protected the *mesencephalon*, or third ventricle, optic lobes, conarium and hypophysis; that of the frontal vertebra the *prosencephalon*, or cerebral hemispheres; that of the nasal vertebra the *rhinencephalon*, or olfactory crura and ganglions.

The superior development of the cerebral hemispheres in the warm-blooded class, and their enormous expansion in them, occasions corresponding development of the neural spines, not only of their proper vertebra, but, by their backward folding over the other primary segments, of those of all the other vertebræ; whilst the more important parts of the neural arch, as the neurapophyses, undergo comparatively little change.

The acoustic nerve escapes between the occipital and parietal vertebræ, but the organ itself is intercalated between the neural arches of these segments and its ossified capsule; the petrosal projects into the cranial cavity between the exoccipital and alisphenoid in the warm-blooded vertebrata. The gustatory nerve (part of the third division of the fifth pair) perforates or notches the alisphenoid, and in crocodiles and many fishes passes through an intervertebral foramen between the alisphenoid and orbitosphenoid; but the gustatory organ is far removed from the neural arches or cranium proper, and is united with its fellow to form the apparently single organ called the tongue. The optic nerve perforates or grooves the orbitosphenoid, and the eyeball intervenes between the frontal and nasal vertebræ, as the earball does between the occipital and parietal: the vertebral elements are modified to form cavities for these organs of sense; that lodging the eye being called the "orbit," that for the ear the "otocrane."

The divergence of the olfactory crura, and the absence of any union or commissure between the olfactory ganglia, leads to an extension of ossification from their neurapophyses, which are always perforated by the olfactory crura or nerves, to the median line between those parts; and the neurapophyses themselves coalesce together there in batrachia, birds, and mammals. This extreme modification was to be expected in a vertebra forming the anterior extremity of the series; and the typical condition of the prefrontals, so well shown in fishes and saurians, is marked in mammals by the enormous development of the capsules of the organ of smell anterior to them, which become ossified and partially anchylosed to the compressed, shrunken and coalesced prefrontals; the whole forming the composite bone called "æthmoid" in anthropotomy. The vomer, or body of the nasal vertebra, has undergone an analogous modification to that which the terminal vertebra of the tail presents in birds; whence its special name, referring to the likeness to a ploughshare, in human anatomy. The spine, or nasal bone, is sometimes single, sometimes divided, like the frontal, the parietal and the supraoccipital bones. Their special adaptive modifications have obtained for them special names.

The hæmal arches corresponding with the above neural arches retain most of their natural position and proportions, as might be expected, in fishes; they are called the scapular, hyoid, mandibular, and maxillary arches. The pleurapophysis of the occipital vertebra is the scapula, and is commonly attached by a head and tubercle to the centrum and parapophysis of its proper occipital vertebra.

The hyoid arch is suspended by the medium of the epitympanic to the mastoid parapophysis of the parietal vertebra, the epitympanic, in fishes, intervening and separating the hæmal arch from its proper vertebra, just as the squamosal intervenes to detach the tympanic pleurapophysis of the mandibular arch from its proper vertebra in mammals; which vertebra the squamosal attains in man by articulating with the process representing the coalesced postfrontal. In return, we find the hyoidean arch resuming its normal connexions in many mammalia, the stylo-hyal element being directly articulated to the mastoid: in man the large petrosal capsule intervenes, and contracts that anchylosis with the proximal or pleurapophysial element of the hyoid arch, which has led to the description of the stylohyal as a process of the temporal bone, in works on human anatomy.

In fishes, the tympanic, which is the true pleurapophysis of the mandibular arch, always articulates with the postfrontal, besides its accessory joint with the mastoid. The maxillary arch is articulated by its pleurapophysis, the palatine bone, with the centrum and neurapophysis (vomer and prefrontal) of the nasal vertebra. This is the normal and constant point of suspension of the maxillary arch; other accessory attachments to ensure its fixation and strength are successively superinduced upon this primary and essential one. Through this knowledge of the general homology of the palatine, an insight was gained into its singular disposition in man, creeping up, as it were, into the orbit, to touch the pars plana of the æthmoid; this secret affinity with the modified neurapophysis of the nasal vertebra becomes intelligible by a recognition of its relations to the general type of the vertebrate skeleton, by its determination as the rib or pleurapophysis of the nasal vertebra, and therefore retaining, as such, more or less of its essential connexion with the centrum (vomer) and neurapophyses (æthmoid or prefrontal) of the nasal vertebra throughout the vertebrate series.

The tympano-mandibular and the hyoidean arches had both been recognized as resembling ribs. A like homology of the scapula had early been detected by Oken; but its relation to the skull or occiput had been masked, and had escaped previous notice, by its displacement from its natural or typical connexions in all the air-breathing vertebrata.

The enunciation of these correspondences has sometimes been received by anatomists conversant with one particular modification of the general type, with as little favor as those of the "cannon-bone" to the metacarpus, of the "great and small pastern" and the "coffin-bones" to the digital phalanges of the human hand, may be supposed to have been by the earlier veterinarians.

Prof. Owen adduced instances of the displacement of different vertebral elements to subserve special exigencies, as that of the neurapophyses in the bird's sacrum, and that of the ribs of the human thorax, in which there could be, and had been, no question as to the reference of such displaced parts severally to their proper vertebral segments. The displacement of the scapular arch from the occiput was a modification of precisely the same kind, and differed only in degree. In the crocodile every cervical as well as every dorsal vertebra had its ribs; and in the immature animal the same elements existed, as distinct parts, in the lumbar, sacral, and in several caudal vertebræ. The occipital vertebra would be represented only by its "centrum" and "neural arch," unless the loose and obviously displaced scapulo-coracoid arch were recognized as its pleurapophysial and hæmapophysial elements. This arch made its first appearance in every vertebrate embryo close to the occiput; and in fishes—the representatives of the embryo-state of higher vertebrata, where the principle of vegetative repetition most prevailed, and the primitive type was least obscured by teleological or adaptive modifications—the scapular arch retained its true and typical connexions with the occiput.

The general homology of the locomotive members as developments of the diverging appendages of the inferior vertebral arches, was illustrated, and the parallelism in the course of the modifications of all such appendages pointed out. As the scapular arch belongs to the skull, so its appendages, the pectoral or anterior members, were essentially parts of the same division of the skeleton segments.

As a corollary to the generalization that the vertebrate skeleton consisted of a series of essentially similar segments, was the power of tracing the corresponding parts from segment to segment in the same skeleton. The study of such "serial homologies" had been commenced by the unfortunate Vicq. d'Azyr, in his memoir "on the parallelism of the fore and hind extremities;" and similar relations could be traced through the more important elements of the series of vertebræ. Prof. Owen believed it to be an appreciation of some of these homologies that lay at the bottom of the epithets, "scapula of the head," "ilium of the head," "femur of the head," &c., applied to certain cranial bones by Oken and Spix. To Cuvier this language had seemed unintelligible jargon; yet the error consisted merely in assigning a special instead of a general name to express the serial homology rightly discerned, in some of the instances, by the acute German anatomists.

"Scapula," "ilium," "rib," &c., were names indicative of particular modifications of one and the same vertebral element. Such element, understood and spoken of in a general sense, ought to have a general name. Had Oken stated that the tympanic bone of the bird, for example, was a "pleurapophysis" (or by any other equivalent term) of the head, his language would not only have been accurate, but intelligible, perhaps, to Cuvier. When Oken called it the "scapula of the head," he then unduly extended such special name, and transferred it to a particularly and differently modified pleurapophysis, which equally required to have its own specific name.

Professor Owen dwelt on the necessity of having clearly-defined terms for distinct ideas, in order to ensure the progress of science; and alluded to the advancement of human anatomy by accurate determinations of the general type, of which man's frame was a modification.

3. *On the Minhocâo of the Goyanes;* by M. AUGUSTE DE SAINT HILAIRE, (Comptes Rendus, Dec. 28, 1846; Ann. Mag. Nat. Hist., xix, 140.)—Luiz Antonio da Silva e Souza, whose acquaintance I made during my travels, and to whom we owe the most valuable researches on the history and statistics of Goyaz, says, in speaking of the lake of Padre Aranda, situated in this vast province, that it is inhabited by minhocôes; then he adds that these monsters—it is thus he expresses himself—dwell in the deepest parts of the lake, and have often drawn horses and horned cattle under the water. The industrious Pizarro, who is so well acquainted with all that relates to Brazil, mentions nearly the same thing, and points out the lake Feia, which is likewise situated in Goyaz, as also being inhabited by minhocôes.

I had already heard of these animals several times, and I considered them as fabulous, when the disappearance of horses, mules and cattle, in fording the rivers, was certified by so many persons, that it became impossible for me altogether to doubt it.

When I was at the Rio dos Pilôes, I also heard much of the minhocôes; I was told that there were some in this river, and that at the period when the waters had risen, they had often dragged in horses and mules whilst swimming across the river.

The word *minhocâo* is an augmentative of *minhoca*, which in Portuguese signifies *earth-worm;* and indeed they state that the monster in question absolutely resembles these worms, with this difference, that it has a visible mouth; they also add, that it is black, short, and of enormous size; that it does not rise to the surface of the water, but that it causes animals to disappear by seizing them by the belly.

When, about twenty days after, having left the village and the river of Pilôes, I was staying with the Governor of Meiapont, M. Joaquim Alvez de Oliveira, I asked him about these minhocôes: he confirmed what I had already been told, mentioned several recent accidents caused by these animals, and assured me at the same time, from the report of several fishermen, that the minhocâo, notwithstanding its very round form, was a true fish provided with fins.

I at first thought that the minhocâo might be the *Gymnotus carapa*, which according to Pohl is found in the Rio Vermelho, which is near to the Rio dos Pilôes; but it appears from the Austrian writer that this species of fish bears the name of *Terma termi* in the country; and moreover the effects produced by the Gymnoti are, according to Pohl, well known to the mulattos and negroes who often felt them, and have nothing in common with what is related of the minhocâo. Professor Gervais, to whom I mentioned my doubts, directed my attention to the description which P. L. Bischoff has given of the *Lepidosiren;* and indeed the little we know of the minhocâo agrees well enough with what is said of the rare and singular animal discovered by M. Natterer.

That naturalist found his *Lepidosiren* in some stagnant waters near the Rio da Madeira and of the Amazon: the minhocâo is not only said to be in rivers, but also in lakes. It is, without doubt, very far from the lake Feia to the two localities mentioned by the Austrian traveller; but we know that the heats are excessive at Goyaz. *La Serra da Paranahyba e do Tocantim*, which crosses this province, is one of the most remarkable dividers of the gigantic water-courses of the north of Brazil from those of the south; the Rio dos Pilôes belongs to the former, as does the Rio da Madeira. The *Lepidosiren paradoxa* of M. Natterer has actually the form of a worm, like the minhocâo. Both have fins; but it is not astonishing that they have not always been recognized in the minhocâo, if, as in the *Lepidosiren*, they are in the animal of the Rio dos Pilôes reduced to simple rudiments. "The teeth of the *Lepidosiren*," says Bischoff, "are well-fitted for seizing and tearing its prey; and to judge of them from their structure and from the muscles of their jaw, they must move with considerable force." These characters agree extremely well with those which we must of necessity admit in the minhocâo, since it seizes very powerfully upon large animals and drags them away to devour them. It is therefore probable that the minhocâo is an enormous species of *Lepidosiren;* and we might, if this conjecture were changed into certainty, join this name to that of the minhocâo to designate the animal of the lake Feia and of the Rio dos Pilôes. Zoologists who travel over these distant countries will do well to sojourn on the borders of the lake Feia, of the lake Padre Aranda, or of the Rio dos Pilôes, in order to ascertain the perfect truth—to learn precisely what the minhocâo is; or whether, notwithstanding the testimony of so many persons, even of the most enlightened men, its existence should be, which is not very likely, rejected as fabulous.

4. *Ear of the Limnæus stagnalis*, (Weigm. Archiv.; L'Institut, March 10, 1847.)—According to observations by M. Frey, the auricular vesicle is visible in the Limnæus stagnalis soon after the rotary movements of the embryo have ceased and the animal has commenced to become coiled in the interior of its shell. There may then be easily observed in the interior part of the body, the rudiments of tentacles, the eyes with their pigment, and the tongue with its characteristic epithelium; and on each side of the base of the tongue, the auditive vesicles may be distinguished. These vesicles are spherical, with a simple contour, and have a diameter of $\frac{1}{60}$ to $\frac{1}{56}$ of a line (French). They appear at first to contain in the interior only a transparent liquid, and are then, like the eyes, without any connection with the central parts of the nervous system. But soon one or two small corpuscles are formed in the liquid interior, whose form, size, and oscillatory move-

ments are wholly similar to those of the otolites pertaining to the ears in the perfect animal. The size of these otolites varies from $\frac{1}{450}$ to $\frac{1}{300}$ of a line. The number increases gradually to twenty, when the animal quits its shell, and at this time the diameter of the vesicle is $\frac{1}{40}$ of a line. They continue multiplying, and are one to two hundred in number in the adult, when the vesicle is $\frac{1}{16}$ to $\frac{1}{10}$ of a line in diameter. The development of the hearing apparatus is the same essentially in the Physa, Paludina, and other terrestrial Gasteropods. In bivalves, the vesicle contains only one otolite of large size, which fills the cavity of the vesicle.

IV. ASTRONOMY.

1. *The Planet Neptune, and its Relations to the Perturbations of Uranus.*—In the Boston Courier of April 30, 1847, Prof. BENJAMIN PEIRCE, of Harvard University, announces the following conclusions:

"The problem of the perturbations of Uranus admits of three solutions, which are decidedly different from each other, and from those of LeVerrier and Adams, and equally complete with theirs. The present place of the theoretical planet, which might have caused the observed irregularities in the motions of Uranus, would, in two of them, be about one hundred and twenty degrees from that of Neptune, the one being behind and the other before this planet. If the above geometers had fallen upon either of these solutions, instead of that which was obtained, Neptune would not have been discovered in consequence of geometrical prediction. The following are the approximate elements for the three solutions at the epoch of Jan. 1, 1847 :—

	I.	II.	III.
Mean longitude, - -	319°	79°	199°
Long. of perihelion, - -	148	219	188
Eccentricity, - -	0·12	0·07	0·16

In each of them (the mass of the sun being unity) the mass is 0·0001187. The period of sidereal revolution is double that of Uranus. It will be observed that the mean distance in all these cases is the same with that of Neptune, and that in the first of them, the present direction is not more than seven degrees from it; and in another solution which I have obtained, the present direction is almost identical with Neptune's. But the coincidence fails in a most important point; for, whereas Walker and Adams both demonstrate, from incontrovertible data, and a simple but indisputable argument, that the new planet cannot be more than 90° from its perihelion, either of these two latter geometrical planets would now be in aphelion and at much too great a distance from the sun.

"All my attempts to reconcile the observed motions of Neptune with the assumption that it is the principal source of the unexplained irregularities in the motions of Uranus, have been frustrated. Whatever orbit is attributed to this planet in my analysis, whether Walker's, or Valz's, or Encke's, or Adams's, or any other which I can suppose, and which is not unquestionably irreconcilable with observation; and whatever may be supposed to be its mass, I cannot materially diminish the amount of residual perturbation, but leave it full as great as it was previous to Galle's discovery. Notwithstanding my repeated examinations, it would be presumptuous in me to claim for my investigations a freedom from error which the greatest geometers have not escaped, especially in the face of the vastly improbable conclusion to which my analysis tends, viz. that the influence of the new planet is wholly different from that demanded by the problem whose solution led to its discovery. It may however be asked whether the attraction of Uranus might not be exhibited in the motions of Neptune, in such a way as to modify the orbit deduced from observation, and thus to reconcile it with theory; but this question cannot be answered without further investigation."

Mr. Walker's important discovery of the identity of Neptune with a star observed by Lalande, May 10, 1795, (Vol. iii, ii Ser., p. 441,) seems now amply confirmed. An examination of the original observations of Lalande, shows that he also observed the body two days previous, but as the two observations disagreed, the earlier was rejected, and the latter marked doubtful. The following communication on the subject, by Mr. Walker, appeared in the National Intelligencer, (Washington,) of June 4, 1847.

Gentlemen,—In my letter of May 22d, announcing the confirmation of my discovery of the Lalande observation of Neptune, I remarked that the elements can now be completed, and that the computation of Neptune's perturbations would afford the means of obtaining the pure elliptic orbit round the sun from the perturbed orbit presented in elements V.

I have just completed this research by freeing them from the effect of the present action of the three great planets, (that of the others is nearly insensible,) and am now able to offer to the public the definitive elements of Neptune's orbit. They are as follows, referred as before to the mean equinox of January 1, 1847, and to mean noon Greenwich:

Elements VII. of Neptune, completed June 1st.

Perihelion point, ...	1° 45′ 32″·90
Ascending node, ...	129 51 13 ·53
Epoch, January 1, 1847, . . .	326 2 1 ·34
Inclination, ...	1 45 38 ·10
Eccentricity, ...	0·005052917
Mean distance, ...	30·17775
Mean daily sidereal motion, . . .	21″·41144
Period in tropical years, . . .	165y·7175

Elements VII. are derived entirely from the planet's recent path for nine months. The test of their correctness is, that they should represent within reasonable limits the two observations of Lalande of May 8th and May 10th, 1795. The great pains bestowed on the reduction of these observations of Lalande, by M. Victor Mauvais of the Institute of France, induce me to adopt his places of Neptune for those dates as published in the *Comptes Rendus* for 1847, No. 16. I have referred them to the mean equinox of January 1, 1847. I have corrected them for parallax, but not for aberration, and have compared them with my ephemeris from Elements VII. The result is as follows:

Comparison with Lalande's Observations.

Date, 1795. Mean time, Paris.	Lalande's two observations of Neptune.		Correction of Ephemeris VII.	
	R. A.	Dec.	R. A.	Dec.
h. m. s.				
May 8th—11 10 57 .	213° 41′ 3″·89	South 11° 35′ 4″·96	+141″·1	+39″·5
May 10th—11 2 55 .	213 38 5 ·16	South 11 34 5 ·64	+147 ·8	+36 ·4
Observed motion in two days,	178″·73	59″·32		
Computed do. Elements VII,	185 ·42	62 ·38		
Discrepancy, . .	6″·69	3″·06		

The small difference of three minutes of arc between theory and observation for 1795, may be ascribed to the perturbations for that date, and for the fifty-two years' interval, which have been neglected.

The tropical period falls short by nearly a year of that which Professor Peirce has pointed out as necessary, in order that the Laplacian Libration should take effect. It is quite possible that a more full discussion of the perturbations may show the necessity of the Libration.

The eccentricity of Venus is 0·007, the smallest before known; that of Neptune is 0·005.

Hence it appears that the orbit of Neptune approaches nearer to a perfect circle than that of any other planet. I regard this value of the eccentricity of Neptune as conclusively established, and with this view will quote from LeVerrier's communication made to the Institute of France on the 29th of March last on the occasion of announcing my discovery. M. LeVerrier remarks:

"We confine ourselves for the present to the remark that this smallness of the eccentricity, which would result from the calculations of M. Walker, would be incompatible with the nature of the perturbations of the planet of Herschel. But it may be that this smallness of eccentricity is not a necessary consequence of the representation of Lalande's observation."

While I feel myself honored by the notice taken of my labors by the French astronomers, I think it just to express my full belief that when they have bestowed on its present orbit the same pains as myself, they will agree with me that this smallness of eccentricity is an unavoidable consequence of the direct observations.

If we admit for the moment that my views are correct, then LeVerrier's announcement of March 29th is in perfect accordance with that of Professor Peirce of the 16th of the same month, viz. that the present visible planet Neptune is not the mathematical planet to which theory had directed the telescope. None of its elements conform to the theoretical limits. Nor does it perform the functions on which alone its existence was predicted, viz. those of removing that opprobrium of astronomers, the unexplained perturbations of Uranus.

We have it on the authority of Professor Peirce that if we ascribe to Neptune a mass of three-fourths of the amount predicted by LeVerrier, it will have the best possible effect in reducing the residual perturbations of Uranus below their former value; but will nevertheless leave them on the average two-thirds as great as before.

It is indeed remarkable that the two distinguished European astronomers, LeVerrier and Adams, should, by a wrong hypothesis, have been led to a right conclusion respecting the actual position of a planet in the heavens. It required for their success a compensation of errors. The unforeseen error of sixty years in their assumed period was compensated by the other unforeseen error of their assumed office of the planet. If both of them had committed only one theoretical error, (not then, but now believed to be such,) they would, according to Prof. Peirce's computations, have agreed in pointing the telescope in the wrong direction, and Neptune might have been unknown for years to come. Yours, respectfully, SEARS C. WALKER.

Washington, June 1, 1847.

V. MISCELLANEOUS INTELLIGENCE.

1. *Facts in Physiological Chemistry;* by J. LIEBIG, (from a letter addressed by Baron von Liebig, to President Everett, of Harvard University.)—I ought several months since to have replied to your letter communicating the interesting intelligence in relation to the action of the vapor of ether. The result of your letter to me, you have doubtless seen in the European papers. The world is filled with the magnitude of this discovery, and we are looking for the most important applications of it in surgical practice. It is a benefaction to suffering humanity, when painful operations, through a medium so simple and safe, can be performed with diminished pain; and the world is most deeply indebted to the man who first employed ether for this purpose.

I have long intended to write in acknowledgment of your friendly letter; but I desired by way of return to incorporate in reply the results of an investigation, which has been brought to a conclusion only within the last few days. It is a chemical investigation of muscle-flesh; in which I have been led to some interesting results.

The fluid in the meat of recently slaughtered animals—the *flesh-fluid* —is *sour* and contains two free acids, whose nature up to this time has been but imperfectly known. I have found that one of the acids is an *organic acid*, and is the same that appears in the process of the souring of milk. The other acid is phosphoric acid. Both acids are but partially free. A part is united to potash, magnesia and lime. They have been recognized in all muscle-flesh thus far examined, as well of carnivorous as of herbivorous animals.

A second ingredient, which I have found in all kinds of flesh, is a crystalline body, which was discovered in broth by Chevreul, eleven years ago, and described by him under the name *Creatine.* It was supposed, inasmuch as Berzelius could find nothing in the fluid expressed from flesh, that this was an accidental ingredient. But this opinion rested upon an error. Creatine is found in the flesh of all healthy animals.

The composition of the body is such that creatine may be regarded as a compound of the body, *Glycocoll*—so accurately studied by Mr. Horsford—and ammonia.*

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* *Note from Prof. Horsford.*—One atom of creatine equals two atoms of glycocoll and one atom of ammonia.

$$C_8H_{11}N_3O_6=2(C_4H_4NO_3)+NH_3.$$

It contains also the elements of urea, glycocoll and wood-spirit.

$$C_8H_{11}N_3O_6=C_2H_4N_2O_2+C_4H_4NO_3+C_2H_3O.$$

Liebig, by boiling creatine a length of time with baryta, separated the urea (doubtless as carbonic acid and ammonia;—$C_2H_4N_2O_2+2HO=2CO_2+2NH_3$,) A third ingredient which is never wanting in fresh meat is a positive organic base of constitution analogous to that of *chinin*, or perhaps more nearly to that of *codein*, which is found in opium. There are also in meat two nitrogenous acids;—altogether, a variety of bodies whose existence in the living body could have been scarcely suspected. I have described these bodies and their chemical relations in a paper which is now in press, and will detail only a few results that may be practically applied.

The presence of two fluids throughout the body of opposite chemical nature, one acid, (the flesh-fluid,) the other alkaline, (the blood and lymph), separated from each other by membranes permeable to both, must satisfy any one that in this arrangement there is a source of electricity or of an electric current. I will not herewith say, that, by consequence, electrical effects must be recognizable in the body, for we know that these as such (electrical) disappear when through any result of motion, chemical action (decomposition or composition) is produced, and I regard the latter as dependent upon an electrical stream.

Moreover, the occurrence in flesh of creatine,—of a substance whose properties are allied to those of the active ingredient of coffee (caffeine), as also of another which has all the properties of an organic base, makes the action of medicines appear no longer so dark and mysterious. The most efficient of all medicines from the vegetable kingdom are organic bases.

If you leach finely chopped meat with cold water, you procure a red fluid and a white residue. The latter is the actual muscular fibre, and the solution contains, beside the above named bodies, a considerable quantity of albumen that may be separated as coagulum by heating the fluid to boiling.

I have found that the residue (the muscular fibre) either for itself or boiled with water is tasteless, and that the water in which the fibre has been boiled derives no taste. The fibre, by boiling, becomes hard and altogether unpalatable.

All the ingredients having odor or taste, may of course, be abstracted with cold water. They are contained in the flesh-fluid of slaughtered animals.

You will not wonder, my most Respected Sir, if I now turn to receipts for the kitchen.

It follows from the above, that one can make for himself, in a few minutes, the best and strongest broth (Fleisch-brühe, Bouillon de viande): if, e. g. a pound of finely chopped beef (mince) with a pound (pint) of *cold* water, be carefully mixed and then slowly heated to boiling, and the fluid separated from the solid parts by pressing through clean cloth. This broth, with the usual condiments—(broiled onions, vegetables, salt, etc.) added, will furnish a dish beyond the criticism of the most fastidious gourmand.

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and there remained the organic base, mentioned in the paragraph which follows above. Its constitution, as given in a letter to Gay Lussac, and published in the Comptes Rendus for Feb. 6, is $C_6H_7NO_4$—and contains the elements of the Lactamide of Pelouze, a product of the action of dry ammonia gas upon lactic acid,—$C_6H_4O_4+NH_2$. It contains also the elements of Glycocoll and wood-spirit, as above intimated.

$$C_6H_7NO_4=C_4H_4NO_3+C_2H_3O.$$

Longer boiling will *not* necessarily make the extract stronger.

If the broth be slowly evaporated over a water bath, it will become brown, and assume a fine taste like broiled meat. If evaporated (by exceedingly gentle heat) to dryness, it yields a brown mass, of which, upon a journey, for example, half an ounce would convert a pound (pint) of water into the strongest broth.

By boiling a piece of meat in the water, a separation of the solution from the insoluble ingredients takes place. The soluble ingredients go into the extract—the broth—the soup. Among these beside those bodies mentioned above, are the alkaline phosphates. The thoroughly boiled meat contains no alkaline phosphates.

Now as these salts are necessary for the formation of the blood, it is clear that the fully boiled* meat, by the loss of them, loses its capacity to become either blood, or through blood to become flesh: *it loses its nutriment when eaten without the juices—the extract.*

In the extract the materials for the formation of albumen and fibrin, are both wanting. *Alone* also, it is not nourishing. Both must be eaten together. *The method of roasting is obviously the best to make flesh most nutritious.* But as the extract—the broth,—contains *all the ingredients of the acid gastric juice*, it may perhaps be the best agent to aid the process of digestion in cases of dyspepsia.

Finally, I have found that the brine which forms in the salting of meat, contains all the ingredients of the flesh-fluid. The composition of salted meat is essentially different from that of fresh meat—inasmuch as phosphoric acid, lactic acid, and the salts of these acids—together with creatine and creatinine are abstracted by being packed down in salt. The salted meat becomes partly reduced by this process to a mere supporter of respiration.† This may be a source of scrofula, where, by eating salt meat, the replacement of the wasted organism is but imperfectly effected—where it loses its constitution without regaining it from the food.

The temperature in the interior of a piece of meat to be boiled or roasted, rarely exceeds 100° C. (=212° F.) The meat is done and palatable when it has been exposed to a temperature of 62° C. (144° F.), but it is in this condition, red like blood. The blood-red places—the undone portions,—were subjected at the highest to a temperature only of 60° C. (= 140° F.) At 70° to 72° C. (= 158° to 162° F.) all these places disappear. At 100° C. (= 212° F.) the fibre breaks up and becomes harder. The crusty property of the meat in chewing, depends upon the quantity of albumen, which, in a coagulated condition, permeates the fibre. The flesh of old animals is deficient in albumen.

If a piece of meat be put in *cold* water, and this heated to boiling, and boiled till it is "done," it will become harder and have less taste, than if the same piece had been thrown into water already boiling. In the first case the matters grateful to the smell and taste, go

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* By this term it is intended to convey the idea of boiled till no further change occurs, or nothing more is extracted.

† Liebig divides food into two kinds. One serves in the formation of tissues; the other burns to sustain animal heat—as sugar and fat. The latter supports respiration.

into the extract—the soup; in the second, the albumen of the meat coagulates from the surface inward, and envelopes the interior with a layer which is impermeable to water. In the latter case the soup will be indifferent, but the meat delicious.

Giessen, 24th March, 1847.

2. *Inhalation of Ether*, (L'Institut, March 10, 1847.)—Experiments on the inhalation of ether by animals, have been extensively prosecuted in Paris, and have led to interesting results. M. Flourens observes from his investigations, that ether acts first upon the cerebrum, and disturbs the intellect; then upon the cerebellum affecting the equilibrium of movement; next upon the spinal cord, when it extinguishes successively sensibility and the power of motion, and finally upon the medulla oblongata, when it extinguishes life. In his late experiments, the action of ether has been pushed to the extinction of life.

M. Flourens, in order to compare the effects with those of asphyxia, subjected two dogs to the simplest kind of asphyxia produced by the gradual consumption of the oxygen contained in a given volume of atmospheric air. When the asphyxia had reached the required point, the spinal marrow, exposed, showed no signs of feeling when cut or lacerated, and only feeble muscular contractions on pinching the motor portion. M. Flourens hence infers that there is a marked analogy between etherization and asphyxia. But in ordinary asphyxia, the nervous system loses its forces under the action of the black blood, the blood deprived of oxygen; and in etherization this takes place, at first, under the quiet influence of the singular agent to which it is subjected.

3. *Gun-Cotton;* M. SCHÖNBEIN's Patent, (Mechanics' Magazine; Mining Journal, April 10, 1847.)—The specification of this patent (taken out in the name of Mr. John Taylor, of the Adelphi) became due, and was enrolled on the 8th inst. The following is a correct abstract of its contents:—The patentee states, that the invention consists in the manufacture of explosive compounds applicable to mining purposes and to projectiles, and as substitutes for gunpowder, by treating and combining matters of vegetable origin with nitric and sulphuric acids.

The matter of vegetable origin which he prefers, as being best suited for the purposes of the invention, is cotton, as it comes into this country, freed from extraneous matters; and it is stated to be desirable to operate on the clean fibres of the cotton in a dry state.

The acids are—nitric acid of from 1·45 to 1·50 specific gravity, and sulphuric acid of 1·85 specific gravity.

The acids are mixed together in the proportion of one measure of nitric acid to three of sulphuric acid, in any suitable or convenient vessel not liable to be affected by the acids. A great degree of heat being generated by the mixture, it is left to cool until its temperature falls to 60° or 50° Fahr. The cotton is then immersed in it, and, so that it may become thoroughly impregnated or saturated with the acids, it is stirred with a rod of glass or other material not affected by the acids. The cotton should be introduced in as open a state as practicable. The acids are then poured or drawn off, and the cotton gently pressed by a presser of glazed earthen ware to press out the acids, after which it is covered up in the vessel, and allowed to stand for about an hour. It is subsequently washed in a continuous flow of water, until the presence of the acids is not indicated by the ordinary test of litmus paper. To remove any uncombined portions of the acids which may remain after the cleansing process, the patentee dips the cotton in a weak solution of carbonate of potash, composed of one ounce of carbonate of potash to one gallon of water, and partially dries by pressing, as before. The cotton is then highly explosive, and may be used in that state, but, to increase its explosive power, it is dipped in a weak solution of nitrate of potash; and, lastly, dried in a room heated by hot air or steam to about 160° Fah. It is considered probable that the use of the solutions of carbonate of potash and nitrate of potash may be dispensed with, although actual experience does not warrant such an omission.

The patentee remarks, that nitric acid may be employed alone in the manufacture of explosive compounds; but that, as far as his experience goes, the article, when so manufactured, is not so good and far more costly.

When used, care should be taken to employ a much less quantity by weight, to produce the same result, than of gunpowder; and it has been found that three parts by weight of the cotton produce the same effect as eight parts by weight of the Tower-proof gunpowder. The cotton, when prepared in the manner before mentioned, may be rammed into a piece of ordnance, a fowling-piece, or musket; or may be made up into the shape of cartridges; or may be pressed, when damp, into moulds of the form of the bore of the piece of ordnance for which it is intended—so that, when dried, it shall retain the required figure; and it may also be placed in caps, like percussion caps, and made to explode by impact. Lastly, the patentee states, that although he prefers the use of cotton, other matters of vegetable origin may be similarly treated with acids to form an explosive compound, and that acids of an inferior specific gravity may be employed.

The patentee having thus described the nature of the invention, and in what manner the same is to be performed, states, that he does not confine himself to any of the details above specified, so long as the peculiar character of the invention is retained—viz., the manufacture of explosive compounds from matters of vegetable origin by means of acids. But, to adopt the patentee's own expression—"What I claim, is the manufacture of explosive compounds from matters of vegetable origin by means of nitric acid, or nitric and sulphuric acids."

4. *Experiments on the use of Gun-Cotton for blasting—its value compared with that of blasting Powder;* by THOMAS B. ADAMS.—The difficulties to be surmounted in ascertaining the relative values of the new and old explosives are neither few nor small. Different qualities of powder are used in different quarries. That which is made in the same mill will produce different effects according to its chemical proportions, and its coarse or fine graining; powder of the same grain will act differently upon different kinds of rock. The powder used for blasting is the coarsest and slowest burning variety.

Gun-cotton is uniform in strength, and fires quicker than the finest gunpowder.

The rock is variable in texture, and liable to be crossed by seams which, if they be slight, may destroy the correctness of the result without being discovered by the operator.

The difference in the action of the two agents, that of the powder being slow, that of the cotton sudden, the imperfections of the mass upon which they act, are causes which render useless many comparisons and weaken our confidence in inferences drawn from a small number of experiments. Great care was taken in the experiments described below, to compare fairly the two explosives.

The gun-cotton was prepared with the strongest acids of commerce; sulphuric, sp. gr. 1·85; nitric, sp. gr. 1·49; time of immersion about twenty minutes. After the superfluous acid was thoroughly removed or neutralized, the cotton was immersed in one of the oxygenating solutions described by Prof. Schönbein, and dyed a light straw color. In short, it was the article of commerce, prepared by Messrs. C. & F. Lennig of Philadelphia, who are patentees of gun-cotton for the United States. A sample accompanies this note.

In May last the writer entered the collieries at Pottsville, Pa., examined and measured the bores in which the blasts were to be discharged, obtained and weighed the quantity of powder intended for each blast; (and upon examination it was found that the miners almost universally underrated the weight of their charges of gunpowder from 33 to 100 per cent.) and carefully noted, on the spot, all the circumstances alluded to in the table below. In noting the *effect*, the opinion of the miners themselves is given. When the results were better than were expected from the proposed charge of powder, they were marked *superior*. When less, *moderate*; and when equal, *good*.

The following extract from the tables is believed to be a fair sample of the whole. In every instance the writer was present during the charging, and discharging of the blasts, and all were made at least 500 feet below the surface.

Extract from Table of Experiments.

No. of discharge.	Kind of explosive.	Rock.	Depth of bore.	Diameter of bore.	Material of cartridge powder.	Depth allowed for powder.	Depth occupied by cotton.	Weight of powder.	Weight of cotton.	Effect.	Smoke.	Vitiation.
			Inch.	Inch.		Inch.	Inch.	Oz.	Oz.			
3	C.	tough slate with iron ore,	18	1½	paper	. .	6	9¾	1	good	none	none.
4	C.	"	16	1¾	"	. .	6	9¾	1	good	none	none.
5	powd.	"	18	1¾	. .	. .	. .	6	.	mod.	dense	considerable.
7	"	"	15½	1¾	. .	5	. .	.	.	mod.	dense	considerable.
8	C.	"	17	1¾	. .	8	6	10	1½	sup.	none	none.
9	C.	red ash coal,	45	1½	. .	19	16	18¼	2¼	sup.	"	"
10	C.	"	27	1½	paper	12	10	9¼	1¼	"	"	"
12	C.	white ash coal,	36	1½	"	10	6	10	1	good	"	"
13	C.	"	36	1¾	"	14	6	13½	1¼	mod.	"	"

June 7, 1847.

5. *Pyroxyline*, (Comptes Rendus, March 8, 1847.)—MM. FLORES DOMONTE and MENARD, on submitting gun-cotton to alcoholized ether, obtained an incomplete solution; and on analysis the part dissolved gave the formula $C_{12}H_8O_8+2NO_5$, (that of Xyloidine according to these authors,) and the insoluble, the formula $C_{12}H_9O_9+3NO_5$. The

two added together, make $C_{24}H_{17}O_{17}+5NO_5$, Pelouze's formula for pyroxyline.* With cane sugar, glucose, mannite, sugar of milk, dextrine, and gum, analogous fulminating compounds have been formed by these chemists. They have succeeded in crystallizing the nitric mannite, and obtained for it the formula $C_{12}O_7H_7+5NO_5$.

6. *Process for Photographs upon paper*; by M. BLANQUART-EVRARD, (Comptes Rendus, Jan., 1847.)—This process is in part a modification of the Calotype, and is, according to its author, susceptible of many variations. The principles upon which it depends, are, 1st, the thorough impregnation of the paper by the photographic agent, so that the image is formed within the paper; and 2d, the perfection of surface given to a moist paper by placing it upon a glass, which, in the camera, is turned toward the lens, the image being formed on the wet surface of paper in contact with the glass.

As this process seems to be more simple than any other, and within the reach of persons of moderate skill, we give it somewhat in detail. For the first or negative proof, the very best letter paper is to be taken; its texture should be close and uniform; the surface very smooth. This paper is to be floated on the surface of a solution of one part nitrate of silver in thirty parts distilled water, observing the usual precautions of not including air bubbles, &c. After one minute the paper is removed, held up to drain by a corner, and then laid upon some impermeable surface and allowed to dry slowly.

Another solution is prepared of 25 parts iodid of potassium, 1 part bromid of potassium, and 560 parts distilled water. In this solution the paper is entirely immersed, with the silver side up, and suffered to remain from one and a half to two minutes, according to the temperature; it is then carefully withdrawn, holding it by two corners, and placed in a large vessel full of pure water; it is next hung up to dry upon a string, being fastened by one corner.

Paper thus prepared should be protected from the light and preserved in a pasteboard case, but not packed too closely. It will keep for months. The solutions kept in vessels covered by opaque paper may be used to exhaustion.

To take a proof, a smooth glass is made quite level upon a suitable support, and upon it are poured a few drops of a solution of 6 parts nitrate of silver, 11 parts crystallizable acetic acid, and 64 parts distilled water; (half of the water should be taken to dissolve the nitrate, and the remainder added about an hour after the acid has been mixed with the first portion.)

The paper is next to be applied to this liquid on the glass, the nitrated side downwards, and smoothed by the hand until there is a perfect contact with the glass without any folds or bubbles. One or more pieces of moist paper, according to the thickness, are then to be placed upon this; next a second glass of the same size, and the whole being properly secured, is used in the camera as a daguerreotype plate. The time of exposure varies according to the temperature, and is about one-fourth that required for plates prepared with chlorid of iodine.

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* In Vol. iii, p. 295, there is an error arising from including with the formula of pyroxyline, the 8HO, which is separated in the process of formation.

When taken from the camera the proof is to be placed upon a plate of glass or porcelain, which has been slightly moistened in order that the paper may adhere to it. A saturated solution of gallic acid being poured over the proof, the image appears at once. The acid is allowed to act until all the details are brought out, but not until the white portions are discolored; to prevent this, the acid is removed by pouring a large quantity of pure water over the proof, which is finally entirely covered by a solution of 1 part bromid of potassium in 40 pts. distilled water. The paper remains in this last solution for a quarter of an hour, and is then well washed with clean water and dried between sheets of filtering paper. To render this negative impression more transparent, for the purpose of copying, a little wax may be scraped upon it and melted by a hot smoothing iron, some sheets of letter paper being placed between.

The paper for the positive proof should be very stout and as smooth as possible. Prepare a solution of 3 parts water saturated with common salt and 10 pts. distilled water; upon this float the paper for two or three minutes, and then dry it as much as possible by absorbent paper; and next float it upon a solution of 1 part nit. silver and 5 pts. water, until another sheet having undergone the previous process is ready to take its place; it is then to be removed, drained, and dried as before directed. In this way a quantity may be prepared in a short time. The positive paper is to be preserved in the way directed for the other, but must not be kept more than one or two weeks, or it will lose its delicacy and become discolored.

The positive proof is made by the usual process, the expose being as far as possible to the direct sunlight; about twenty minutes being the average time.

To fix this proof, it is to be taken into a darkened apartment, soaked for fifteen minutes in pure water, and then put into a solution of 1 part hyposulphate of soda and 8 pts. distilled water. It may now be examined by daylight, and the action of the hyposulphate watched. Gradually the lights become more brilliant, and the shades pass from a dirty red to a bistre and finally come to resemble those of an aquatint. When the desired tint is reached, the operation is stopped and the salt removed by soaking in water for five or six hours to a whole day. Several proofs can be immersed at the same time in the hyposulphate, and those which do not stand its action for two hours must be rejected. The operations although in appearance complicated, are in reality quite simple and of easy execution. G. C. S.

7. *Report on the Aurora Borealis.—Aurores Boréales*, 1 vol., 8vo. Accompagné d'un Atlas de 12 planches in folio; par MM. LOTTIN, BRAVAIS, LILLIEHÖÖK, et SILJESTRÖM.*

The following notice of this great work is from M. Bravais. He remarks:—

I have divided my general review of the subject into eight paragraphs. In the first, I examine the much controverted question, as to the nature

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* This is one of a series of twenty-six volumes of large 8vo, and seven folio atlases, published as the results of "Voyages de la Commission Scientifique du Nord, en Scandinavie, en Laponie, au Spitzburg et aux Feröe, pendant les années

of the dark segments lying generally below the auroral arches, or at their base. This segment, according to some, is merely an effect of contrast; according to others it is something material, (or real,) but independent of the aurora, caused perhaps by the polar fogs; and others consider it the generating source of the auroral light. I next show, that the light cannot be an effect of reflection, except in rare cases, and actually exists where it is observed.

In the second paragraph I consider the forms and portions of arches, their movements, light, and apparent structure. According to Hansteen, an auroral arch is a luminous ring situated in the upper regions of the atmosphere, sustained in all its parts at the same height, above the earth's surface, and whose axis corresponds nearly with the magnetic axis of the globe. Such a ring ought to appear more or less elevated above the horizon according to the position of the observer, and it ought to be seen to cut the plane of the magnetic meridian at right angles. The hypothesis of Hansteen, which is altogether the most probable, has been made the basis of our investigations with regard to the orientation, the height, and the amplitude of the arches. I understand by amplitude, the angular distance between the east and west sides measured on the plane of the horizon and on the north sides of the sky. At Bossekop, the summit of the arc is not only eight to ten degrees to the left of the *magnetic north*, but the deviation goes on increasing as the arch rises from the north toward the zenith and from the zenith to the south. The amplitude increases quite regularly during this movement of the arc. It does not become one hundred and eighty degrees until the arch has passed the zenith to the southern part of the sky.

It also results from our observations, that the curve of the arch is very similar to that of a small circle of the celestial sphere. This small circle projected upon the vertical plane which contains the culminant point of the arch is a straight line; and I show that on approaching the horizon, this right line becomes a hyperbolic curve though scarcely appreciable, and important only in a theoretical point of view, from its connection with the theory assumed.

From the simultaneous variation of the heights and amplitudes, (adopting the theory of Hansteen,) I have found the mean elevation above the earth to be 227 kilometers, (140 miles Eng. statute,) which corresponds to the upper limits of our atmosphere, or the region of falling stars, &c.

The third paragraph is devoted to the rays of the aurora borealis.

The rays (streamers) are columns of light suspended in the air; they undergo rapid movement or changes, and appear to converge towards the magnetic zenith, where they thus form what is called the corona.

1838, 1839 et 1840, sur la corvette La Recherche commandée par M. Fabvre, Lieut. de Vaisseau; publiès par ordre du Roi sous la direction de M. Paul Gaimard, President de la Commission Scientifique du Nord." They include Reports on Astronomy, Pendulum Observations, Hydrography, Tides, 1 vol.; Meteorology, 3 vols.; Terrestrial Magnetism, 2 vols.; Aurora Borealis, 1 vol.; Geology, Mineralogy, Metallurgy, and Chemistry, 2 vols.; Botany, Physical Geography, Physiology, and Medicine, 2 vols.; Zoology, 3 vols.; History of Scandinavia and its Literature, and History of the Voyage, 4 vols.

With reference to the relation between the column and the arches, I have shown, in discussing our observations on partial corona, that even when the rays appear isolated and independent, they have a general arrangement in files or ranges, parallel to the direction of the arches. I have also shown a tendency in the arches to dissolve into columns; whence it is obvious that the simple ray is the result of an arrangement of the auroral light in lines parallel to the dipping needle. The arched form results from this, that if two rays exist simultaneously, they tend to place themselves so that their common place shall be perpendicular to the magnetic meridian, as if the equilibrium of two rays were not stable except in this position. But how this condition of stability is consistent with the idea that the rays have an electric nature and origin, is yet enveloped in mystery.

The luminous currents, exhibited in the ranges of columns, passing either from the east to the west or the reverse, are not equally frequent in the different directions; the same remark applies to the modes of progression in the arches from the north to the south and from the south to the north. I state the facts on this subject without pretending to offer any explanation.

We have observed the extra-zenith corona so frequently, as to be able to affirm that the coronas may appear in all possible directions in relation to the observer, and that their connection with the magnetic zenith is a simple result of linear perspective.

In the fourth paragraph I have treated of the auroral sheets. They are allied to the rays, but differ in their flickering or palpitating light and also in appearing only at a later hour of the night.

The fifth paragraph relates to the colors of the auroral light, which are less varied than generally supposed; for but three or four distinct shades were observed by us.

In the sixth paragraph I consider the facts which may lead the observer to suppose that the aurora is situated but a small distance from him. Although believing that their appearances are mostly deceptive, I do not affirm that all observations of this kind hitherto made are necessarily incorrect. I next treat of a resemblance, between the mean orientation of cirro-cumuli clouds in parallel bands optically convergent, and auroral arches.

In order to determine the altitude of auroral arches, M. Lottin and myself observed simultaneously, at opposite extremities of a base of 16 kilometers (10 miles); and we arrived at the result that the height at least exceeded 50 kilometers (31 miles). A longer base is necessary for a more precise determination. For such investigations, the base line should be about 100 kilometers long (60 miles), and in the direction of a terrestrial magnetic meridian.

The last paragraph contains general remarks on the frequency of the phenomena, its duration, hour of appearance, its possible continuance during a succession of days. I show that the progressive movements of the arches are wholly independent of the motion of the earth, which sets aside any theory founded on the idea of the cosmical origin of the Aurora, and sustains the view that it belongs to our atmosphere and almost exclusively to its upper regions.

8. *Hieroglyphical Mica Plates from the Mounds;* by E. Geo. Squier, (in a letter to Prof. Silliman.)—You have probably observed a paragraph, going the rounds of the newspapers, credited to a journal published at Lower Sandusky in this state, to the effect that a number of inscribed plates of mica were recently discovered, in excavating an ancient mound near that place. These plates are represented, in the account, as oval in shape, measuring seven by ten inches, and "covered with *hieroglyphics* of different and beautiful colors, betokening a more advanced and entirely different state of the arts than has heretofore been discovered in the remains of the Indian tribes!" As this announcement has created some degree of interest, and elicited some inquiries, it will not be out of place to observe, that one of the plates has been placed in our hands, through the kindness of a friend, residing at the point mentioned. The form of the plates and their size are correctly represented, but the hieroglyphics are nothing more nor less than *discolorations* caused either by the infiltration of a mineral solution between the laminæ, or by its presence at the period of crystallization. The material is very well known as *graphic* or *hieroglyphic mica*, a deposit of which occurs upon the Schuylkill, not far above Philadelphia. Although the discoloration, following the planes of crystallization, falls, in places, into right lines, it seems utterly unaccountable that they were mistaken for the work of man! This is another illustration of the very loose manner in which facts relating to our antiquities have been placed before the world:—a looseness, unfortunately, not entirely peculiar to newspaper statements. The plates are very pretty specimens of the mineral, and are each perforated, near one of the ends, with a small hole. They were undoubtedly used for purposes of ornament. Mica is common in the mounds, sometimes cut into the form of scrolls and other ornamental plates. I have taken a bushel of the sheets from a single mound.

9. *Water-Power of Europe*, (Mining Journal, April 10, 1847.)—A curious communication has been addressed to the Paris Academy of Sciences, from M. Daubrée, containing a calculation of the quantity of heat annually applied to the evaporation of the water on the surface of the globe, and of the dynamic force of the streams of continents. He finds that the evaporation employs a quantity of heat about equal to one-third of what is received from the sun; or, in other words, equal to melting a bed of ice of nearly thirty-five feet in thickness, if spread over the globe. The motive force of the streams in Europe is, according to M. Daubrée, equal to between 273,508,970 and 364,678,620 horses, working incessantly during the whole period of the year.

10. *Auroral Belt of April* 7, 1847.—Observations made at Hartford, Conn., by P. W. Ellsworth, M.D., combined with those made at New Haven, show that the auroral bow or arch of April 7, 1847, was elevated not less than 100 miles, nor more than 120, above the earth's surface. The observations will be published in the next number.

A similar auroral bow or arch was seen at various places in England, on the 19th March, 1847. According to the mean of various observations, its elevation was about 177 miles. A brilliant display of the Aurora Borealis was seen at New Haven, on that evening, but no such arch was visible here up to 11h. 30m. P. M.

E. C. H.

11. *Volcanic Eruption at the Cape Verds.*—There was a volcanic eruption about the 1st of April, on the island of Fogo, (of the Cape Verd group,) which continued ten or fifteen days, throwing out showers of earth and stones to a great height, and emitting huge streams of lava, which, running down the mountain, destroyed many houses and plantations, and caused some loss of life. All vegetation and many goats and cattle were destroyed by the heat of the earth, the showers of stones and the lava. The shock was distinctly felt on the neighboring islands, and caused much alarm at Port Praya, where the vibrations were very violent and almost unceasing for seven or eight days. The crater of Fogo is 12,000 feet above the sea, and eruptions occur once in twenty or thirty years.—*Salem Reg.*

12. *Science and the Arts at Harvard.*—The Hon. ABBOTT LAWRENCE of Boston, has presented to the Corporation of Harvard University, the sum of fifty thousand dollars, to be expended in establishing a school for the purpose of teaching the practical sciences, embracing Engineering, Mining in its extended sense, including Metallurgy, and the invention and manufacture of Machinery. One department is already occupied by the Rumford Professor in that institution, Prof. E. N. Horsford.

13. *Association of American Geologists and Naturalists.*—The eighth annual meeting of the Association of American Geologists and Naturalists, will be held in Boston, commencing on the third Monday (20th) of September, 1847, at 10, A. M., continuing for one week thereafter.

Officers of the Association elected at the last meeting:

Chairman, Dr. AMOS BINNEY.*
Treasurer, Prof. B. SILLIMAN, Jr.
Secretary, Dr. J. WYMAN.

Standing Committee.—The President, Treasurer, and Secretary, *ex officio*. Dr. J. E. HOLBROOK. Prof. H. D. ROGERS. Prof. B. SILLIMAN. Pres. E. HITCHCOCK. WILLIAM C. REDFIELD, Esq. LARDNER VANUXEM, Esq. L. C. BECK. JOHN L. HAYES.

Local Committee.

Hon. NATHAN APPLETON.
Hon. ABBOTT LAWRENCE.
JOHN A. LOWELL, Esq.
Dr. JOHN C. WARREN.
Prof. A. GRAY.

Dr. A. A. GOULD.
Dr. D. H. STORER.
Dr. S. CABOT, Jr.
Dr. C. T. JACKSON.
FRANCIS ALGER, Esq.

VI. BIBLIOGRAPHY.

1. *Elementary Geology;* by EDWARD HITCHCOCK, D.D., LL.D., President of Amherst College; eighth edition, revised, enlarged and adapted to the present advanced state of the science, with an introductory notice by John Pye Smith, D.D., F.R.S., and F.G.S., &c. New York, 1847.—This work has long sustained its well deserved reputation.

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* Since deceased.

It is in some respects peculiar; its structure is highly methodical; the subjects are presented in distinct propositions, with definitions, principles, proofs, remarks, inferences, descriptions, illustrations, causes, &c., all drawn out under distinct heads, and distinguished by larger and smaller type. If this construction presents a page more broken up than is agreeable to the eye, and less readable as a straight forward treatise, it presents important advantages, as a book for classical study and recitation. The pupil will know what to study and how to study, and the instructor what to enquire for. The unsolicited expressions of approbation from many geologists and reviews which are prefixed to the work, especially the beautiful notice of the distinguished Dr. John Pye Smith, of London, himself the author of an important work on the relation of geology to the Mosaic cosmogony, are to be regarded as decisive proofs of the approbation of those who are the best qualified to judge. The work bears throughout, the impress of a working, thinking man, of strong powers of observation and reasoning; of one whose impressions are obtained from nature quite as much as from books; whose facts are correct, whose views are sound and tenable, and who is therefore a safe guide.

2. *Dr. Mantell's Geology of the Isle of Wight.*—At the moment of closing the present number, we have received a copy of this new and beautiful work of Dr. Mantell, of which a fuller notice will be given hereafter.

3. *Medical Botany, or descriptions of the more important Plants used in Medicine, with their history, properties, and mode of administration;* by R. Eglesfeld Griffith, M.D. Philadelphia: Lea and Blanchard. 1847; pp. 704, 8vo. Illustrated by 338 wood-cuts.—The author of this volume is well known to be particularly qualified for this undertaking, by his botanical, as well as medical and pharmaceutical knowledge; and it strikes us, on a cursory examination, that it has been prepared with much care and faithfulness, and that it will take its place at once as the standard work on the subject in this country. A succinct introductory chapter is devoted to the anatomy and structure of plants, their chemical composition and products, and the outlines of classification. The officinal plants are introduced under their several natural orders, which, with the general systematic arrangement of De Candolle, are thrown into groups after the manner of Lindley. The class of *Sporogens* is retained, as is still done by the last named author, although it has been abundantly shown that its assumed character is without foundation in nature. The plants which are really important in the materia medica are described in full, as well as the officinal part or production; the others are more briefly noticed; and the references which are faithfully made, both to the botanical and medical authorities, will serve in all cases to direct the inquirer to the original sources of information. A. Gr.

4. *Principles of Geology—or, the Modern Changes of the Earth and its Inhabitants, considered as illustrative of Geology;* by Charles Lyell. Seventh edition, entirely revised, with plates, maps and woodcuts. London: John Murray. 1847.—This work, heretofore published in three and four duodecimo volumes, now appears in one thick 8vo of 810 pages, agreeably to a modern usage in scientific works of frequent reference.

It is unnecessary to say any thing of the excellence of a work, whose reputation has been long established and which no one can read without both pleasure and instruction. One of the most striking peculiarities in this edition is seen in the more frequent reference to American facts with which the author's two visits to this country and extensive travels in it have made him acquainted.

5. *A Dictionary of Modern Gardening;* by GEO. WM. JOHNSON. London. Edited by WM. LANDRETH of Philadelphia. Lea & Blanchard. 1847. 1 vol. 12mo. pp. 635.—This is a useful compendium of all that description of information which is valuable to the modern gardener. It quotes largely from the best standard authors, journals, and transactions of societies; and the labors of the American editor have fitted it for the United States, by judicious additions and omissions. The volume is abundantly illustrated with figures in the text. The articles, 'apple,' 'pear,' 'cherry,' 'plum,' 'peach,' embrace a brief and judicious selection of those varieties of fruits which experience has shown to be well suited to the United States.

6. *A Manual of Road Making, comprising the location, construction, and improvement of Roads (common, Macadam, paved, plank, etc.) and Railroads;* by WM. GILLESPIE, A.M., C.E., Professor of Civil Engineering in Union College. New York: A. S. Barnes & Co. 1 vol. 12mo. pp. 336. 1847.—If the well established principles of road building, which are so plainly set forth in Prof. Gillespie's valuable work, and so well illustrated, could be once put into general use in this country, every traveller would bear testimony to the fact, that the author is a public benefactor.

7. *Transactions of the American Philosophical Society, Philadelphia,* Vol. ix, New Series, part iii.—p. 275. Description of New Fresh Water and Land Shells, with figures; by *I. Lea.*—p. 283. Observations made in the years 1838–1843, to determine the magnetic dip and intensity in the United States; by *John Locke,* M.D., Prof. Chem. and Pharm. in the Med. College of Ohio.—p. 329. Observations of the magnetic dip made at several positions, chiefly on the southwestern and northeastern frontiers of the United States, and the magnetic declination at two positions on the river Sabine, in 1840; by Maj. *J. D. Graham,* U. S. Corps of Topographical Engineers.

The following officers of this Society were elected on January last.

President—Nathaniel Chapman, M.D.

Vice-Presidents—R. M. Patterson, M.D., Franklin Bache, M.D., A. Dallas Bache, LL.D.

Secretaries—Hon. J. K. Kane, Robley Dunglison, M.D., A. L. Elwyn, M.D., J. F. Frazer.

Counsellors for Three Years—Robert Hare, M.D., Wm. Hembel, C. D. Meigs, M.D., Henry Vethake.

Curators—E. Peale, J. P. Wetherill, John C. Cresson.

Treasurer—George Ord.

PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY.—Vol. iv, No. 36, *July—December,* 1846.—p. 279, Letter from Dr. *Franklin* to Dr. Kimmersly, on "the effect of lightning on Mr. Holder's House."—p. 285, Observation by *Prof. Henry* on the interference of rays of heat, including his result that two rays may be thrown on each other so as to produce a reduction of temperature.—p. 287, Remarks on the Corpuscular theory; *Prof. Henry.*

No. 37. *Jan., Feb. and March,* 1847.—p. 299, List of officers for the year.—p. 305, On the Corpus luteum; *Dr. Meigs.*—p. 311, A missing star in Lalande's Chart, shown probably to be LeVerrier's planet, and determining the position of this planet in 1795; *S. C. Walker.*

Proceedings of the Academy of Natural Sciences of Philadelphia.—Vol. iii, No. 7, *Jan. and Feb.*, 1847.—p. 143, Observation on fossil trees in the Nova Scotia coal mines, by *R. Brown*, Esq.; in which he remarks of one tree, "it has exposed two long roots, one branching to the north and the other to the south, about seven feet each way. They are very broad and flat, and are genuine *Stigmaria.* I could not trace any rootlets, but the areolæ are not to be mistaken. I have preserved some large pieces, as also some of the bark of the tree, which is apparently an irregularly fluted *Sigillaria.*"—p. 149, Description of new Insects; *S. S. Haldeman:* Blethsia quadricollis, Chorea (n. gen.) pulsator, Eburia distincta, Enapholodes simplicicollis, Stenura? cyanea, Ploiaria maculata.—On the Cranium of the Zeuglodon from the Upper Eocene of South Carolina; *M. Tuomey.* "Length 14½ inches; greatest breadth 7½ in.; height 5½. It was evidently a young individual. The double occipital condyle shows it to have been a mammal, while the squamous sutures and a symmetrical form refer it to the Cetacea."—p. 154, Remarks on the birds observed in Upper California; *Wm. Gambel:* includes the new genus Chamæa, instituted for Parus fasciatus, (Proc. Acad. Nat. Sci., ii, 265,) and various valuable observations on known species.—New Coleoptera of the United States; *F. E. Melsheimer:* includes species of the genera Donacia, Orsodacna, Microrhopala, Galeruca, Calomicrus, Œdionychis, Pachyonychus, Disonycha, Graptodera, Systena, Crepidodera, Psylliodes, Aphthona, Thyamis, Dibolia, Chætocnema, Sphæroderma, Metachroma, Eumolpus, Cryptocephalus, Monachus, Gastrophysa, Phædon, Tritoma, Triplax, Lycoperdina, Coccinella, Brachiacantha, Hyperaspis, Exochomus, Chilocorus, Scymnus. This closes the descriptions of Dr. Melsheimer, which were begun in Vol. ii, No. 2, (April, 1844,) of the Proceedings.

No. 8, *March and April.*—p. 185, On living hybrids in Pennsylvania between the Guinea fowl and the Turkey; *A. Sharpless* and *W. Kite.*—p. 190, Larva of the Cicada septendecim; *Miss Morris.*—p. 191, Composition of the dust of anthracite furnace flues; *Prof. Johnson.*—p. 199, Cyminidis Wilsonii, a new rapacious bird from Cuba; *J. Cassin.*—p. 200, Remarks on the birds observed in Upper California; *Wm. Gambel.*

Proceedings of the Boston Society of Natural History, February, 1847.—p. 193, Blind Crawfish of the Mammoth Cave, (Astacus pellucidus;) *W. F. Channing.*—Prof. Agassiz mentioned the fact ascertained by Erichson, that the Crawfishes of America have all one pair of gills less than those of the old world.—p. 195, Microscopic examination of Gun-cotton; *Dr. Bacon.*—p. 196 and 200, Description of New Shells of the Exploring Expedition, (three species of Partula, two of Pupa, one of Balea, five of Achatinella, seven of Helicina, nine of Cyclostoma, and four of Truncatella; *A. A. Gould*—p. 198, A new species of Manatus, from Cape Palmas, (M. nasutus;) *G. A. Perkins.*

Ann. and Mag. Nat. Hist., Vol. xix, No. 126, April, 1847.—On Genus of Insects, Trachyphlæus; *J. Walton.*—A new species of Dawsonia; *R. K. Greville.*—On some Chalcidites and Cynipites in the collection of Rev. F. W. Hope; *F. Walker.*—Birds of Calcutta; *C. J. Sundevall.*—Development of the Lycopodiaceæ; *K. Müller.*—On the Siliceous Bodies of the Chalk and other formations; *J. S. Bowerbank.*—A new species of Penella.—Development of Echinidæ; *M. Dufossé.*—Zoological Society.—*L. Pfeiffer* on new land shells; *L. Reeve* on new species of Chama; *J. H. Jonas* on two new shells.—Bot. Soc. of Edinb.—*Rev. Dr. Fleming* on the defoliation of trees; *Dr. Balfour* on Carex saxatilis and C. Grahami.

Annales des Sciences Naturelles.—*September.*—Forms of the Crania of the inhabitants of the North; *Retzius, Creplin.*—On the Nemertidæ; *de Quatrefages.*—On the Arceuthobium Oxycedri; *A. R. de Fonvert.*—On grafting of Gramineæ; *J. Calderini.*—Conspectus of the genus Biebersteinia; *Joubert* and *Spach.*—On varieties, subspecies and species; *Chevreul.*

October.—On the Nemertidæ; *de Quatrefages.*—On species, &c.; *Chevreul.*—Development of leaves; *C. E. de Mercklin.*—On the genus Godoya and its analogues; *E. Planchon.*

November.—On the Nemertidæ; *de Quatrefages.*—Pulmograde Medusæ of the British Seas; *E. Forbes.*—Genera and species of Echinodermata; *Agassiz* and *Desor.*—Genus Godoya and its analogues; *E. Planchon.*—On the Development of the embryo and anomalous corolla in the Ranunculaceæ and Violariæ; *F. M. Barneoul:* ibid, *A. Brongniart.*—On the origin of roots; *A. Trécul.*

December.—Agassiz's Echinodermata continued.—Metamorphosis of the Scathopses nigra; *Dufour.*—Origin of roots; *A. Trécul.*—Analecta Boliviana; *J. Remy.*—Note on the Zamia muricata; *de Vriese.*—Flora of Colombia; *L. R. Tulasne.*—On the duration of the faculty of germinating in grains of different families.

January, 1847.—Metamorphosis of the Subula citripes and Cassida maculata; *Dufour.*—On the petrifaction of shells in the Mediterranean; *M. de Serres* and *L. Figuier.*—Development of the Echini; *Dufossé.*—Lobiger and Lophocercus, new genera of Gasteropoda; *Krohn.*—On the circulation of the blood in the Coleoptera; *Nicolet.*—Development of the ovule in the Avicennia; *W. Griffith.*—On the Ustilagineæ, compared with the Uredineæ; *L. R. and C. Tulasne.*

Comptes Rendus Acad. Sci. Paris.—*Dec.* 28, 1846.—On the Trilobites of the schist of Brittany; *M. Rouault.*—On the elasticity and cohesion of the principal tissues of the human body; *G. Wertheim.*—*Jan.* 4, 1847.—On pyroxyline; *Pelouze.*—Microscopic anatomical researches on the shell of Decapod Crustacea; *J. Lavalle.*—*Jan.* 11.—On the relation between charges of powder and the initial force they communicate to balls, &c.; *Morin.*—Provisional elements of Leverrier's planet; *Valz.*—*Jan.* 18.—Essay on tidal currents and liquid waves; *Keller.*—*Jan.* 25.—On pyroxyline, hypoazotic cotton and xyloidine; *Payen.*—Compounds with Mannite, &c. analogous to pyroxyline; *Flores Domonte* and *Menard.*—Effects of ether in respiration; *Roux, Velpeau, Langier, Gerdy.*—On the borates; *A. Laurent.*—*Feb.* 1.—Effects of ether; *Velpeau, Magendie, Milne Edwards, Roux, Lallemand.*—New system of aerial locomotion; *van Hencke.*—*Feb.* 8.—Effects of ether on animals; *Gruby.*—New series of acids of sulphur; *Plessy.*—Inhalation of ether; *Bourier, Hutin, Tavernier.*—*Feb.* 15.—Memoir on a new mode of treating nitrates, and especially saltpetre; *Pelouze.*—Action of chlorated alkalies on polarized light and on the animal economy; *A. Laurent.*—Effects of ether; *Serres, Magendie, Velpeau, Roux, Flourens.*—M. Civiale elected a member in place of M. Bory de Saint Vincent, deceased.—On detonating products from nitric acid and sugar, dextrine, &c.; *A. Sobrero.*—*Feb.* 22.—Effects of inhalation of ether on the medulla oblongata; *Flourens, Magendie.*—Connection between the difference in constitution of sulphuric and nitric ethers, and their different effects on the animal economy; *Balard.*—Equilibrium of bodies; *de Saint-Venant.*—Influence of alkalies in different natural phenomena, and especially of ammonia in nutrition; *F. Kuhlmann.*—Inhalation of ether; *Laugier, Gerdy, Amussat, Landouzy.*—On the compounds of phosphorus; *Wurtz.*—Formation of the Aorta.—Elements of Hind's comet of Feb. 6.—*March* 1.—On the decease of B. Delessert.—On the Artesian well near Calais.—On the movements of a system of molecules; *Cauchy:*—on some properties of complex factors; *Cauchy.*—*March* 8.—On the Hipparitherium, new genus of Solipeds; *Christol.*—Researches on electric conductility; *Becquerel.*—On the use of ether for distinguishing pretended disorders from real; *Baudens.*—Effects of ether; *Flourens, Joly, Amussat, Cardan, Bourguet, Mayor.*—Pyroxyline; *Richier.*—*March* 15.—On the mineral water of the Paramo de Ruiz, N. Granada; *Boussingault, Lewy.*—Compositions of different kinds of wood; *Chevandier.*—On the true nature of anhydrous fluohydric acid; *Louyet.*—Compounds of cyanogen; *Wurtz.*—On terrestrial magnetism, or a new principle of celestial physics; *Lion.*—Glaciers of the north and center of Europe; *Durocher.*—Hind's comet.—*March* 22.—Polynomial radicals; *Cauchy.*—Ether injected into the veins; *Flourens.*—Effects of ether.—Hind's comet.—*March* 29.—Simple electro-chemical currents formed of liquids; *Becquerel.*—Polynomial radicals; *Cauchy.*—Identity of Leverrier's planet with a star observed by Lalande.—Theory of dew; *Melloni.* On the potato disease; *Payen.*—Mechanical properties of different kinds of wood; *Chevandier and Wertheim.*—Method of determining the nitrogen in organic substances; *Peligot.*—Apparatus for determining the velocity of electricity; *Silbermann.*

Archiv für Naturgeschichte, *Berlin, 4th Heft*, 1846.—On a new species of Proteus; *H. Freyer.*—On the contractile cells of the embryo of Planaria; *A. Kölliker.*—Gammarus ambulans, n. sp.; *A. F. Müller.*—Acanthocerus rigidus, n. sp. of Crustacea, Fam. Cladocera; *J. E. Shödler.*—Notice of works and memoirs on mammalia and birds, for the year 1845; *A. Wagner.*

APPENDIX.

Descriptions of Fossil Shells of the Collections of the Exploring Expedition under the command of Charles Wilkes, U.S.N., *obtained in Australia, from the lower layers of the coal formation in Illawarra, and from a deposit probably of nearly the same age at Harper's Hill, valley of the Hunter;* by James D. Dana, Geologist of the Expedition.*

1. *Bellerophon undulatus.*—Sparingly compressed, back of whorls rounded, surface smooth, having a series of distant plications crossing the back parallel with the lines of growth, (or nearly V shape with the angle rounded,) giving it an undulate outline, plicæ most abrupt on posterior side, becoming obsolete laterally, aperture deltoido-lunate, a little dilated laterally.—Diameter of species ¾ inch; thickness through the centre ⅜ of an inch; about four plications in a distance of half an inch. —*Harper's Hill.*

2. *Bellerophon strictus.*—Discoid, much compressed, smooth and without markings, aperture narrow compressed-lunate, not dilated, the part of the aperture either side of the included body of the shell very narrow; back of the whorls rotund. Thickness at middle half the diameter. Resembles a Goniatite, but there are no septa.—*Illawarra.*

3. *Platyschisma? depressum.*—Large, very much depressed, suborbicular, spire very low; whorls three or four, much flattened, back somewhat truncate, surface without markings excepting striæ of growth. —Diameter 4½ inches.—*Harper's Hill.*

4. *Pleurotomaria tri-filata.*—Shell rather short turreted; whorls four, separated by a distinct suture, back tri-carinate, the middle carina largest, subacute; aperture orbicular.—Large specimens are eight lines long, and five broad at base.—*Harper's Hill* and *Illawarra.*

5. *Pleurotomaria nuda.*—Shell much depressed, whorls four or five, smooth, rounded, low-carinate, with an obsolete sulcus either side of carina; volutions separated by a distinct suture.—Specimen is ¾ of an inch in diameter, and about half an inch in length.—*Harper's Hill.*

6. *Natica* ——?—*Illawarra.*

7. *Patella tenella.*—Short conical, apex pointed, slightly recurved, not projecting beyond base; base oblong ovate, narrowest beneath the beak, length about twice greatest breadth. Length of base ⅝ of an inch; height ⅜ of an inch. On the specimen, which is a neatly pre-

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* A detailed account of these and other fossils from Australia, illustrated by figures, will appear in the Government Geological Report by the writer, now nearly ready for publication. As interesting associations of species and genera will be perceived, the writer would remark, that the species with few exceptions were obtained by himself at the localities. He offers here no opinion as to the particular age of the deposits.

The writer would acknowledge the very essential aid he has kindly received from Prof. Agassiz in the study of many of the species.

served cast, only a small portion of the original shell remains, from which it appears that the surface was smooth, and marked only by faint lines of growth.—*Harper's Hill.*

PENTADIA, (nov. gen.)—This name is proposed for singular flat fossils, which have one side quite smooth, the other delicately and closely marked with parallel subcrenulate ridges having the angles of a regular pentagon and concentric. Two of the specimens are casts of the exterior, and the other is a calcareous petrifaction. As the last mentioned is quite solid, having the oblique cleavage of many calcareous fossils, (the spines of Echini, &c.) it is evident that the original was solid, and could not have been a *Porpita*, which one of the specimens somewhat resembles. And since, besides, there is no appearance of a mouth or any opening, or organs of motion, and the form varies very much, we may infer that the fossils were an internal secretion probably of some mollusk, and more allied to the cuttle-fish bone than any thing else we can suggest. The first species here described has much the appearance of a Spatangus.

8. *Pentadia spatangus.*—Form pentagonal or approximately twelve-sided, suborbicular, with five broad and rounded folds (one largest) radiating from the centre. The concentric pentagonal markings have the five angles at the centres of the triangular sections; and at the centres of four of the sides of the pentagon, there is a reëntering angle.—Diameter 2 inches; thickness $\frac{1}{8}$ inch.—*Illawarra.*

9. *Pentadia reniformis.*—Resembles a single segment of the preceding, with a broad lateral wing-like prolongation, nearly as large as the segment. It is quite thin, and its shape is reniform, though somewhat arcuately flexed. The specimen is undoubtedly a perfect individual.—Length $\frac{3}{4}$ inch; breadth $1\frac{1}{4}$ inch; thickness 1 line.—*Illawarra.*

10. *Pentadia trigona.*—Shape triangular, slightly arcuately flexed. It is thicker than either of the preceding, and has a rounded margin. It resembles the last in its markings, having the same angle of intersection (that of a pentagon) between two sets of parallel lines.—Breadth 1 inch; thickness $\frac{1}{4}$ inch.—*Illawarra.*

11. *Lingula ovata.*—Quite small, regularly broad ovate, acute at beak, margin not at all truncate; valves thin, very convex; surface smooth with faint concentric lines of growth.—Dimensions, from the beak to the opposite margin $\frac{1}{3}$ of an inch; transverse line a fourth less.—Very near the *L. lata* of Murchison, (Sil. Syst., pl. 8, fig. 11,) but not at all "squarish."—*Illawarra.*

12. *Terebratula amygdala.*—Oblong ovate, attenuate above, thickest about the centre, valves about equally and regularly convex, inferior margin arcuate, ventral valve very regularly ovate in outline; beak reflexed close to apex of ventral valve; aperture round and rather large; line of junction of valves in side view almost straight, very slightly bent above, the cardinal edges being little concave; surface smooth with a few concentric folds and some faint radiations.—Cardinal angle 82°; height $1\frac{1}{8}$ inch; breadth $\frac{72}{100}$ H.; thickness $\frac{46}{100}$ H. Near the *T. hastata.*—*Illawarra.*

13. *Terebratula elongata.*—(*Verneuil*, Palæozoic Rocks of Russia, p. 63, pl. ix, fig. 9.)—Scarcely differs from this species as described and figured by Verneuil.—*Illawarra.*

14. *Productus fragilis.*—Subquadrate, with front angles rounded, rather broader than long, hinge line straight, nearly of the breadth of the shell, front straight, upper valve very convex, irregularly longitudinally striated, with some concentric plications, sometimes with occasional rudiments of spines, front and sides rather abruptly reflexed; beak small, projecting but little below the hinge line, and the apex not much inflexed.—Length of hinge line $1\frac{1}{2}$ inches; depth of concavity below, over half an inch.—This species is very unlike the *brachythærus* in its less prominent beak and longer hinge line. It is near the *rugosus*, but is much thicker and more convex above.—*Illawarra.*

15. *Solen* (*Solecurtus?*) *ellipticus.*—Shell very slightly convex, very regularly elliptical, with no trace of a beak, breadth little less than half the length, anterior part rather more than one-third the whole length; smooth with fine scarcely apparent concentric striæ, supero-anterior margin slightly depressed, and perhaps two or three faint radiations from the hinge over the lateral surface (apparent in the cast of the under surface of the valve, but not of the upper); cast of the hinge showing no teeth though apparently perfect.—Length 1·4 inches; height $\frac{48}{100}$ L.—*Illawarra.*

16. *Solen* (*Solecurtus?*) *planulatus.*—Shell flat except a slight bending over the postero-dorsal portion; no beak, elliptical in outline with the inferior and dorsal margins straight, and the anterior and posterior extremities of equal breadth; breadth more than half the length; surface smooth with some faint concentric undulations and lines of growth, apparent especially near inferior margin; no palleal or muscular impressions visible.—Length $1\frac{2}{3}$ inch; height $\frac{48}{100}$ L.—*Harper's Hill.*

17. *Pholadomya undata.*—Nearly or quite equivalve, oblong transverse, subelliptical; beak projecting but little; thinning to an acute edge in front, prolonged and narrowing somewhat behind; sides flattened, posterior surface from the beak to the posterior angle obliquely truncate and exteriorly subcarinate; cardinal area linear, circumscribed; surface with a few irregular obsolescent longitudinal plicæ or undulations, smooth, crossed, especially below, by faint radiations.—Length $3\frac{1}{16}$ inches; height $\frac{59}{100}$ L; thickness $\frac{35}{100}$ L; distance of summit of beak from anterior margin $\frac{33}{100}$ L; apical angle 138°; projection of beak above cardinal margin one-eighth of an inch.—*Illawarra.*

18. *Allorisma audax.*—Transverse, very inequilateral, left valve largest, front very broad and flattened, and having a narrow area adjoining the margin extending down from the beaks which is a little concave; posterior prolonged and much compressed, narrowing and somewhat recurved, gaping; beaks very large and prominent, incurved, contiguous; lateral surface anterior to middle strongly flattened, or even concave; surface unevenly plicate and having some faint radiations laterally and posteriorly, plications large rounded and smooth, the alternate mostly becoming obsolete towards middle of lateral surface.

Length $4\frac{3}{4}$ inches; height $\frac{63}{100}$ L; thickness $\frac{47}{100}$ L; the beaks are much more prominent than in the *A. curvatum*, the posterior extremity much narrower, the flank less inflated, and the front more abruptly truncate.—*Illawarra.*

Cleobis, (nov. gen.)—Shell inequivalve, inequilateral, thick, transverse subovate, closed (or nearly so.) Beaks large, salient and incurved. Posterior margin broadly rounded and a little dilated. Ligament internal. Hinge line flexed to one side at middle and passing beneath the lower of the beaks. Valves thin. Surface marked unevenly with regular concentric striæ of growth and without radiations.—This genus appears to be near the Ceromya of Agassiz; but of this we cannot be certain, as the palleal and muscular impressions are not visible. There is much external resemblance to the *Avicula cuneiformis* of Verneuil, (Russia, pl. xli.) The beaks are prominent and incurved, but are not flexed at all forward; they project over or overhang the cardinal line, the summit being separated from it by an intervening space. The valves are quite thin, the thickness being less than a line in a large species measuring seven inches in length.

19. *Cleobis grandis.*—Thick, very convex, right valve largest; front very abrupt; anterior part about one-third the whole length; inferior margin regularly arcuate; surface concentrically striate and a little undulate.—Length of large specimens seven inches, height $\frac{69}{100}$ L; thickness $\frac{60}{100}$ L; apical angle 105° —*Illawarra.*

20. *Cleobis gracilis.*—Resembling *C. grandis*, but more projecting anteriorly; anterior portion, about two-fifths the whole length.—Length 2·9 inches; height $\frac{72}{100}$ L; thickness $\frac{50}{100}$ L; apical angle 125°.—*Illawarra.*

21. *Cleobis? recta.*—Subelliptical, somewhat compressed; lateral surface flattened; marked with concentric lines of growth; inferior margin straight at middle, parallel with dorsal; postero-dorsal margin much dilated.—Length 3½ inches; height probably $\frac{60}{100}$ L; thickness $\frac{41}{100}$ L. The straight lines of growth over the medio-lateral surface, and straight medio-inferior margin give a peculiar character to this species.—*Illawarra.*

22. *Astarte gemma.*—Transverse, very nearly equilateral, surface evenly convex, delicately marked with deep concentric striæ, margin of the valves crenulate within; large anterior muscular impression a little excavate, transverse and suboval; smaller anterior excavate, oblong; posterior rather faint; palleal impression faint but distinctly without a sinus, and quite reaching the anterior muscular impression; surface of cast smooth.—Length $\frac{3}{5}$ inch; height $\frac{83}{100}$ L; thickness $\frac{45}{100}$ L; anterior part $\frac{7}{15}$ of the whole length; apical angle 140°. The impression of two divergent teeth is finely preserved.—*Illawarra.*

The following species have the entire palleal impression, two anterior and one posterior muscular impressions, and the external ligament of *Astarte*. Yet the form is more transverse and inequilateral than is characteristic of that genus, and the ligament is longer, occupying the whole cardinal area. The beak of an interior cast has the summit obliquely truncate, and the lateral surface just posterior to middle is more or less flattened. The large muscular impressions are broad subelliptical or suborbicular, with the upper side often straight. The smaller anterior is situated under the beaks as in Astarte. The exterior surface is concentrically striate. The valves at middle are quite thin, hardly $\frac{1}{60}$ of an inch in the first of the following species, and they thicken below towards the margin, where the same species is half a line thick. Although we have not yet made out the teeth of the hinge, we propose to describe the species under the generic name *Astartila.*

23. *Astartila intrepida.*—Thick, somewhat transverse, neatly but somewhat unevenly concentric striate; anterior part about $\frac{1}{3}$ the whole length. Anterior muscular impression excavate; smaller subquadrate or a little oblong; larger marked with a number of fine vertical striæ on the lower posterior quarter; antero-lateral surface of the interior with two parallel flattened areas, the one adjoining the muscular impression convex, (concave in the cast.)—Length $1\frac{3}{4}$ inch; height $\frac{80}{100}$ L; thickness $\frac{52}{100}$ L; apical angle about 120°.—*Illawarra.*

24. *Astartila cyprina.*—Thick, transverse, length more than one third greater than height; palleal impression very distinct, inner surface of valve very minutely rugose, below palleal impression radiately subplicate; posterior muscular impression not excavate, crossed vertically by a fold; large anterior deeply excavate, convex, crossed by a few faint vertical lines, which are closer towards the posterior margin; smaller somewhat excavate, oblong sigmoid. Cast with antero-lateral surface simply a little flattened.—Length $2\frac{1}{12}$ inches; height $\frac{72}{100}$ L; thickness $\frac{58}{100}$ L; apical angle about 118°.—*Illawarra.*

25. *Astartila cytherea.*—Thick, slightly longer than the height; inner surface smooth, palleal impression rather faint; posterior muscular impression large and very distinct, very slightly excavated, not intersected by a vertical fold; larger of the two anterior deeply excavate, the excavation deep and very abrupt on the upper side, four or five striæ crossing the muscular impression vertically near posterior margin; smaller anterior oblong sigmoid, but not excavate. Cast with antero-lateral surface simply somewhat flattened.—Length of *cast* $1\frac{1}{2}$ inch; height $\frac{90}{100}$ L; thickness $\frac{66}{100}$ L; apical angle 112°.—*Illawarra.*

26. *Astartila polita.*—Rather thin, somewhat transverse; surface smooth and shining, with faint lines of growth; muscular impressions scarcely excavate and palleal impression faint; the larger anterior very even and without vertical striæ or plications; a slight fold in the surface just anterior to posterior muscular impression, and a smaller one crossing this muscular impression. Cast with antero-lateral surface simply very slightly flattened.—Length 1 to $1\frac{3}{4}$ inch; height $\frac{74}{100}$ L; thickness $\frac{50}{100}$ L; apical angle about 113°.—*Illawarra.*

27. *Astartila cyclas.*—Rather thin, slightly transverse; surface marked unevenly with concentric striæ; posterior muscular impression very distinct but hardly excavate, a fold in the inner surface of the valve just anterior to it; both of the anterior muscular impressions strongly excavate; the larger without vertical striæ; the smaller placed obliquely so that the cast of it is a linear trenchant ridge; palleal impression very distinct, somewhat plicatulate. Cast with summits of beaks quite thin, the lateral surface strongly flattened, and another flattened area adjoining anterior muscular impression.—Length $1\frac{1}{3}$ inch; height $\frac{90}{100}$ L; thickness $\frac{45}{100}$ L; thickness of cast $\frac{40}{100}$ L; apical angle 135°.—*Illawarra.*

28. *Astartila transversa.*—Thick, transverse, length full a third greater than height; posterior muscular impression faint; crossed by a fold vertically, and another more distinct in the surface just anterior to

the muscle; large anterior somewhat excavate, without vertical striæ, small anterior obliquely excavate; palleal impression not very distinct. Cast with antero-lateral surface of beak strongly flattened in two parallel planes, that adjoining the anterior muscular impression a little concave. —Length of cast 1½ inch; height $\frac{73}{100}$ L; thickness $\frac{55}{100}$ L; apical angle of cast 105°, of shell about 115°. This species has two parallel flattened areas on the lateral surface like the *intrepida* and *cyclas;* but its form, the absence of vertical striæ from the anterior muscular impression and other characters distinguish it.—*Illawarra.*

Genus CARDINIA, (*Ag.*)—Form of the species below-described, transverse, and dorsal margin more or less convex without a salient beak; two strong anterior muscular impressions, and one posterior less distinct, the smaller anterior linear, and situated vertically on the front; the palleal impression entire, and not quite reaching to the anterior muscular impression. No cardinal area to the shell, but a strongly defined one to the cast of the interior. The species differ from Cardinia in having the lateral surface posteriorly marked with radiations; the front of an interior cast is strongly truncate, and the flat truncate surface extends on and separates the anterior margins of the large anterior muscular impressions from the medial line; the cardinal areas in the cast are very long linear, and but slightly widen posteriorly. We refer the *Orthonota? costata*, of Morris, to this genus.

29. *Cardinia recta.*—Very inequilateral, narrowing much posteriorly, length 2½ times the breadth, dorsal margin a little convex, inferior straight at middle; lateral surface not depressed, marked with concentric striæ and faint radiations, these radiations producing slight undulations in the lines of growth; palleal and posterior muscular impressions very faint, both of the anterior strong, a convex linear area adjoining the larger extending upward. Interior cast having a very neat, narrow and quite flat cardinal area, with the dorsal margin prominent; lower edge of the cast very thin; surface quite smooth with faint radiations.—Length 2 inches; height $\frac{45}{100}$ L; thickness $\frac{20}{100}$ L; apical angle 125°. The cast resembles much Verneuil's *Solemya primæva*, pl. xix, fig. 5.—*Illawarra.*

30. *Cardinia cuneata.*—Very inequilateral, length about twice the breadth, diminishing posteriorly, and thinning below; superior margin arcuate, interior strongly concave just posterior to middle, and lateral surface depressed; palleal impression distinct; anterior and posterior muscular impressions excavate. Cast with cardinal areas concave and separated from lateral surface by a strong carina, very long, extending to posterior margin.—Length of cast 1½ inch; height $\frac{53}{100}$ L; thickness $\frac{30}{100}$ L; apical angle of cast 110°.—*Illawarra.*

Genus PYRAMUS, (nov. gen.)—Equivalve, somewhat inequilateral, transverse, elliptical, with the front and posterior margins nearly alike, entirely closed; beak somewhat prominent. Ligament external. Palleal impression entire, distant from the margin. Three muscular impressions to each valve, two anterior and one posterior; the larger anterior, suborbicular, smaller anterior, facing the same way with the larger, and situated just above its upper angle; posterior faint. Surface marked with concentric lines of growth. Cast of summit of beak a slender point. Shape nearly of Donacilla and Sanguinolaria, but it differs in its entire palleal impression, and has also two anterior muscular impressions which belong together, to each valve, as in *Corbis.* From the impression of the hinge of a left valve, there appear to be no prominent teeth; it has a very oblique shallow sulcus, directed posteriorly from the centre of the hinge, and a slight excavation anterior to the centre. The form is more transverse and the teeth less distinct than in *Corbis.* It has not the long lunate muscular impression of *Lucina.*

31. *Pyramus ellipticus.*—Oblong, length half greater than breadth, lower margin arcuate, sides evenly convex, surface strongly but unevenly marked with regular concentric striæ, posterior and large anterior muscular impressions rather indistinct, not excavate; palleal impression perceptible and posteriorly plicatulate. Cast of beak acute at apex.—Length $1\frac{3}{4}$ inch; height $\frac{70}{100}$ L; thickness $\frac{41}{100}$ L; apical angle 137°. Another specimen, probably same species, three inches long.—*Harper's Hill.*

32. *Pyramus myiformis.*—Oblong, length two-thirds greater than breadth; exterior smooth, with faint striæ of growth; lower margin nearly straight, lateral surface below somewhat flattened; muscular impressions distinct, posterior not excavate, large anterior a little so above, smaller anterior deeply excavate, and the surface of attachment facing the same way with the larger; palleal impression faint. Cast having the beak terminate in a minute cylinder, and having the lateral surface, from the summit obliquely downward and backward, depressed. —Length 2 inches; height $\frac{61}{100}$ L; thickness about $\frac{35}{100}$ L; apical angle 148° or 150°. The front and posterior margin are more broadly rounded than in the preceding, the lower margin straiter, the apical angle much larger.—*Illawarra.*

33. *Nucula abrupta.*—Thick, elongate, transverse, rather abruptly narrowing behind the summit, and diminishing posteriorly; posterior dorsal margin much concave; anterior margin rounded; cast strongly carinate from the beak to the posterior angle, and having a wide and flat cardinal area; palleal impression distinct, somewhat excavate, smooth; anterior muscular impression somewhat excavate, smooth; posterior strongly excavate in the upper part, (in the cast it lies around the posterior carina, and the upper extremity forms an abrupt angle on the outline of the carina;) surface of cast smooth, some faint radiations hardly distinguishable.—Length $1\frac{1}{3}$ inch; height $\frac{77}{100}$ L; thickness $\frac{40}{100}$ or $\frac{45}{100}$ L; apical angle about 135°; height in the line of the upper part of posterior muscle, about half greatest height.—*Illawarra.*

34. *Nucula* —— ? *Harper's Hill.*

35. *Cypricardia rugulosa.*—Oblong transverse, anterior part one-third whole length, narrowing rather abruptly from the beak posteriorly, posterior surface (flank) broad and flat truncate, with a carinate margin extending from the beak to the lower posterior angle; cardinal area distinct, profound; lateral surface marked with longitudinal striæ of growth, which are quite irregular or undulate, making a right angle (and in some parts a less angle) at the carina; also a few large obsolescent longitudinal folds.—Length 2·9 inches; height $\frac{55}{100}$ L; thickness $\frac{33}{100}$ L; apical angle 132°.—*Illawarra.*

36. *Cypricardia sinuosa.*—Oblong transverse, anterior part about $\frac{2}{5}$ whole length; posterior rather rapidly narrowing but not abruptly;

flank nearly flat and rounding broadly into the lateral surface; lateral surface with a depressed area, extending from the beak to middle of inferior margin; inferior margin straight at middle; surface marked unevenly with fine striæ of growth which are regularly concentric.——Length 3$\frac{2}{3}$ inches; height $\frac{58}{100}$ L; thickness $\frac{35}{100}$ L; apical angle about 142°.—*Illawarra.*

MYONIA, (nov. gen.)—Shell thick, oblong transverse, inequivalve, very inequilateral, much gaping behind. Palleal impression strong, entire. Muscular impressions three to each valve; two anterior and one posterior, all excavate, smaller anterior on the front, posterior on the rounded carina between the flank and lateral surface. Valves thick. Lateral surface strongly flattened at middle or even concave.—Resembles much Panopæa and Pholadomya, especially Agassiz's Arcomya; but differs in its *entire* palleal impression, its second anterior muscle, as well as other characters.

37. *Myonia elongata.*—Thick, right valve rather the larger; greatest height half the length; gradually narrowing behind the beak, inferior margin just posterior to middle somewhat concave, carina from beak to posterior angle broadly rounded, not bent, flank flat, cardinal area long and circumscribed; surface strongly marked unevenly with regular concentric striæ of growth.—Length 6$\frac{1}{5}$ inches; height $\frac{53}{100}$ L; thickness $\frac{42}{100}$ L; anterior part about half the posterior; apical angle 145°. —*Illawarra.*

38. *Myonia valida.*—General form of the *M. elongata*:—but greatest height much less than half the length; flank in cast flattened and distinctly bent near the posterior muscular impression; muscular impressions deeply excavate, and marked with deep vertical sulcations; palleal impression very strong with slender vermiform erosions extending upward from it; also scattered muscular impressions over lateral surface. —Of the same length with the preceding; but greatest height $\frac{58}{100}$ L; apical angle of cast 128°.—*Illawarra.*

39. *Eurydesma elliptica.*—Somewhat compressed, and dilated anteriorly and posteriorly, transverse, right valve largest; beaks contiguous; lateral surface not flattened; surface nearly smooth with occasional faint lines of growth and no trace of radiations; inferior margin arcuate.—Length 2$\frac{3}{4}$ inches; height $\frac{89}{100}$ L; thickness $\frac{55}{100}$ L; apical angle 124°.—*Harper's Hill.*

40. *Eurydesma globosa.*—Thick, tumid, suborbicular, not transverse, very evenly convex; beaks contiguous; lateral surface every where convex; surface smooth with faint concentric lines of growth and no trace of radiations; inferior margin and lines of growth, regularly orbiculate.—Length and breadth 1$\frac{9}{10}$ inch; thickness $\frac{70}{100}$ L; apical angle 97°.—*Harper's Hill?* *Illawarra.*

41. *Modiolopsis simplex.*—Elongate, length rather more than twice the height, very inequilateral, enlarging a little posteriorly; dorsal line horizontal, straight, and rounding into the posterior margin; obliquely truncate in front; inferior margin arcuate; lateral surface evenly convex without a depression anteriorly, or a carina posteriorly; surface marked rather faintly with lines of growth, a little uneven. —Length 1$\frac{1}{2}$ inch; height $\frac{44}{100}$ L; apical angle about 132°.—*Illawarra.*

42. *Modiolopsis siliqua.*—Elongate, length nearly twice the height, very inequilateral, enlarging a little posteriorly; front obliquely truncate; anterior part less than a fourth whole length; dorsal margin straight and nearly horizontal, inferior margin straight; lateral surface flattened but not concave; posterior surface rounded or scarcely carinate near summit of beak; surface marked with irregular obsolescent plicæ and showing also lines of growth.—Length $1\frac{1}{4}$ inch; height (greatest) $\frac{52}{100}$ L; apical angle about 130°. Near *Mytilus Teplofi* of Verneuil, (Russia, pl. xix, 17,) and *Modiolopsis faba*, of J. Hall, (N. Y. Palæont. Report, pl. xxxv, fig. 6.)—*Illawarra.*

43. *Modiolopsis prærupta.*—Elongate (length about twice the greatest height), enlarging somewhat posteriorly, dorsal margin straight or very slightly arcuate, rounding into the posterior margin; inferior excavate anterior to middle; front abruptly truncate; lateral surface excavate from the beak posteriorly downward, also an oblique depression adjoining anterior muscular impression; a few faint rays from the beak over the posterior surface, concentric striæ of growth distinct; anterior muscular impression marginal, excavate, but small and suborbicular. —Length $1\frac{4}{10}$ inch; greatest height $\frac{53}{100}$ L; apical angle 100°. Near *M. faba* of Hall.—*Illawarra.*

44. *Modiolopsis imbricata.*—Moderately elongate, enlarging posteriorly, very inequilateral; dorsal margin straight, and prolonged; inferior margin straight anteriorly, front rounded; lateral surface depressed or somewhat excavate from the beak obliquely backward and downward, having neat concentric subimbricate markings (and some fine radiations on the posterior surface of cast near beak); from beak to posterior margin scarcely carinate; anterior muscular impression very large, oblong, marginal; beaks of cast thin at summit. Texture of shell delicately fibrous and apparently no nacre below.*—Length $2\frac{1}{8}$ inches; greatest height about half the length.—*Harper's Hill.*

45. *Modiolopsis arcodes.*—A thick species resembling the preceding in form and in external markings; but it is much broader in proportion, lateral surface is less flattened anteriorly, cardinal line much shorter than shell, being much less prolonged posteriorly than in *M. imbricata*; line from beak posteriorly more decidedly carinate, beaks thicker. The fibrous texture is very distinct. The anterior muscular impression is very oblong vertically, and projects anterior to the beaks, nearly as in the *Myophora* of Bronn.—Length $1\frac{2}{3}$ inch; height much less than half length. Looks much like an Arca in general form.—*Harper's Hill.*

46. *Modiolopsis acutifrons.*—Thick, elongate, very much broader posteriorly; cardinal line straight, very oblique, very much shorter than shell; front acuminate, posterior broadly rounded; inferior margin excavate near anterior extremity and also just posterior to beak; lateral surface from beak downward and backward excavate, from beak to posterior margin very convex, hardly carinate; surface marked with a few concentric folds, and some lines of growth. Anterior muscular impres-

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* Judging from this texture, the species of Modiolopsis (Hall) are more allied to Avicula than Mytilus, although having a large and strong anterior muscular impression.

sion large and deeply excavate, scarcely marginal. Texture of shell finely fibrous as in preceding species.—Length $3\frac{3}{4}$ inches; angle between cardinal line and line of elongation of shell about 32°. Resembles much a Gervillia in its oblique form.—*Illawarra.*

47. *Avicula* —— ?—Very near *A. volgensis* of Verneuil, Russia, p. 473, pl. xli, fig. 13.—Specimen from *Illawarra.*

48. *Pecten comptus.*—Suborbicular, costæ 20 to 22, without markings, regular, prominent, low triangular with shallow concave furrows, which have usually at middle a slender costa and one or two similar less prominent either side; ears rather large and longitudinally striate. —Length and height $2\frac{1}{3}$ inches; distance at lower margin between middle of two costæ a fifth of an inch. Only one valve was obtained and that was convex. Near *P. Fittoni* of Morris, (Strzelecki, p. 277, pl. 14, fig. 2,) but rays much more numerous.—*Harper's Hill.*

49. *Pecten tenuicollis.*—Nearly orbicular; costæ about twenty-four, very slender and smooth with nearly flat smooth interstices having an intermediate smaller costa.—Length of specimen $1\frac{1}{8}$ inch; height $1\frac{1}{5}$ inch nearly; distance of middle of two costæ at lower margin about $\frac{4}{5}$ of a line. Only a single valve was obtained and that was very convex.—*Harper's Hill.*

50. *Pecten leniusculus.*—Large, nearly orbicular, one valve nearly flat, the other convex; flat valve having concentric undulations; surface very nearly smooth with fine obsolescent striations; striations more distant and rather more distinct on the convex valve; ears large, crossed obliquely by a few folds and striate longitudinally.—Length and height $4\frac{1}{2}$ inches; thickness $1\frac{1}{2}$ inch.—*Illawarra.*

The following additional species of fossil shells from Australia in our collections are described by Morris in *Strzelecki's N. S. Wales and Van Dieman's Land*, Mr. J. D. Sowerby in *Mitchell's Australia*, or G. Sowerby in Darwin *on Volcanic Islands.*

From *Harper's Hill*:—Bellerophon micromphalus (*M.*); Platyschisma oculus (*J. S.*) *M.*, P. rotundatum (*M.*); Theca lanceolata (*M.*); Spirifer subradiatus (*G. S.*); Eurydesma cordata (*M.*); Eurydesma (Isocardia? *J. D. S.*); Pecten illawarrensis (*M.*); Pachydomus antiquatus (*J. D. S.*) *M.*, P. cuneatus (*J. D. S.*) *M.*, Conularia levigata, (*M.*)

From Illawarra:—Pleurotomaria Strzeleckiana (*M.*); Spirifer Darwinii (*M.*); S. subradiatus (*G. S.*), S. avicula (*G. S.*), S. vespertilio (*G. S.*); Productus brachythærus (*G. S.*); Allorisma curvatum (M.); Orthonota (Cardinia) costata (*M.*); Pterinea macroptera (*M.*)

Our collections contain also other undetermined species from these localities, besides several species from Glendon, the species of corals described by Lonsdale, and several new species of coal plants from Illawarra and Newcastle.

ERRATA.

P. 22, l. 14 from bottom, and p. 24, line 17 from top, for "longioribus," read "superantibus."—P. 64, line 16 from top, for "bright," read "light."—P. 74, line 5 from top, for "Class II," read "Class I."—P. 114, after note at bottom, insert Eds.

Vol. iii, p. 295, in the formula of pyroxyline, dele 8HO.

The next No. of this Journal will be published on the first of Sept.

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ART. XIII.—*On the Destruction and partial Reproduction of Forests in British North America;* by JOHN WILLIAM DAWSON, Esq. of Pictou.*

THE changes produced by the agency of civilized man, in the condition of the earth's surface, and the numbers and distribution of its living inhabitants, though not of great importance when compared with those which result from the unceasing operation of natural causes, are interesting to the naturalist, as they illustrate the vicissitudes which many parts of the earth's surface have experienced in ancient times, the extent to which plants and animals can accommodate themselves to changes of circumstances, and the natural compensations which have been provided for the destruction or diminution of particular species. Inquiry into such changes is also of importance as a means of dispelling the mystery which frequently envelopes the succession of organized beings in circumstances of physical change; a mystery which has induced some naturalists to recur to the doctrine of spontaneous generation and the transmutation of species, for explanations of phenomena which if properly examined, would have been found to result from some of the most ordinary causes of the maintenance and distribution of animal and vegetable life.

In North America, and especially in those parts of it forming the United States and British Provinces, such changes have occurred with great rapidity, converting, in a few years, uninhabited forests into countries having the aspect of regions long inhabited

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* From the Edinburgh New Philosophical Journal, April, 1847, vol. xlii, p. 259.

by civilized men. The forests have been destroyed, their living inhabitants extirpated or obliged to adopt new modes of life, new animals and plants introduced and naturalized; and, indeed, a revolution effected in all the departments of organized nature, in the lapse of a single generation. To notice a few of these changes, with reference more especially to the destruction and partial reproduction of forests, is my present object. The facts which I propose to state have been collected principally in the province of Nova Scotia.

In their natural state, Nova Scotia and the neighboring provinces were covered with dense woods, extending from the shores to the summits of the hills. These woods did not form detached groves, but constituted a nearly continuous sheet of foliage, the individual trees composing which were so closely placed as to prevent them from assuming full and rounded forms, and to oblige them to assume tall and slender shapes, that each might obtain air and light. The only exceptions to this are certain rich and usually light soils, where the forest is sometimes more open, and hills too rocky to support a covering of trees. When viewed from the summit of a hill, the forest presents a continuous undulating surface of a more or less dark color and uneven form, in proportion to the prevalence of the deep colors and uneven outlines of the evergreen coniferæ, or of the lighter tints and rounded contours of the deciduous trees; and these two classes are usually arranged in belts or irregular patches, containing mixtures of trees corresponding to the fertility and dryness of the soil. In general the deciduous or hardwood trees prevail on intervale ground, fertile uplands, and the flanks and summits of slaty and trappean hills; while swamps, the less fertile and lightest upland soils, and granitic hills, are chiefly occupied by coniferous trees.

The forest trees spring from a bed of black vegetable mould, whose surface is rendered uneven by the little hillocks of earth and stones thrown up by windfalls; and which, though usually named *Cradle hills*, are in reality the graves of departed members of the forest, whose trunks have mouldered into the mossy soil. These cradle hills are most numerous in thin soils; and are chiefly produced by the coniferous trees, and especially by the hemlock-spruce. There is usually little underwood in the original forest; mosses, lycopodia, ferns, and a few herbaceous flowering plants, however, flourish beneath the shade of the woods.

The woods perish by the axe and by fire, either purposely applied for their destruction or accidental. Forest fires have not been confined to the period of European occupation. The traditions of the Indians tell of extensive ancient conflagrations; and it is believed that some of the aboriginal names of places in Nova Scotia originated in these events. In later times, however, fires have been more numerous and destructive. In clearing land, the trees when cut down are always burned, and, that this may be effected as completely as possible, the driest weather is frequently selected; although the fire then is much more likely to spread into the surrounding woods. It frequently happens that the woods contain large quantities of dry branches and tops of trees, left by cutters of timber and firewood, who rarely consider any part of the tree except the trunk worthy of their attention. Even without this preparation, however, the woods may in dry weather be easily inflamed; for although the trunks and foliage of growing trees are not very combustible, the mossy vegetable soil, much resembling peat, burns easily and rapidly. Upon this mossy soil depends, in a great measure, the propagation of fires, the only exception being when the burning of groves of the resinous coniferous trees is assisted by winds, causing the flame to stream through their tops more rapidly than it can pass along the ground. In such cases some of the grandest appearances ever shewn by forest fires, occur. The fire, spreading for a time along the ground, suddenly rushes up the tall resinous trees with a loud crashing report, and streams far beyond their summits, in columns and streamers of lurid flame. It frequently happens, however, that in wet or swampy ground, where the fire cannot spread around their roots, even the resinous trees refuse to burn; and thus swampy tracts are comparatively secure from fire. In addition to the causes of the progress of fires above referred to, it is probable that at a certain state of the growth of the forests, when the trees have attained to great ages, and are beginning to decay, they are more readily destroyed by accidental conflagrations. In this condition the trees are often much moss-grown, and have much dead and dry wood; and it is possible that we should regard fires arising from natural or accidental causes, as the ordinary and natural agents for the removal of such worn-out forests.

Where circumstances are favorable to their progress, forest fires may extend over great areas. The great fire which occurred in 1825, in the neighborhood of the Miramichi river, in New Brunswick, devastated a region one hundred miles in length and fifty miles in breadth. One hundred and sixty persons, and more than eight hundred cattle, besides innumerable wild animals, are said to have perished in this conflagration. In this case, a remarkably dry summer, a light soil easily affected by drought, and a forest composed of full-grown pine trees, concurred with other causes in producing a conflagration of unusual extent.

When the fire has passed through a portion of forest, if this consist principally of hardwood trees, they are usually merely scorched,—to such a degree, however, as in most cases to cause their death; some trees such as the birches, probably from the more inflammable nature of their outer bark, being more easily killed than others. Where the woods consist of softwood or coniferous trees, the fire often leaves nothing but bare trunks and branches, or at most a little foliage, scorched to a rusty-brown color. In either case, a vast quantity of wood remains unconsumed, and soon becomes sufficiently dry to furnish food for a new conflagration; so that the same portion of forest is liable to be repeatedly burned, until it becomes a bare and desolate "barren," with only a few charred and wasted trunks towering above the blackened surface. This has been the fate of large districts in Nova Scotia and the neighboring colonies; and as these burned tracts could not be immediately occupied for agricultural purposes, and are diminished in value by the loss of their timber, they have been left to the unaided efforts of nature to restore their original verdure. Before proceeding to consider more particularly the mode in which this restoration is effected, and the appearances by which it is accompanied, I may quote, from an article in a colonial periodical, the views of Mr. Titus Smith, secretary of the Board of Agriculture of Nova Scotia, on this subject. These views, as the results of long and careful observation, are entitled to much respect.

"If an acre or two be cut down in the midst of a forest, and then neglected, it will soon be occupied by a growth similar to that which was cut down; but when all the timber, on tracts of great size, is killed by fires, except certain parts of swamps, a very different growth springs up; at first a great number of herbs and shrubs, which did not grow on the land when covered by living wood. The turfy coat, filled with the decaying fibres of the roots of the trees and plants of the forest, now all killed by the fire, becomes a kind of hot-bed, and seeds which had lain dormant for centuries, spring up and flourish in the mellow soil. On the most barren portions, the blueberry appears almost everywhere; great fields of red raspberries and fire-weed or French willow, spring up along the edges of the beech and hemlock land, and abundance of redberried-elder and wild red-cherry appear soon after; but in a few years, the raspberries and most of the herbage disappear, and are followed by a growth of firs, white and yellow birch, and poplar. When a succession of fires has occurred, small shrubs occupy the barren, the Kalmia or sheep-poison being the most abundant; and, in the course of ten or twelve years form so much turf, that a thicket of small alder begins to grow, under the shelter of which fir, spruce, hacmetac (larch), and white birch spring up. When the ground is thoroughly shaded by a thicket twenty feet high, the species which originally occupied the ground begins to prevail, and suffocate the wood which sheltered it; and within sixty years, the land will generally be covered with a young growth of the same kind that it produced of old." Assuming the above statements to be a correct summary of the principal modes in which forests are reproduced, we may proceed to consider them more in detail.

1*st*, Where the wood is merely cut down and not burned, the same description of wood is immediately reproduced, and this may be easily accounted for. The soil contains abundance of the seeds of these trees; there are even numerous young plants ready to take the place of those which have been destroyed; and if the trees have been cut in winter, their stumps produce young shoots. Even in cases of this kind, however, a number of shrubs and herbaceous plants, not formerly growing in the place, spring up; the cause of this may be more properly noticed when describing cases of another kind. This simplest mode of the destruction of the forest, may assume another aspect. If the original wood have been of kinds requiring a fertile soil, such as maple or beech, and if this wood be removed, for example, for firewood, it may happen that the quantity of inorganic matter thus removed from the soil may incapacitate it, at least for a long time, from producing the same description of timber. In this case, some species requiring a less fertile soil may occupy the ground. For this reason, forests of beach growing on light soils, when removed for firewood, are some times succeeded by spruce and fir. I have observed instances of this kind, both in Nova Scotia and Prince Edward Island.

2*dly*, When the trees are burned, without the destruction of the whole of the vegetable soil, the woods are reproduced by a more complicated process, which may occupy a number of years. In its first stage, the burned ground bears a luxuriant crop of herbs and shrubs, which if it be fertile and not of very great extent, may nearly cover its surface in the summer succeeding the fire. This first growth may comprise a considerable variety of species, which we may divide into three groups. The first of these consists of herbaceous plants, which have their roots so deeply buried in the soil as to escape the effects of the fire. Of this kind, is a small species of Trillium, whose tubers are deeply imbedded in the black mould of the woods, and whose flowers may sometimes be seen thickly sprinkled over the black surface of woodland very recently burned. Some species of ferns, also in this way, occasionally survive forest fires. A second group is composed of plants whose seeds are readily transported by the wind. Of this kind, is the species of Epilobium, known in Nova Scotia as the fire-weed or French willow, whose feathered seeds are admirably adapted for flying to great distances, and which often covers large tracts of burned ground so completely, that its purple flowers communicate their own color to the whole surface, when viewed from a distance. This plant appears to prefer the less fertile soils, and the name of fire-weed has been given to it, in consequence of its occupying these when their wood has been destroyed by fire. Various species of Solidago and Aster, and other composite plants, and Ferns, Lycopodia, and

Mosses, are also among the first occupants of burned ground, and their presence may be explained in the same way with that of Epilobium; their seeds and sporules being easily scattered over the surface of the barren by wind. A third group of species, found abundantly on burned ground, consists of plants bearing edible fruits. The seeds of these are scattered over the barren by birds which feed on the fruits, and finding a rich and congenial soil, soon bear abundantly and attract more birds, bringing with them the seeds of other species. In this way it sometimes happens that a patch of burned ground, only a few acres in extent, may, in a few years, contain specimens of nearly all the fruit-bearing shrubs and herbs indigenous in the country. Among the most common plants which overspread the burned ground in this manner, are the raspberry, which, in good soils, is one of the first to make its appearance; two species of vaccinium, called in Nova Scotia, blueberries; the tea-berry wintergreen (*Gaultheria procumbens*); the pigeon-berry (*Cornus canadensis*); and the wild strawberry. It is not denied that some plants may be found in recently burned districts, whose presence may not be explicable in the above modes; but no person acquainted with the facts, can deny that all the plants which appear, in any considerable quantity, within a few years after the occurrence of a fire, may readily be included in the groups which have been mentioned. By the simple means which have been described, a clothing of vegetation is speedily furnished to the burned district; the unsightliness of its appearauce is thus removed, abundant supplies of food are furnished to a great variety of animals, and the fertility of the soil is preserved, until a new forest has time to overspread it.

With the smaller plants which first cover a burned district, great numbers of seedling trees spring up, and these, though for a few years not very conspicuous, eventually overtop, and, if numerous, suffocate the humbler vegetation. Many of these young trees are of the species which composed the original wood, but the majority are usually different from the former occupants of the soil. The original forest may have consisted of white or red pine; black, white, or hemlock spruce; maple, beech, black or yellow birch, or of other trees of large dimensions, and capable of attaining to a great age. The "second growth" which succeeds these, usually consists of poplar, white or poplar birch, wild cherry, balsam fir, scrub pine, alder, and other trees of small stature, and usually of rapid growth, which, in good soils, prepare the way for the larger forest trees, and occupy permanently, only the less fertile soils. A few examples will show the contrast which thus appears between the primeval forest and that which succeeds it after a fire. Near the town of Pictou, woods chiefly consisting of beech, maple, and hemlock, have been succeeded by white birch and firs. A small clearing in woods of maple and beech in New Annan, which, thirty years ago, was under cultivation, is now thickly covered with poplars thirty feet in height. In Prince Edward Island, fine hardwood forests have been succeeded by fir and spruce. The pine woods of Miramichi, destroyed by the great fire above referred to, have been followed by a second growth, principally composed of white birch, poplar, and wild cherry. When I visited this place, a few years since, the second growth had attained to nearly half the height of the dead trunks of the ancient pines, which were still standing in great numbers.

As already stated, the second growth almost always includes many trees similar to those which preceded it, and when the smaller trees have attained their full height, these and other trees capable of attaining a greater magnitude, overtop them, and finally cause their death. The forest has then attained its last stage, that of perfect renovation. The cause of the last part of the process evidently is, that in an old forest, trees of the largest size and longest life have a tendency to prevail, to the exclusion of others. For reasons which will be afterwards stated, this last stage is rarely attained by the burned forests, in countries beginning to be occupied by civilized man.

In accounting for the presence of the seeds necessary for the production of the second growth, we may refer to the same causes which supply the seeds of the smaller plants appearing immediately after the fire. The seeds of many forest trees, especially the poplar, the birch, and the firs, and spruces, are furnished with ample means for their conveyance through the air. The cottony pappus of the poplar seems especially to adapt it for this purpose. The seeds of the wild cherry, another species of frequent occurrence in woods of the second growth, are dispersed by birds, which are fond of the fruit; the same remark applies to some other fruit-bearing species of less frequent occurrence. When the seeds that are dispersed in these ways fall in the growing woods, they cannot vegetate, but when they are deposited on the comparatively bare surface of a barren, they readily grow; and if the soil be suited to them, the young plants increase in size with great rapidity.

It is possible, however, that the seeds of the trees of the second growth may be already in the soil. It has been already stated that deeply buried tubers sometimes escape the effects of fire, and, in the same manner, seeds imbedded in the vegetable mould, or buried in cradle hills, may retain their vitality, and being supplied by the ashes which cover the ground, with alkaline solutions well-fitted to promote their vegetation, may spring up before a supply of seed could be furnished from any extraneous source. It is even probable that many of the old forests may already have passed through a rotation similar to that above detailed, and that the seeds deposited by former preparatory growths may retain their vitality, and be called into life by the favorable conditions existing after a fire. This is a point, however, requiring for its establishment a series of experiments which I have not yet been able to undertake.

If, as already suggested, forest fires, in the uncultivated state of the country, be a provision for removing old and decayed forests, then such changes as those above detailed, must have an important use in the economy of nature, since by their means different portions of the country would succeed each other in assuming the state of "barrens," producing an abundance of herbs and wild fruits suitable for the sustenance of animals which could not subsist in the old forests; and these gradually becoming wooded, would keep up a succession of young and vigorous forests.

3dly, The progress of restoration may be interrupted by successive fires. These are most likely to occur soon after the first burning, but may happen at any subsequent stage. The resources of nature are not, however, easily exhausted. When fires pass through young woods some trees always escape; and so long as any vegetable soil remains, young plants continue to spring up, though not so plentifully as at first. Repeated fires, however, greatly impoverish the soil, since the most valuable part of the ashes is readily removed by rains, and the vegetable mould is entirely consumed. In this case, if the ground be not of great natural fertility, it becomes incapable of supporting a vigorous crop of young trees. It is then permanently occupied by shrubs and herbaceous plants; at least these remain in exclusive possession of the soil for a long period. In this state the burned ground is usually considered a permanent barren; a name which does not, however, well express its character, for though it may appear bleak and desolate when viewed from a distance, it is a perfect garden of flowering and fruit-bearing plants, and of beautiful mosses and lichens. There are few persons born in the American colonies, who cannot recall the memory of happy youthful days spent in gathering flowers and berries in the burnt barrens. Most of the plants already referred to as appearing soon after fires, continue to grow in these more permanent barrens. In addition to these, however, a great variety of other plants gradually appear, especially the Kalmia angustifolia or sheep laurel, which often becomes the predominant plant over large tracts. Cattle straying into barrens deposit the seeds of cultivated plants, as the grasses and clovers, as well as of many exotic weeds, which often grow as luxuriantly as any of the native plants.

Lastly, When the ground is permanently occupied for agricultural purposes, the reproduction of the forest is of course entirely prevented. In this case, the greater number of the smaller plants found in the barrens disappear. Some species of the Solidago and Aster, and the Canada thistle, as well as a few smaller plants, remain in the fields, and sometimes become troublesome weeds. The most injurious weeds found in the cultivated ground, are not, however, native plants, but foreign species, which have been introduced with the cultivated grains and grasses; the ox-eyed daisy or white weed, and the crowsfoot or buttercup, are two of the most abundant of these.

When a district has undergone the last change, when the sombre woods and the shade-loving plants that grow beneath them, have given place to open fields, clothed with cultivated plants, the metamorphosis which has taken place extends in its effects to the indigenous animals; and in this department, its effects are nearly as conspicuous and important as in relation to vegetation. Some wild animals are incapable of accommodating themselves to the change of circumstances; others at once adapt themselves to new modes of life, and increase greatly in numbers. It was before stated that the barrens, when clothed with shrubs, young trees, and herbaceous plants, were in a condition highly favorable to the support of wild animals; and perhaps there are few species which could not subsist more easily in a country at least partially in this state. For this reason, the transition of a country from the forest state to that of burned barrens is temporarily favorable to many species, which disappear before the progress of cultivation; and this would be more evident than it is, if European colonization did not tend to produce a more destructive warfare against such species than could be carried on by the Aborigines. The ruffed grouse, a truly woodland bird, becomes, when unmolested, more numerous on the margins of barrens and clearings than in other parts of the woods. The hare multiplies exceedingly in young second growths of birch. The wild pigeon has its favorite resort in the barrens during a great part of the summer. The moose and cariboo, in summer, find better supplies of food in second growth and barrens than in the old forests. The large quantities of decaying wood, left by fires and wood-cutters, afford more abundant means of subsistence to the tribe of woodpeckers. Many of the fly-catchers, warblers, thrushes, and sparrows, greatly prefer the barrens to most other places. Carnivorous birds and quadrupeds are found in such places in numbers proportioned to the supplies of food which they afford. The number of instances of this kind might be increased to a great extent if necessary; enough has, however, been stated to illustrate the fact.

Nearly all the animals above noticed, and many others, disappear when the country becomes cultivated. There are, however, other species which increase in numbers and at once adapt themselves to the new conditions introduced by man. The robin (Turdus migratorius) resorts to and derives its subsistence from the fields, and greatly multiplies, though much persecuted by sportsmen. The Fringilla nivalis, a summer bird in Nova Scotia, becomes very familiar, building in out-houses, and frequenting barns in search of food. The song sparrow and Savannah finch, swarm in the cultivated ground. The yellow bird (Sylvia æstiva) becomes very familiar, often building in gardens. The golden-winged woodpecker resorts to the cultivated fields, picking grubs and worms from the ground. The cliff-swallow exchanges the faces of rocks for the eaves of barns and houses, and the barn and chimney swallows are everywhere ready to avail themselves of the accommodation afforded by buildings. The acadian or little owl makes its abode in barns during winter. The bob-lincoln, the king bird, the waxwing or cherry bird, and the humming bird, are among the species which profit by the progress of cultivation. The larger quadrupeds disappear, but the fox and ermine still prowl about the cultivated grounds, and the field-mouse (Arvicola Pennsylvanica) which is very abundant in some parts of the woods, is equally so in the fields. Many insects are vastly increased in numbers, in consequence of the clearing of the forests. Of this kind are the grasshoppers and locusts, which, in dry seasons, are very destructive to grass and grain; the frog-spittle insects (Cercopis) of which several species are found in the fields and gardens, and are very injurious to vegetation; and the lepidoptera, nearly the whole of which find greater abundance of food and more favorable conditions in the burned barrens and cultivated fields, than in the growing woods. It may be remarked, in general, that there is no animal, frequenting in Europe the cultivated grounds, and either beneficial or noxious to man, which has not, in the indigenous species of America, an exact representative, filling its place in the economy of nature, and often, in a natural historical point of view, closely related to it. This results from the general sameness of arrangement in the system of nature in the old and new world; and if studied in its details, would form a subject of great interest to the zoologist and physical geographer.

Art. XIV.—*Review of the Organic Chemistry of* M. Charles Gerhardt.

(Concluded from p. 100.)

We have already seen that M. Gerhardt halves the equivalents of most substances, taking the equivalent of hydrogen to be represented by the weight of its atom. Chlorine, bromine and iodine which unite with hydrogen, volume for volume, are also divided so that their volumes correspond to that of oxygen. In many reactions in which carbonic acid and water are evolved, they are observed to be in the proportions $C_2\ O_4$ and $H_4\ O_2$, or in quantities double those which are regarded as equivalents in mineral chemistry. It will also be observed that in the formulas of all those substances which like alcohol and its derivatives are ordinarily represented by four volumes of vapor, the equivalents of carbon and oxygen are divisible by two and those of hydrogen by four. This has led many chemists to consider the oxygen in organic compounds as having double the equivalent ascribed to it in mineral combinations. If we regard $C_2\ O_4$ and $H_4\ O_2$ as representing single equivalents, it will then be necessary to double the formulas of mineral chemistry in order to harmonize the two. If on the other hand these represent two equivalents, the formulas of organic compounds must be divided; and this last course has been adopted by M. Gerhardt.

The protoxyds of the metals corresponding to water in their composition, will hence be expressed by $M_2\ O$, and the equivalents of metals themselves will be one-half the number usually adopted. The equivalents of organic acids are generally determined from their silver salts, and in the monobasic acids the weight corresponding to one atom of silver is taken as the equivalent of the salt; thus the acetic acid is $C_2\ H_4\ O_2$, and the acetate of silver $C_2\ (H_3\ Ag)\ O_2$, in which it is impossible to imagine the existence of water or oxyd of silver, which are $H_2\ O$ and $Ag_2\ O$.

The equivalents of chlorine, bromine and iodine, will by this arrangement, be like oxygen represented by a single volume; those of nitrogen, phosphorus and arsenic, are also divided, while carbon with sulphur and selenium are retained unaltered. The equivalent of water is represented by $H_2\ O$ and equals two volumes of vapor, hydrochloric acid is $HCl = 2$ vol. vapor, and ammonia in like manner is $N\ H_3$ and its equivalent is expressed by two volumes.—(Précis, Vol. I, pp. 47–53.)

Mode of Combination.—Many compounds have the power of exchanging one or more of their equivalents of hydrogen for a metal, thus producing a series of compounds known as salts. All of those metals which unite with chlorine in single equivalents, are able to exchange themselves for hydrogen, equivalent for equivalent. The acids are then to be regarded as salts of hydrogen, and the view which regards them as compounds of an anhydrous acid with water, is inadmissible, as the monobasic acids contain but one equivalent of hydrogen, which is replaced by a metal, while water contains two equivalents of that element. A second mode of combination is that designated by title of *metalepsis* or equivalent substitution. In these as in the salt compounds, certain elements are capable of being replaced by others, without altering the molecular constitution of the organic substance. The phenomena of metalepsis are divided into two classes, those in which hydrogen is replaced by chlorine, bromine or iodine, and those where oxygen is exchanged for sulphur, selenium or tellurium. The two metaleptic groups are illustrated by the following examples.

Metalepsis of Hydrogen.

$C H_4$ Formene, (marsh gas.)
$C (H_3 Cl)$ Chlorinized formene, (chlorid of methyle.)
$C (H_3 Br)$ Brominized formene, (bromid of methyle.)
$C (H_3 I)$ Iodized formene, (iodid of methyle.)
$C (H_2 Cl_2)$ Bichlorinized formene.
$C (HCl_3)$ Trichlorinized formene, (chloroform.)
CCl_4 Quadrichlorinized formene, (chlorid of carbon.)
$C_2 H_4 O_2$ Normal acetate, (acetic acid.)
$C_2 (HCl_3) O_2$ Trichlorinized acetate, (chloracetic acid.)

Metalepsis of Oxygen.

$C_4 H_{10} O$ Ether, (sulphuric ether.)
$C_4 H_{10} S$ Sulphuretted ether, (sulphuret of ethyle.)
$C_4 H_{10} Se$ Seleniuretted ether, (seleniuret of ethyle.)
$C_4 H_{10} Te$ Telluretted ether, (telluret of ethyle.)

In these reactions the substitutions are always equivalent, and since one equivalent of chlorine corresponds to one of hydrogen, and one of oxygen to two of hydrogen, it follows that oxygen cannot like chlorine replace hydrogen.

The metaleptic hydrogen is to be carefully distinguished from that which is replaceable by a metal. The action of chlorine upon acetic acid, removes three equivalents of its hydrogen and substitutes three of chlorine in their place, forming chloracetic acid $C_2 (HCl_3) O_2$, but the fourth equivalent can only be removed by substituting a metal in its place.

Substitution of Residues.—The action of nitric acid upon many organic substances, results in the formation of water and a new compound which contains the elements of the acid; thus benzene $C_6 H_6$, with nitric acid NHO_3 forms an equivalent of water and the new substance $C_6 H_5 NO_4$. In this and analogous compounds, NO_2 has been viewed as replacing one equivalent of hydrogen in the organic body, but a more extended examination has led to the establishment of the following principle. "The hydrogen of one of the bodies unites with the oxygen of the other to form water and the remaining elements are left in combination." The action of nitric acid and benzene may then be thus represented.

$(C_6 H_6 - H_2) + (NHO_3 - O) = C_6 H_4 NHO_2$ and $H_2 O$.

The residue NHO_2 replaces H_2 in the compound.

To distinguish this phenomenon from metalepsis, M. Gerhardt designates it as *accouplement* and the compounds thus formed as *coupled bodies.* This beautiful law admits of a very extended application, and renders useless the various hypothetical radicals which have been assumed to explain the different reactions of organic compounds.

Another class of combinations are those formed by the direct union of two bodies, of which we have examples in the complication of two molecules of the oil of bitter almonds to form one of benzoine; chlorine and hydrochloric acid also unite directly with many essential oils, and the salts of ammonia and the organic alkaloids are examples of the same class of compounds. The application of these principles to different classes of products will be considered farther on.—(Précis, Vol. I, pp. 58–66.)

These changes in the view of the composition of bodies necessarily require some change in nomenclature. Our present system was a grand and beautiful conception worthy of the genius of its framers, and undoubtedly more complete in its plan and its capability of extension than that of any other science. But since it involves in its names of salts the idea that they contain hydrogen in the state of water and metals as oxyds, a theory which is now no longer admissible, some alteration has become necessary. The principle that the name of the compound should express its composition, which is one of the most important features of the old system, is still retained, and the name of the typical substance is the designation of a genus of which the bodies derived from it by replacements, are species to which the binomial nomenclature of Linnæus is applied. The type of the genus is that which contains only the organic elements, and is designated as the *normal species.*

Species of the genus Acetate.

Normal Acetate,	(Acetic acid,)	$C_2 H_4 O_2$.
Potassic do.	(Acetate of potash,)	$C_2 (H_3 K) O_2$.
Argentic do.	(Acetate of silver,)	$C_2 (H_3 Ag) O_2$.
Trichlorinzed do.	(Chloracetic acid,)	$C_2 (Cl_3 H) O_2$.
Trichloro-potassic do.	(Chloracetate of potash,)	$C_2 (Cl_3 K) O_2$.
Trichloro-argentic do.	(Chloracetate of silver,)	$C_2 (Cl_3 Ag) O_2$.

The terminations in *ate* and *uret* are restricted to saline combinations; the hydrocarbons have their ending in *ene;* the oxygenized volatile liquids, like the alcohols and essential oils, in *ol;* and the alkaloids in *ine.*

The second part of the work is devoted to a consideration of the characters of the several classes of organic substances. The salts as among the most important compounds are first noticed; under this title are included the acids (salts of hydrogen) with their derivations, the coupled acids and the various sesquisalts and emetics. An acid may be characterized as a compound which can exchange one or more equivalents of its hydrogen for a metal, and which unites with alcohol to form an ether, with the separation of the elements of water. We know at present those which are capable of exchanging one, two or three equivalents of their hydrogen, constituting monobasic, bibasic, and tribasic salts. The terms bibasic and tribasic are often applied to the compounds of neutral monobasic salts with certain metallic oxyds; the acetate of lead unites with two equivalents of oxyd of lead to form the salts known as the *tribasic acetate;* in this but one equivalent of hydrogen is replaced by the metal, and the two equivalents of oxyd are but feebly united, performing perhaps a function analogous to water of crystallization. Such as these M. Gerhardt conveniently distinguishes as *surbasic salts;* and the compound just noticed, which is $C_2(H_3Pb)O_2$ $+Pb_2O$, will then be the *bisurbasic acetate.*

The action of the oxyds of the formula M_2O with acids results in the formation of neutral salts, and the elimination of the elements of water, which is formed from the union of the oxygen of the oxyd with the hydrogen of two equivalents of the acid. The oxyds of the form M_4O_3, as the sesquioxyd of iron, unite in the same manner with the separation of the elements of water, but their three equivalents of oxygen form water with the replaceable hydrogen of six equivalents of the acid, and the residue which replaces this is equal to only four equivalents. Thus $6C_2H_4O_2+Fe_4O_3=3H_2O+C_{12}H_{18}Fe_4O_{12}$. If we would represent this substitution as equivalent, $Fe_{\frac{2}{3}}$ designated as $Fe^{\beta}=H$, then the peracetate of iron is $C_2H_3Fe^{\beta}O_2$.

In the same manner the sesquioxyd of antimony Sb_2O_3 and arsenious acid As_2O_3 unite with the bibasic acids and form compounds in which Sb_2 is substituted for H_6 or $Sb_{\frac{1}{3}}$ represented by our author as $Sb^{a}=H$. Tartar emetic is an instance of this class of compounds; when the acid, tartrate of potash, is boiled with sesquioxyd of antimony it dissolves, and on cooling, a salt separates, which is $C_4H_4KSbO_7$ Aq. It is formed from $2C_4H_5KO_6+Sb_2O_3=2C_4H_4KSbO_7+H_2O$. The oxyd here loses but one equivalent of its oxygen, and it is the residue $\mathrm{Sb_2O_2 = Sb_2O_3 - O}$ which replaces $\mathrm{H_2}$; we may represent SbO by $\mathrm{Sb^{\circ} = H}$, and the composition of the salt is then $\mathrm{C_4H_4KSb^{\circ}O_6 + Aq}$, while that of tartaric acid is $\mathrm{C_4H_6O_6}$. At a temperature of 212° F. the combined water is expelled and at 428° F. the equivalent of oxygen which we have considered as existing in $\mathrm{Sb^{\circ}}$ unites with two equivalents of the hydrogen and is evolved in the form of water; the reduction of the oxyd is now complete and a new salt results, which is $\mathrm{C_4H_2KSbO_6}$, or as according to the notation of M. Gerhardt, the equivalent of antimony replacing hydrogen is $\mathrm{Sb_{\frac{1}{3}} = Sb^{\alpha}}$, it is $\mathrm{C_4H_2K\,Sb^{\alpha}_3O_6}$. The oxyd of uranium is analogous in constitution to that of antimony, and M. Peligot has obtained a double tartrate of antimony and uranium, which, dried at 212° contains $\mathrm{C_4(H_4U^{\circ}Sb^{\circ})O_8}$; at 392°, a decomposition similar to that of tartar emetic takes place, and the whole of the hydrogen is expelled in the form of water, the residue contains $\mathrm{C_4USbO_6 = C_4U^{\alpha}_3Sb^{\alpha}_3O_6}$. Arsenious and boracic acids form with cream of tartar double salts, analogous to tartar emetic and undergoing a similar decomposition by heat.—(Précis, Vol. I, pp. 498–502.)

These singular compounds are so far removed in many of their characters from ordinary saline compounds, that it is difficult to say in what view we are to regard them.

The use of symbols to denote the forms in which the metal replaces the hydrogen is merely for the purpose of illustration. To regard these as really equivalent substitutions would be to adopt a principle which would involve much perplexity and confusion in other cases, and it is better to view them, as in truth, substitutions by residue, in which the idea of metaleptic substitution is not necessarily implied. The metal in them is frequently no longer recognizable by the ordinary tests; thus in tartar emetic the antimony is not precipitable by alkalies, and the power of the tartaric and many other polybasic vegetable acids to prevent the precipitation of iron and alumina by ammonia is well known. The oxalate of chrome and potash is but partially decomposed either by potash or salts of lime. It is worthy of notice that the volatile acids, a portion of whose hydrogen is metaleptic or replaceable by chlorine, do not like the tartaric acid form compounds in which $\mathrm{M^{\alpha}}$ is substituted for the hydrogen.

The number of equivalents of oxygen in an acid bears a certain relation to its basicity. A monobasic acid may contain two, three, or four equivalents, a bibasic acid from four to eight, and a tribasic acid six or seven; two, four, and six being the minima of oxygen found in the three classes. When a monobasic acid is exposed to the joint action of heat and of a basic oxyd, as of lime or baryta, it loses one equivalent of carbonic acid, and is transformed into a compound which is either a hydro-carbon like benzene, or a neutral oxygenized substance like phenol. This same decomposition is often effected by heat alone, as when the vapor is passed through an ignited tube. The bibasic acids under the influence of heat, lose one or two equivalents of carbonic acid, yielding in the one case monobasic acids, and in the other neutral compounds like the previous class, which result perhaps from the decomposition of the acids previously formed. Tribasic acids in the same manner yield one equivalent of carbonic acid, and a bibasic acid or two, and monobasic and perhaps a neutral compound, with the elimination of three of carbonic acid. In many of these reactions a portion of the oxygen and hydrogen is also disengaged in the form of water.—(Précis, Vol. I, pp. 78–80.)

The solubility of acids in water bears a certain relation to their equivalents and to the amount of oxygen which they contain; in those containing atomically the same proportions it is inversely as their equivalent; this is well illustrated by the class of acids mentioned on page 99. When the carbon is the same, the solubility increases with the amount of oxygen; for example, the tannic, coumaric, and cinnamic acids each contain $C_9 H_8$; while the amount of oxygen is respectively six, three, and two equivalents. The tannic is very soluble in water, the coumaric slightly so, and the cinnamic least of all. Similar relations are to be observed in neutral bodies, and very often guide us in the examination of new and unknown substances.

Coupled Salts.—We have already explained our author's use of the term accouplement to describe certain combinations in which an acid unites with an organic substance with the separation of the elements of water, and forms a compound in which the peculiar properties of neither of its components are recognizable. Those formed by a monobasic acid are neutral, but if the acid is polybasic and combines with but one equivalent of the organic substance, the result is a *coupled acid.* Sulphuric acid unites in this way with almost all organic substances; with alcohol it forms the sulpho-vinic acid; it combines with the hydrocarbons, as napthaline and benzene, with sugar and starch, with azotized bodies like indigo, and with acids, as the acetic and succinic. Analysis demonstrates that these combinations contain the elements of one equivalent of organic matter, and one of sulphuric acid minus the elements of one equivalent of water.

The baryta salts of all these acids are soluble in water and frequently in alcohol. The acids produced by the accouplement of neutral substances with sulphuric acid are monobasic; those formed with a monobasic acid, as the acetic, are bibasic;

while those, like the sulpho-succinic, derived from the bibasic acid, are tribasic. The sulphuric acid is bibasic,* and from these facts we deduce the law, that the basicity or capacity of saturation in a coupled salt is always less by one than the sum of the basicities of its components. Thus sulpho-vinic acid is formed from one equivalent of a bibasic acid and one of alcohol, which is neutral, and is monobasic $(2+0)-0=1$. The sulpho-succinic is derived from two bibasic acids and is tribasic, $(2+2)-1=3$. This law is applicable to all cases of accouplement. The phosphoric acid, which is tribasic, unites with alcohol to form a bibasic acid. Similar coupled acids are formed by oxalic, carbonic, tartaric acids and others with the alcohols.

The couples of sulphuric acids are often found by the simple mixture of the two bodies, but with the hydro-carbons of a high equivalent it is necessary to dissolve them in the fuming acid or expose them to the vapor of anhydrous sulphuric acid, and then heat the product with water; in this way the sulpho-acetic acid was formed by Melsens. The lime and baryta salts of all these acids are soluble in water, although the sulphates of these bases are quite insoluble.—(Précis, pp. 98–104.)

The nitric acid being monobasic does not form coupled acids with neutral bodies like alcohol, but its action upon monobasic acids yields a series of azotized acids which are themselves monobasic as $(1+1)-1=1$. The benzoic acid, when boiled for some time with strong nitric acid, yields the *nitrobenzoic*, which contains the elements of one equivalent of each of the acids *minus* one equivalent of water, $C_7H_6O_2+NHO_3=C_7H_5NO_4+H_2O$. The residue of the nitric acid $NHO_3-O=NHO_2$ must be regarded as replacing H_2 in the acid; which is consequently $C_7(H_4NHO_2)O_2$; it is scarcely distinguished from normal benzoic acid in its characters. These acids and their salts are characterized by exploding when suddenly heated. The action of nitric acid upon phenol gives rise to a curious azotized compound described at different times as the *bitter principle of Welter*, carbazotic, picric, nitro-picric and nitro-phenisic acids. It is the final product of the action of nitric acid upon indigo, salicine and many other bodies, but is directly formed from phenol by the same process. Its formula is $C_6H_3N_3O_7$, while phenol is C_6H_6O, and it is derived from this by the complete replacement of its hydrogen by the residue of nitric acid; it may be represented by $C_6(NHO_2)_3=O$; the strongest nitric acid is totally without action upon it.

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[*] Although the sulphuric acid is generally regarded as monobasic, the existence of double and acid salts, and its reactions with organic substances, clearly show that it is a bibasic acid. In these respects it is strikingly contrasted with the nitric acid, which is truly monobasic, forms no acid or double salts, and yields only neutral couples with organic bodies.

Anhydrides.—Many organic acids by the action of heat, lose the elements of water and are converted into substances which in accordance with the theory which regarded the acids as compounds of a dry acid with water, have been styled anhydrous acids. These substances are neutral in their reaction and their solutions have no action upon alkaline carbonates, but when long boiled with water they take up the elements of that liquid and regenerate acids. The acids thus obtained often differ in their properties from the originals; this has been particularly observed of the anhydrides of camphoric and itaconic acids.—(Précis, Vol. I, pp. 106–109.)

The anhydrides formed by the action of heat alone, are those of certain bibasic acids which lose their basic hydrogen in the form of water. Some monobasic acids as the stearic and margaric are decomposed by distillation with anhydrous phosphoric acid and yield neutral fatty substances; but in these the acid loses two equivalents of hydrogen of which only one is basic; the type is hence destroyed and the acid cannot be regenerated from them.

In this class we may conveniently consider all those compounds which under certain circumstances assume the elements of water aud form acids. Isatine when dissolved in a solution of potash, in this way generates an isatate, and when this acid is set free, it is decomposed by a gentle heat into isatiric acid and water. Camphor also when heated with hydrate of potash yields campholic acid which is formed by the union of the elements of water; according to the general idea both camphor and isatine are anhydrous acids.

Amides.—Few subjects have been the cause of more perplexity to chemists that the action of ammonia with organic substances. M. Dumas first observed in the products of the dry distillation of oxalate of ammonia, a white insoluble body to which he gave the name of *oxamide.* It is derived from oxalate of ammonia by the abstraction of the elements of water; $C_2 H_2 O_4 + 2NH_3 = C_2 H_4 N_2 O_2 + 2H_2 O$, and by the action of acids or alkalies reassumes them and regenerates the oxalate and ammonia. When ammonia is added to a solution of chlorid of mercury, hydrochloric acid is set free and forms salammoniac while a white precipitate falls which is $Hg_2 NH_2$; this may be received as a compound of chlorid of mercury with $Hg NH_2$. The residue of the ammonia NH_2 was hence conceived to be compound radical analogous to chlorine in its reactions, to which the name of *amide* or *amidogen* was given, and oxamide was regarded as an amide of CO, the assumed base of oxalic acid, $C_2 H_4 N_2 O_2 = 2(CO + NH_2)$. Subsequently M. Laurent was induced to imagine another radical NH which he called *imide*, and which he viewed as existing in many organic compounds sustaining the same relations as amide. Oxamide itself, might be viewed as containing this substance. The ammonia gives two equivalents of its hydrogen to combine with the oxygen of the organic substance. Thus $C_2 H_2 O_2 + 2 NH$. In other cases the whole of the hydrogen of the ammonia is eliminated in the form of water, and N alone remains combined with the residue. Three equivalents of bitter almond oil and two of ammonia form one of hydrobenzamide with the solution of three of water, $3 C_7 H_6 O + 2NH_3 = C_{21} H_{18} N_2 + 3 H_2 O$. As N_2 here replaces O_3, MM. Millon and Bineau have been induced to consider the equivalent of nitrogen as two-thirds of the number generally adopted. The explanation of all these difficulties is found in the fact that according to the nature of the organic substances, ammonia loses one, two or three equivalents of its hydrogen and leaves NH_2, NH or N only in combination.

The amides of the monobasic acids are derived from one equivalent of the acid and one of ammonia by the elimination of $H_2 O$; thus benzoic acid, $C_7 H_6 O_2$ and $NH_3 =$ benzamide $C_7 H_7 NO + H_2 O$. The amides of the bibasic acids are formed in the same manner from one equivalent of acid and two of ammonia by the elimination of two of water. When but one equivalent of ammonia enters into the reaction, an acid amide is obtained which may be regarded as analogous to the coupled acids already described, (p. 176.) The acid oxalate of ammonia $C_2 H_2 O_4$, NH_3 affords *oxamic acid* $C_2 H_3 NO_3 + H_2 O$. These acids are monobasic in accordance with the law before given; $(2+O)-1=1$. When they or their salts are placed in contact with acids or an excess of caustic potash, they resume the elements of water and regenerate the acid and ammonia. The same change takes place when the acids are long boiled with water.

The amides of some of the bibasic acids are formed in decomposing the ammoniacal salts by heat, and the amides of the other acids may be obtained by the action of ammonia upon their ethers, a process which will be again noticed. Some anhydrides like succinide and isatine combine with ammonia with the evolution of water and the formation of a new amide. That of succinide is called *succinidam;* it is neutral and contains the elements of one equivalent of ammonia and one of succinic acid *minus* $3H_2 O$; by the action of alkalies it regenerates succinic acid and ammonia. The number of amides which may be derived from a single substance is often very great.* The amide acids themselves may form amides; asparagine is the amide of aspartic acid, and when boiled with an alkali takes up $H_2 O$ and loses ammonia forming aspartic acid, which is itself an amide. By the aid of

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* For a notice of the amides of phosphoric acid, the reader is referred to this Journal, ii Series, vol. iii, No. 7, p. 105.

certain ferments, asparagine is completely converted into succinate of ammonia.

The compounds like succinidam which differ from ordinary amides by the elements of water are designated by M. Gerhardt as *hydride amides;* they often present acid characters. Prussic acid is anhydride amide of formic acid, in other words the amide of formic anhydride which is carbonic oxyd CO. When formate of ammonia is heated it is directly resolved into this acid and water $CH_2O,NH_3=2H_2O+CHN$; and when prussic acid is mixed with strong acids, or when its salts are boiled with alkalies, it reassumes the elements of water and regenerates a formate and ammonia. The cyanic acid is the amide of carbonic anhydride (carbonic acid gas), and like the other amides, regenerates ammonia and the acid under the influence of acids and alkalies. A large number of azotized acids are included in this class.—(Précis, Vol. I, pp. 110–120.)

Ethers.—These are compounds resulting from the action of mineral and organic acids upon the alcohols, and like the amides contain the elements of both their constituents *minus* the elements of water. Those of the monobasic acids are formed from one equivalent of the alcohol and one of the acid, by the abstraction of the elements of one equivalent of water. The ethers of the bibasic acids are in a similar manner produced by their reaction upon two equivalents of alcohol. In accordance with the theory of compound radicals, they are regarded as salts of the oxyd of a radical which is derived from the alcohol by the abstraction of the elements of water, but the acids in these supposed salts cannot be detected by the usual reagents; the *chlorid* and *oxalate of ethyle* are not decomposed by salts of silver and lime. When the ethers are heated with a solution of potash, they reassume the elements of water and regenerate alcohol and the acid. In their formation and decomposition these compounds present a close resemblance to the amides; corresponding to the acid amides we have *acid ethers*, or vinic acids. The bibasic acids with one equivalent of alcohol yield coupled acids (see p. 176) which are monobasic. In these and similar reactions, "the substances in which hydrogen or one of the elements at the positive extremity of the electrical scale, predominates, are attacked by oxygen, chlorine and other elements which are placed at the negative extremity of the scale, or by compounds in which these negatively electric elements predominate." The acids, chlorine, bromine and some metallic chlorids are thus electro-negative, while the alcohols, hydro-carbons and ammonia are electro-positive. This division is of necessity only relatively true; thus benzoic acid by its oxygen is negative to alcohol, but is positive to chlorine and nitric acid which act upon its hydrogen.—(Précis, Vol. II, pp. 495, 496.)

In the amides and ethers the ammonia and alcohol are active by their hydrogen, which unites with the oxygen of the acid; if we represent the residue of ammonia $NH_3 - H_2$ by *Am* and that of alcohol $C_2 H_6 O_5 H_2$ by *Al* replacing O; the neutral amide of oxalic acid will be $C_2 H_2 O_2$ *Am_2* and oxamic acid $C_2 H_2 O_3$ *Am;* oxalic ether will be $C_2 H_2 O_2$ *Al_2*, and oxalovinic acid $C_2 H_2 O_3$ *Al.* The action of ammonia upon neutral ethers results in the regeneration of alcohol and the formation of amide. In this way Malaguti has succeeded in forming an immense number of amides. When ammonia is added to oxalic ether in a quantity insufficient to form oxamide, a beautiful crystalline, neutral compound results, which was first discovered by M. Dumas and by him named *oxamethane;* it is an ether-amide and its composition may be represented by $C_2 H_2$ *Am Al.* Oxamethane is an example of a large class of similar compounds which are formed by the action of ammonia upon the bibasic ethers; M. Gerhardt adopts for them the generic name of *amethanes.* The sulphuric ether of wood-spirit, with ammonia, forms *sulphamephylane,* which is $SH_2 O_2$ *Am Al*, the ether being $SH_2 O_2$ *Al_2*.

The ethers of the organic acids are often formed by heating the acid with alcohol, but the action is slow and incomplete, and they are best obtained by distilling a mixture of the alcohol and acid with sulphuric acid. When the ether is not volatile it is easily prepared by passing hydrochloric acid gas through a hot solution of the acid in alcohol; in this way the ethers of the fatty acids are obtained. The ethers are generally artificial compounds, and produced by the reaction of the alcohol and acid; the salicylic ether of wood-spirit however, constitutes the principal part of the essential oil of wintergreen, *Gaultheria procumbens*, and similarity between the odors of many ethers and those of different fruits, renders it not improbable that the odor of the latter may be due to them. Benzoic ether has been observed as a product in the dry distillation of the resin of Tolu balsam.

The ethers of the hydracids contain, like the other ethers of monobasic acid, the elements of one equivalent of alcohol and one of acid *minus* one equivalent of water; but the acid does not contain either the oxygen or hydrogen to form the water eliminated, and hence, according to the view just given, they cannot be regarded as ethers. M. Gerhardt considers them as species, derived from the compound $C_2 H_6$, to which he has given the name of *acetene.* Hydro-chloric ether is *chlorinized acetene* $C_2 H_5 Cl$; when heated with potassium it is decomposed and yields chlorid of potassium and a crystalline compound which is $C_2 H_5 K$. This is decomposed by water into potash and an oily liquid, which was described by Löwig as the radical ethyle, but is really acetene. The hyponitrous ether of Liebig is *nitric acetene* $C_2 H_4 NHO_2$. The corresponding compounds of wood-spirit are the derivatives, a homologous body *formene* CH_4, which is marsh gas.*

The product of the action of sulphuric acid upon alcohol known by the name of ether, contains in an equivalent, = 2 volumes of vapor, the elements of two equivalents of alcohol minus one of water, $2(C_2 H_6 O) - H_2 O = C_4 H_{10} O$. It is found by the accouplement of two molecules of alcohol, and like other coupled bodies, by the influence of acids and chlorine, reassumes the elements of water and yields products which are derived from alcohol. It is evident that ether cannot exist in the ethers of acids as Liebig supposes. The gaseous ether of wood-spirit (methylic gas) is identical with alcohol ether in constitution.

Glycerides.—The researches of Scheele and Chevreul have shown that the vegetable and animal fats are decomposed by the action of potash, lime, and other energetic bases, furnishing a fatty acid and a sweet soluble substance, to which the name of glycerine is given. They were hence regarded as salts of glycerine, until it was shown that this body could not exist in them, when Berzelius proposed to consider them as compounds of the acids with the oxyd of a compound radical, *lipyle*, which formed glycerine by uniting with the elements of water. The inadequacy of such theories has been already seen; our author proposes to regard them as compounds, which like the ethers are derived from the elements of the acid and glycerine by the abstraction of the elements of water. The glycerids of the monobasic acids (the only ones as yet known) contain the elements of two equivalents of the acid and one of glycerine *minus* three of water; stearine is represented by $2C_{19} H_{38} O_2 + C_3 H_8 O_3 - 3H_2 O = C_{44} H_{78} O_4$. The glycerids are decomposed by alkalies with the assimilation of the elements of water; concentrated sulphuric acid acts in the same manner and forms a coupled acid with the glycerine; ammonia decomposes them and yields an amide of the acid: this has been observed in the case of margarine, which produces *margaramide.*

The principal glycerids known are those of the group of homologous acids mentioned on page 99; all of these acids, with the exception of the formic, acetic, and metacetonic, are known to have corresponding glycerids. The *phocenine* obtained by Chevreul from porpoise-oil, is the glyceride of valerianic acid, which the researches of Dumas and Munro have shown to be identical with the phocenic.

The glycerids have hitherto been known only as the products of the vegetable and animal organism, but MM. Pelouze and Gelis have lately observed that on heating a mixture of butyric acid and glycerine, a neutral oily substance separates, which appears

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* See page 172.

to be identical with the *butyrine* of butter, and like it is decomposed by potash, with the formation of glycerine and a butyrate.

Among the other glycerides are oleine, that of castor oil, and some more which have been but partially studied. Oleine undergoes a singular change by the action of nitrous acid or protonitrate of mercury; when a few bubbles of nitrous acid gas are passed through it, it solidifies after a short time into a granular mass, which when saponified affords a white crystalline acid, identical in composition with the liquid oleic acid. Castor oil yields a similar result with nitrous acid, and the same effect is produced upon it by sulphurous acid gas. The glycerids are characterized by evolving the pungent oder of *acroleine* when decomposed by heat.

Alkaloids.—The organic alkaloids are a class of nitrogenized bodies which unite directly with acids. Ammonia may be taken as the representative of them. This substance combines with nitric acid NHO_3, and with the nitrate of copper $NCuO_3$, in both cases forming neutral salts. As the compounds of ammonia with acids present a close resemblance to the salts of potash, it was proposed to regard them as containing a compound metal NH_4, which replaces the hydrogen. The nitrate of ammonia $NHO_3 NH_3$, is upon this view $N(NH_4)O_3$, assimilated to nitrate of potash NKO_3. But this view is sustained but by few analogies. Since ammonia unites in the same manner with acids and their salts, the latter as the ammonia-nitrate of copper $NCuO_3 NH_3$ must be assumed to contain another compound metal $NH_3 Cu$; and from the complete similarity between ammonia and the vegetable alkaloids, their salts according to this theory must each contain a compound metal which is composed of the elements of the alkaloid *plus* an equivalent of hydrogen. In view of the immense number of hypothetical compounds which this theory requires, and the imperfect analogy upon which it is founded, it is preferable to regard the alkaloids and ammonia as bodies which unite directly with acids and metallic salts. Strychnine, for example, combines with nitric acid to form the compound $C_{22} H_{24} N_2 O_2$, NHO_3, and with nitrate of silver $C_{22} H_{24} N_2 O_2$, $NAgO_3$.

These bodies may be divided into two classes; the first are those composed of carbon, hydrogen, and nitrogen. If the equivalent of these is low they are volatile liquids, but when this is more elevated they are often crystalline and not volatile without decomposition. Among them are anilene, quinoleine, nicotine, and conine, with naphthalidam and sinapoline. It is probable that none of these exist ready formed in plants, for although nicotine is obtained when tobacco is distilled with a solution of potash, late researches have shown that it is formed in the process, and the same is probably true of conine. These alkaloids, at least the four first named, are very poisonous. The second class includes those which contain oxygen; these are all solid and crystallizable, and with but a few exceptions, obtained from plants, of which they constitute the active principles. Urea is the only alkaloid which is found in the animal organism, and the only natural one which we have been able to reproduce artificially. The action of ammonia upon oil of mustard and of sulphuretted and seleniuretted hydrogen and ammonia upon aldehyde, afford alkaloids in which sulphur and selenium replace oxygen. Alkarsine is one in which acesenic replaces nitrogen.

M. Hoffmann, in his late beautiful researches, has discovered several new alkaloids derived from anilene $C_6 H_7 N$, by a replacement of its hydrogen. *Chlorainline* and *bichlorainlene* correspond to anilene in which one or two equivalents of hydrogen have been replaced by chlorine, and two corresponding species are obtained which contain bromine. In nitranilene we have a beautiful instance of substitution by the residue of nitric acid. It is anilene in which $NHO_3 - O$ replaces H_2, and is represented by $C_6 (H_5 NHO_2) N$; although it contains the elements of a powerful acid its neutralizing power is the same as anilene itself.

The researches of M. Gerhardt have shown that the alkaloids, like ammonia, act by their hydrogen upon oxydized bodies to form compounds which correspond precisely to the amides. The oxalate of anilene when decomposed by heat loses two equivalents of water, and forms *oxanilide*, which, like oxamide, regenerates oxalic acid and the alkaloids by the influence of acids or alkalies. The anilide of formic acid has also been obtained, and *sulphanilic acid* which is monobasic, and corresponds to the oxamic. The *oxaluric acid* is a coupled acid in which urea sustains the same relation as ammonia in the oxamic; in its decomposition it assumes the elements of water and regenerates oxalic acid and urea.

The artificial alkaloids are formed by a great variety of processes. The action of fused hydrate of potash upon indigo or isatine results in the abstraction of its oxygen and a portion of carbon, which is oxydized at the expense of the water, and forms carbonate of potash, while anilene and hydrogen gas are evolved. The oxygenized alkaloids, quinine, cinchonine, and strychnine, by the same process afford quinoleine. The action of nascent hydrogen upon the nitric species of hydro-carbons has furnished many new alkaloids. When a solution of nitro-benzene $C_6 H_5 NO_2$ is mixed with dilute sulphuric acid and zinc, the liberated hydrogen combines with it and forms anilene with the liberation of two equivalents of water $C_6 H_5 NO_2 + 6H = C_5 H_7 N + 2H_2 O$. The same result is obtained by the action of sulphuretted hydrogen, the sulphur separating. It is from the decomposition of binitric benzene that nitraniline is obtained.

These bodies are often isomeric with amides of known substances, and M. Gerhardt regards them as all amidized species of some nonazotized substances, but differing from ordinary amides in not regenerating ammonia by the action of alkalies or acids. Mr. Fownes has observed that the amides of furfurol and benzoilol, which regenerate ammonia and the oils by the action of acids, may be boiled with a dilute solution of potash without evolving ammonia. On cooling, the alkaline solutions deposit crystals which have the same composition as the original amides; they are no longer decomposed by acids, but combine with them and form well characterized salts, being converted into alkaloids, (furfuroline and benzoline, or amarine of Laurent.) The alkaloids, melamine and ammeline, obtained by Liebig from the decomposition of sulphocyanate of ammonia, correspond to the amides of cyanuric acid, and by long boiling with a dilute acid, are decomposed into salts of ammonia and cyanuric acid. The direct action of ammonia upon organic substances sometimes produces alkaloids; amarine, the benzoline of Fownes, which is isomeric with hydrobenzamide, was obtained by Laurent by the action of ammonia upon a solution of the oil. Phenol combines directly with ammonia at ordinary temperatures, but if the compound is heated for some time in a closed tube, it gives up the elements of water and forms aniline, which corresponds to the amide of phenol. These compounds are designated by M. Gerhardt as *alkalamides*.

There are many other subjects in this portion of the work which it would be interesting to notice, as the characters of the carburets of hydrogen, their constitution and boiling points; but this sketch has already exceeded its proposed limits, and their consideration must be reserved for another time.

The third part of the first volume is devoted to the consideration of the effects of heat and other reagents upon organic substances, and the nature of the changes which they undergo. This is followed by a particular description of all organic bodies, arranged in the order of their families. The latter part of the second volume contains an exposition of the theory of homologues, with an ingenious application of the principles developed in the previous portions of the work, to a natural classification of organic substances with reference to their origin and derivation from each other, and which may form the subject of another notice.

In conclusion, we recommend to all interested in the progress of chemistry, the study of this work, which by its profound research, grand generalizations, and beautiful system, establishes the title of its talented author, to a high rank among the philosophers of the age.

ART. XV.—*On the relative Age and Position of the so-called Nummulite Limestone of Alabama;* by C. LYELL, F.R.S. and V.P.G.S.

IN a former paper, published in the Quarterly Journal of the Geological Society of London,[*] I stated that the limestone containing abundantly the Nummulites Mantelli, Morton, which occurs near Suggesville, Clarksville, and other places between the rivers Alabama and Tombeckbee in the state of Alabama, was a member of the eocene tertiary group, and that so far from constituting any part of the cretaceous formation as had formerly been imagined, it holds in reality a place high up in the eocene series of the South. In the same memoir I gave a section extending from Claiborne through Suggesville and Macon to the west of Clarksville, Alabama, in which the position of the so-called Nummulite limestone was explained. It was stated to be newer than all the beds of the well-known Claiborne bluff, and I mentioned that "the bones of the gigantic cetacean called Zeuglodon by Owen, were everywhere found in Clarke county, in a limestone below the level of the Nummulite rock, and above the beds which contain the greater number of perfectly preserved eocene shells, such as Cardita, Planicosta and others."[†]

At the time that my first communication was written, I had not finished my explorings in Alabama nor visited St. Stephen's bluff on the Tombeckbee river, where I afterwards obtained additional proofs of the order of superposition above indicated. Nor had I then compared the eocene strata at Vicksburg with those of Jackson in the state of Mississippi, which throw light on the same question of relative position. Before adverting to these last mentioned localities, I will first offer a few observations on the country between Claiborne and Clarksville, for I understand that doubts have been lately thrown on the correctness of the views which I have expressed relatively to the true age and place in the series to be assigned to the "rotten limestone of Alabama," and the associated rock in which the fossil first named Nummulites Mantelli, by Morton, abounds.[‡]

Before restating the grounds of my former opinion and corroborating it with fresh proofs, it may be well to say something of the nature and zoological relations of the discoid bodies from Alabama which have passed under the name of Nummulites and

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[*] Vol. ii, p. 405, May, 1846.

[†] Quart. Journ. Geol. Soc., vol. ii, p. 409, May, 1846.

[‡] Sir R. I. Murchison announced to the Geological Society of London, at their meeting, May 26th, 1847, that he had just received a letter from M. Agassiz, in which he stated that M. Desor had clearly shown that the rotten limestone of Alabama was not cretaceous, as Morton and Conrad had supposed, nor eocene, as Lyell had considered it, but was of the age of the *terrain nummulitique* of Biaritz.

which constitute the chief part in bulk, of considerable masses of limestone in certain districts. Having obtained many specimens both from Alabama and from Vicksburg in Mississippi, in which the structure of this fossil was beautifully preserved, I first showed them to Prof. E. Forbes, who at once pronounced them not to be Nummulites, but related to some living plants or zoophytes which Mr. Jukes had brought from Australia. Mr. Lonsdale, who examined them immediately afterwards, said, "They are certainly not Nummulites, but allied to some of the bodies usually termed *Orbitolites*, and are I believe *corals* in the usual acceptation of that word." Afterwards Mr. Forbes having compared the American fossil with the living species from Australia and satisfied himself of its near affinity, sent me the following note, dated June 14th, 1847. "On the so-called 'Nummulites Mantelli.' The American Nummulites Mantelli, judging from Mr. Lyell's specimen, is not a Nummulite nor is it a foraminiferous shell. It is a species of *Orbitolites* and consequently a zoophyte, (probably Ascidian.) The genus *Orbitolites* was established by Lamarck for the reception of a fossil of the Paris basin, the *Orbitolites complanata*, which may be regarded as the type. Other tertiary species and a Maestricht fossil, were associated by Lamarck in the same genus, in which he also placed the '*Orbitolites marginalis*' of the European seas. Respecting the true position of the last-named body, however, there is considerable doubt."

The *Orbitolites* complanata is very nearly allied to the American fossil. The *Orbitolites elliptica* of Michelin, from near Nice, and that author's *Orbitolites Pratti*, are also closely allied species.

In British strata, species of Orbitolites are recorded from the greensand of Milber down, from the chalk of Lewes, and from the coralline crag of Sutton. It is possible however that bodies belonging to distinct genera have been placed together in our lists.

Mr. Jukes has collected at Swan river, in Australia, numerous disciform bodies, apparently Ascidian zoophytes, which occur there in great numbers upon marine plants resembling Zostera, and when dead are found in great abundance in mud, procured by the dredge from various depths under seventeen fathoms. These disks are usually about half an inch in diameter and are composed of minute cells. They appear to me to belong to the same generic group with the tertiary Orbitolites, and such appears also to have been the opinion of Defrance, for we can scarcely doubt that these are the bodies alluded to by him (in the following passage) as living in the seas of New Holland: "Cette espece" (i. e. *Orbitolites complanata* of the Paris basin) "a les plus grands rapports avec celle que l'on trouve vivant dans les mers de la Nouvelle Hollande."* Marginopora of Quoy and Gaimard seems to be a similar body.

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* Dict. des. Sc. Nat., p. 36, Art. Orbitolites.

As the subject stands at present, then, we have no right to infer from the presence of an Orbitolite however abundant, that the stratum in which it occurs belongs to one period more than another between the commencement of the cretaceous epoch and our own times.*

In my former paper, I endeavored to point out the cause of the obscurity in which the true age of the Orbitolite limestone of Alabama had been involved, it having been considered sometimes as an upper cretaceous group, and at others as intermediate between the cretaceous and the eocene formations. The accompanying section from Claiborne bluff to Bettis's Hill, near Macon in Alabama, may serve to explain the relations which I found to exist between the white limestone group of the south, comprising the successive formations 1, 2, 3, and the overlying group 4, which is perhaps of equal thickness but which from the absence of calcareous matter rarely yields organic remains, and those consisting only of silicified casts of shells and corals. This upper formation (4) is composed of variously colored red, pink and white sands, and of yellow ochre-colored sands, white quartzose gravel and sand with beds of chert and flint, blood-red and pink clays and clays of white kaolin or porcelain earth all horizontally stratified. I could find no fossils in those in Alabama, and only conjectured that they are of eocene date from the analogy of Georgia, where a deposit of the like aspect and nature and occupying a similar position contains eocene shells and corals. I formerly explained in 1841–42, the relative position of the upper clay and sands with flint of the burrstone formation of Georgia to the underlying white limestone and marl of the state of South Carolina, in a diagram published in the Journal of the Geol. Soc., vol. i, p. 438, where the newer group is represented as resting on the eocene limestone of Jacksonborough, near the Savannah river. It appeared in that case as in Alabama, that the older calcareous strata of limestone and marl, had undergone great denudation and had acquired a very uneven surface, having been shaped into hills and valleys, before the incumbent clays and sands were thrown down.

At the bluff on the Alabama River at Claiborne, where so rich a harvest of fossils has been obtained, especially in some of the beds of No. 2, we see at one spot called "The old landing," that nearly the whole precipice in its lower one hundred and sixty feet, exposes to view the calcareous beds 1 and 2, covered with about twenty feet of red clay and sand. Whereas at the distance of less than a mile from this spot, the upper formation No. 4, occupies more than one hundred feet of the face of the same cliff from its summit, while at the base the lower members of the cal-

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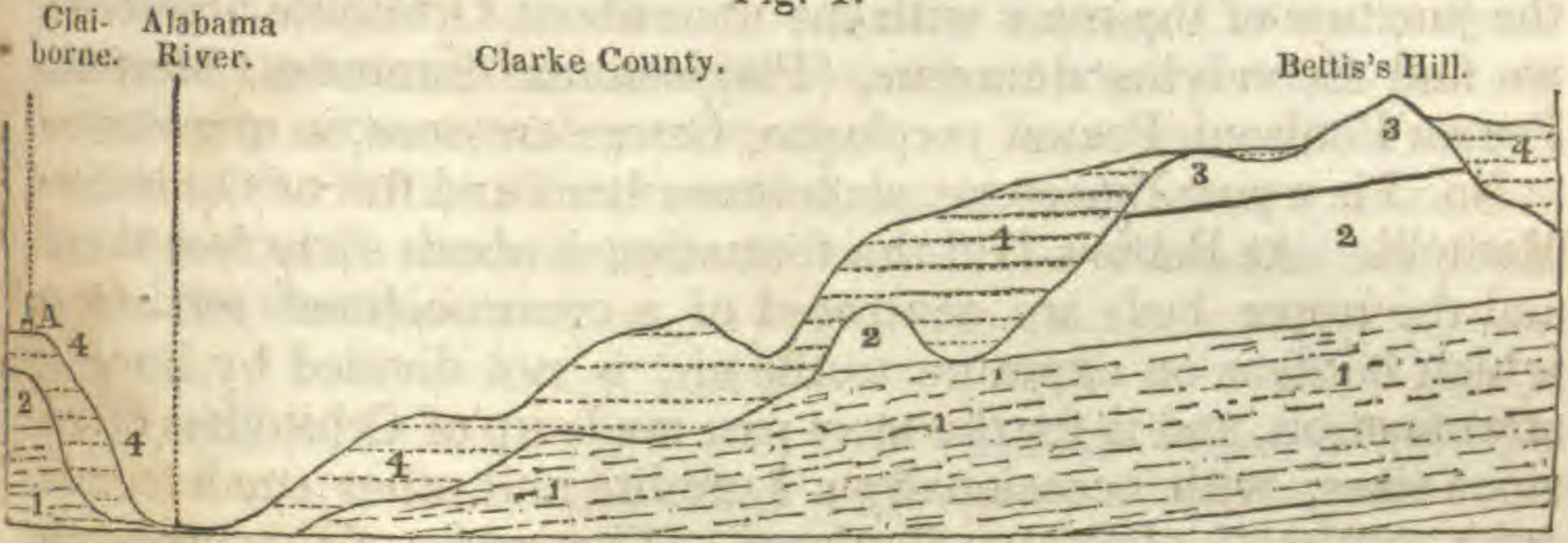
* "The Plagiostoma dumosum of Morton, is decidedly a Spondylus."

careous series crop out from beneath the horizontal and incumbent beds of sand and clay. This twofold composition of the mass of strata in the bluff at Claiborne, is expressed at A, in the annexed wood-cut, (fig. 1,) and I verified a similar mode of juxtaposition of the two series of beds in several places in the interior of Clarke County, where the limestone often ends abruptly and is succeeded sometimes in the same ridge or hill by the newer beds, (No. 4.) the latter having evidently filled up the inequalities of a previously denuded deposit, after which the whole was again denuded.

Fig. 1.



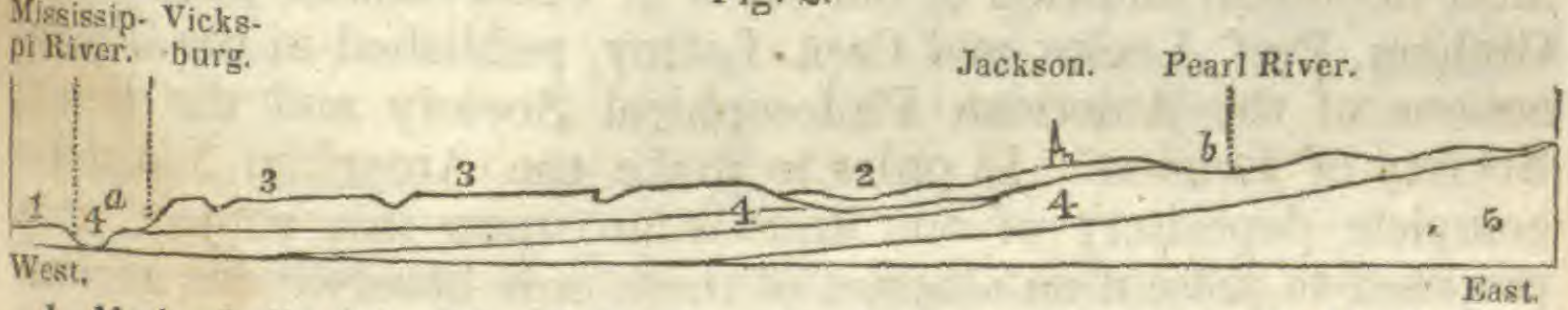
1. Eocene sand, marl, &c., with numerous fossils.—2. White or rotten limestone; Zeuglodon, nautilus, &c., eocene.—3. Orbitolite limestone, eocene.—4. Overlying sand, clay, &c., eocene.

I have suppressed several details and repetitions of the same phenomena in the country represented in the above diagram, (fig. 1,) and have been obliged to give a considerable inclination to the strata, because in the distance of twelve or more miles between Claiborne and Bettis's Hill, although the dip is not perceptible to the eye, the same beds are at the latter place more than twice as high above the Alabama river as at Claiborne. The mass No. 1, about one hundred feet thick at Claiborne, which constitutes the lowest visible member of the eocene series in this region, comprises marly beds with *Astrea sellæformis* seen at the base of the cliff at Claiborne, and an argillaceous stratum with impressions of leaves and sandy beds, with marine shells among which are found Cardita alta and Cardita planicosta, Cardita parva, Crassatella prætexta, Cytherea æquorea, Oliva Alabamensis, Pleurotoma (several species), Solarium canalicaletum, Crepidula lyrata, Endopachys alatum, Lonsdale, and two hundred other species. No. 2, about fifty feet thick, is the white or rotten limestone, which is sometimes soft and argillaceous, but in parts very compact and calcareous, and contains Flabellum cuneiforme, Lonsdale, Scutella Lyelli, Conrad, Lunulites, and several shells, some peculiar, others common to the formation below. Mr. Conrad has already described this section at Claiborne, and I hope soon to give a fuller notice of it with the observations which I made there in 1846. Of the limestone, No. 2, only the lower portion is seen here, for it is cut off at the top of the bluff by the newer series of beds No. 4, but in many parts of Clarke County, as near Bettis's Hill and near Clarksville, the same No. 2 is found more largely developed. It is characterized among other organic remains by a large Nautilus allied to N. ziczac and by the gigantic zeuglodon of Owen. Near the juncture of the mass with the incumbent Orbitolite limestone, we find Spondylus dumosus, (Plagiostoma dumosum, Morton,) Pecten Poulsoni, Pecten perplanus, Ostrea cretacea, in abundance.

No. 3 is a pure limestone, sometimes hard and full of Orbitolites Mantelli. At Bettis's Hill the formation is about sixty feet thick, and the upper beds are composed of a cream-colored soft stone, which hardens on exposure to the air, is not divided by lines of stratification, and is for the most part made up of Orbitolites of various sizes, with occasionally a Lunulite and other small corals, with specimens of Pecten Poulsoni. The origin of this limestone like that of our white chalk, the softer varieties of which it much resembles, is I believe due to the decomposition of corals, and like our chalk downs, the surface of the country where it prevails is sometimes marked by the absence of wood, by which all the other deposits in this part of Alabama are continuously covered. The spots where few or no trees appear are called "bald prairies," but in some places, and at Bettis's Hill among others, the Orbitolite rock produces what is termed a "cedar knoll;" the red cedar, *Juniperus virginiana* having exclusive possession of the ground. I was much struck with the resemblance of such calcareous tracks, covered with the trees above mentioned, to certain chalk regions in the south of England, where the only wood which grows on the white rock consists of yew trees accompanied here and there by shrubs of juniper.

At St. Stephens, on the left bank of the Tombeckbee river, in Alabama, a similar limestone with Orbitolites forms a perpendicular bluff. The water of the river at the time of my visit was too high to enable me to collect fossils from the older beds at the base of the cliff, but I was afterwards furnished with them through the kindness of Prof. Brumby of Tuscaloosa. They are imbedded in a ferruginous ochreous-colored sand, and consist in part of shells common to Claiborne bluff, such as Terebra costata, Conrad, Cardita parva, Dentalium thalloides, Flabellum cuneiforme, Lonsdale, Scutella Lyelli, Con., and several more.

I shall now conclude by adverting briefly to the result of a comparison which I made of the fossils contained in the eocene strata of Vicksburg, on the left bank of the Mississippi river, the position of which is indicated at 4*a* in the wood-cut on the next page, with those of other eocene beds forty-five miles further inland or eastward at Jackson, in the same state. In the former of these at 4*a*, the Orbitolites Mantelli abounds, together with Pecten Poulsoni, Dentalium thalloides, Sigaretus arctatus, Con., Terebra costata, Con., and a few others common to Claiborne; but the great bulk of the associate fossils do not agree specifically with those of Claiborne bluff. I found these distinct species at Vicksburg to be referable to the genera Voluta, Conus, Terebra, Fusus, Murex, Cassis, Pleurotoma, Oliva, Solarium, Natica, Turritella, Corbula, Panopæa, Crassatella, Lucina, Venus, Cardium, Arca, Pinna, Pecten, and Ostrea, with several corals, the whole having a decidedly tertiary and eocene aspect. The genus Pleurotoma, for example, which is represented by several species, is one of the forms most characteristic of tertiary as distinguished from secondary formations.

Fig. 2.

1. Mud of alluvial plain of Mississippi.—2. Superficial drift.—3. Freshwater loam with land shells.—4. Eocene strata.—5. Cretaceous strata —Length of section fifty miles.

At Jackson, which, as before stated, is more than forty miles to the eastward, eocene beds, older than those of Vicksburg, crop out near to the area occupied by cretaceous deposits, as at 4*b*, wood-cut, (No. 2.) Here on the Pearl river I found no specimens of Orbitolites Mantelli, although some are said to have been met with in the vicinity. But I observed that a larger proportion among the fossils, were specimens common to Claiborne bluff, than at Vicksburg. Among these may be mentioned Cardita planicostata, Cardita rotunda, Cytherea æquorea, Natica, like one which I obtained at Claiborne, Flabellum cuneiforme, Lonsdale, and Endopachys alatum, Lonsd., (Turbinolia Maclurii of Lea.) These I found in strata of yellow loam, sand, and marl, on the Pearl river and in the banks and bed of one of its tributaries. The other shells collected by me at the same place, several of them I believe identical with Claiborne species, belong to the genera Voluta, Oliva, Terebra, Rostellaria, Murex, Plurotoma, Umbrella, Natica, Turritella, Crepidula, Dentalium, Corbula, Mactra, Lucina, Cytherea, Cardium, Cardita, Pectunculus, Nucula, Pinna, Pecten, and Ostrea. With these are corals, teeth of fish, &c. I was shown the remains of a Zeuglodon procured from the neighborhood, at a place five miles south of Jackson, on the right bank of the Pearl river, but as I did not visit the locality I cannot point out the precise place in the eocene series which it occupies. Some of the accompanying corals, however, were the same specifically as those occurring with the shells above mentioned at Jackson, and one of my informants stated that this Zeuglodon bed was immediately under "the rotten limestone."

London, June 18, 1847.

ART. XVI.—*Notice of some recent Additions to our Knowledge of the Magnetism of the United States and its Vicinity;* by ELIAS LOOMIS, Professor of Mathematics and Natural Philosophy in the University of the City of New York.

IN the forty-third volume of this Journal I have given a discussion of all the observations of magnetic dip in the United States with which I was then acquainted; and in the forty-seventh volume I have given the comparison of these observations with Gauss's theory. Quite recently we have received a most important addition to our stock of observations, from Major Graham, Prof. Locke, and Capt. Lefroy, published in the Transactions of the American Philosophical Society and the Royal Society of London. In order to make the American Journal a complete depository of our knowledge upon this subject, it is proposed to present an abstract of these new observations accompanied by a few remarks.

The observations of Major Graham were made in the years 1840, '41, '43, '44, and '45. Those of 1840 were made with a dipping needle constructed by Troughton and Simms, having a vertical circle eight inches in diameter, graduated to fifteen minutes. The azimuth circle reads to single minutes by the aid of a vernier. The observations subsequent to 1840 were made with an instrument by Gambey, having a vertical circle ten inches in diameter, and graduated to ten minutes. In conducting the observations, the usual precautions were observed of reversing the poles of the needles, and reading with face alternately east and west. The following is a summary of Major Graham's observations.

TABLE I.

Station.	Latitude.	Longitude.	Dip.	Date.
Lake Pohenagamook, .	47° 28′	69° 13′	77° 49′·2	1843
Beau Lac, . . .	47 22	69 3	77 47	1843
Madawaska River, . .	47 22	68 19	77 47·5	1843
River St. John, . .	47 17	68 27	77 44·5	1843
Fish River, . . .	47 15	68 35	77 43·1	1843
St. Francis River, . .	47 11	68 54	77 43·5	1843
Grand River, . : .	47 11	67 57	77 38·4	1844
Little Black River, .	47 7	69 5	77 40·5	1844
River St. John, . .	47 4	67 47	77 31·0	1843
Falls of St. John, . .	47 3	67 45	77 29·5	1843
Peconk Hill, . . .	46 59	67 47	77 32·2	1841
Big Black River, . .	46 57	69 27	77 37·5	1843
Aroostook, . . .	46 47	67 47	77 24·1	1841
Blue Hill, . . .	46 38	67 47	77 18·1	1841
River St. John, . .	46 35	69 53	77 25·9	1843
Branch of St. John, .	46 25	70 4	77 24·8	1844
Park's Hill, . . .	46 7	67 47	77 1·6	1840
Source of St. Croix, .	45 57	67 47	76 57·4	1840
Taschereau's, . .	45 49	70 24	76 50·4	1844
Moose River, . .	45 39	70 16	76 48·5	1844

TABLE I.—*Continued.*

Station.	Latitude.	Longitude	Dip.	Date.
Kennebec,	45° 20′	69° 58′	76° 23′·7	1844
Canaan Corner,	45 0	71 31	76 23·5	1845
Lake Memphremagog,	45 0	72 13	76 8·4	1845
Rouse's Point,	45 0	73 22	76 40·7	1845
Bangor,	44 48	68 47	76 11·6	1841
Portsmouth,	43 5	70 44	74 51·0	1844
Cambridge,	42 22	71 8	74 17·8	1842
Boston,	42 21	71 4	74 9·4	1841
West Point,	41 24	74 1	73 20·1	1840
New York,	40 43	74 1	72 28·9	1844
Philadelphia,	39 57	75 11	72 1·8	1842
Baltimore,	39 17	76 37	71 39·7	1842
Washington,	38 53	77 1	71 13·1	1842
Sabine River,	32 1	94 0	61 36·8	1840
Natchitoches,	31 44	93 15	61 15·9	1840
Gaines's Ferry,	31 28	93 45	60 57	1840
Mouth of Sabine,	29 44	93 51	58 32·9	1840
Mouth of Mississippi,	28 59	89 21	58 42·2	1840

The observations of Prof. Locke were made with instruments manufactured by the late Mr. Robinson of London. The dipping compass was furnished with two needles, each of six inches in length. The intensity apparatus was of the model invented by Prof. Bache, the needles being vibrated in a glass vessel nearly exhausted of air. The observations of 1838, '39, and '40 having already been copied into this Journal, are not here repeated. The following is a summary of the observations of 1841, '42, '43, and '44.

TABLE II.

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
Isle Royale,	48° 6′	88° 47′	78° 7′·6	1·889	1843
Magnet Inlet,	47 28	88 1	78 38·5	1·910	1843
U. S. Agency,	47 28	88 0	77 13·5	1·950	1843
Houghton's River,	47 28	88 1	77 20·7	1·842	1843
Eagle River,	47 27	88 23	77 54·5	1·861	1843
Ontonagon,	46 52	89 31	77 13·2	1·865	1843
La Pointe,	46 47	90 58	76 56·0	1·875	1843
Encampment, Lake Superior,	46 44	87 43	76 58·3	1·856	1843
Sault St. Marie,	46 31	84 32	77 30·2	1·861	1843
Mackinaw,	45 54	84 10	76 38·8	1·864	1843
Toronto,	43 33	79 20	75 13·0	1·836	1844
Lockport,	43 11	78 46	74 44·2	1·808	1844
Rochester,	43 8	77 51	74 38·8	1·806	1844
Utica,	43 7	75 13	74 48·8	1·809	1844
Buffalo,	42 53	78 55	74 36·5	1·825	1844
Albany,	42 39	73 45	74 41·6	1·792	1844
Detroit,	42 25	82 56	73 32·4	1·815	1843
Boston,	42 22	70 59	74 5·7	1·767	1842
Cambridge,	42 22	71 8	74 14·9	1·774	1842
Ann Arbor,	42 16	83 39	73 13·7	1·828	1843
Ashtabula,	41 52	80 52	73 25·0	1·855	1844
Poughkeepsie,	41 41	73 55	74 5·0	1·799	1844
Cleveland,	41 30	81 42	73 8·0	1·824	1843
Huron,	41 26	82 27	73 0·0	1·817	1843
New Haven,	41 18	72 57	73 29·8	1·774	1842
Warren,	41 16	80 55	72 55·9	1·805	1844
New York,	40 43	74 1	72 37·2	1·783	1842

TABLE II.—*Continued.*

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date
Newark,	40° 43′	74° 10′	72° 48′·5	1·784	1843
Wellsville,	40 38	80 44	72 35·3	1·794	1844
Pittsburgh,	40 32	80 2	72 43·5	1·803	1841
New Brunswick,	40 30	74 25	72 43·2	1·785	1844
Princeton,	40 22	74 39	72 39·5	1·784	1844
Trenton,	40 13	74 40	71 59·0	1·790	1841
Wheeling,	40 8	80 47	72 19·3	1·813	1844
Bristol,	40 6	74 47	72 25	1·768	1842
Philadelphia,	39 57	75 10	72 0·1	1·784	1842
Chambersburg,	39 55	77 40	71 57·1	1·788	1842
Mt. St. Mary's College,	39 41	77 18	71 46·3	1·790	1842
Cumberland,	39 39	78 44	71 36·0	1·789	1844
Baltimore,	39 17	76 37	71 36·8	1·781	1841
Cincinnati,	39 6	84 22	70 25·4	1·795	1842
Washington,	38 53	77 1	71 22·7	1·786	1844
Georgetown,	38 53	77 3	71 19·0	1·768	1844
Mount Vernon,	38 41	77 7	70 55·5	1·782	1844

The observations of Capt. Lefroy were made in the execution of a plan for a magnetic survey of a considerable portion of the North American continent at the expense of the British government. This survey was urged upon the British Association in the year 1837, by Lieut. Colonel Sabine; and in the year 1839 he formed a plan to execute the survey in person, but being called upon to superintend the publication of the observations made at the colonial observatories, the survey was subsequently entrusted to Lieut. (since Captain) Lefroy. Lieut. Lefroy was provided with an inclinometer of nine inches by Gambey; a Fox's inclinometer of seven inches diameter; a portable unifilar magnetometer; an azimuth compass; a portable declinometer; a portable bifilar magnetometer; and a portable induction inclinometer. He left Montreal in May, 1843, and ascending the Ottawa river, proceeded by the way of Lakes Huron and Superior to the Lake of the Woods; thence to York Factory on Hudson's Bay; and thence to Lake Athabasca, where he spent the winter. In the spring of 1844, he descended McKenzie's river to the Arctic circle, and returned to Toronto near the close of the same year. He thus passed directly over the region of greatest magnetic intensity in the northern hemisphere. The following table contains a summary of most of Capt. Lefroy's observations, and includes also a few observations by Messrs. Younghusband and Rae.

TABLE III.

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
Fort Good Hope,	66° 16′ N.	128° 30′ W.	82° 56′·0	1·802	1844
Fort Norman,	64 31	124 44	82 34·3	1·801	1844
Fort Simpson,	61 51	121 25	81 52·3	1·829	1844
Fort Resolution,	61 10	113 45	82 44·5	1·848	1844
Athabasca,	58 43	111 18	81 37·0	1·838	1843
Fort Vermilion,	58 25	116 15	80 48·0	1·811	1844
Pointe Brulée,	58 7	111 25	81 30·6	1·852	1843
Pierre au Calumet,	57 24	111 35	81 16·8	1·938	1843

TABLE III.—*Continued.*

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
York Factory, . . .	57° 0′ N.	92° 26′ W.	83° 47′·2	1·855	1843
Clearwater River, . .	56 39	110 49	80 36·2	1·850	1843
Portage de la Loche, . .	56 34	109 44	80 36·4	1·835	1843
Shamatawa, . . .	56 21	92 56	83 36·2	1·861	1843
River de la Loche, . .	56 15	109 23	80 19·7	1·826	1843
Buffalo Lake, . . .	56 5	108 51	80 37·0	1·854	1843
Fort Dunvegan, . . .	55 56	118 34	78 46·2	1·809	1844
Portage Sonnante, . .	55 54	107 47	80 11·2	1·858	1843
Snake Rapid, . . .	55 46	106 30	80 38·7	1·874	1843
Pine Portage, . . .	55 43	105 50	80 40·3	1·884	1843
Great Devil's Portage, .	55 40	104 49	80 30·9	1·875	1843
Little Rock Portage, . .	55 34	104 33	80 16·5	1·995	1843
Lesser Slave Lake, . .	55 33	115 53	78 39·0	1·833	1844
White Earth Portage, .	55 32	93 50	83 2·9	1·862	1843
Frog Portage, . . .	55 28	103 30	80 59·3	1·857	1843
Isle a la Crosse, . . .	55 27	107 54	80 9·8	1·851	1843
Hill River, ...	55 25	94 0	82 55·0	1·871	1843
Long Portage, . . .	55 15	94 25	82 13·9	1·879	1843
Portage des Epinettes, .	55 6	102 42	80 52·6	1·871	1843
Oxford House, . . .	54 56	95 30	82 38·8	1·877	1843
Windy Lake, . . .	54 37	96 2	81 57·0	1·870	1843
Beaver Lake, . . .	54 32	102 10	80 34·2	1·869	1843
White Fall Portage, . .	54 24	96 26	81 47·9	1·869	1843
Hairy Lake, . . .	54 21	97 11	81 20·9	1·859	1843
Saskatchawan River, . .	54 5	111 44	78 5·2	1·811	1844
Norway House, . . .	53 59	98 7	81 10·0	1·873	1843
Cumberland House, . .	53 57	102 19	80 24·9	1·867	1843
Saskatchawan River, . .	53 50	110 30	78 33·5	1·829	1844
Near the Pas, . . .	53 48	101 28	80 24·4	1·892	1844
Old Norway House, . .	53 42	98 1	80 45·4	1·874	1843
Fort Pitt, ...	53 34	109 19	78 41·0	1·870	1844
Fort Edmonton, . . .	53 31	112 57	77 54·2	1·809	1844
Lake Winnipeg, . . .	53 31	99 12	80 16·8	1·862	1843
Devil's Drum Island, . .	53 19	100 40	80 0·0	1·826	1844
Saskatchawan River, .	53 16	104 48	79 11·2	1·842	1844
Cedar Lake, . . .	53 12	100 30	80 7·1	1·871	1843
Cross Lake, . . .	53 10	99 32	80 28·2	1·876	1843
Grand Rapid, . . .	53 8	99 28	80 26·5	1·875	1843
Saskatchawan River, . .	53 7	108 30	78 28·1	1·881	1844
Carlton House, . . .	52 51	106 13	78 30·7	1·815	1844
Lake Winnipeg, . . .	52 29	97 13	80 5·4	1·866	1843
Saskatchawan River, . .	52 23	107 4	78 16·6	1·859	1844
Lake Winnipeg, . . .	52 21	97 9	80 24·4	1·900	1844
Lake Winnipeg, . . .	51 44	96 48	79 39·0	2·031	1844
Lake Winnipeg, . . .	51 34	96 40	79 6·1	1·903	1844
Lake Winnipeg, . . .	51 4	96 21	79 31·5	1·918	1844
Fort Alexander, . . .	50 37	96 21	78 57·4	1·857	1843
Lake Winnipeg, . . .	50 27	96 38	79 5·2	1·867	1843
Mouth of Red River, . .	50 19	96 45	78 32·6	1·864	1843
Slave Portage, . . .	50 11	95 37	78 57·1	1·867	1843
Upper Fort Garry, . .	49 53	97 2	78 17·8	1·862	1843
Rat Portage, . . .	49 46	94 39	78 7·5	1·858	1843
Lake of the Woods, . .	49 23	94 41	78 10·2	1·861	1843
Prairie Portage, . . .	48 58	90 1	78 26·2	1·858	1843
Rainy River, . . .	48 48	94 31	77 57·4	1·895	1843
Lake Superior, . . .	48 46	87 40	78 24·0	2·099	1844
Portage du Chien, . .	48 39	89 34	78 26·8	1·865	1843
Pic Fort, ...	48 38	86 39	78 37·1	1·846	1844
Fort Francis, . . .	48 37	93 29	77 34·2	1·853	1844
French Portage, . . .	48 35	91 7	78 20·4	1·860	1843
Sturgeon Lake, . . .	48 27	92 41	77 44·8	1·861	1843
Fort William, . . .	48 24	89 23	78 6·8	1·866	1844

TABLE III.—*Continued.*

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
Pointe Tonnere, ...	48° 19′ N.	89° 2′ W.	78° 23′·2	1·876	1843
Otter Island, . . .	48 6	86 17	79 43·6	1·801	1843
Michipicoton, . . .	47 56	85 5	78 6·4	1·855	1844
Gargantua, ...	47 37	85 11	77 56·1	2·016	1844
Pointe aux Crêpe, . .	46 58	84 58	77 11·5	1·877	1843
Quebec, ...	46 49	71 16	77 15·3	1·814	1842
Pointe aux Pins, . .	46 29	84 41	77 14·7	1·862	1844
Three Rivers, . . .	46 19	72 36	77 10·7	1·826	1842
Little River, . . .	46 18	78 43	77 28·5	1·838	1843
Lac du Grand Vase, . .	46 18	79 26	77 21·7	1·846	1843
Tessalon Point, . . .	46 16	83 31	76 59·3	1·852	1843
Lake Nipissing, . . .	46 13	79 59	77 9·5	1·836	1843
Fort la Cloche, . . .	46 7	82 25	76 50·2	1·802	1844
Snake Island, . . .	46 7	83 0	77 5·5	1·833	1843
Pointe Baptême, . .	46 6	77 26	77 26·6	1·822	1843
Sorel, ...	46 2	73 0	77 17·0	1·815	1842
Lake Huron, . . .	46 0	81 50	77 5·6	1·840	1843
Ricolet Falls, . . .	45 57	81 1	76 45·4	1·870	1843
Kingsey, ...	45 48	72 19	77 40·0	1·808	1842
Grand Calumet, . . .	45 45	76 40	76 44·4	1·826	1843
Pointe aux Chênes, . .	45 37	74 55	76 55·4	1·805	1843
La Combes, . . .	45 32	74 9	76 50·6	1·825	1843
Montreal, ...	45 30	73 36	77 8·6	1·788	1845
Point Aylmer, . . .	45 29	75 48	76 41·0	1·825	1843
Isle d'Urval, . . .	45 24	73 46	77 21·1	1·806	1843
Stanstead, ...	45 2	72 10	76 19·5	1·799	1842
Penetanguishene, . .	44 49	80 1	76 20·1	1·860	1844
Goderich, ...	43 45	81 52	75 4·8	1·828	1845
Toronto, ...	43 39	79 21	75 15·5	1·836	1843
Niagara, ...	43 5	79 9	74 46·8	1·822	1845
Port Sarnia, . . .	42 58	82 34	74 15·7	1·825	1845
Buffalo, ...	42 52	78 54	74 37·0	1·814	1845
Albany, ...	42 39	73 45	74 44·6	1·797	1842
Detroit, ...	42 24	83 0	73 38·8	1·820	1845
Cambridge, ...	42 22	71 8	74 19·5	1·777	1842
Amherstburg, . . .	42 6	83 13	73 29·9	1·822	1845
Providence, . . .	41 49	71 25	74 0·0	1·781	1842
West Point, . . .	41 24	74 1	73 30·4	1·807	1842
New Haven, . . .	41 18	72 57	73 27·4	1·773	1842
New York, . . .	40 49	74 3	72 39·5	1·769	1842
Princeton, ...	40 22	74 40	72 43·5	1·783	1842
Philadelphia, . . .	39 58	75 10	71 59·0	1·793	1842
Baltimore, ...	39 17	76 37	71 41·4	1·782	1842
Washington, . . .	38 53	77 1	71 13·8	1·785	1842

Remarks on the Preceding Observations.

The preceding observations of dip combined with those previously made, enable us to draw the lines of equal dip for the northern part of the United States in a very satisfactory manner. The observations of Major Graham supply what was before wanting in the northeastern section of the United States. Those of Prof. Locke supply the deficiency in the northwest quarter; while those of Lieut. Lefroy extend over a large portion of the British possessions on the north of us. Our knowledge of the dip of the magnetic needle is therefore tolerably complete for one-half of the United States; but with the exception of the five observations of Major Graham, the southern half of this country is still an untrodden field. Cannot some volunteers be found to do for the south, what has already been done for the north?

The observations of the magnetic intensity, possess, if possible, a greater interest than those of the dip. The region of greatest intensity for the northern hemisphere has now been surveyed; and what is the result? The greatest intensity anywhere observed in the northern hemisphere is 2·099; the intensity in Peru, as observed by Humboldt, being called unity. This intensity in Peru was formerly supposed to be the least which would be found in any part of the globe; but an intensity has since been found as low as ·743; so that the greatest magnetic intensity now known upon any part of the globe, is not quite *three times* the least. It was formerly attempted to explain the phenomena of terrestrial magnetism by supposing an enormous magnet to be situated within the earth, having one pole in the continent of North America, and the other south of New Holland. But if the poles of such a magnet approached very near the surface of the earth, the force of its attraction should there be many thousand times greater than it is at the equator. If it is proposed to explain the observed phenomena by a permanent magnet situated within the earth, then we must conclude that its poles are so far below the surface that we are *very little nearer* them at one point of the earth's surface than at another; we must place the poles full three thousand miles below the earth's surface. Then to explain the high intensity observed in Siberia, we must introduce a second magnet whose axis makes a considerable angle with the former. But all this has been attempted in vain. Such hypotheses will serve to explain the observed phenomena only in a very rude and inadequate manner. We must wait patiently until the entire globe has been surveyed, and then we may expect to see the Newton who shall develop the grand law of terrestrial magnetism. Within a few years we have made rapid progress towards obtaining the requisite materials for this research. For the most interesting part of this continent, the survey may be pronounced nearly complete. If we call the intensity under the equator in South America unity, this intensity slowly increases as we travel northward, amounting to 1·4 among the West India Islands, while at New York it amounts to 1·8. Lines passing through all those places on the earth where the intensity is the same, are called lines of equal intensity, or *isodynamic* lines. The particular object of the expedition undertaken by Lieut. Lefroy, was to trace out the line of 1·8, and determine the position of the point of greatest intensity upon this continent. This object has been accomplished. The isodynamic line of 1·8 is a closed curve of an oval shape, extending somewhat below lat. 40° in the longitude of Cincinnati, and reaching off nearly to

Beering's straits, including the great northern lakes and a considerable part of Hudson's bay. The isodynamic line of 1·85 is a smaller oval included within the former, and passing nearly through Fort Mackinaw. The isodynamic line of 1·875 is an oval 446 geographical miles in length, and 170 in breadth. Its centre is in latitude 52° 19′ N., and longitude 92° W.; where the intensity is 1·878. These are the results which accord best with all the observations of Lieut. Lefroy and Prof. Locke. But it must not be understood that the observations agree perfectly among themselves. Many of the observations present unexplained anomalies, which, in our ignorance of their cause, we ascribe to *local attraction.* Thus while the great mass of observations assign to the magnetic focus above mentioned an intensity of 1·878, and indicate that from this point the intensity slowly diminishes in every direction, a few of the observations indicate an intensity considerably greater. In three instances, Lieut. Lefroy observed intensities greater than 2, viz., in lat. 48° 46′, lon. 87° 40′, intensity 2·099; lat. 51° 44′, lon. 96° 48′, intensity 2·031; and lat. 47° 37′, lon. 85° 11′, intensity 2·016. And in sixteen instances he observed intensities greater than 1·878. Prof. Locke also observed intensities greater than 1·878 in four instances, one of them rising as high as 1·950 in lat. 47° 28′, lon. 88° 1′. This point he inferred to be the point of maximum intensity for this continent; but Lefroy observed still higher intensities, and each of these cases was doubtless the effect of some local cause of limited extent. Within less than one mile's distance of the point where Prof. Locke observed the intensity 1·950, he found the intensity reduced to 1·842. The cause then, whatever it may be, of the high intensity on Porter's Island is extremely circumscribed in its influence. Prof. Locke has made some important observations to determine the laws of local attraction. At Patterson, N. J., on the summit of a trap rock one hundred and fifty feet high, he found the dip to be 75°; while at the bottom of the rock the dip was only 72° 17′; making a difference of 2° 43′ within a distance of a few hundred yards. Near Fort Lee, about nine miles north of New York, on the ridge of the palisades, the magnetic intensity at two stations only *forty feet* apart, was found to vary by nearly one-twentieth of its whole value. Prof. Locke infers that trap rocks become magnets by terrestrial induction, diminishing the magnetism of the earth at their bases, and increasing it at their summits.

Lieut. Col. Sabine, in his magnetic survey of Scotland, mentions an instance of local attraction even more remarkable than the preceding. In the northwestern part of Scotland, near Lake Scavig, on a rock intersected by trap veins, he observed a dip of 78° 10′. On the other side of the harbor, the dip was only 73°, being a difference of *more than five degrees.* These cases of local attraction deserve a particular examination.

ART. XVII.—*On the Trap Tuff, or Volcanic Grit of the Connecticut Valley, with the bearings of its history upon the age of the Trap Rock and Sandstone generally in that Valley*; by Rev. EDWARD HITCHCOCK, President of Amherst College.

(Read before the Association of American Geologists and Naturalists in Washington, May, 1844.)

IN my Reports on the Geology of Massachusetts, I have given a brief account of a rock under the name of *tufaceous conglomerate*, connected with the sandstone and trap of the Connecticut valley, which appears to me to deserve more attention. For if I mistake not, we have in its history, a clue that will conduct to the solution of some difficult questions concerning the relative age of the trap and sandstone, and the period of the elevation of the latter. I have, therefore, given this rock a reëxamination in that part of the valley within the state of Massachusetts, and propose to present the result in this paper.

I understand all tufas of igneous origin, to have resulted from fragments of scoriæ and pumice, with dust from the same, falling upon the dry land, or into the sea, when thrown up by volcanic eruption. Sometimes they carry along with them fragments of other rocks, and when they fall upon the bottom of the sea they mix with the sand and gravel there, and it may be that melted matter from the same eruption mixes with the tufaceous matter, so that rocks of every grade are produced, from perfect trap to stratified sandstones and conglomerates containing a portion of volcanic matter and altered by heat. Such an origin and such a composition correspond with the rocks which I am about to describe. I have observed in them the following varieties.

Lithological Characters.

1. *A hard reddish micaceous sandstone*, with more or less of volcanic matter, mostly dust or scoriæ. It is more or less metamorphic, often abounds in greenish spots, and passes insensibly into pure sandstone.

2. *Conglomerates.*—There are several varieties. The most common consists of rounded masses of trap, and occasional masses of red and grey sandstone, imbedded in a scoriaceous base. The nodules vary in size from that of a pea to masses two feet in diameter. The trap nodules are chiefly a fine grained greenstone. They are usually more or less rounded, but do not appear like the smooth pebbles in conglomerates of an entirely aqueous origin. They have evidently been worn mechanically, but their surfaces have been acted upon by heat, so as to have lost their smoothness.

Other varieties take into their composition, in addition to the trap nodules, distinctly rounded pebbles of older rocks, such as granite, quartz rock, clay slate, &c. These rocks appear more or less crystalline in the structure of their cement, and contain, especially, foliated nodules of calcareous spar.

3. *Volcanic Breccia.*—This is composed of angular fragments of trap, of a highly ferruginous character, with a small proportion of cement of the same character. This rock abounds in the large ridges of intrusive trap in the vicinity.

4. *Amygdaloid*, with a somewhat compact base, and nodules of calcareous spar. The base has the aspect of indurated volcanic mud.

5. *Volcanic Slags.*—These differ but little from the amygdaloid, except in being more vesicular, and the cavities are empty. They cannot be distinguished from recent vesicular lava, except in not being so fresh.

6. *Concretionary Nodules.*—These are made up of concentric coats and are a dirty color and highly ferruginous. They are rarely more than three or four inches in diameter.

7. *Common Greenstone.*—This differs not at all from the greenstone that constitutes the great mass of the trap of this valley, except perhaps in being usually more compact.

8. *Porphyritic Trap.*—This takes distinct crystals of feldspar into its composition, and has a gray base more argillaceous than greenstone. The same rock occurs in connection with the principal ranges of trap.

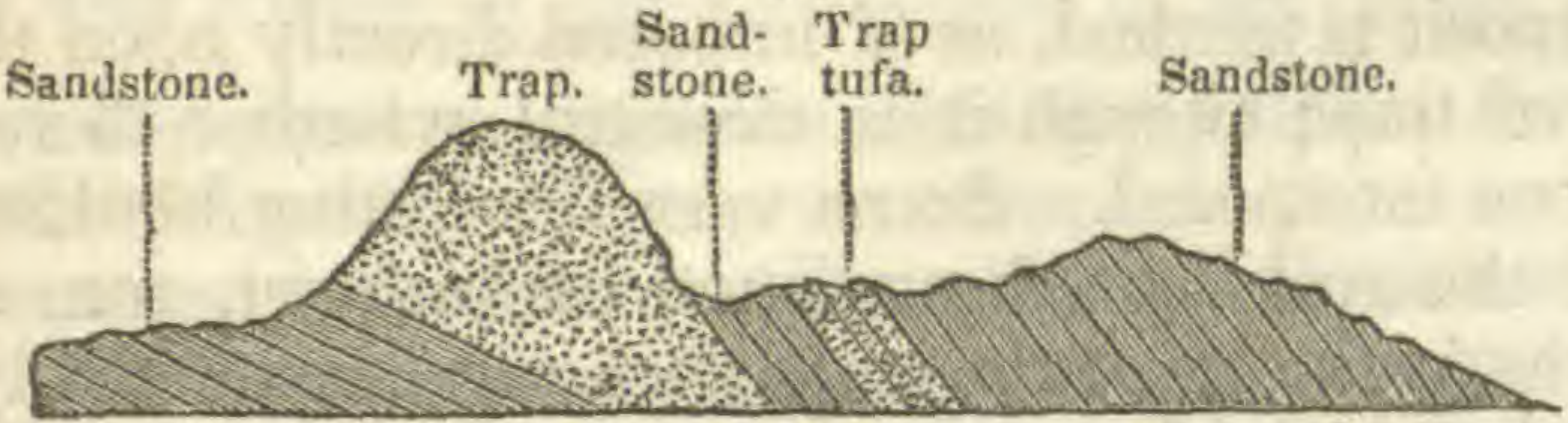
Relative Position and Stratification of these Deposits.

The usual dip of the strata of sandstone in the valley of Connecticut, is easterly, averaging about 15° or 20°; and the large ranges of trap appear to have been protruded to the surface between the strata. Consequently they lie upon the sandstone as seen on the west side of the range; while on the east side, the sandstone lies in an inclined position upon the trap, frequently with a higher inclination than the sandstone beneath. The east side of the trap, therefore, I call the *upper side*, and the west side, the *under side.* Now it is upon the upper side only that the trap tuff occurs. After receding a greater or less distance from the trap range, we find the tuff interstratified with the sandstone, as shown on the sections, figs. 1 and 2; and the tuff is also, for the most part, distinctly stratified conformably to the

Fig. 1.

Section across Mount Tom from west to east.

Fig. 2.



Section across Mount Holyoke southeasterly.

sandstone. I say for the most part; because when the mass is considerably thick, the west or the lower portion of it, is usually distinct greenstone, having no more stratification than trap in any other position. And so in the amygdaloidal and scoriaceous varieties, the stratification is indistinct, and indeed, in proportion as the igneous agency predominated, the rock loses its division into layers, and exhibits it where the aqueous agency predominated.

It ought also to be stated, that the amygdaloidal, scoriaceous, and porphyritic varieties of this rock occur of considerable thickness on the upper side of the principal ranges of trap, and to some extent they are stratified. The brecciated variety is, also, common, capping and underlying the columns, in various parts of the range. I have never, however, found the tufaceous conglomerates and sandstones as a part of the main range of trap, unless it be in West Springfield: where I was not able to find any sandstone between the conglomerate and the main range of trap.

Topography.

Nearly all the examples of this rock which I have discovered, occur upon what I call the back or southeasterly side of Mounts Holyoke and Tom. These form an almost continuous ridge, extending from Belchertown in Massachusetts, nearly to New Haven in Connecticut. Starting at Belchertown, we find the ridge running nearly west for several miles, then turning south to Connecticut river, and forming Mount Holyoke. Continuing across the river, it rises into the still higher ridge called Mount Tom; and thence in a lower ridge, into Connecticut. The top of this whole ridge is common trap, prismatic, amygdaloidal, and scoriaceous, resting upon thick bedded sandstone, which crops out upon its western and northern side; and on its other side, grey and red micaceous sandstone and shale shoot up upon its back. Now it is within this great curve of the principal trap range, and on its back side, that all the deposits of trap tuff, with which I am acquainted, occur. Three of these are shown on the map, Plate I, on the south side of Holyoke, in Granby and South Hadley. There may be others there: but the country being chiefly covered with thick woods, it is difficult to explore it. On the opposite side of Connecticut river, a still larger deposit occurs in Northampton, on the back side of Mount Tom. In West Springfield, another narrow deposit is marked, as if imposed directly upon the principal range of trap; though it is doubtful whether there may not be sandstone interposed. Some very interesting boulders of one variety of this rock have been found in Amherst, torn off probably from the back side of the trap range running northerly through Sunderland, Deerfield, and Greenfield, where we still find a similar rock forming a part of the range. I have, also, seen many years ago, boulders of the tufaceous conglomerate, a few miles south of Hartford; but whether any large ledges exist there I know not.

Organic Remains.

The extreme paucity of organic remains in the new red sandstone of New England, and the highly igneous character of most varieties of the trap tufa, would lead us scarcely to expect any animal or vegetable relic in the rock under consideration. But in fact a single very distinct example does occur. It is a vegetable stem, from one to three inches in diameter, scarcely flattened. I found it in boulders of the porphyritic trap that has been described, scattered in abundance over the fields, in Amherst. I have not been able to trace it to its place in the mountains. But a similar rock abounds along the east side of the trap range running through Deerfield and Greenfield, and that too in just the direction from which the drift of Amherst has been derived. But in the ledges I have not found any vegetable stems. The largest boulder in which I have found these stems, is about two feet in diameter, and three of these stems run parallel to one another entirely through it, and do not diminish much in size, so that probably they were five times that length. The rock is a dark gray trap, not at all vesicular, yet occasionally containing prehnite and being porphyritic. But the stems are changed into what I have called a volcanic slag, being highly vesicular, resembling the toadstone of the geologists. I think this fact may be explained very reasonably; but it will be better understood when I have presented the theory of the formation of these peculiar rocks.

I ought to add, that I have been able to procure several of these unique specimens; but the best and largest has been divided between my own and the state collection of Massachusetts. Still farther I should state, that I have given a description of them with a poor drawing, in my Final Report on the Geology of Massachusetts; although I was there obliged to refer them to real trap rock, not having understood, as I think I now do, the relations of the trap tufa.

Mode and Period of the Production of the Trap Tufa.

Such are the facts in regard to this formation. I now come to the mode and period of its production.

Two positions in relation to this subject, I think will be easy to prove. The first is, that this rock must have been of contemporaneous production with the sandstone in which its beds are interstratified. The very fact of their being interstratified, shows that they could not have been subsequently injected. They are divided into layers, if not as thin, yet often as distinct, as the sandstone. Consequently, after the deposition of the sandstone on which they rest, they must in some similar manner have been deposited, before the layers of sandstone, now above them, were formed over them.

The second position is, that these rocks must have been the joint product of igneous and aqueous agency, The stratification and mechanical structure of some of the varieties clearly prove the agency of water, while the vesicular and concretionary structure of other varieties, and the entire resemblance of others still to unstratified trap, where the deposit is thick, as well as the volcanic character of the cement, even of the most decidedly mechanical layers, are equally conclusive proofs of the agency of heat. Indeed there is no part of the trap formation in this valley that presents so decidedly a volcanic aspect, as some of the weathered and disintegrated hummocks of this rock. It is impossible, then, to explain the production of this rock without calling in the joint action of fire and water. But how and when did this joint action take place? I adopt, almost without modification, the views advanced by Mr. Murchison, to account for the origin of similar rocks, called by him *volcanic grits*, and "bedded and contemporaneous trap," connected with the older fossiliferous rocks of Great Britain. He supposes them to have resulted from early and minor volcanic outbursts at the bottom of the ocean, at different intervals, previous to the period when the principal ranges of amorphous trap were protruded along the same lines. These preparatory eruptions would of course throw out abundance of scoriaceous matter, finely levigated, with some melted matter, which would spread over the bottom of the sea, and mix with the sand, gravel, and mud, there accumulated; so as to form the tufaceous conglomerates above described: while, if the quantity of liquid matter was large, a portion of it might cool slowly, and neither mix with the sand and gravel, nor come in contact with the water, except at the surface: and there the sudden refrigeration and commotion produced by the vapor and gases, would form scoriaceous and amygdaloidal rock. If in the bottom of the ocean this mixture of ashes, scoria, and lava, should envelope the remains of animals or plants, the heat might not be sufficient to destroy all their organic structure, yet great enough to convert them into a scoriaceous mass; or if the organic matter had been driven off, to fill up the space with such matter rendered vesicular, (as in the particular case which I have described,) by the gas resulting from the decomposition of the organic compounds. Thus we might have organic remains in nearly melted rock, and thus might volcanic matter be made to take a stratified structure; but when quiet was again restored on the ocean's bed, new deposits of sandstone and shale would take place. After all this, the principal eruption of trappean matter might take place along nearly the same line, and the principal ridges of unstratified trap be protruded, and the sandstone and bedded trap, at least in the vicinity, be tilted up.

Now in respect to the sandstone and tufaceous rock of the valley of the Connecticut, we have the most decided evidence that those parts of these strata near the principal amorphous ridges of trap, have been elevated since their deposition. I have stated that the general dip of the sandstone in the valley is 15° or 20° easterly, both below and above (or west and east of) the trap ridges; and the fact that it is nearly the same below as above, shows conclusively that this general dip was not produced by the protrusion of the greenstone: for how could that elevate strata lying beneath it? It must, therefore, have been originally deposited with its present dip, or elevated by some other agency than the trap. But on the upper side of the trap ridges, we find numerous examples where the strata have been elevated very much more than the general dip; which greater slope, however, dies away as we recede from the trap. Take for an example, the section given on fig. 2; which crosses Mount Holyoke near its east end from Amherst southeasterly into Belchertown. Beneath the trap the dip is as usual; but on passing over the ridge, we find the strata dipping pretty uniformly as much as 50°, and running from N.E. to S.W. as if turned aside 45° from the usual course. The deposit of trap tufa, which is crossed by the section, shares in the increased dip. Now it is not possible that sandstone, most of it rather coarse, should have been deposited on a slope of 50°. It must have been tilted up after its deposition, and consequently after the deposition of the tufaceous rock. At the other beds of this rock, the dip is not much greater on the upper than on the lower side of the principal trap range. But along the south side of Holyoke generally, the dip is southeasterly, although not usually more than 20°; and I see not how this can be explained except by imputing it to the protrusion of the trap range in a direction at right angles to the usual strike of the strata of sandstone.

Near the northern extremity of the sandstone formation in this valley, at Turner's falls, we have another example, where the strata, composed of fine shales and sandstones, are raised for a considerable distance from the ridge of trap, so as to dip 45°. But at this place is another fact still more conclusive to prove the elevation of the strata since their deposition. Those strata, dipping about 45°, are often covered with the most perfect footmarks in connection with raindrops, and not one of them have I ever seen in the least distorted, as if the animal had walked on a slope. The mud was so delicate as to retain the impressions of each phalanx of the foot most perfectly, and yet it has not yielded at all laterally. No one at all familiar with the tracks of living or extinct animals, can doubt that the surface must have been nearly level when these markings were made. The same is essentially the case at the Horse Race, three miles farther up the stream, and indeed at almost every locality of footmarks the slope of the strata appears to me too great not to have shown the slidings of the animal, if he walked upon it at the same dip which it now has. For I have some examples where the effect of walking on an inclined surface is manifest; and yet at that locality the dip rarely amounted to 10°. On the west side of Connecticut river in Northampton, where are numerous footprints of the huge Brontozoum giganteum, a majority of the rows of tracks cross the strata at right angles to the strike; so that if the strata had their present dip at that time—which is about 12°—either the animals must have walked so high up the bank that no tide or other rise of water could have covered them, as must have been done to bring over a layer of mud, or the strata must have had a less inclination than at present; since some of these rows are several rods long. The latter supposition seems to me to be the true one; and the general fact may here be stated, that, with one exception just discovered, (July, 1847,) it is only on the east or upper side of the trap ranges that the footmarks occur, doubtless because the water was too deep when the rock was soft. My theory is this: That the earlier outbursts of the trap, which perhaps formed the trap tufa, lifted the bottom of what was then the ocean, so as to form a low mud or sand beach, whither the birds resorted, and over which the water frequently flowed, loaded with silt. As successive masses of trap were protruded, successive deposits would come over it, on which other tracks might be formed; and it seems to me that in this way we might explain their occurrence upon successive layers, to a considerable thickness, without resorting, as Mr. Lyell does, to subsidences. And yet when volcanic agency was so common as we know it was during the volcanic period, vertical movements of the surface must have been a common occurrence.

But I have wandered somewhat from the subject in hand; and to return, it seems to me we have decisive proof that the protrusion of the principal ranges of trap constituting Holyoke and Tom, must have been the last of the changes that brought the rocks of the valley into their present position; and that the tufaceous traps had previously been protruded and consolidated. It is possible that the principal ranges of trap may have been, at an earlier date than above supposed, partially elevated, and then ultimately have been thrust forward in a solid state, as we know to have been done in some modern examples. And, indeed, the fact that a portion of the turfaceous conglomerates contains really rounded masses of solid trap, shows at least that a good deal of that rock existed in order to furnish these materials. And it must have been more or less above the water in order that the currents should tear up and wear its fragments. This might in part have been done by igneous agency, as the masses were driven upwards through the fissure; yet they appear to me for the most part, to have been acted upon by water. And it is a curious fact that the ripple marks, in some places, show that the current was southerly, as it now is.

Tilting of the Sandstone Formation Generally.

We are conducted, then, as it seems to me, by these facts and reasonings, to a probable solution of the question concerning the relative age of the trap and sandstone of the Connecticut valley. It appears that all the thick bedded sandstone below the trap, constituting at least one-half, was deposited before the protrusion of any trap. Then succeeded some small outbursts, as precursors of the principal ones, and the bedded or contemporaneous trap was produced at intervals, while the upper beds of sandstone were being deposited; and last of all, the principal trap ranges emerged with considerable disturbance of the sandstone. But I have shown that the general dip of that rock, extending through the whole formation, was not the result of the protrusion of the trap. Was it then the result of original deposition, as some maintain, or of some other upheaving force? I incline to the last supposition for the following reasons:—

In the first place, if originally deposited with its present dip, the west side of the valley must have formed the shore of the ocean, and the materials have been brought in from the west side of the valley, and have gradually extended entirely across it, with a very uniform easterly dip. But most of the materials composing the sandstone and conglomerates, so far as it is possible to determine, appear to have been derived from the north.

In the second place, as already stated, we have some evidence in the ripple marks, that the current was from the north when the sandstone was deposited. I will mention one striking example. At the footmark locality in Northampton, the ripple marks on the fine sandstone are at right angles to the present course of Connecticut river; and as I was looking at them one day, close at the water's edge, I saw that they appeared to be continued beneath the stream. But on close examination I found quite a deposit of mud above the rock, and on this mud the current had formed ripple marks very similar to those upon the stone. The rounded masses of trap, which enter into the composition of the tufaceous conglomerate, also, must have been swept southerly.

In the third place, the eastern side of the valley appears to have been elevated earlier than the west side, and to nearly the same height, as I have endeavored to show in my Final Report on the Geology of Massachusetts. If so, it must have presented currents moving from the west shore to the eastward, so as to carry materials for rocks across the entire valley, even if each shore had not been entirely above the waters. Yet we find in fact that the coarsest materials were deposited latest; that is, on the east side of the valley; but as the sides of the valley rose higher and higher, the easterly current, if it existed, must have been weaker and weaker; whereas, that elevation might have made a southerly current more violent, as we find must have been the case.

In the fourth place, a dip from 10° to 20° is too great to be the result of deposition, where the materials are very fine, as in the present case, and where they are spread with great evenness over large surfaces. Unless in peculiar circumstances, plastic materials cannot be retained on such a slope.

Finally, in the elevation and plication of the Hoosic or Green Mountain range, lying west of the valley, it may be by a lateral force, we have an adequate cause for the elevation of the sandstone. This will explain the uniformity of its dip through the whole valley, and its existence even on the eastern border of the valley. It appears to me, therefore, more in accordance with sound geological reasoning, to regard these sandstone strata as tilted up by some of those later movements, probably by lateral pressure, which folded up the Green, Hoosic, and Appalachian ranges.

Art. XVIII.—*On Terrestrial Magnetism*; by William A. Norton, Professor of Mathematics and Natural Philosophy in Delaware College.

(Concluded from p. 12.)

Declination of the Magnetic Needle.

The first computation was of the declination for London, assuming the poles of greatest cold to be coincident with the magnetic poles. The result was a declination a number of degrees too small. After two or three trials I found that by placing hypothetically the Asiatic pole in east longitude 160°, and lat. 65°, and the American pole in west longitude 72°, and latitude 67°, the declination came out very near the truth, and at the same time the mean annual temperature, as computed from Brewster's formula, by taking $n=\frac{3}{4}$, corresponded very closely with observation. It was supposed that, as the temperature of the Asiatic was some 4° (Fahrenheit) higher than that of the American pole, while in Brewster's formula they were regarded as equal, the former ought to be removed hypothetically to a greater distance, and the latter perhaps brought nearer. But the necessary changes of position, though lying in the direction thus suggested, are apparently much too great to be reasonably attributed to this cause. Upon making the calculations for other places, it was found necessary in each instance to place the cold poles hypothetically in positions more or less different from their true positions. The computed declinations, compared with the observed, together with the supposed longitudes and polar distances of the two cold poles, are given in the following table.

TABLE I.

Place.	Longitude.	Latitude.	Declination.		Diff.	American pole.		Asiatic pole.	
			Computed.	Observed.		Lon.	P. dist.	Lon.	P. dist.
London,	0° 6′ W.	51° 31′	24° 54′ W.	24° 0′ W.	+0° 54′	72° W.	23°	160° E.	25°
Paris,	2 21 E.	48 52	22 9 W.	22 4 W.	+0 5	65 W.	22	159 E.	25
Milan,	9 9 E.	45 28	19 3 W.	18 33 W.	+0 30	65 W.	23	155 E.	22
Göttingen,	9 56 E.	51 32	16 47 W.	18 48 W.	−2 1	70 W.	23	155 E.	22
Berlin,	13 24 E.	52 30	14 30 W.	17 5 W.	−2 35	70 W.	20	153$\frac{1}{3}$ E.	20
Spitzbergen,	11 40 E.	79 50	24 0 W.	25 12 W.	−1 12	85 W.	20	160 E.	25
Moscow,	37 37 E.	55 46	0 9 E.	0 8 E.	+0 1	70 W.	20	127 E.	12
Tobolsk,	68 16 E.	58 11	11 6 E.	10 29 E.	+0 37	80 W.	20	115 E.	12
Urga,	106 42 E.	47 55	2 10 E.	1 16 E.	+0 54	95 W.	20	106$\frac{3}{4}$ E.	11
Pekin,	116 26 E.	39 54	1 1 W.	1 48 W.	−0 47	85 W.	20	101$\frac{3}{4}$ E.	10
Stretensk,	117 40 E.	52 15	1 56 W.	2 52 W.	−0 56	85 W.	20	101$\frac{1}{6}$ E.	10
Jakutsk,	129 45 E.	62 1	6 30 W.	5 50 W.	+0 40	110 W.	20	110 E.	15
Tschernoljes	136 23 E.	61 31	2 52 W.	3 30 W.	−0 35	110 W.	20	115 E.	12
The Azores,	26 W.	36	24 11 W.	23 45 W.	+0 26	80 W.	25	134 E.	25
New York,	74 1 W.	40 43	3 20 W.	5 23 W.	−2 3	87 W.	15	86 E.	25
Washington,	77 1 W.	38 53	1 29 W.	1 41 W.	−0 12	85 W.	15	83 E.	25
Havana,	77 12 W.	23 9	5 20 E.	5 30 E.	−0 10	50 W.	10	83 E.	25
St. Louis,	90 15 W.	38 37	8 27 E.	8 44 E.	−0 17	70 W.	15	70 E.	25
Sitka,	135 25 W.	57 3	29 30 E.	28 19 E.	+1 11	85 W.	20	44 E.	25
	93 0 W.	50 0	6 35 E.	8 0 E.	−1 25	83 W.	16	67 E.	25
	93 0 W.	55 0	5 50 E.	7 0 E.	−1 5	86 W.	17	67 E.	25
	93 0 W.	60 0	5 0 E.	5 0 E.	0 0	90 W.	18	67 E.	25

The observed declinations were taken from Gauss's table of comparisons, Hansteen's table of declinations according to the latest observations, Loomis's table of comparisons of numerous determinations of declination for the United States by Gauss's formula with observation, published in the No. of this Journal issued in October, 1844, and in the case of the last three places and for the Azores, from Barlow's "Chart of Magnetic Curves of Equal Variation." The observation for Havana was made in 1816. None of the other observations date more than twenty years back. The observed declinations for the United States were reduced by Professor Loomis to the epoch of 1837.

The following table contains the mean annual temperatures of the different places in Table I, as computed from Brewster's formula, with the values of the distances δ and δ' used in the calculations of the declinations. The formula is

$$T=(t-\tau)\,(\sin^n\delta\,\sin^n\delta')+\tau$$

and with the assumed values of the constants,

$$T=\Big(28^\circ-(-19^\circ)\Big)(\sin^{\frac{3}{4}}\delta\sin^{\frac{3}{4}}\delta')-19^\circ=47^\circ(\sin^{\frac{3}{4}}\delta\sin^{\frac{3}{4}}\delta')-19^\circ \quad . \; (8.)$$

TABLE II.

Place.	M. Annual Temp.		Diff.	Place.	M. Annual Temp.		Diff.
	computed	observed			computed	observed	
London,	10°·5	10°·4	+0°·1	Jakutsk,	−7°·0	−9°·0	+2°·0
Paris,	10 ·7	11 ·0	−0 ·3	Tschernoljes,	−5 ·0	−7	+2 ·0
Milan,	13 ·5	13 ·6	−0 ·1	The Azores,	15 ·6	16	−0 ·4
Göttingen,	9 ·7	9 ·8	−0 ·1	New York,	10 ·6	10 ·7	−0 ·1
Berlin,	9 ·7	8 ·8	+0 ·9	Washington,	11 ·9	12 ·7	−0 ·8
Spitzbergen,	−5 ·3	−4	−1 ·3	Havana,	22 ·5	25 ·0	−2 ·5
Moscow,	5 ·0	4 ·4	+0 ·6	St. Louis,	12 ·6	13 ·0	−0 ·4
Tobolsk,	1 ·0	−1	+2 ·0	Lon. 93° W., Lat. 50°	3 ·3	2 ·5	+0 ·8
Urga,	6 ·9	6	+0 ·9	Lon. 93° W., Lat. 55°	−1 ·5	−2 ·5	+1 ·0
Pekin,	13 ·3	13	+0 ·3	Lon. 93° W., Lat. 60°	−6 ·6	−8 ·0	+1 ·4
Stretensk,	4 ·0	3	+1 ·0	Sitka,	2 ·7	3 ·0	−0 ·3

The observed mean annual temperatures were generally taken from Mahlmann's table, as published in the French edition of Kaemtz's Complete Course of Meteorology. The temperatures of the following places were obtained by estimation from Kaemtz's Chart of Isothermal lines; viz., Spitzbergen, Tobolsk, Urga, Pekin, Stretensk, Tschernoljes, the Azores, Sitka, and long. 93° W., lats. 50°, 55°, and 60°. The mean temperatures for Berlin, Paris, London, and Milan, are from observations continued through twenty-five, thirty-three, forty, and seventy years, respectively. For the other places the observations in no instance extend farther back than twenty years. The temperatures for Göttingen, Paris, Milan, Berlin, Moscow, and Jakutsk were reduced to the level of the sea by allowing 1° (centigrade) for from 173 metres to 190 metres of altitude, agreeably to Kaemtz's data. This is a larger allowance than it has been customary to make. According to Professor Forry no reduction is necessary for St. Louis.

In the calculation of Table II, t was taken in Brewster's formula very nearly equal to the mean temperature on the equator, and τ at about the temperature of the American pole of greatest cold. But it appears by the formula that t is the temperature which obtains at the point on the earth's surface where δ and δ' are both 90°. This point appears to be situated in Africa a few degrees north of the equator. Now Kaemtz gives for the temperature of the interior of Africa in the vicinity of the equator, and at an elevation of 300 metres, 29°·2. Reducing this to the level of the sea we have 31° nearly. The value to be assigned to τ would seem to be the mean of the temperatures of the two cold poles. According to Berghaus, these are, $-19°{\cdot}7$ and $-17°{\cdot}2$; the mean of which is $-18{\cdot}4$. The most probable values of t and τ are then 31°, and $-18°$. The following table was calculated with these values, taking $n=\frac{8}{9}$; or by the formula

$$T=49°(\sin^{\frac{8}{9}}\delta \sin^{\frac{8}{9}}\delta') - 18°. \quad . \quad . \quad . \quad . \qquad (9.)$$

It will be seen that the difference between the computed and observed temperatures in no case exceeds 1°, and is generally much less. Thus the same values of δ and δ' give by this formula the temperature of a place, and by formula (6), derived from this by differentiation, the declination of the magnetic needle.

TABLE III.

Place.	M. Annual Temp computed	observed	Diff.	Place.	M. Annual Temp. computed	observed	Diff.
Berlin,	9°·3	8°·8	+0°·5	Havana,	24°·4	25°·0	−0°·6
Moscow,	4 ·1	4 ·4	−0 ·3	Washington,	11 ·8	12 ·7	−0 ·9
Stretensk,	3 ·5	3 ·0	+0 ·5	St. Louis,	12 ·6	13 ·0	−0 ·4
Tschernoljes	−6 ·4	−7	+0 ·6	Lon. 93° W., Lat. 50°	2 ·5	2 ·5	0 ·0
Urga,	6 ·2	6	+0 ·2	Lon. 93° W., Lat. 55°	−2 ·5	−2 ·5	−0 ·3
The Azores,	15 ·6	16	−0 ·4	Lon. 93° W., Lat. 60°	−8 ·0	−8 ·0	0 ·0

On examining Table I, it will be perceived that, leaving out of view the cases of Havana, Jakutsk, and Tschernoljes, the polar distance of the fictitious American pole varies between 23° and 15°, and its longitude between 65° and 95°. In Western Europe its longitude is from 65° to 72°; in Asia from 80° to 95°; in the eastern and northern parts of North America from 85° to 90°, and in the western part from 70° to 85°. The smaller polar distances obtain only on this continent. As to the Asiatic pole; on the meridian of Paris, over the Atlantic Ocean, and throughout this continent, it is to be taken 160° east of the meridian of the place, and at the distance of 25° from the geographical pole. In passing over Europe and Asia, the Asiatic pole moves westwardly, and at the same time approaches the geographical pole. At from 100° to 120° east longitude, it falls to the west of the meridian of the place, and its polar distance becomes from 10° to 15°. As we approach either magnetic pole, the hypothetical pole of maximum cold approaches this pole and the true position of the cold pole. A change either in longitude or latitude alters more or less the ideal positions of the cold poles. The changes of longitude and latitude of the Asiatic pole are about twice as great as those of the longitude and latitude of the American pole.

It appears from Tables II and III, that in using Brewster's formula for the calculation of the mean temperature of a place, each place may be regarded as having its particular cold poles. The results given in Table I, show that if we regard these poles as stationary for an indefinitely small change in the position of the place, and determine the direction of the isothermal or isogeothermal line on this supposition, the needle makes a right angle with this direction. In point of fact however, these poles change their situation with every change in the position of the place; and hence, formula (6) will not give the true direction of the isothermal line. But the amount of the error will be quite different in different places. In high latitudes the displacement of the ideal cold poles is slight, and less in proportion as the place is nearer to either of these poles; and accordingly formula (6) gives very nearly the true direction of the isothermal line. From the meridian of Paris westward, across the Atlantic Ocean, and throughout the United States, while the change of longitude of the Asiatic pole is equal to that of the place, the change in its distance from the place from this cause is slight; since, as it has been seen, this pole is almost directly opposite to the place on the other side of the geographical pole. The motion of the American pole is much less, and tends to diminish the variation of the computed temperature produced by the motion of the other; since, while δ is increased by the one, δ' is diminished by the other, and thus the variation of $\sin^n\delta \sin^n\delta'$ in equa. (4), is less than would arise from the change of either δ or δ' alone. Throughout the portion of the earth's surface just designated, therefore, formula (6) gives nearly the true direction of the isothermal line. In passing eastwardly from the meridian of Paris, over Europe and Asia, the displacement of the Asiatic pole is more rapid, while that of the American pole is about the same. The two tend to counteract each other, but it would seem that the effect of the former must preponderate, and therefore that the true direction of the isothermal line may materially differ from that given by formula (6). The indications are, however, that the error lies in one direction over Europe and Asia, and in the other direction across the Pacific Ocean, and thus, that the isothermal line as traced by means of formula (6) would no where differ very widely from the truth.

On referring to a chart of isothermal lines, constructed from observations, (see Kaemtz's Complete Course of Meteorology, French edition, Plate VI,) it will be seen that generally the course of these lines is in fact similar to that of the lines traced by formula (6.) Thus, in crossing the continent of North America, from the western to the eastern coast, they tend south of east; and in crossing the Atlantic Ocean, from America to Europe, north of east. From Western Europe to the eastern coast of Asia, their direction is south of east. The points of inflexion, or of change of direction from one side to the other of the east and west line, of the two systems of lines, are however generally separated by a moderate interval. The comparison is here confined to the Temperate and Frigid Zones.

We may lay down the following great truths as apparently established by this discussion.

1. Lines traced upon the earth's surface such that the magnetic needle is every where perpendicular to their direction, have a very intimate relation to the isogeothermal lines, and a general correspondence of direction with them, indicative of a close physical connection between the distribution of the earth's heat and that of its magnetism.

2. If we assume that the intensity of the magnetism of each particle is every where proportional to its temperature, and that its magnetic force is of the character of a tangential force, (as it has been defined,) the formula which makes known the temperture furnishes by differentiation another which makes known the first set of lines above mentioned; and which differs from the formula for the isogeothermal lines only in this, that in the one, the displacement of the cold poles answering to an indefinitely small displacement of the situation of the place is taken into account, in the other neglected.

In what precedes, I have assumed, on the authority of Sir David Brewster, that the isothermal and isogeothermal lines are parallel to each other. If a more extended and minute investigation should reveal differences in the direction of these two classes of lines, it may be found that the lines of equal molecular magnetic intensity to which the needle is every where perpendicular, correspond more nearly in their direction with the true isogeothermal lines than with the isothermal lines, to which the isogeothermal lines have been assumed to be parallel.

The small differences which appear to exist between the isogeothermal lines and the lines to which the needle is perpendicular, (whether strictly lines of equal molecular magnetic intensity or not,) must be left for future consideration. I will only remark here, that the differences may prove not to be incompatible with the supposition made at the outset, that the terrestrial molecular magnetic intensity is strictly proportional to the temperature, as they may be attributable to a want of parallelism in the isogeothermal lines lying within the circle of sensible action upon the needle, geological differences in the earth's crust, &c.; and that, if they are incompatible with this supposition, they are not necessarily opposed to the undulatory theory of magnetism, since the supposed difference between the waves of heat and magnetism affords reasonable ground for the supposition, that there may be more or less of difference in the detail of the distribution of these two principles over the earth. It is to be observed, moreover, that, as it appears from the foregoing discussion that the differences between the two classes of lines follow a certain law, the molecular magnetic intensity is not only approximately proportional to the temperature, but must be rigorously connected with it by some law.

Horizontal Intensity.

The formula which has been investigated, for the horizontal component of the directive force, or the horizontal magnetic intensity of a place, is

$$\text{Hor. intensity} = C' \, T \quad . \quad . \quad . \quad (10.)$$

in which C′ is an unknown constant, and T the mean annual temperature of a place; understanding by the mean annual temperature, the mean intensity of the heat of the earth at the place. Temperatures are experimentally obtained by means of thermometers, which give the height of the mercury above an arbitrary zero, and by an arbitrary scale. It is not to be supposed, therefore, that any of those in use furnish the proportional absolute amounts of heat. The only resource, then, is to add arbitrarily different numbers to the thermometric values of T until one be found, if possible, which will give values of the horizontal intensity that accord with observation. The following table gives the results obtained for a number of places, by adding 15° (centigrade) to T° (centigrade.) The formula was

$$\text{Hor. intensity} = H \frac{t + 15^\circ}{T + 15^\circ} \quad . \quad . \quad . \quad (11.)$$

in which H is the observed horizontal intensity for some particular place, T the temperature at this place, and t the temperature at the place for which the horizontal intensity is required. For the western continent H = horizontal intensity at New York = ·5291; for Europe, H = horizontal intensity at Paris = ·518. The temperatures, as in all other investigations in the present article, were taken from Mahlmann's table, or from Kaemtz, pp. 192, 193, and reduced when necessary to the level of the sea. The "observed" horizontal intensities were deduced from the observed total intensities and inclinations; these being derived from the same authorities as the declinations, with the addition of Sabine's Report on the magnetic intensity of the earth. To avoid repetition, I will here remark that the observations employed in the subsequent parts of this article were derived from the same sources.

TABLE IV.

Place.	Hor. Intensity.		Diff.	Place.	Hor. Intensity.		Diff.
	computed	observed			computed	observed	
New York,		·5291		Paris,		·518	
Montreal,	·443	·409	+·034	Moscow,	·382	·504	—·122
Dorchester,	·500	·481	+·019	Christiania,	·410	·437	—·027
Albany,	·500	·482	+.018	Königsberg,	·422	·479	—·057
Washington,	·571	·576	—·005	Berlin,	·474	·509	—·035
Cincinnati,	·575	·576	—·001	Edinburgh,	·478	·446	+·032
St. Louis,	·591	·616	—·025	Göttingen,	·494	·510	—·016
Chapel Hill,	·640	·645	—·005	London,	·506	·485	+.021
St. Augustine,	·770	·753	+·017	Milan,	·568	·571	—·003
Key West,	·820	·821	—·001	Marseilles,	·584	·543	+·041
Equator, eastern coast of S. America,	·882	·936	—·054	Naples,	·632	·657	—·025
				Lat. 25°, W. coast of Africa,	·754	·814	—·060
				Equator, do.	·854	·920	—·066
				do. do.	·921	·920	+·001

The second result for the equator, at the end of the table, was calculated from ·814, the observed horizontal intensity at latitude 25°, W. coast of Africa.

The following observed elements were obtained by estimation from the tables and charts of Sabine, Gauss, and Loomis: Chapel Hill, intensity $=1·77$, dip$=68° 37'$; St. Augustine, intensity $=$ $1·66$, dip $=63°$; Key West, intensity $=1·55$, dip $=58°$; equator, E. coast of S. America, intensity $=1·06$, dip $=28°$; latitude 25°, W. coast of Africa, intensity $=1·3$, dip $=51° 15'$; equator, W. coast of Africa, intensity $=·920$, dip $=0°$.

It will be observed that the differences for Europe are greater than for America. The following table was calculated from the formula

$$\text{Hor. intensity} = \text{H}\frac{t+20°}{\text{T}+20°} \quad . \quad . \quad . \quad (12.)$$

TABLE V.

Place.	Hor. Intensity.		Diff.	Place.	Hor. Intensity.		Diff.
	computed.	observed.			computed.	observed	
Moscow,	·408	·504	—·094	London,	·508	·485	+ 023
Christiania,	·424	·437	—·013	Milan,	·561	·571	—·010
Königsberg,	·438	·479	—·041	Marseilles,	·573	·543	+·030
Berlin,	·481	·509	—·028	Naples,	·614	.657	—·043
Edinburgh,	·486	·446	+·040	Lat. 25°, W. coast of Africa,	·716	·814	—·098
Göttingen,	·500	·510	—·010	Equator, do.	·800	·920	—·120

The differences here are generally less than in the previous table. The same formula would however give results wider from the truth than the first one, for the western continent.

More accurate results might be obtained by making the calculations from the observed horizontal intensities of a greater number of places.

Theoretical investigations have conducted to the law that the change of temperature of the earth is proportional to that of the square of the cosine of the latitude, and observations are said to lead to the same conclusion. Assuming this law to be true, the temperature must every where be proportional to the square of the cosine of the latitude, plus or minus some number. That is, $\text{T}=\text{A}\cos.^2 \text{lat.} \pm \text{C}$. This gives the formula

$$\text{Hor. intensity} = \text{H}\frac{\cos^2 l \pm \text{C}}{\cos^2 \text{L} \pm \text{C}} = \text{H}\frac{1+\cos 2l \pm \text{C}}{1+\cos 2\text{L} \pm \text{C}} \quad . \quad . \quad (13.)$$

l and L denoting two different latitudes, and H the horizontal intensity at L. The results given in the following table are calculated from this formula, taking $\text{C}=0$, and $\text{H}=$ horizontal intensity at New York $=·5291$.

TABLE VI.

Place.	Hor. Intensity.		Diff.	Place.	Hor. Intensity.		Diff.
	computed.	observed.			computed.	observed.	
Montreal,	·453	·409	+·044	Prairie du Chien,	·492	·505	-·013
Dorchester,	·503	·481	+·022	Dubuque,	·501	·516	-·015
Albany,	·498	·482	+·016	Louisville,	·561	·598	-·037
Springfield,	·507	·499	+·008	St. Louis,	·562	·616	-·054
Providence,	·511	·501	+·010	Lat. 35°, E. coast of U. States,	·618	·665	-.047
West Point,	·518	·521	—·003	Lat. 30°, do.	·691	·753	-·062
New Haven,	·520	·507	+·013	Lat. 25°, do.	·756	·821	-·065
Princeton,	·535	·540	—·005	Lat. 20°, do.	·813	·872	-·059
Philadelphia,	·541	·549	—·008	Lat. 15°, do.	·859	·892	-·033
Washington,	·560	·576	—·016	Lat. 10°, do.	·893	·919	-·026
Hudson, Ohio,	·521	.532	—·011	Lat. 5°, do.	·914	·917	-·003
Cincinnati,	·555	·576	—·021	Equator, do.	·921	·936	-·015

It will be observed that the differences are greatest between the latitudes 15° and 35°. But the observed elements are less accurately known between these limits, being obtained by estimation. It would appear, however, that the supposition that $C=0$ in formula (13) is incorrect. It will be seen that the determinations for latitudes south of New York are almost all in deficiency, while those for places north of New York are in excess. More accurate results might accordingly be obtained by subtracting some number from $1+\cos 2l$ and $1+\cos 2L$. Table VII, was calculated in this manner, or from the formula

$$\text{Hor. intensity} = H\,\frac{1+\cos 2l - C}{1+\cos 2L - C} \quad . \quad . \quad . \quad (14.)$$

Different values were given to C for every different place. These values were empirically obtained from the observed temperatures in the following manner. Kaemtz in his Course of Meteorology, furnishes the following table of mean temperatures.

Temperature.	Latitudes.	
	East Coast of America.	West Coast of Europe.
25°	24° 21′	18° 49′
20	32 20	31 27
15	38 24	41 33
10	41 30	52 3
5	44 51	60 7
0	51 57	66 48

Taking the data of the second column of this table, we find that the difference between the temperature at the equator and the temperature at a certain latitude varies as $1-\cos 2\text{lat.} - C$: so that at two different latitudes, l and L, the differences are as $1-\cos 2l - C : 1-\cos 2L - C$. The value of C changes more or less if we change either of the latitudes l or L. If we take $L=24°\ 21'$, and give successively to l the values 32° 20′, 38° 24′, 41° 30′, 44° 51′, 51° 57′, we find for C the values ·211, ·222, ·242, ·220, ·240. If we take $L=38°\ 24'$ and $l=41°\ 30'$, $C=$

·500. Now by taking L = latitude of New York, and l = latitude of the place for which the horizontal intensity is to be computed, and making use of the observed temperatures, the respective values of C determined as above, are those which have been empirically substituted in equation (14), and used in calculating the following table.

TABLE VII.

Place.	Hor. intensity.		Diff.	Values of C.
	Computed.	Observed.		
Montreal, . . .	·440	·409	+·031	
Washington, . . .	·573	·576	−·003	·380
Chapel Hill, Lat. 36°, .	·635	·645	−·010	·330
St. Augustine, Lat. 30°, .	·759	·750	+·009	·323
Key West. Lat. 24½°, .	·816	·826	−·010	·211

By taking the data furnished by the third column of the small table of temperatures just given, I find that on the western coast of Europe and Africa, the difference between the temperature at the equator and the temperature at a given latitude, varies as $1-\cos n\text{lat.}$, n having various values for different latitudes, from 2 to 1·5. This makes the temperature proportional to $1+\cos n\text{lat.}+\mathrm{C}$, C being some constant number, either positive or negative. For, supposing this to be the law of variation of the temperature, and denoting the temperatures at the equator and a given latitude (l) by T and T′, we have $\mathrm{T}:\mathrm{T}'::2+\mathrm{C}:1+\cos nl+\mathrm{C}$. Whence $\mathrm{T}:\mathrm{T}-\mathrm{T}'::2+\mathrm{C}:1-\cos nl$, and $\mathrm{T}-\mathrm{T}'=\frac{\mathrm{T}}{2+\mathrm{C}}(1-\cos nl)$. For any other latitude (L) we have in like manner $\mathrm{T}-\mathrm{T}''=\frac{\mathrm{T}}{2+\mathrm{C}}(1-\cos n\mathrm{L})$. These equations give $\mathrm{T}-\mathrm{T}':\mathrm{T}-\mathrm{T}''::1-\cos nl:1-\cos n\mathrm{L}$. We have therefore for the calculation of the horizontal intensity on the coast of Europe, the following formulæ.

$$\text{Hor. intensity}=\mathrm{H}\frac{1+\cos nl+\mathrm{C}}{1+\cos n\mathrm{L}+\mathrm{C}};$$

Or, assuming C = 0,

$$\text{Hor. intensity}=\mathrm{H}\frac{1+\cos nl}{1+\cos n\mathrm{L}} \quad . \quad . \quad . \quad . \quad (15.)$$

Table VIII. contains the results of numerous calculations made with this formula. The values of n, as given in the table, were obtained from the consideration that for each place the excess of the observed temperature at the equator over that of the place, was proportional to $1-\cos n\text{lat.}$ H was taken = ·814 = hor. intensity at latitude 25° on west coast of Africa. The temperature at the equator on the west coast of Africa was taken at 27°·85. The difference between this and the temperature at latitude 25°, was obtained by means of the table given on page 215, by supposing, what the table shows to be true, that the difference varies from one latitude to another proportionally to 1 − cos 2lat.

TABLE VIII.

Place.	Hor. Intensity.		Diff.	n
	Computed.	Observed.		
Lat. 25°, W. coast of Africa,		·814		
Christiania, ...	·454	·437	+·017	1·5
Moscow, ...	·504	·504	·000	1·5
Edinburgh, ...	·464	·446	+·018	1·6
Göttingen, ...	·480	·510	—·030	1·75
London, ...	·488	·485	+·003	1·7
Berlin, ...	·510	·509	+·001	1·6
Paris, ...	·523	·518	+·005	1·7
Milan, ...	·530	·571	—·041	1·85
Marseilles, ...	·538	·543	—·005	1·95
Lat. 35°, W. coast of Africa,	·665	·650	+·015	2·
Lat. 30°, do. do. .	·743	·746	—·003	2·
Lat. 20°, do. do. .	·878	·823	+·055	2·
Lat. 10°, do. do. .	·961	·900	+·061	2·
Lat. 0°, do. do. .	·991	·920	+·071	2·

The value of *n* was assumed the same for Moscow as for Christiania. A direct calculation from the observed temperature at Moscow gives *n* = 1 (nearly), and horizontal intensity = ·6 (nearly). For London *n* was assumed the same as for Paris. This accords with the general law of variation of temperature in these latitudes. The actual variation of temperature between Paris and London is less than this law requires.

The results which are given in Tables IV. to VIII, seem fully to establish that the horizontal intensity is a function of the temperature of the place; and those of Table IV. indicate that it is very nearly proportional to the temperature estimated from a point on the scale of the Centigrade thermometer 15° below the zero. This point is within 2° of the zero of Fahrenheit. We have therefore this curious and important result, viz. that the horizontal magnetic intensity is nearly proportional to the mean annual temperature of the place, as measured by a Fahrenheit's thermometer. The zero of Fahrenheit is very nearly the temperature which obtains at the two cold poles. At these poles also the horizontal intensity is very feeble. The result just stated will then accord with the fundamental principle of our theory of the magnetic forces, that the magnetic intensity of each particle of the earth's mass is proportional to the intensity of its heat, if we make this modification in the statement of this principle, viz. that the magnetic intensity is nearly proportional to the intensity of the heat over and above that which obtains at the poles of maximum cold. The real state of the case would probably be better represented by supposing that the magnetic intensity of the particles of the earth decreases more rapidly than the absolute intensity of heat, and becomes comparatively feeble at the zero of Fahrenheit, without becoming absolutely zero at this, or perhaps any other known temperature. We shall see hereafter that it is not necessary to suppose that the molecular magnetic force becomes zero at the magnetic poles, in order to explain the fact of the horizontal intensity becoming reduced to zero there.

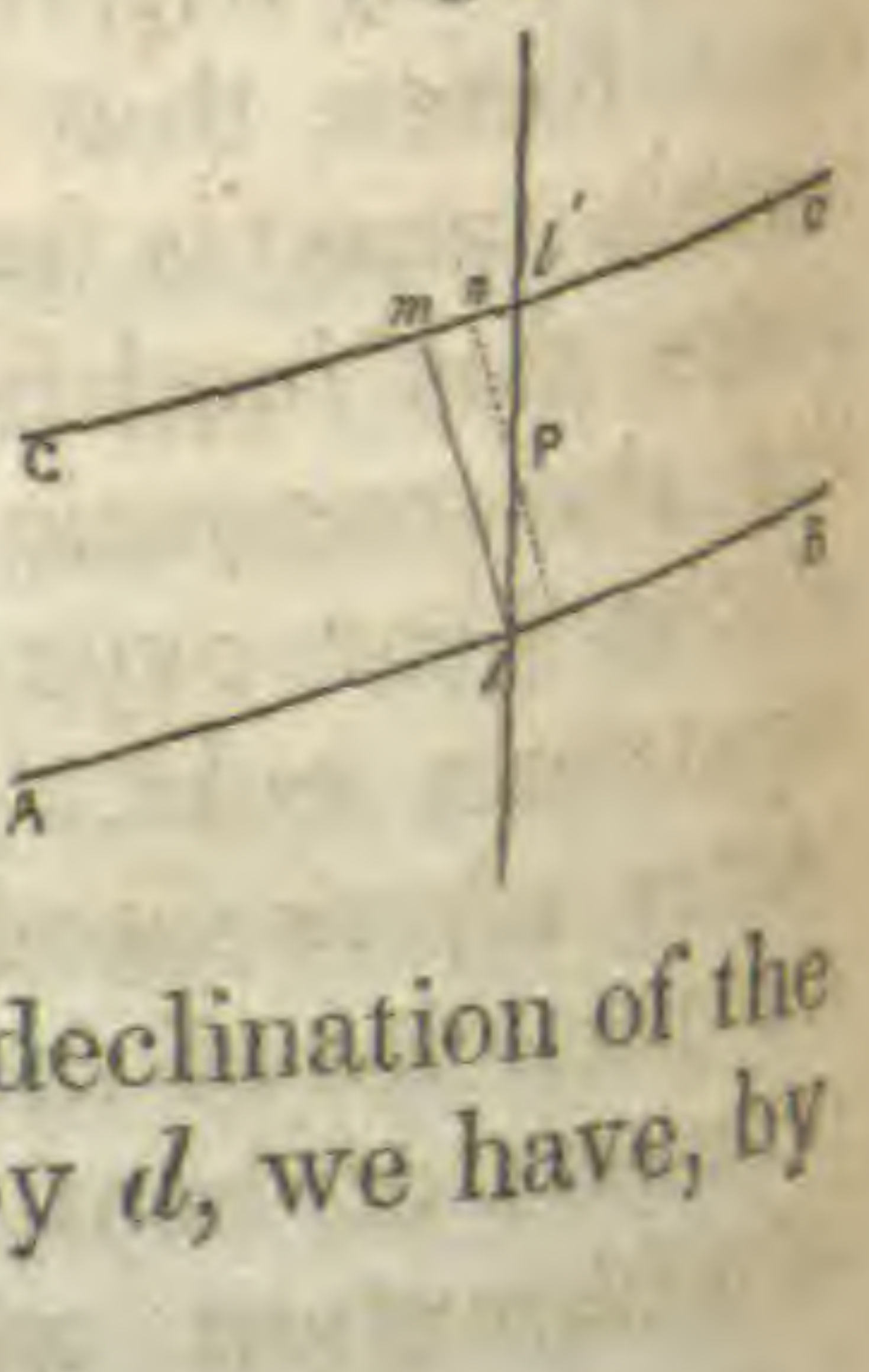
Vertical Intensity.

The formula obtained for the vertical intensity is,

$$\text{Ver. intensity} = \mathrm{C}(t-t') \quad . \quad . \quad (16.)$$

C being a constant, and t, t', the mean annual temperatures at two places situated at certain equal distances north and south of the given place, in a direction perpendicular to the isogeothermal line, or rather line of equal molecular magnetic intensity. t and t' in the formula are in general the measures of the molecular magnetic intensities; and it is assumed that the temperatures may be taken as these measures. Since the temperatures t and t' cannot in general be readily obtained from existing observations, we will seek for the law of variation of $t-t'$. It has already been seen that the diminution of temperature from the equator northward, on the western continent, is as $1-\cos 2\text{lat.}-\mathrm{C}$. Now, for a small number of degrees north and south of the given place, C may be considered as constant; and hence the difference of temperature of two places situated the same number of degrees, say 5°, to the north and south of the given place, is proportional to $\cos 2(\text{lat.}-5^\circ)-\cos 2(\text{lat.}+5^\circ)$. This is equivalent to the generally received law that the temperature varies, for a moderate distance, as the square of the cosine of the latitude. For $\cos^2\text{lat.} \backsim 1+\cos 2\text{lat}$, and hence, putting d and d' equal to the variations of temperature between the given place and the two places in question, and $l=$ latitude of given place, $d \backsim (1+\cos 2(l-5^\circ))-(1+\cos 2l)$, $d' \backsim (1+\cos 2l)-(1+\cos 2(l+5^\circ))$. Whence $d+d' \backsim \cos 2(l-5^\circ)-\cos 2(l+5^\circ)$. This is the measure of the variation of temperature on a meridian passing through the place. To obtain the variation in a direction perpendicular to the isogeothermal line, we must increase this in the proportion of cosine of the angle included between this perpendicular and the geographic meridian to unity. For, let P, Fig. 9, be the given place, lPl' the meridian through P, AB and CD two parallel isogeothermal lines at equal distances from P, and lm a perpendicular to AB and CD. The variation of temperature for a given distance will be as much greater in the direction lm than in the direction ll', as lm is less than ll'. But $lm : ll' :: \cos l'lm : 1$. We may take for the approximate value of $l'lm$ the declination of the magnetic needle. If therefore we denote this by d, we have, by substitution in formula (16),

Fig. 9.



$$\text{Ver. intensity} = \mathrm{C}\frac{\cos 2(l-5^\circ)-\cos 2(l+5^\circ)}{\cos d}.$$

Or, designating by V the observed vertical intensity at some particular place, by L the latitude of this place, and by D the declination of the needle there, we have

$$\text{Ver. intensity} = \mathrm{V}\frac{\cos 2(l-5^\circ)-\cos 2(l+5^\circ)}{\cos 2(\mathrm{L}-5^\circ)-\cos 2(\mathrm{L}+5^\circ)}\cdot\frac{\cos \mathrm{D}}{\cos d}\,..(17.)$$

It was remarked on page 10, of this volume, that it might be found necessary to increase the results of formula (16), except in high latitudes, by reason of the deviation of the change of temperature from the supposed law of uniformity. If any term or factor is to be added to formula (17) on this account, it must be some function of the differential of $\cos^2 l$, that is, of $\sin 2l$.

In the calculation of the following table, V was taken equal to 1·7236 = vertical intensity at New York; except for St. Louis, Dubuque, Louisville, and Hudson, (the first result,) whose vertical intensities were computed from that of Cincinnati (1·643.)

TABLE IX.

Place.	Ver. Intensity.		Diff.	Place.	Ver. Intensity.		Diff.
	computed.	observed.			computed.	observed.	
New York,		1·7236		Cincinnati,	1·705	1·643	+·062
Montreal,	1·766	1.758	+·008	Prairie du Chien,	1·690	1·707	−·017
Dorchester,	1·747	1·720	+·027	Dubuque,	1·685	1·690	−·005
Springfield,	1·743	1·755	−·012	Louisville,	1·633	1·646	−·013
Albany,	1·741	1·744	−·003	St. Louis,	1·649	1·636	+·013
Providence,	1·742	1·741	+·001	Lat. 35°, E. coast of U. States,	1·638	1·648	−·010
West Point,	1·734	1·757	−·023				
New Haven,	1·731	1·706	+·025	Lat. 30°, do. do.	1·510	1·479	+·031
Princeton,	1·719	1·725	−·006	Lat. 25°, do. do.	1·335	1·314	+·021
Philadelphia,	1·714	1·716	−·002	Lat. 20°, W. India Isles,	1·120	1·160	−.040
Washington,	1·696	1·690	+·006				
Hudson, Ohio,	1·657	1·727	−·070	Lat. 10°, E. coast of S. America.	·600	·771	−·171
do. do.	1·721	1·727	−·006				

South of latitude 20°, the difference becomes large. For this three reasons may be assigned. 1. Errors in the "observed" elements obtained by estimation. 2. The deviation of the change of temperature from uniformity. 3. The inaccuracy, in the vicinity of the equator, of the supposed law, that the variation of temperature is proportional to the variation of the cosine of twice the latitude; for this law supposes that on each meridian the temperature has its maximum value at the equator, whereas Captain Duperrey has found that the warmest point of each meridian is the point of intersection with the magnetic equator. This is probably the principal source of the errors in low latitudes. The magnetic equator traverses South America at a distance of some 10° south of the geographical equator; and thus in low latitudes on the western continent, the computed vertical intensities ought to come out considerably too small. In the calculations which follow, for the eastern continent, (Table X,) this source of error does not exist, since the magnetic equator crosses the geographical equator very near the coast of Africa.

We have seen that for the coast of Europe, and of Africa, the excess of the mean temperature at the equator over that at any latitude l, is proportional to $1 - \cos nl$; n having various values at different latitudes, intermediate between 2 and 1·5. This makes the formula for the vertical intensity in western Europe and Africa,

$$\text{Ver. intensity} = \text{V}\frac{\cos n(l-5^\circ) - \cos n(l+5)}{\cos n(\text{L}-5^\circ) - \cos n(\text{L}+5^\circ)} \cdot \frac{\cos \text{D}}{\cos d}.$$

This formula gives results too small in the lower latitudes. It can however be made to represent the observations by introducing the factor $\frac{1+\sin n\text{L}}{1+\sin nl}$. This being done, we have

$$\text{Ver. intens.} = \text{V}\frac{\cos n(l-5^\circ) - \cos n(l+5^\circ)}{\cos n(\text{L}-5^\circ) - \cos n(\text{L}+5^\circ)} \cdot \frac{\cos \text{D}}{\cos d} \cdot \frac{1+\sin n\text{L}}{1+\sin nl} \,. \quad (18.)$$

Whether the introduction of this factor is due to the fact that the variation of temperature is not uniform from 5° south to 5° north of the given place, as supposed in the investigation of the formula, (becoming necessary here because of the more northern situation of the magnetic equator,) or to some other cause, I have not yet undertaken to determine. It is important to observe that this factor although empirically introduced, is still a function of the differential variation of temperature. For the diminution of temperature in passing from the equator to any latitude l, is proportional to $1 - \cos nl$. The differential of this, or the differential variation of temperature, is $\sin nl \,.\, ndl$. In obtaining the results given in the following table, V was at first taken equal to 1·2445, the observed vertical intensity at Paris, L = 48° 50′, and D = 22°. The vertical intensity for latitude 25°, western coast of Africa, was then calculated by the formula, and found to be 1·007. The other determinations were subsequently obtained by giving this value (1·007) to V, and taking L = 25°, and D = 20°. So that the calculations were all virtually made from the observed intensity at Paris. The same values of n were used as in the calculations of the horizontal intensities, (see Table VIII.)

TABLE X.

Place.	Ver. Intensity.		Diff.	Place.	Ver. Intensity.		Diff.
	computed.	observed.			computed.	observed.	
Paris, . .		1·2445		Berlin, . .	1·266	1·268	−·002
Lat. 25°, W. coast of Africa, .	1·007	1·014	−·007	Milan, . .	1·188	1·159	+·029
Christiania, .	1·330	1·353	−·023	Marseilles, .	1·175	1·174	+·001
Edinburgh, .	1·351	1·340	+·011	Lat. 35°, W. coast of Africa,	1·133	1·126	+·007
Göttingen, .	1·223	1·257	−·034	Lat. 10°, do. do.	·579	·631	−·052
London, . .	1·284	1·282	+·002	Lat. 0°, do. do.	0	0	·000

The differences between the results of computation and observation, both in this and the previous table, cannot but be regarded as remarkably small, when it is considered that these are first determinations in which the nicest attention to accuracy would have been misplaced. The same may be said of the determinations of horizontal intensity and declination. The differences in Tables IX and X, might be made still smaller by making the calculations from a greater number of observed intensities.

An elaborate discussion can alone decide the question of the origin of the small differences (not due to errors of observation) that exist between the computations of vertical and horizontal intensities and declinations, and the observed values of the same: —determine whether they are not attributable (partially or entirely) to thermal differences between the magnetic crust of the earth and the air, variations in the constitution of this crust in passing from one point to another, &c., or are referable to small deviations of the theory from the truth.

Dip and Total Intensity.

The total intensity, or directive force of the needle, may be obtained by taking the square root of the sum of the squares of the horizontal and vertical intensities; and the dip by dividing the vertical by the horizontal intensity. The quotient will be the tangent of the dip. The error of total intensity will be in all instances less than the sum of the errors of the horizontal and vertical intensities. Denoting by E the error of vertical intensity and by d the dip of the needle, the error (e) entailed upon the total intensity by this, will be $e = \mathrm{E} \sin d$. The error e' entailed by that of the horizontal intensity will be $e' = \mathrm{E}' \cos d$. The total error will then be nearly $\mathrm{E} \sin d + \mathrm{E}' \cos d$. This error, except in very low latitudes where the formula for the vertical intensity is theoretically inaccurate, is every where less than 0·1, and generally only a few hundredths. Denoting the total intensity by M, we have, tangent of error of dip due to $\mathrm{E} = \frac{\mathrm{E} \cos d,}{\mathrm{M}}$; and, tangent of error of dip due to $\mathrm{E}' = \frac{\mathrm{E}' \sin d}{\mathrm{M}}$. Hence, tangent of total error of dip $= \frac{\mathrm{E} \cos d - \mathrm{E}' \sin d}{\mathrm{M}}$ (nearly.) Without going into a detailed calculation, it may be seen that the error of the dip cannot exceed 4°, (except near the equator on the western continent, where the formula for the vertical intensity is theoretically inaccurate;) and is generally very much less than this.

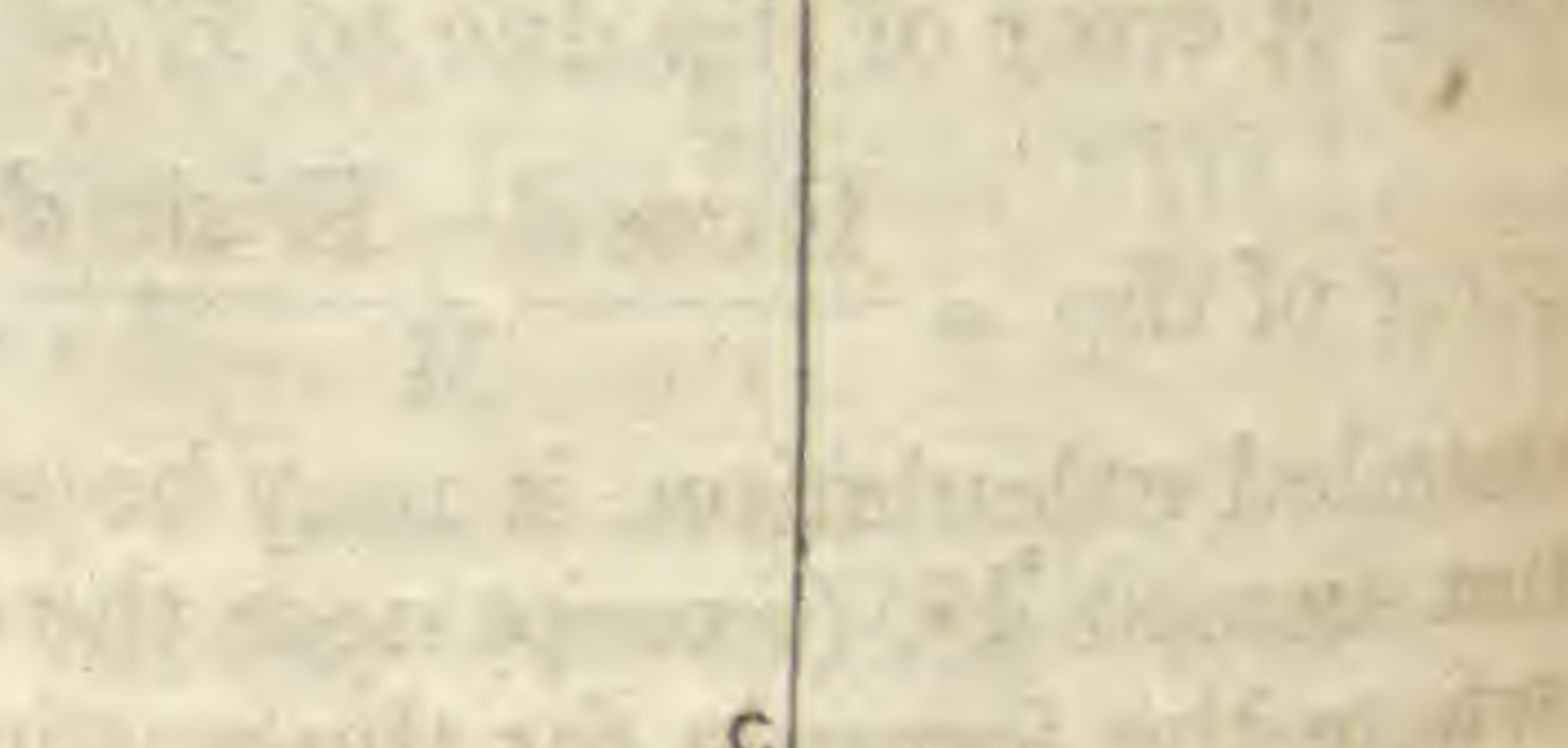
It has been ascertained, from a discussion of the observations which have been made upon the intensity and dip, that the intensity is not a function of the dip; or that the intensity is not necessarily the same, though the dip is the same. This fact shows that the horizontal and vertical components of the intensity cannot be functions of the same element; for, if they were, when this element remained the same, both these forces would remain the same, and thus both the dip and intensity would be unaltered. The isoclinal and isodynamic lines would therefore coincide. It accords therefore, with the theory under discussion, since, upon this theory, one of these forces is a function of the absolute temperature at the place, and the other of the variation of temperature. Now, while the absolute temperature is the same at two different places, the variation of temperature may be different.

Magnetic Poles.—Magnetic Equator.

The true magnetic poles of the earth are the points on its surface where the dip of the needle is 90°; and where, therefore, the horizontal intensity is equal to zero. The existence of such points may be attributed *à priori*, to either of the two following named causes: 1. The magnetic intensity of the particles of the earth in the immediate vicinity of the place, to whose action the horizontal intensity is due, may be so feeble as to afford no appreciable horizontal force in comparison with the vertical force, which, as it depends upon the difference of the molecular intensities north and south of the place, has no necessary connection with the absolute molecular intensities. 2. The acting forces may be so related in direction and intensity that their horizontal actions may destroy each other.

We have already had reason to suppose that the absolute magnetic intensities of the particles of the earth are very feeble at the poles of maximum cold, which are in the immediate vicinity of the magnetic poles, so called, and perhaps identical with them. But, whether this be true or not, it may easily be shown that the disposition of the forces is such at these points as to make the horizontal intensity disappear, or nearly so. Let AB, fig. 10, represent a great circle passing through *p*, one of the cold poles. If we suppose that the temperature increases by equal degrees in every direction from *p*, or in other words, that the isogeothermal lines are circles traced around *p*, the magnetic intensity of the two particles *m* and *n*, equally distant from *p*, is the same. Now the acting forces of these particles will have the directions P *a* and P *b*, equally inclined to the vertical P C. The same is true of every other pair of similarly situated particles. The directive force of the needle at *p* will therefore be vertical. The supposition that the isogeothermal lines are circles, in the vicinity of the

Fig. 10.



cold poles, is doubtless not strictly true; nor have they probably the precise form of any curve disposed symmetrically around *p*, and therefore the point where the dip is 90° ought not to be in perfect coincidence with the pole of greatest cold. In fact it is conceivable that the distribution of temperature may be such that the needle will no where have the dip of 90°. This would seem to be the case at the Asiatic pole.

Agreeably to the theory which has been propounded, the magnetic equator is the line traced through all the points at which the difference of temperature on the north and south is equal to zero; for at all such places the vertical intensity and therefore the dip would be equal to zero. Now it may be presumed that the places where the difference of temperature is equal to zero, are the warmest points on the different meridians; and, in fact, according to Captain Duperrey, these are precisely the points which lie on the magnetic equator.

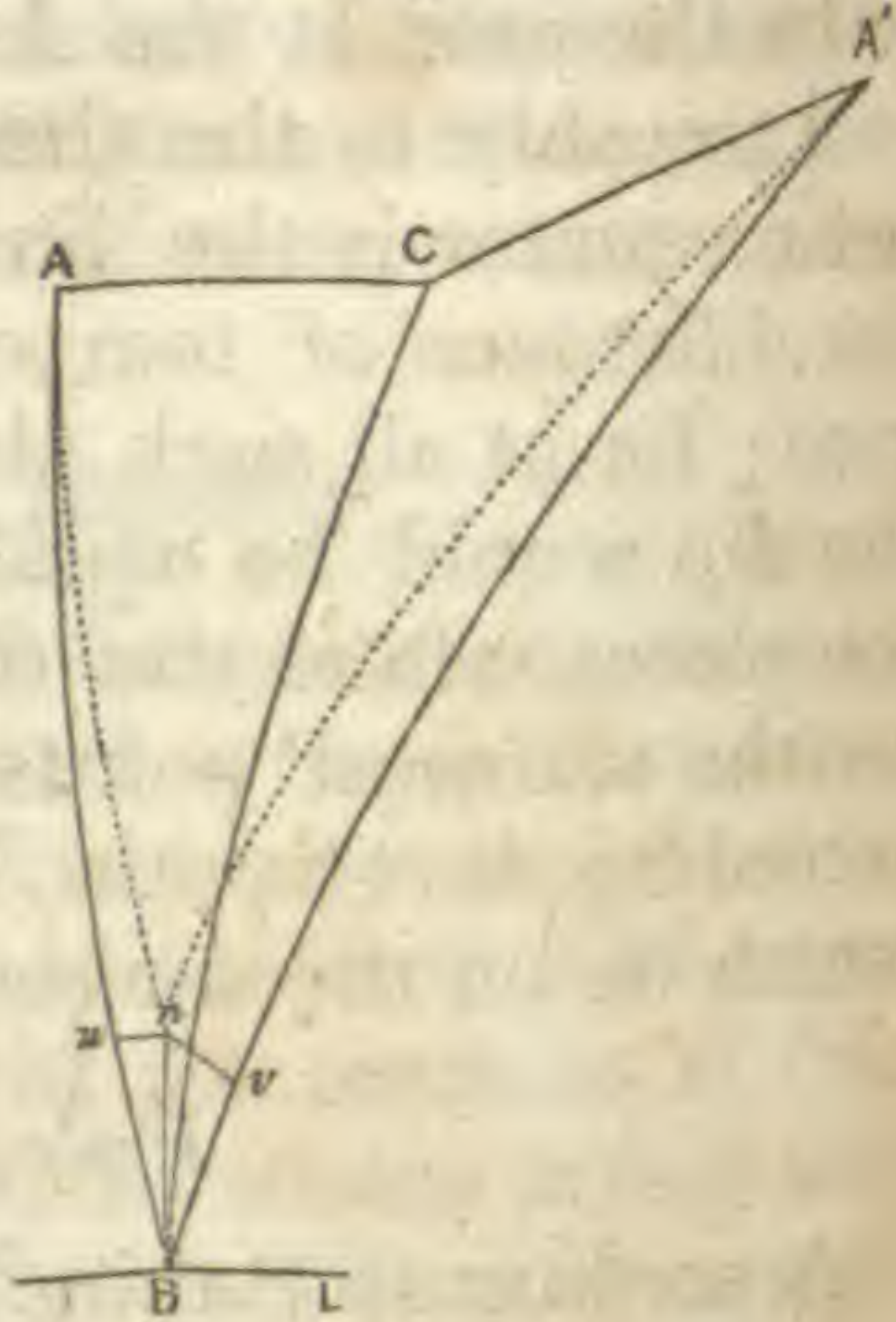
Pole of Maximum Intensity.

According to Sabine's Chart of Isodynamic Lines, the American pole of maximum magnetic intensity is situated in longitude 90° to 96°, and latitude 50° to 55°. Professor Locke, of Cincinnati, made in the year 1838, &c., a series of observations, which led to the more accurate determination of this point. The result to which he arrived, is that the pole of maximum intensity is situated about in long. 90°, and latitude $47\frac{1}{2}$°; or nearly on the same meridian with the pole of greatest dip, and about 20° south of it. Let us attempt to determine the situation of this point from theoretical considerations.

In the first place let it be observed that the horizontal intensity decreases from the equator northward, while the vertical intensity increases; the one varying with the temperature and the other with the difference of temperature. It follows from this that the pole of maximum intensity will be situated on the meridian on which the greatest difference of temperature obtains, provided this difference also occurs at a lower latitude than the greatest difference upon any other meridian; for the maximum vertical intensity will then be associated with a greater horizontal intensity than is the greatest vertical intensity upon any other meridian. The presumption is that the greatest difference of temperature occurs on the meridian which contains the pole of greatest cold, since there is a greater variation of temperature from the equator to the latitude of the cold pole (70° to 75°), on this than on any other meridian. We may naturally expect also, that the point of maximum variation will occur farther to the south, upon this meridian. The truth of these presumptions may be established by deriving from Brewster's formula for the temperature, a general expression for the variation of temperature in a direction perpendicular to the isothermal line. It has already been seen that the general expression for the variation of temperature answering to an indefinitely small change of place is,

$$dT = \frac{Cn\,(\cos\delta\sin\delta'\,d\delta + \cos\delta'\sin\delta\, d\delta')}{\sin^{-n+1}\delta\,\sin^{-n+1}\delta'} \quad . \quad . \quad (19.)$$

Fig. 11.



Let C, fig. 11, be the geographical pole, A, A′ the two cold poles, A being the American pole, BL the direction of the isogeothermal line at B, B*n* an arc perpendicular to BL and *nu*, *nv* arcs perpendicular to AB and A′B. Let B*n*=*k* and denote the angles AB*n* and A′B*n* by *b* and *b′*. Then $d\delta = Bu = Bn \cos ABn = k \cos b$; and $d\delta' = Bv = Bn \cos A'Bn = k \cos b'$. Substituting in equation (19),

$$dT = \frac{Cn(\cos\delta\sin\delta' k\cos b + \cos\delta'\sin\delta\, k\cos b')}{\sin^{-n+1}\delta\,\sin^{-n+1}\delta'} \quad . \quad (20.)$$

$$\text{And } d\,T \propto \frac{\cos\delta\sin\delta'\cos b + \cos\delta'\sin\delta\cos b'}{\sin^{-n+1}\delta\,\sin^{-n+1}\delta'} \quad . \quad . \quad (21.)$$

Now the calculations of the declination which have been made, show that *b* and *b′* diminish (along with the angle ABA′) and thus cos *b* and cos *b′* increase as we follow the same parallel of latitude from the meridian of Paris, westward, as far as longitude 90° to 100°, (for example, for London $b = 12° 55'$, $b' = 34° 17'$, and for longitude 93° W., and latitude 50°, $b = 0$ and $b' = 3°$); also that δ' remains the same while δ diminishes, and that δ' is greater than δ, and is nearly equal to the colatitude of the place +25°. The tendency of the changes of cos *b* and cos *b′* is to make the expression (21) for *d*T greater in proportion as we draw nearer to the meridian 93°, or thereabouts. Omitting cos *b* and cos *b′*, the numerator becomes $\cos\delta\sin\delta' + \sin\delta\cos\delta' = \sin(\delta+\delta')$. This will be the greatest when $\delta+\delta' = 90°$; and since δ' remains the same on the same parallel of latitude and δ diminishes with the angle ABA′, as we go westward towards the meridian 93°, it is plain that $\delta+\delta'$ will be equal to 90° at the lowest latitude on, or near, the meridian where the angle ABA′ is equal to zero. At this point the numerator of the fractional expression (21) is greater than at the same latitude, or at any latitude, on any other meridian; for it is only on this meridian that cos *b* and cos *b′* may be regarded as equal to unity. It is only necessary then, to establish that on each meridian the greatest value of *d*T obtains where $\delta+\delta' = 90°$, and that a greater value obtains at this point on or near the meridian of 93° than on any other meridian. We will attempt to establish the latter first. Let us suppose that $b=b'$, and that each has the value of the smaller of the two. This supposition is an unfavorable one, since it will make the value of dT for other meridians than 93° greater than expression (21) makes it. Upon this supposition (21) becomes

$$\frac{\cos b(\cos\delta\sin\delta'+\sin\delta\cos\delta')}{\sin^{-n+1}\delta\sin^{-n+1}\delta'}=\frac{\cos b\sin(\delta+\delta')}{\sin^{-n+1}\delta\sin^{-n+1}\delta'},\qquad(22.)$$

and for the point where $\delta+\delta'=90°$,

$$\frac{\cos b}{\sin^{-n+1}\delta\sin^{-n+1}\delta'};\ \text{or}\ \frac{\cos b}{\sin^{\frac{1}{9}}\delta\sin^{\frac{1}{9}}\delta'},\quad .\quad .\quad(23.)$$

putting $n=\frac{8}{9}$, the value which accords best with the observations of temperature. Now making the calculation of the declination for the latitude 50°, and longitude 93° W., by formula (6), I find $\delta=24°\ 40'$, $\delta'=63°\ 56'$, $b=0$ (very nearly), $b'=3°$, $\delta+\delta'=88°\ 36'$. The same calculation for London (latitude 51° 31′) gives $\delta=37°\ 18'$, $\delta'=62°\ 29'$, $b=12°\ 55'$, $b'=34°\ 17'$, $\delta+\delta'=99°\ 47'$. The point where $\delta+\delta'=90°$ is then in latitude 50° (nearly), on the meridian 93° W. For other meridians it is north of 50°. This is evidently the case for the meridian of London; and that it is true for other meridians, east or west of 93°, appears from the fact, deducible from the various calculations of declination and temperature, that while δ' remains the same on the same parallel of latitude, δ diminishes towards 93°. On these meridians then δ' is a certain number of degrees less, and δ the same number of degrees greater than on the meridian of 93°, at the point for which $\delta+\delta'=90°$. The effect of the increase of δ upon the value of expression (23) will more than compensate for that of the diminution of δ'; and the augmented value of b, by making $\cos b$ less, will increase the difference. It appears, therefore, that (23) has its maximum value in the vicinity of 93° of longitude;—on the meridian for which the angle between δ and δ' is zero. The details of the calculations of declination make it evident that this meridian, and therefore that of maximum value, lies a few degrees to the west of 93°.

We have still to show that the maximum value of expression (21), on each meridian, is at the point where $\delta+\delta'=90°$. In longitude 93° this value of $\delta+\delta'$ occurs about in latitude 50°. For this locality and its vicinity $b=0$ (very nearly), and $b'=$ some 3° or 4°. In going north from 50° to 60°, b is constantly from 4′ to 5′, and b' increases about 2½°. In going south b preserves about the same value, while b' diminishes; as may be seen from the fact that at St. Louis (long. 90° 15′, lat. 38° 37′) the sum of the two angles b and b' does not exceed 10′. Now, let us suppose that $b=b'$ in expression (21), which will give

$$\frac{\cos b' \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad . \quad (24.)$$

For the point where $\delta+\delta'=90°$ this becomes

$$\frac{\cos b'}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad . \quad (25.)$$

(25) is less than the value of (21) for latitude 50°. South of this latitude let us suppose that $b'=b$ in (21), which gives

$$\frac{\cos b \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad . \quad (26.)$$

(26) is greater than (21) south of 50°. If therefore we show that (26) is less than (25), we shall have established that (21) decreases south of 50°. The denominator of (26) is greater than that of 25. It will only be necessary then to show that the numerator of (26) is less than that of (25). At 50°, $b'=3°$, and $\cos b'=\cos 3°=\cdot 99863$. b may be regarded as zero. The details of the calculations of declination show that the variation, due to a change of latitude, of $\delta+\delta'$ is more than twice the change of latitude. Thus, while $\delta+\delta'$ is equal to $88\frac{1}{2}°$ at latitude 50°, at latitude 60° it is equal to 66°, and at St. Louis (lat. $38\frac{1}{2}°$) it is 113°. Thus at latitude 47°, 3° south of 50°, the numerator of (26) is less than $\sin 96°=\cdot 99452$. It follows therefore that (21) diminishes, as we follow the meridian 93° south from the latitude of 50°. North of 50° the increase of b' tends to diminish (21). Dropping b', (b being equal to zero,) we have

$$\frac{\sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad . \quad (27.)$$

Whether this fraction, and consequently (21), will increase or diminish, depends upon the value given to n. If we suppose $n=\frac{5}{8}$ as approximately determined by Brewster, or $\frac{6}{8}$, there will be a continual increase from 50° northward. But, as we have already seen, the observations of temperature are best satisfied by taking $n=\frac{8}{9}$, and at the same time $t=31°$ and $\tau=-18°$. This will be more evident on inspecting the following table calculated from the formulæ

$$T=\Big(28°-(-19°)\Big)\left(\sin^{\frac{3}{4}}\delta \sin^{\frac{3}{4}}\delta'\right)-19°$$

$$T=\Big(30°-(-17°)\Big)\left(\sin^{\frac{7}{8}}\delta \sin^{\frac{7}{8}}\delta'\right)-17°$$

$$T=\Big(31°-(-18°)\Big)\left(\sin^{\frac{8}{9}}\delta \sin^{\frac{3}{9}}\delta'\right)-18°.$$

TABLE XI.

Place.	Temperatures.		Diff.	Temperatures.		Diff.	Temperatures.		Diff.
	$n=\frac{3}{4}$	observed		$n=\frac{7}{8}$	observed		$n=\frac{8}{9}$	observed	
Lat. 60°, Lon 93° W.	-6° 6	-8°·0	+1°·4	-7°·1	-8°·0	+0°·9	-8°·0	-8°·0	0°·0
Lat. 55°, do. do.	-1·5	-2·5	+1·0	-2·2	-2·5	+0·3	-2·8	-2·5	-0·3
Lat. 50°, do. do.	3·3	2·5	+0·8	2·9	2·5	+0·4	2·5	2·5	0·0
Tschernoljes, .	-5·0	-7·0	+2·0	-5·6	-7·0	+1·4	-6·4	-7·0	+0·6
Stretensk, . .	4·0	3·0	+1·0	3·9	3·0	+0·9	3·5	3·0	+0·5
Moscow, . .	5·0	4·4	+0·6	4·4	4·4	0·0	4·1	4·4	-0·3
Urga, . . .	6·9	6·0	+0·9	6·4	6·0	+0·4	6·2	6·0	+0·2
Berlin, . . .	9·7	8·8	+0·9	9·4	8·8	+0·6	9·3	8·8	+0·5
Washington, .	11·9	12·7	-0·8	11·8	12·7	-0·9	11·8	12·7	-0·9
St. Louis, . .	12·6	13·0	-0·4	12·6	13·0	-0·4	12·6	13·0	-0·4
The Azores, .	15·6	16·0	-0·4	15·9	16·0	-0·1	15·6	16·0	-0·4
Havana, . .	22·5	25·0	-2·5	23·7	25·0	-1·3	24·4	25·0	-0·6

Now making $n=\frac{8}{9}$, and making the calculations for various latitudes north of 50°, I find that expressions (27) and (21) remain very nearly constant. The value of (21) does not vary more than 0·01 from 50° to 60° of latitude. If we suppose n to be a very small fraction greater than $\frac{8}{9}$, then (21) will decrease from 50° northward. In fact, that (21) will decrease for n nearly equal to unity may at once be seen by considering that, when $n=1$, (21) is reduced to its numerator.

For other meridians than 93°, or thereabouts, the diminutions of cos b and cos b' are greater in going north, and thus (21) diminishes north of the point where $\delta+\delta'=90$, even for $n=\frac{8}{9}$. To determine the variation of (21) south of this point, we will take the same expressions (25) and (26) as for the meridian of 93°. On either side of this meridian b and b' increases, but b' is continually greater than b. If we take the meridian for which b', at the point of $\delta+\delta'=90°$, is equal to 10°, it appears that on this meridian $\delta+\delta'$ varies for any change of latitude an amount equal to about twice the latitude. This will be evident on comparing the facts for the meridian of 93° with the statement that for New York, for the meridian of which b' at the point above mentioned is about 20°, $\delta+\delta'$ is equal to $105\frac{1}{2}°$. It follows, therefore, that for the meridian assumed, 5° south of the point at which $\delta+\delta'=90°$, the numerator of (26) is less than sin 100° = ·90481, while the numerator of (25) = cos 10° = ·90481. The denominator of (26) is greater than that of (25). Hence (26) is less than (25). Whence it appears that (21) diminishes south from the point where $\delta+\delta'=90°$, or from very near this point. For meridians at a distance from 93° a detailed calculation is necessary to make out distinctly that (21) diminishes southward. We may avoid this calculation by establishing that, south of the points at which $\delta+\delta'=90°$, (21) is greater for the meridian of 93° (or rather for the meridian a little to the west of this on which the angle between δ and δ' is zero) than for every such meridian, at every considerable latitude. By making unfavorable suppositions we obtain from (21) for the meridian 93° the expression $\frac{\cos b' \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$, and for any other meridian the expression $\frac{\cos b \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$. Now for the same latitude δ is less for 93°, or thereabouts, than for any other meridian, while δ' is the same; and therefore south of the point of maximum on 93°, or of latitude 50°, the numerator of the fraction $\frac{\sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$ is greater and denominator less, and therefore the fraction itself greater upon this meridian than any other. Again near this meridian b' for 10° south of 50° is less than 2°; and some 15° from it the value of b exceeds this amount. The maximum value of (21) for the meridian of 93° is then greater than its value at the same latitude (50°) on any other meridian, or at any lower latitude. We have also before made out that it is greater than the value on another meridian at the point for which $\delta+\delta'=90°$, or any where to the north of this. It only remains then to show that it is greater than any value between this point and 50°. The expression for the maximum value in question is $\frac{1}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$, and that for the value of (21) between the two points just mentioned is $\frac{\cos b \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$. We have already seen that the denominator of the first fraction is less than that of the second for each of the two points in question. As the denominator of the second gradually decreases from one point to the other, it follows therefore that it is continually greater than that of the first. Hence between these points the second fraction is less than the first.

We conclude therefore that the pole of maximum intensity is situated about in latitude 50°, and longitude 93° to 100°.

In what precedes, it has been supposed that expression (21) is rigorously true, but in its investigation no account was taken of the motion of the fictitious cold poles. The error from this cause is trifling, except at considerable distances from the cold poles, and cannot vitiate the result just obtained. Our conclusions with respect to the situations of the points of greatest intensity on distant meridians, may not be strictly correct, from this cause.

A more elaborate discussion will be necessary to fix the precise value of n for all parts of the earth. It is not improbable that it may be necessary in expression (21) to assign different values to n for different quarters of the earth, varying from $\frac{3}{4}$ to 1. In fact

(21) cannot be made to extend to the cold poles except by supposing n there equal to unity.

If we consult a chart of isothermal lines, we find the greatest variation of temperature to be set down for about longitude 90° W., and latitude 45°; and that this occurs at a lower latitude than the maximum variations on other meridians: which nearly accords with the theoretical conclusion obtained above.

It is to be observed that all the considerable changes of total intensity in high latitudes, are almost entirely attributable to changes in the vertical intensity. In latitude 50° on this continent, the entire suppression of the horizontal intensity would not diminish the total intensity more than 0·07. On consulting Mahlmann's table of temperatures, it may be seen that the change in the variation of temperature in the direction towards the cold pole, as we go north beyond 40°, is much less than from the equator to 40°; and that the changes of temperature in this direction accord very well with the changes of magnetic intensity in high latitudes upon this continent, as exhibited by Sabine's chart.

GENERAL RESULTS.

The following points appear to have been conclusively established by the foregoing discussion.

1. All the magnetic elements of any place on the earth, may be deduced from the thermal elements of the same; and all the great features of the distribution of the earth's magnetism may be theoretically derived from certain prominent features in the distribution of its heat.

2. Of the magnetic elements, the horizontal intensity is nearly proportional to the mean temperature as measured by a Fahrenheit's thermometer; the vertical intensity is nearly proportional to the difference between the mean temperatures at two points situated at equal distances north and south of the place, in a direction perpendicular to the isogeothermal line; and, in general, the direction of the needle is nearly at right angles to the isogeothermal line, while the precise course of the inflected line to which it is perpendicular may be deduced from Brewster's formula for the temperature, by differentiating and putting the differential equal to zero.

3. As a consequence, the laws of the terrestrial distribution of the physical principles of magnetism and heat must be the same, or nearly the same; and these principles themselves must have towards one another the most intimate physical relations.

4. The principle of terrestrial magnetism, in so far as the phenomena of the magnetic needle are concerned, must be confined to the earth's surface, or to a comparatively thin stratum of the mass of the earth.

5. The mechanical theory of terrestrial magnetism which has been under discussion, must be true in all its essential features.

6. We may derive the magnetic elements by very simple formulæ, and with an accuracy equal to that of Gauss's formulæ, from a very small number of magnetic data determined by observation, and the mean annual temperature of the place.

The great importance of these results cannot well be questioned. Whether or not they be regarded as supporting the theoretical views of the physical nature of magnetism which have been briefly alluded to, they cannot fail, it would seem, to throw some additional light upon this hitherto mysterious subject. They also link together in the closest bonds of union, the two sciences of Terrestrial Magnetism and Meteorology, and confer a new value upon the observations made in each of these two great departments of science.

ART. XIX.—*Notice of Dr. Mantell's Isle of Wight.**

WHILE mentioning this new work of Dr. Mantell, we can respond to the sentiment of Scott.† In earlier years we visited the "beautiful island," and found in it the most remarkable features —topographical, geological, picturesque and agricultural: while in connexion with the vicinal coast of Dorset, Hampshire and Sussex, it is full of interesting historical associations. Upon this coast the Romans first made their landing—the Saxons, Danes, and Normans followed, and it is easy to understand that the geological events recorded in the strata, and the historical events that have clustered on the surface, may combine to impart to this region peculiar attractions. It lies on the narrow channel which divides England from France, and in a climate which is regarded as the mildest in Great Britain.

This region is rich in the fossil treasures of the tertiary, the chalk, and the Wealden; and Dr. Mantell has done much to explore and make known the geology of the S.E. of England. The science is greatly indebted to him for his very able works on local geology, as well as for his comprehensive Survey of the Wonders of Geology, and of the Medals of the Creation.

The present work is a large 12mo., of the size of the Medals; it contains 430 pages, and is illustrated by 20 plates, including a geological map of the Isle of Wight, and 36 lignographs or

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* Geological Excursions round the Isle of Wight and along the adjacent coasts of Dorsetshire, illustrative of the most interesting geological phenomena and organic remains. By GIDEON ALGERNON MANTELL, Esq., LL.D., F.R.S., Author of "The Medals of the Creation," "Thoughts on Animalcules," &c.

† "That beautiful island, which he who once sees never forgets, through whatever part of the wide world his future path may lead him."—*Sir Walter Scott.*

wood-cuts. It is got up in the same elegant style of paper and typography as the Medals, and is intended as a companion both to the tourist and the geologist. The Isle of Wight, long a favorite resort of travellers and invalids, is now for a part of the year, the residence of the royal family, and of course presents new attractions to a loyal people. The work of Dr. Mantell is therefore in harmony with the era, and as we understand, meets a wide demand.

Although the Isle of Wight is visited by the general traveller with particular reference to its picturesque scenery, it possesses, in the language of the author, still stronger claims to the attention of the natural philosopher, for, the strata of which it is composed present phenomena of the highest interest, which elucidate some of the most important pages in the earth's physical history. Notwithstanding the publications of Sir H. Englefield, Mr. Thomas Webster, and other able observers, and of the models of Captain Ibbetson, it is affirmed by the author that the majority of the inhabitants, and that thousands of intelligent strangers who annually traverse the island, pass unconsciously over a country "rich in the spoils of nature and teeming with objects of the highest interest to the instructed observer." This deficiency of knowledge is supplied in the work before us, and its usefulness is not confined to the travellers in this small island, since the phenomena here recorded and the fossils here observed and described, and the conclusions drawn, have an important bearing upon the geology of similar regions found in other countries. It is difficult to give an analysis of a work whose leading topics are necessarily local. Some principal features may however be presented with due prominence. The chalk formation is ably illustrated: in this the author is peculiarly at home, as he was born and lived most of his life among the chalk downs and cliffs, and is familiar both with the upper and the lower chalk, forming together with the associated strata, masses of one thousand feet in thickness in the deepest beds.

In the instructive summary of the author:—

The character of the cretaceous system is that of an ocean-bed, formed in a vast basin by successive accumulations of sedimentary detritus, transported by currents, and thrown down in the tranquil depth of the sea; arenaceous and argillaceous deposits prevailed in the lower, and cretaceous in the upper division of the series; periodical intrusions of heated fluids charged with silex having taken place at uncertain intervals. The fossils prove that the ocean swarmed with innumerable beings of the usual orders of vertebrate and invertebrate marine organisms, belonging for the most part to species and genera now unknown; and in the chalk are seen, for the last time, that numerous tribe of Cephalopoda, the ammonites, of which, so far as our knowledge at present extends, not a single species is known either in the tertiary strata or in more recent deposits: with the chalk the whole race of the *ammonites* disappeared. With respect to the vegetable kingdom of the cretaceous period, the presence of numerous marine fuci attests the nature of the marine flora; and the fragments of drifted coniferous wood, fir-cones, stems and leaves, which are found in the flint and chalk in some localities, prove that the dry land was clothed with pine forests and cycadeous plants. The occasional discovery of bones and teeth of reptiles, shows that the islands and continents were tenanted by oviparous quadrupeds. Of birds and mammalia not a vestige has been discovered.

The Wealden Formation, so ably investigated by Dr. Mantell and other English geologists on the opposite coast of England, has been fully made out in the Isle of Wight, and we may therefore presume that it is continuous beneath the English channel. The clays and fresh-water limestones and beds of lignite of the Wealden, are found at Sandown and Compton bays in this island, and the limestones contain both bivalves and univalves. Petrified trees are found in great abundance at Brook Point, sometimes retaining the ligneous structure, at other times in the form of a coally black matter or filled with pyrites. The trees are all lying postrate and appear to have been accumulated under water like the rafts of the Mississippi. Some of the trees lying along the shore are three feet in diameter, and appear to have been covered when in a state of maturity. Two stems were traced to a length of twenty feet, and indicated trees from forty feet to fifty feet long while living. The annual and annular lines of growth are often very distinct, and bear a close resemblance to the Auracaria or Norfolk Island pine. Thirty or forty have been traced on a single stem; they are all of unequal thickness, thus indicating the variation of the seasons in heat and moisture. The wood was mineralized by calcareous and not by siliceous matter, and the bark was generally turned into lignite.

"In the clays for several hundred yards, both to the east and west of Brook Point, bones of the Wealden reptiles are numerous; with these are associated large mussel shells and lignite."

Among the fossil reptiles the bones of the colossal Iguanodon are conspicuous, an animal whose former existence was first proved by Dr. Mantell. These bones are washed out by the sea and strewed along the shore, subject to the destroying action of the waves, and are in general water-worn masses of bone indicating the enormous magnitude of the animals to which they belonged. The bones are generally impregnated with iron—often garnished with brilliant crystals of pyrites, and the medullary cavities filled with calcareous spar. The bones collected within the last few years in Sandown, Brixton, Brook, and

Compton bays must have belonged to one hundred and fifty or two hundred individuals, and they prove that the country then teemed with colossal viviparous quadrupeds, some of them indicating animals more gigantic than even those of Tilgate forest.

On the shores of this island, bones are found of all the well known Wealden reptiles, the Iguanodon, Hylæosaurus, Megalosaurus, and Streptospondylus, besides the Cetiosaurus and Plesiosaurus. Dr. Mantell estimates the entire length of the fossil thigh and leg bone found in Sandown bay to have been over nine feet. A toe bone measured six inches long and fifteen in circumference.

The body of the Iguanodon must have been equal in magnitude to that of the elephant, and its limbs of proportionate size. One of the thigh bones in the British Museum if suitably invested with muscles and integuments, would form a limb seven feet in circumference.

The animal was a vegetable eater, and probably found its food among the palms, ferns, cicadeæ and coniferæ of that era. The hinder extremities, massive and unwieldy, resembled those of the hippopotamus or rhinoceros, and were supported by a very strong short* foot furnished with claws like those of some turtles.

Although the bones of the extremities of the Iguanodon were six or eight times larger than those of the most gigantic alligator —the whole length appears not to have exceeded thirty feet, supposing the head to have been about three feet long with a short neck and the tail thirteen feet—the trunk would be about twelve feet, which is much more than is seen in any living animal. It is thought that the body may have been twelve or fifteen feet high, and must have presented a monstrous appearance unlike to that of any existing animal.† Remains of the Hylæosaurus and Megalosaurus are also found in the Isle of Wight—the latter about thirty feet long and the former of half that length.

Bones of the Cetiosaurus or whale-like lizard—of the Streptospondylus or lizard with reversed vertebræ, the ball being placed anteriorly upon the vertebra, and bones of the Plesiosaurus, have also been found in this island.

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* Short in proportion to the colossal bulk of the animal; but a single separate bone of the foot has been found to measure thirty inches in length, and the last joint of the toe to which a claw was attached, was five and a half inches long. —*Ansted's Ancient World*, p. 212.

† The elephant rarely attains the height of eleven feet. Eleven hundred elephants, examined on a particular occasion in India, did not present a single individual of eleven feet in height.—*Ansted's Ancient World*, p. 213, note.

The Iguanodon, Megalosaurus and Hylæosaurus appear to have formed a peculiar group of land lizards—the first herbivorous—the second carnivorous, and the last not yet determined.

The 12th and last chapter of Dr. Mantell's work contains a detailed notice of the geology and topography of the neighboring coast, which abounds with interesting and instructive facts, among which the petrified forest of the oolite of the peninsula of Portland is one of the most remarkable.

The retrospect which closes the volume is so fine a specimen of geological induction that we insert it entire.

"In attempting to interpret the natural records of the earth's physical history, the geologist is often in the condition of the antiquary who endeavors to decipher an ancient manuscript, in which the original characters are obscure and partially obliterated by later superscriptions. It is, indeed, frequently difficult, and sometimes impossible, to determine the synchronism of those geological changes, of which the only indications are insulated and but obscurely related phenomena. Bearing in mind the caution of a distinguished philosopher, 'that the language of theory can never fall from our lips with any grace or fitness, unless it appear as the simple enunciation of those general facts with which by observation alone we have become acquainted,' we will take a retrospective view of what has been advanced, and endeavor to deduce therefrom some general results as to the nature of those physical mutations, of which we have obtained such unequivocal proofs. Fortunately, the evidence of the important changes which the organic and inorganic kingdoms of nature have undergone in this part of the globe, during the vast periods embraced by our researches, is so conclusive, that the attentive reader will perceive the following inferences, startling as they may appear, naturally result from the facts that have been submitted to his observation.

"I. *The Oolitic Epoch.*—The most ancient deposits comprehended in our Excursions, are the upper beds of an oceanic formation of great extent—the *Oolite*—which is characterized by numerous peculiar species and genera of marine reptiles, fishes, mollusks, radiaria, corals, zoophytes, &c. With these strata are intercalated in some places, deposits of variable extent and thickness, containing carbonized vegetable remains, and the stems and foliage of palms, arborescent and herbaceous ferns, cycadeous plants, and coniferæ; with bones and teeth of terrestrial reptiles, and of marsupial and insectivorous mammalia, associated with vestiges of insects. These beds are evidently attributable to the action of rivers and streams, by which the spoils of the land were transported into the abyss of the ocean. But our present survey only refers to the period when a portion of the bed of the Oolitic sea was elevated above the waters, and constituted an island clothed with pine-forests and cycadeous plants.

"II. *The Wealden Epoch.*—The country with its pine-forests was gradually submerged, and formed the beds of estuaries and bays, into which land floods, loaded with sedimentary detritus, deposited mud, silt, and sand, abounding in the remains of freshwater mollusks and crustaceans; in which from occasional irruptions of the sea, were intercalated layers of oysters, and estuarine shells. Bones and teeth of terrestrial reptiles, and of river fishes, with stems and fragments of coniferous wood, were also drifted into the estuaries and bays by the streams and rivers. The gradual subsidence of the sea-bottom covered by these freshwater beds continued, and the sediments acquired an exclusively fluviatile character, till at length the accumulated deposits of a vast river formed an extensive delta, many hundred feet in thickness, upon the inferior strata. The imbedded organic remains attest, that throughout this epoch the fauna and flora of the country through which the river flowed, corresponded with those of the islands and continents of the Oolitic period.

"III. *The Cretaceous Epoch.*—The commencement of this era was marked by the subsidence of the entire era now occupied by the greensand formation, to a depth sufficient to admit of the accumulation of the deep sea deposits, of which the greater part of the cretaceous beds of England, and of the adjacent portion of the European continent, consist. The Wealden sediments were submerged to a great depth, and upon them were deposited sands, and argillaceous mud, and calcareous detritus, teeming with marine exuviæ. But the ocean of the chalk extended far beyond the limits of the Wealden; it buried beneath its waters a considerable portion of modern Europe, and its waves reached the New World, and covered part of the continent of North America. This ocean swarmed with numerous forms of marine organisms, belonging in a great measure to species and genera unknown in the earlier, and in the later geological epochs. The interspersions of freshwater deposits containing terrestrial exuviæ, though inconsiderable, prove that although the delta of the country of the Iguanodon was submerged in the abyss of the ocean, a group of islands, or a continent, inhabited by that colossal reptile and its contemporaries, and covered with pine-forests, cycadeæ, and ferns, flourished up to a late period of the cretaceous epoch.

"IV. *The Tertiary Epoch.*—The bed of the chalk ocean was broken up, and considerable areas were elevated above the sea, and covered with vegetation, and tenanted by pachydermata and other mammalia; the dry land of Europe during this period was less extensive than at the present time.

"In the basins and depressions formed by the submerged portions of the cretaceous strata, new sediments began to take place; the sea which deposited them teeming with marine animals, distinct from those of the preëxisting ocean. Localintrusions of freshwater deposits, abounding in the spoils of the land and its inhabitants, denote the existence of islands or continents, tenanted by mammalia allied to the tapir, elephant, rhinoceros, horse, deer, &c.; and the vegetable remains consisting of palms and dicotyledonous trees, indicate an approach to the flora of the warm regions of the south of Europe. A few reptiles, principally of the alligator and crocodilian types, and lizards of small size, appear as the representatives of the swarms of colossal oviparous quadrupeds of the previous epochs.

"V. *The Pre-historic Epoch.*—From the most recent tertiary deposits, to those in which occur the remains of animals which seem to have always been contemporary with the human race, the transition is imperceptible. But elevatory movements, and subsidences, more or less general, appear to have continually taken place, by which the relative position of the land and sea was subjected to repeated oscillation. During this period, large pachyderms, as the mammoth, mastodon, hippopotamus, rhinoceros, &c.—several species of horse—gigantic elks and deer—and many carnivora, as the lion, tiger, bear, hyena, &c.—inhabited the European continent and islands. While this fauna prevailed, a succession of terrestrial disturbances occurred, by which the physical configuration of the land was materially changed. England and its islands were separated from the continent; and to this epoch is probably referable the formation of the lines of elevation, that traverse the districts over which our observations have extended.

"*Lastly.*—Man took possession of the land, and such of the large mammalia as had survived the preceding geological revolutions, were either exterminated by his agency, or reduced to a domesticated state. Subsequently to the occupation of these islands by the aboriginal tribes, the country has undergone no important physical mutations. The usual effects of the atmosphere, the wasting of the shores by the encroachments of the sea, the erosion of the land by streams and rivers, the silting up of valleys, and the formation of deltas, are apparently the only terrestrial changes to which England and its islands have been subjected during the historic ages.

"*Corollary.*—From this examination of the geological phenomena of the southeast of England, we learn that at a period incalculably remote, there existed in the northern hemisphere an island or continent, possessing a climate of such a temperature, that its surface was covered with arborescent ferns, palms, cycadeæ, and other coniferæ; and the ocean that watered its shores, was inhabited by turtles and marine lizards of extinct genera. This country suffered a partial subsidence, which was effected so tranquilly, that many of the trees retained their erect position, and the cycadeous plants, and a considerable layer of the vegetable mould in which they grew, remained undisturbed. In this state an inundation of freshwater covered the country and its forests, and deposited upon the soil and around the trees a calcareous mud, which was gradually consolidated into limestone; thermal streams, holding flint in solution, percolated the mass, and silicified the submerged trees and plants.

"A further subsidence took place, floods of freshwater overwhelmed the petrified forest, and heaped upon it accumulations of detritus, which streams and rivers had transported from the land. The country traversed by the rivers, like that of the submerged forest, enjoyed a tropical climate, and was clothed with palms, arborescent ferns, and cycadeæ; it was tenanted by gigantic herbivorous and carnivorous reptiles, and its waters abounded in turtles, and various kinds of fishes and mollusca. The bones of the reptiles, the teeth and scales of the fishes, the shells of the mollusca, and the stems, leaves, and seed-vessels of the trees and plants, were brought down by the streams, and imbedded in the mud of the delta, beneath which the petrified forest was now buried.

"This state continued for an indefinite period—another change took place—the Country of Reptiles with its inhabitants was swept away, and the delta, and the fossil trees with the marine strata on which they once grew, subsided to a great depth, and formed part of the bottom of a profound ocean; the waters of which teemed with countless myriads of zoophytes, shells, and fishes, of species long since extinct. Periodical intrusions of thermal streams charged with silex, gave rise to layers and veins of nodular and tabular flint, and occasioned the silicification of the organic remains subjected to their influence.

"This epoch, which was of long duration, was succeeded by elevatory movements, by which the bottom of the deep was broken up, and large areas were slowly upheaved; and as the elevation continued, the deposits which had accumulated in the depths of the ocean approached the surface, and were exposed to the action of the waves. These masses of cretaceous strata now began to suffer destruction, and the delta of the country of the Iguanodon gradully emerged above the waters; and finally the petrified forest of the Oolite rose in the midst of the sea, and became dry land. At length some portions of the elevated strata attained an altitude of several hundred feet, and a group of islands was formed; but in the basins or depressions beneath the waters, sediments derived from the disintegration of the sea-cliffs were deposited. Large herbivorous mammalia now inhabited such portions of the former ocean-bed as were covered with vegetation sufficient for their support; and as these animals died, their bones became enveloped in the accumulations of mud and gravel, which were forming in the bays and estuaries.

"This era also passed away—the elevatory movements continued—other masses of the bed of the chalk ocean, and of the Wealden strata beneath, became dry land—and at length those more recent deposits containing the remains of the herbivorous mammalia which were the last tenants of the country. The oak, elm, ash, and other trees of modern Europe, now sprang up where the groves of palms and tree-ferns once flourished—the stag, boar, and horse, ranged over the plains in which were entombed the bones of the colossal reptiles—and finally, *Man* appeared, and took possession of the soil.

"At the present time, the deposits containing the remains of the mammoth and other extinct mammalia, are the sites of towns and villages, and support busy communities of the human race; the huntsman courses, and the shepherd tends his flocks on the elevated masses of the bottom of the ancient chalk ocean—the farmer reaps his harvests upon the cultivated soil of the delta of the country of the Iguanodon—and the architect obtains from beneath the petrified forest, the materials with which to construct his temples and his palaces: while from these various strata, the geologist gathers together the relics of the beings that lived and died in periods of unfathomable antiquity, and of which the very types have long since been obliterated from the face of the earth, and by these natural memorials is enabled to determine the nature and succession of those physical revolutions, which preceded all history and tradition."

ART. XX.—*Seventeenth Meeting of the British Association for the Advancement of Science.**

"THE order of Proceedings at this Seventeenth Meeting of the British Association," (held at Oxford on Wednesday, the 23d of June, and the week thereafter,) "was much the same as on former occasions, with such varieties only as the locality induced. We give our usual summary. On Wednesday, the General Committee assembled. On Thursday, the work of the Sections began; and Prof. Powell lectured in the Radcliffe Library, on Shooting Stars. On Friday evening, Prof. Faraday delivered, at

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* From the London Athenæum, Nos. 1026 and 1027, June 26, and July 3, 1847. The superior interest of the Address of the President of the British Association, at its late meeting, requires the omission of some other matter, which will be inserted in a future number.

the same place, a lecture on the subject of new discoveries in Electricity and Magnetism. Saturday morning was occupied in excursions to Swindon, Shotover Hill, and Blenheim—and boat excursions on the Isis to Moreham, where the Archbishop of York had thrown open his grounds to the Association. For those who preferred business, there was a meeting of the General Committee in the morning, at nine; and meetings afterward in the mathematical and chemical Sections. In the evening there was a conversational *soirée* at the Taylor buildings. On Sunday, the Bishop of Oxford preached a Sermon at St. Mary's, which we understand will shortly be printed, at the request of some leading members of the Association; and in the evening, Prof. Powell held a *soirée* at his house. On Monday, the proceedings in some of the Sections were enlivened by the presence of Prince Albert, who arrived in the morning, accompanied by the Duke Saxe Weimar; and in the evening, Mr. Strickland delivered at the Radcliffe Library, a conversational lecture on the Dodo, and the Dean of Westminster some Geological Remarks. On Tuesday, after the sectional meetings, there was an evening exhibition of Microscopes at the Radcliffe Library. On Wednesday morning, the members of the General Committee gave a breakfast in the hall of Christ Church to the foreign visitors of the Association—and several of the Sections met for business. At one o'clock the concluding meetings of the General Committee were held for the purpose of sanctioning the grants which had passed the Committee of Recommendations; and at three, the concluding general meeting of the Association assembled to pass the customary votes of thanks."

On Wednesday afternoon, at three o'clock, the general meeting convened to hear the speech of Sir Roderick Impy Murchison, on retiring from the chair. "Sir R. H. Inglis then took the chair, and after a brief pause delivered the following address:—

THE PRESIDENT'S ADDRESS.

"May it please you, Mr. Vice Chancellor, Sir Roderick Murchison, Gentlemen of the British Association:—When I consider the attainments of the distinguished person whom I succeed in this chair, I might well shrink from a position which places me in any degree in comparison with him: and when I look back on the array of the most illustrious names in science of this age and nation, some of whom add civil and social rank to the eminence which they have acquired by their personal labors, and who have in succession been your presidents, I feel far more strongly than I can express, the undeserved honor which was most unexpectedly conferred upon me when the Council desired to nominate me to my present position. Though in early years, when I enjoyed more leisure, I took such interest as I could in some branches of natural philosophy and in chemistry,—and though I look back to those opportunities with the most grateful recollection of their value and of the pleasure which I derived from them,—(it is my own fault if I did not derive profit, also, from Kidd in this place, and from Playfair and from Hope in Edinburgh,)—my occupations have, for the larger portions of my life, been such as to prevent my persevering in the pursuits which most of those before me have continued to follow, to their own honor among their fellow men and to the benefit of our common country.

"It has been the practice of former presidents to address the first general meeting of the Association on the progress of science during the preceding year, and on its state and prospects in the present. Sir Roderick Murchison, my eminent friend, who did honor to this chair, took a comprehensive grasp of all the objects which this duty placed within his reach. When I read his Address, I felt, even more than before, my unfitness to follow him; but such as I am, you have selected me to succeed to his position and his duties; and I shall endeavor to discharge my functions with as little discredit to your choice as may be in my power. Whatever may be good in the observations which follow this exordium, will be owing to my friends, the Rev. Dr. Robinson, Prof. Owen, Mr. Robert Brown, and Colonel Sabine. Anxious as I am not to disgrace your judgment in placing me where I am, I am still more anxious not to assume a merit which does not belong to me; and, therefore, unfeignedly begging you to attribute to the sources which I have pointed out, whatever may in detail interest you in the continuation of my Address, I am content with the distinction of calling such men my personal friends.

"I begin with ASTRONOMY.—The progress of astronomy during the past year has been distinguished by a discovery the most remarkable, perhaps, ever made as the result of pure intellect exercised *before* observation,—and determining *without* observation the existence and force of a planet; which existence and which force were subsequently verified *by* observation. It had previously been considered as the great trial and triumph of dynamical science, to determine the disturbances caused by the mutual action of 'the stars in their courses,' even when their position and their orbits were fully known; but it has been reserved for these days to reverse the process, and to investigate from the discordance actually observed, the existence and the place of the wondrous stranger which had been silently, since its creation, exerting this mysterious power. It was reserved for these days to track the path and to measure the force which the great Creator had given to this hitherto unknown orb among the myriads of the air.

"I am aware that Lalande, more than fifty years ago, on two nights—which, if he had pursued the object then first discovered, would have been well distinguished from the rest of the year, and would have added new glory to his own name—did observe what is now fully ascertained to have been the planet Neptune; but though Uranus had just been added to those bright orbs which to mortal eyes for more than two thousand years have been known to circle our sun, Lalande was observing before Piazzi, Olbers, and Harding had added Ceres, Pallas, Juno and Vesta to that number, and before by those discoveries it was proved, not only that the planets round the sun had passed the mystic number of seven—since Herschel had confuted that ancient belief—

but that others might also remain to reward the patient labors of other observers. He therefore distrusted his own eyes; and preferred to believe that he had been mistaken, rather than that the existence and force of a new planet had been reserved for the discovery of this latter age. What his eyes saw, but what his judgment failed to discriminate and apply, has since become a recognized fact in science.

"I will not presume to measure the claims of the two illustrious names of Leverrier and Adams; of him, who, in midnight workings and watchings, discovered the truth in our own country, and of the hardly happier philosopher who was permitted and enabled to be the first, after equal workings and watchings, to proclaim the great reality which his science had prepared, and assured him to expect. I will trust myself with only two observations: the one, my earnest hope that the rivalry not merely of the illustrious Leverrier and of my illustrious countryman, Adams, but of the two great nations which they represent, France and England, respectively, may always be confined to pursuits in which victory is without woe, and to studies which enlarge and elevate the mind, and which, if rightly directed, may produce alike glory to God and good to mankind: and the other, my equal hope, that for those (some of whom I trust may now hear me) who employ the same scientific training and the same laborious industry which have marked the researches of Leverrier and Adams, there may still remain similar triumphs in the yet unpenetrated regions of space; and that—unlike the greater son of a great father—they may not have to mourn that there are no more worlds to be conquered.

"It is a remarkable fact, that the seeing of the planet Neptune was effected as suddenly at Berlin by means of one of the star-maps which has proceeded from an association of astronomers chiefly Germans; such maps forming in themselves a sufficient illustration of the value of such Associations as our own, by which the labor and the expense—too great, perhaps, for any one individual—are supplied by the combined exertions of many kindred followers of science.

"It is another result of the circulation of these star-maps, that a new visitor, a comet, can hardly be within the range of a telescope for a few hours, without his presence being discovered and announced through Europe. Those comets which have been of larger apparent dimensions, or which have continued longer within view, have, in consequence, for more than two thousand years been observed with more or less accuracy; their orbits have been calculated; and the return of some has been determined with a precision which in past ages exercised the wonder of nations;—but now, improved maps of the heavens, and improved instruments, by which the strangers who pass along those heavens are observed, carry knowledge where conjecture lately dared not to penetrate. It is not that more comets exist, as has sometimes been said, but more are observed.

"An Englishman—a subject of this United Kingdom—cannot refer to the enlarged means of astronomical observation enjoyed by the present age, without some allusion to the noble Earl, Lord Rosse, one of the Vice Presidents of this day, who, himself educated amongst us here in Oxford, has devoted large means and untiring labor to the completion of the most wonderful telescope which science, art, and wealth have ever yet combined to perfect; and which the Dean of Ely—a man worthy to praise the work—pronounced to be a rare combination of mechanical, chemical, and mathematical skill and knowledge. Its actual operations have been suspended by a cause not less honorable to Lord Rosse in another character, than the conception and early progress of his great instrument were to him as a man of science. They have been retarded, so far as he himself is concerned, by the more immediate and, I will say, higher duties which, as a magistrate, as a landowner, and as a Christian gentleman, he owed, and has been paying to his neighbors, his tenantry, and his country, during the late awful visitation which has afflicted Ireland. Yet perhaps my noble friend will permit me to say, that while we not only do not blame him—we even praise him cordially for having devoted his time, his mind, and his wealth to those claims which could not be postponed, since they affected the lives of those who in God's providence surrounded him—there were, and there are others, two at least in his own country, and one his most illustrious friend, Dr. Robinson, (but I speak without any communication on the subject from that great observer and greater philosopher,) who might have carried on the series of observations which this wonderful telescope alone can effect, and might thus have secured for his own division of the empire, the discovery of the planet Neptune.

"The Catalogues of Lacaille and the Histoire Céleste are now before the world; and with the Catalogue of our Association, constitute a series of most important gifts conferred on astronomy. I have already said that I will not presume to measure the relative merits of two eminent individuals;—it is as little within my power to measure the value of such gifts to science. That value can be duly appreciated by none but the great masters of this, the greatest of the sciences: but I may be permitted to add, that here, also, come into beneficial action the powers and the uses of such an association, which, rising above the mere calculations of pecuniary profit, provides for the few who only are capable of extracting the just benefit from such works, those materials of advancing knowledge which are beyond the reach of individuals.

"The Astronomer Royal has done me the honor and the kindness, by a paper which I have just received from him, to make me the vehicle of communicating his wisdom to you on a most important and interesting discovery of the past year.

"'In the lunar theory a very important step has been made in the course of the past year. When near the beginning of the present century, a considerable number of the Greenwich lunar observations were reduced by Bürg for the purpose of obtaining elements for the construction of his Lunar Tables, and generally for the comparison of the moon's observed place with Laplace's theory, it was found impossible to reconcile the theoretical with the observed places except by the assumption that some slowly varying error affected the epoch of the moon's mean longitude. From the nature of the process by which the errors of the elements are found, the conclusion upon the existence of this peculiar error is less subject to doubt than that upon any other error. So certain did it appear, that Laplace devoted to it one entire chapter in the *Mécanique Céleste*, with the title 'On an inequality of long period by which the moon's mean motion appears to be affected.' Guided by the general analogy of terms producing inequalities of long period, he suggested as its probable cause an inequality whose argument depends upon a complicated combination of the longitude of the earth's perihelion, the longitude of the moon's perigee, the longitude of the moon's node, and the moon's angular distance from the sun. But he made no attempt to calculate its theoretical effect. He also suggested an inequality depending on a possible difference in the northern and southern hemispheres of the earth. Many years elapsed before these suggested theoretical inequalities were carefully examined by physical astronomers. At length the introduction of new methods enabled Poisson and Lubbock successfully to enter upon the investigation of the theoretical values; and they proved that inequalities depending on the arguments suggested by Laplace could not have sensible values. The theory was now left in greater doubt than ever; and suspicion fell even on the accuracy of the reductions of the observations.

" 'A few years since, as is well known to members of the British Association, the British Government, at the representation of the Association, sanctioned the complete reduction, on an uniform plan, of all the observations of the moon made at the Royal Observatory of Greenwich since the year 1750: and the immediate superintendence of this work was undertaken by the Astronomer Royal. The reductions are now printing in all necessary detail; and the press-work is at this time very far advanced. In the last summer the corrections of the elements of the moon's orbit were generally obtained; and the errors of epoch in particular at different times were found with great accuracy. These results confirmed those of Bürg, and extended the law of the inequality to a much later time. In this state they were exhibited by the Astronomer Royal, to Prof. Hansen of Gotha, who was known to be engaged in the Lunar Theory. Prof. Hansen immediately undertook a search for their theoretical causes. His perfect knowledge of the state of the existing theories enabled him at once to single out the class of disturbances produced by the action of the planets as that in which the explanation of this inequality would probably be found. In the course of a systematic search, many inequalities of long period were found; but none of sensible magnitude. At length two were found, both produced by the disturbing force of Venus, of a magnitude entirely unexpected. One depends upon the circumstance, that eighteen times the mean anomaly of Venus diminished by sixteen times the mean anomaly of the Earth, increases at very nearly the same rate as the mean anomaly of the Moon: its co-efficient is 27″ and its period two hundred and seventy-three years. The other depends upon the circumstance, that eight times the mean anomaly of Venus increases at very nearly the same rate as thirteen times the mean anomaly of the Earth: its co-efficient is 23″ and its period two hundred and thirty-nine years. The combination of these two explains almost perfectly the error of epoch, which had so long been a subject of difficulty. The discovery of these two inequalities, whether we regard the peculiarity of their laws, the labors expended upon the investigations, or the perfect success of their results, must be regarded as the most important step made in physical astronomy for many years.'

"The doctrine of the influence of the moon and of the sun on the tides was no sooner established, than it became eminently probable that an influence exerted so strongly upon a fluid so heavy as water, could not but have the lighter and all but imponderable fluid of air under its grasp. I speak not of the influence attributed to the moon in the popular language and belief of nations ancient and modern,—of Western Europe and of Central Asia, in respect to disease; but of the direct and measurable influence of the moon and of the sun in respect to the air. It is now clear, as the result of the observations at St. Helena by my friend Col. Sabine, that as on the waters, so on the atmosphere, there is a corresponding influence exerted by the same causes. There are tides in the air as in the sea; the extent is of course determinable only by the most careful observations with the most delicate instruments; since the minuteness of the effect, both in itself and in comparison with the disburbances which are occasioned in the equilibrium of the atmosphere from other causes, must always present great difficulty in the way of ascertaining the truth—and had, in fact, till Col. Sabine's researches, prevented any decisive testimony of the fact being obtained by direct observation. But the hourly observations of the barometer made for some years past at the Meteorological and Magnetical Observatory at St. Helena, have now placed beyond a doubt the existence of a lunar atmospheric tide. It appears that in each day the barometer at St. Helena stands, on an average, four thousandths of an inch higher at the two periods when the moon is on the meridian above or below the pole, than when she is six hours distant from the meridian on either side; the progression between the maximum and minimum being moreover continuous and uninterrupted:—thus furnishing a new element in the attainment of physical truth; and, to quote the expression of a distinguished foreigner now present, which he uttered in my own house when the subject was mentioned, 'We are thus making astronomical observations with the barometer'—that is, we are reasoning from the position of the mercury in a barometer, which we can touch, as to the position of the heavenly bodies which, unseen by us, are influencing its visible fall and rise. 'It is no exaggeration to say,' —and here I use the words of my friend, the Rev. Dr. Robinson,— 'that we could even, if our satellite were incapable of reflecting light, have determined its existence, nay, more, have approximated to its eccentricity and period.'

"I am unwilling to quit this subject without expressing any deep sense of the services rendered to science by the patient, laborious, unobtrusive observation and researches of my eminent friend, Col. Sabine, in meteorology, and above all, magnetism, in connection with different and very distant points of the earth: researches undertaken, some of them, before public attention was so generally called to the subject as it has been in later years—(since the British Association urged the importance of such investigation upon the government at home;) and undertaken at great sacrifice of domestic comfort, and at the risk of life, not in the ordinary duties of his noble profession, but in the persuit of science for its own sake,—science one year at the North Pole, and the next, I think, in Sierra Leone. The reputation thus acquired does not come quickly, but it comes surely, and will survive permanently; and the reputation of the individual adds to the reputation of his country.

"I hardly know why, on this division of my subject more than on any other, I should recall to the notice of the meeting the address of that master mind, Dr. Robinson of Amagh, to the Monaghan Society; an address delivered to a provincial body in Ireland, which ought to be spread over the whole empire:—but as I read it with the deepest interest, as it is far too little known, and as I owe much to Dr. Robinson for the assistance which he has now intrusted to me, I am unwilling to omit this tribute of respect and gratitude.

"In concluding this sketch of the progress and state of astronomy, pardon me if I here quote a passage, which has been a favorite with me for thirty years, and which I always desire to apply as a lesson first to myself—and perhaps, though with great deference, as a lesson to others also. It is taken from a great master of the English language in the best age of English literature, Henry Peacham. He is referring, in substance, to the parallax of the fixed stars, and his illustration is to this effect:—If from two points of the earth's surface the same star appears of the same bigness, how great must be that star—how inconsiderable, the earth! His conclusion is strengthened by discoveries unknown in his age: and I may extend his truth and supply the figures which make it more striking. If at two extremities of the earth's orbit (between which extremities not less than 180,000,000 of miles intervene) there is no parallax, or the smallest measurable, between the position of a star seen from one extremity and the position of the same star seen from the other extremity, in reference to one other star or to all other stars, how infinitely great must be the distance and the size of the stars—how inconsiderable, the earth! But Peacham's application of the truth known in his own days I give in his own words:—

"'If the earth were of any quantitie in respect of the higher orbes, the starres should seeme bigger or lesse in regard of those *hypsomata* (altitudes) or the climes; but it is certaine that at the selfesame time sundrie astronomers finde the same bignesse and elevation of the selfesame starre observed by their calculation to differ no whit at all; whereby we may see, if that distance of place which is on the earth (in respect of the heavenly orbes) exceedeth all sence, it followes that the earth (poore little point as it is) seemes the like, if it be compared with heaven: yet this is that point which, with fire and sword, is divided among so many nations, the matter of our glorie, our seate; heere we have our honors, our armies, our commands; heere we heape up riches, at perpetual warre and strife among ourselves, who (like the toad) shal fall asleepe with most earth in his pawes; never thinking how of a moment of time well spent upon this poore plot or dung-hill, common to beasts as well as ourselves, dependeth eternitie and the fruition of our true happinesse in the presence of heaven, and court of the King of Kings for ever and ever.'

"The extensive and diversified field of PHYSIOLOGY presents so many objects of nearly equal interest, as to make it difficult, in a rapid sketch like the present,—and above all for one like me,—to select those which may least unworthily occupy the attention of the Association.

"In physiology, the most remarkable of the discoveries, or rather improvements of previous discoveries, which the past year has seen, is, perhaps, that connected with the labors of the distinguished Tuscan philosopher, Matteucci; who on several former occasions has coöperated with this Association in the sections devoted to the advancement of the physical and physiological sciences. I refer in this instance to his experiments on the generation of electric currents by muscular contraction in the living body. This subject he has continued to pursue; and, by the happy combination of the rigorous methods of physical experiment with the ordinary course of physiological research, Prof. Matteucci has fully established the important fact of the existence of an electrical current—feeble, indeed, and such as could only be made manifest by his own delicate galvanoscope—between the deep and the superficial parts of a muscle. Such electric currents pervade every muscle in every species of animal which has been the subject of experiment; and may, therefore, be inferred to be a general phenomena of living bodies. Even after life has been extinguished by violence, these currents continue for a short time; but they cease more speedily in the muscles of the warm-blooded than in those of the cold-blooded animals. The Association will find his own exposition of the physiological action of the electric current in his work, 'Leçons sur les Phénomènes Physiques des Corps Vivants,' 1847.

"The delicate experiments of Matteucci on the torpedo, agree with those made by our own Faraday (whom I may call doubly our own in this place, where he is a Doctor of our University) upon the *Gymnotus electricus*, in proving that the shocks communicated by those fishes are due to electric currents generated by peculiar electric organs, which owe their most immediate and powerful stimulus to the action of the nerves.—In both species of fishes the electricity generated by the action of their peculiar organized batteries—besides its benumbing and stunning effects on living animals,—renders the needle magnetic, decomposes chemical compounds, emits the spark, and, in short, exercises all the other known powers of the ordinary electricity developed in inorganic matter or by the artificial apparatus of the laboratory.

"ETHERIZATION, a kindred subject,—one to which deep and natural importance is now attached,—may not unfitly follow the mention of Prof. Matteucci's investigations.

"It is the subject of the influence of the vapor of ether on the human frame—a discovery of the last year, and one the value of which in diminishing human pain has been experienced in countless instances, in every variety of disease, and especially during the performance of trying and often agonizing operations. Several experiments on the tracts and nerve roots appropriated respectively to the functions of sensation and volition, have been resumed and repeated in connexion with this new agency on the nervous system. Messrs. Flourens and Longet have shown that the sensatorial functions are first affected, and are completely, though temporarily, suspended under the operation of the vapor of ether; then the mental or cerebral powers; and finally, the motor and excito-motor forces are abrogated. It would seem that the stimulus of ether applied so largely or continuously as to produce *that* effect is full of danger—and that weak constitutions are sometimes unable to rally and recover from it; but that when the influence is allowed to extend no further than to the suspension of sensation, the recovery is as a general rule complete. It is this remarkable property of ether which has led to its recent application with such success as may well lead us to thank God, who, in his providemce, has directed the eminent physicians and surgeons amongst our brethren in the United States to make this discovery;—a discovery which will long place the name of Dr. Charles T. Jackson, its author, among the benefactors of our common nature.

"At the same time, much careful observation on the *modus operandi* of this most singular agent, seems still requisite before a general, systematic, safe, and successful application of it can be established for the relief of suffering humanity. So great, however, is the number of well-recorded instances of its having saved the patient from the pain of a surgical operation without any ill effect in reference to his subsequent recovery, as to make the subject of the influence of the vapor of ether upon the nervous system, and the modification of that influence on different temperaments, one eminently deserving the attention of the physiological section of the British Association.

"With regard to the functions of the primary division and parts of the brain itself, there has been of late a happy tendency to substitute observations on the modifications of those parts in the series of the lower animals in the place of experimental mutilations on a single species, in reference to the advancement of cerebral physiology. Experiment is, no doubt, in some instances, indispensable: but we ought ever to rejoice when the same end is attained by comparative anatomy rather than by experimental vivisections; and every true philosopher will concur with my most eminent friend, Professor Owen, in his doubt, (I quote his own words) 'whether nature ever answers so truly when put to the torture, as she does when speaking voluntarily through her own experiments, if we may so call the ablation and addition of parts which comparative anatomy offers to our contemplation.'—[Owen's Hunterian Lecture, Vertebrata, p. 187.]

"I was always struck with that passage in the 'Life of Sir W. Jones' in which that great man, who united so many claims to the admiration of mankind, declined to accept the offer of a friend to collect, and in collecting to put to death, a number of insects in the eastern islands, to be transmitted to Calcutta. He did not, of course, deny the value and importance, and, in one sense, the necessity, of forming such collections: but he limited the right of posessing them to those who could *use* them; and he would not have one of those, the wonders of God's animal world, put to death for the mere gratification of his own unscientific curiosity. He quotes the lines of Ferdusi, for which Saadi invokes a blessing on his spirit, and the last of which contains all my own morality in respect to the lower animals,—

O spare yon emmet, rich in hoarded grain,
He lives with pleasure, and he dies with pain.

I am aware that the doctrine assumed in the first line of the couplet in reference to the particular insect, is denied by some naturalists; and that the fact assumed in the last line, in reference to the lower animals, is denied by others. Whatever be the truth as to the first point, I have no more doubt than I have of my own existence, that some of the lower animals feel severe pain: and even if the words of our immortal Shakspeare as to the corporal sufferance of the beetle trod upon be not litererally accurate—yet who is entitled to affirm the contrary?—this, I think, is clear, that the child who is indulged in mutilating or killing an insect for his own pleasure, has learnt the first lesson of inhumanity to his own species.

"To revert, however, for a minute, to the principle on which true results may be obtained from the observed variations of organs in the animal series, it is in the first place essential (I speak on the authority of Professor Owen, and, of course, not on my own) to determine the parts which truly answer to those, the functions of which it is the object of the comparative anatomist to elucidate. An elaborate and valuable contribution with this aim, was communicated by Dr. Carpenter to the Physiological Section of this Association, at its meeting at Southampton; having for its subject the homologies and functions of the parts of the *encephalon*.

"It is needless to dwell on the obvious necessity of the knowledge of the essential nature,—signified by the true definition and name—of the part of the animal series, in order to insure correct reasoning on the physiological import of the varieties of such parts. The British Association has already manifested its appreciation of the value and necessity of this preliminary step in comparative physiology, by calling for the report on the homologies of the vertebrate skeleton; and that report, just published, is itself the best evidence of the importance of the subject, and a model of the mode in which it should be treated, and in which, happily for this Association, it has been treated by the Cuvier of England, Professor Owen.

"In no department of the science of organized bodies has the progress been greater or more assured, than in that which relates to the microscopic structure of the constituent tissues of animal bodies, both in their healthy and in their morbid states; and this progress is specially marked in this country during the period which has elapsed since the communication to the British Association by Professor Owen, of his researches into the intimate structure of recent and fossil teeth.

"The result of these researches having demonstrated the constancy of well-defined and clearly appreciable characters in the dental tissues of each species of animal, (by which characters such species could be determined, in many instances, by the examination of a fragment of a tooth,) other observers have been stimulated to pursue the same minute inquiries into the diversities of structure of the tissues of other organs. Such inquiries, for example, have been most ably and successfully pursued by Dr. Carpenter in reference to the microscopic structure of recent and fossil shells; and the anatomist, the naturalist, and the palæontologist, are alike indebted to the zeal and the skill of that eminent physiologist: while, in another sense, all are indebted to the British Association for aiding and stimulating his inquiries, and for the illustrations with which the publication of Dr. Carpenter's Report has been accompanied in the transactions of the Association.

"The *hairs* of the different mammalian animals offer to the microscopical anatomist a field of observation as richly and remarkably developed as the *teeth*, which formed the subject of Professor Owen's communication in 1838, and as the external coverings of the testaceous mollusca, which formed the subject of Dr. Carpenter's communication in 1846.

"The structure of the softer tissues of the animal frame has not been less successfully investigated by microscopic observers. One of the most extraordinary, perhaps, of the recent discoveries by the microscope is that which is due chiefly to Purkingé and Valentin, and which in this country has been well established by Dr. Sharpey, relative to the important part in the motion of fluids on internal surfaces, performed by the vibratile action of myriads of extremely minute hairs or cilia which beset those surfaces. These ciliary movements, for example, raise the mucus of the wind-pipe to the throat against gravity. They have been detected in the ventricles of the brain, as well as many other parts.

"Microscopic anatomy has been chiefly indebted to Ehrenberg, Remak, and Dr. Martin Barry, for the exposition of the ultimate structure of the nervous and cerebral fibres.

"Exact knowledge of the nature of the retina, or the vitreous and crystalline humors, and of other delicate constituents of the organ of vision—the most wonderful of all the organs with which God has entrusted man—has been remarkably advanced by the skilful use of the improved microscopes of the present day. I rejoice that, among the proposed arrangements of the Association at its present meeting, one evening, Tuesday the 29th, will be specially devoted to an exhibition of microscopic objects. The beautiful discoveries of Sir David Brewster (whom, in this Association, we must always mention as one of our earliest friends and patrons, three times one of our Vice Presidents,) have been carefully confirmed; and many interesting varieties have been noticed in the structure of the crystalline lens of the eyes of different species of animals.

"The most brilliant result, perhaps, of microscopic anatomical research has been the actual observation of the transit of the blood from the arteries to the veins; the last fact required—if, indeed, such an expression be allowable—for the full proof of Harvey's doctrine of the circulation of the blood. Malpighi first observed the transit in the large capillaries of the frog's web. It has since been observed in most other tissues, and in many other animals.

"No part of the animal body has been the subject of more, or of more successful, researches than the blood itself. The forms and dimensions and diversities of structure characteristic of the colored discs, corpuscles, or blood globules, as they were once termed, in the different classes, orders, and genera of animals, have been described, and for the most part accurately depicted; and through the concurrence of numerous observers, the anatomical knowledge of these minute particles, invisible to the naked eye, has become as exact and precise as the knowledge of the blood vessels themselves, or of any other of the grosser and more conspicuous systems of organs; and has added,—when we consider how easily the action is deranged, by how many causes it may be diseased or stopped,—another to the many proofs that we are fearfully as well as wonderfully made. In surveying how our frame is formed, how sustained, how revived by sleep, one of the most wondrous of all the incidents of our nature, what suffering is produced by any pressure on the lungs, and yet how unconsciously we breathe a million times in health for one in sickness,—I cannot but feel that our Heavenly Father gave another proof of His essential character when, in answer to the prayer of Moses, 'Shew me thy glory,' God answered, 'I will cause *all my goodness* to pass before thee.'

"In no department of science has the confluence of its cultivators—at such annual meetings as the present—been more influential in advancing its progress in the right direction than in natural history.

"Natural history is preëminently the science of observation; a science made up of insulated facts and phenomena collected from the earth, the air, and the waters,—first, carefully observed, and then distributed or generalized according to resemblances and analogies. Every fact, if it be deserving such a description—that is to say, if it be truly observed and accurately stated—is welcome to the man of science, though the observer himself may not be in a condition to recognize the full signification of his own fact or its bearings on collateral phenomena. But if this be the case when one fact is communicated to one man of science, such particulars when communicated to an association like the present and discussed in its appropriate section of scientific observers, speedily gain their right place and do their duty in the steady advancement of natural science. The observer thus, for the first time, made cognizant of the full value and importance of his own observation, returns to his own locality and to his own particular department of science with renewed interest, with increased zeal, and, perhaps, also with a better direction given to his observations.

"The rapid progress of the scientific knowledge of the animals of our own islands, and the great advance in the determination of the British fauna, may be produced in illustration of the benefit which has followed these assemblages, and the encouragement which the British Association, as a body, has given to the investigation of the facts and the publication of the results.

"In no department of the living works of the Creator has this been more manifested than in that humble, and, therefore, heretofore much neglected class of the molluscous or gelatinous animals which people the seas around our island. Among the naturalists who have rescued this branch of zoology from neglect, the name of Edward Forbes deserves early and honorable mention. The stimulus given by his successful exertions with the dredge and with the towing net, in collecting new species of Conchifera, Echinoderma, and Acalepa, and the brilliant generalizations which he has deduced from the fruits of these researches, may be discerned in the beautiful monograph by Messrs. Alder and Hancock on the British Nudibranchiata, now in course of publication by the Ray Society—in the interesting work on British Zoophytes, just completed by Dr. Johnston—and in the new discoveries annually communicated to the Zoological Section of the British Association, by Dr. Allman, Dr. Thompson, and other eminent naturalists from Ireland; by Prof. Goodsir and other excellent observers in Scotland; by Mr. Price, as the fruit of his observations on the shores of Birkenhead; and by Mr. Peach from the coasts of Cornwall. But the reports of the sectional meetings and those other reports which have been suggested or encouraged by the grants of the British Association, will best attest the influence of this Association in the promotion of natural history in general and of home zoology in particular.

"I cannot utter one or two technical terms which I have lately addressed to the meeting, without adding one passing reference to the great ancient authority from which they are derived; and which, high as its value is in its proper place in relation to those unchanged sciences of morals and mind, the cultivation of which is the distinguishing object of the academical education of Oxford, is also high even in natural science also: for, while the ethics of Aristotle remain the monument of his profound reason, his claim to eminence as a great observer of natural history remains also, after the experience of two thousand years, unshaken and unalterable.

"I proceed now to notice the science of BOTANY; which, aided in these days by the microscope, and by chemistry, as to the structure, functions and uses of the living plant, and as to the analogies in the vegetable world in its fossil state, presents one of the most interesting subjects of inquiry to the student and to the general observer.

"Systematic botany is constantly receiving additions to the number of species.

"In England, with respect to living plants, for the greater part of the accession to the plants in cultivation during the preceding year we are indebted to Mr. Fortune, the Horticultural Society's collector in China; who has recently published an account of his mission: and we are not less indebted to those who, as collectors and correspondents in various parts of the world, communicate the results of their labors to the Royal Botanic Gardens at Kew. That establishment, under the direction of my friend, Sir William Jackson Hooker, has unquestionably become the first botanic garden in Europe. I use this expression on the authority of another friend whom I have had the privilege of knowing for forty years, whom Humboldt described as *le premier Botaniste de l'Europe*, accurate, sagacious, and profound, and whose knowledge is only equalled by his modesty. After this, it is not for your sakes but my own, that I name Robert Brown; may I add, in passing, the expression of every one's wish that he would deposit more of his knowledge in print.

"Before I quit the subject of the great institution at Kew, I ought to mention as one of the latest accessions to it, a cactus weighing a ton, as stated by Sir W. J. Hooker, in his Report laid before Parliament; who adds, that the collection of that most singular family, so recently made familiar to us, (he refers to the collection at Kew,) 'is now unrivalled in Europe.'

"With respect to new species of plants received only in the state of specimens for the herbarium, they have been in part obtained from China, South America, and New Zealand; but chiefly from Australia. The late expedition into the interior, or at least further into the interior of that great continent than in any other direction had hitherto been made,—expeditions so creditable to the enterprise, perseverance, and intelligence of their conductors—have however been but little productive, so far as we at present know, in the department of botany. The animal productions of New Holland, so wonderful in their forms and structures, have long formed the most remarkable characteristic of its vast region; nor is its botany without distinctions of much interest, though as yet but very imperfectly explored. It may be said, however, in reference to the results of these later expeditions, which have penetrated further inland, that they have not brought to our knowledge any peculiarities in the vegetable kingdom so various and so striking as those which exist near the coasts, and which are sufficient to distinguish New Holland and the Australian colonies from the other regions of the world.

"In the diffusion of the riches of the vegetable world, steam navigation has obviously been a most favorable auxiliary; so that 'even cuttings of plants' are now 'actually sent successfully to Calcutta, Ceylon, &c.' In speaking of the exports from Kew, it is not unfitting to add, that 'between four and five thousand plants of the famous Tussae grass have been dispersed from the Royal Gardens at Kew during the past year.'

"The increase in the number of visitors to that most flourishing establishment is some evidence at least of an increase of a taste for the development of science, and probably of that increase of the love of science which it is one of the objects of the British Association to encourage in all classes.

"In 1841, the number of visitors was 9,174; but they are nearly doubling every year. In 1844, they were 15,114; in 1845, 28,139; in 1846, 46,573.

"In vegetable physiology, microscopic observers have of late been much occupied in investigating the phenomena of fecundation, and especially as to the mode of action of the pollen.

"On this subject botanists are still divided. Several experienced observers adopt the theory lately advanced and ingeniously supported by Prof. Schleiden, of Berlin; while others of great eminence deny the correctness on which this theory is founded. Among these, the celebrated microscopic observer, Prof. Amici, of Florence, very recently in an essay—communicated to the scientific meeting held in 1846 at Genoa—has endeavored by a minute examination of several species of Orchis, to prove the existence of the essential part of the embryo anterior to the application of the pollen, which, according to him, acts as the specific stimulus to its development.

"This view receives great support from some singular exceptions to the general law of fecundation.

"Of these, the most striking occurs in a New Holland shrub, which has been cultivated several years in the Botanic Garden at Kew; and which, though producing female flowers only, has constantly ripened seeds from which plants have been raised perfectly resembling the parent:—while yet there is no suspicion either of the presence of male flowers in the same plant, or of minute stamina in the female flower itself, nor of fecundation by any related plant cultivated along with it.

"This plant has been figured and described in a recent volume of the Linnean Society's 'Transactions,' under the name of *Cælebogyne ilicifolia*, by Mr. J. Smith, the intelligent curator of the Kew Garden, by whom, indeed, this remarkably fact was first noticed. It is not the least curious part of the history of the *Cælebogyne*, that male flowers have lately been discovered in New Holland unquestionably of the same species.

"Prof. Gasparini, of Naples, has more recently communicated to the scientific meeting held in that city in 1845, his observations and experiments on the cultivated fig, which, though entirely detitute of male flowers, produced seeds having a perfectly developed embryo, independent of fecundation; access to the pollen of the wild fig, generally supposed to be carried by insects, being, in his experiments, prevented by the early and complete shutting up of the only channel in the fig by which it could be introduced.

"An elaborate memoir has very recently appeared in the Transactions of the Linnean Society, by the late Mr. W. Griffiths, 'On the Structure and Affinities of Plants Parasitical on Roots.' These singular productions have been regarded by several distinguished botanists as forming one natural class which they have called *Rhizanthea.* Mr. Griffiths, on the other hand, who was eminently qualified, both as a systematic and physiological botanist, to judge of such a question, has adopted the opposite view taken by other observers, namely, that these plants really belong to several distinct, and not even nearly related, families; the points of internal structure and external appearance which they have in common arising from the peculiar mode in which they receive their nourishment.

"The extension of the means of communication by the ELECTRIC TELEGRAPH is yearly facilitating intercourse, almost as rapid as light or as thought, between distant portions of England, and between distant provinces in the vast empire of our Queen.

"The last pamphlet which I had in my hand before leaving home yesterday, was a Report presented to the Legislative Council and Assembly of New Brunswick, relative to a project for constructing a railway, and with it a line of electro-magnetic telegraph, from Halifax to Quebec.

"Distance is time; and when by steam, whether on water or on land, personal communication is facilitated, and when armies can be transported without fatigue in as many hours as days were formerly required, and when orders are conveyed from one extremity of an empire to another almost like a flash of lightning, the facility of governing a large state becomes almost equal to the facility of governing the smallest. I remember, many years ago, in the *Scotsman*, an ingenious and able article showing how England could be governed as easy as Attica under Pericles; and I believe the same conclusion was deduced by William Cobbet from the same illustration.

"The system is daily extending. It was, however, in the United States of America that it was first adopted on a great scale, by Prof. Morse in 1844; and it is there that it is now already developed most extensively. Lines for above 1,300 miles are in action; and connect those States with Her Majesty's Canadian Provinces; and it is in a course of development so rapid, that, in the words of the report of Mr. Wilkinson, to my distinguished friend, his Excellency Sir W. E. Colebrooke, the governor of New Brunswick, to which I have just adverted, 'No schedule of telegraphic lines can now be relied upon for a month in succession, as hundreds of miles may be added in that space of time. So easy of attainment does such a result appear to be, and so lively is the interest felt in its accomplishment, that it is scarcely doubtful that the whole of the populous parts of the United States, will, within two or three years, be covered with a telegraphic network like a spider's web, suspending its principal threads upon important points along the sea-board of the Atlantic on one side, and upon similar points along the lake frontier on the other.' I am indebted to the same Report for another fact, which I think the Association will regard with equal interest. 'The confidence in the efficiency of telegraphic communication has now become so established, that the most important commercial transactions daily transpire, by its means, between correspondents several hundred miles apart. Ocular evidence of this was afforded me by a communication a few minutes old, between a merchant in Toronto and his correspondent in New York, distant about six hundred and thirty-two miles.' I am anxious to call your attention to the advantages which other classes also may experience from this mode of communication, as I find it in the same Report. When the *Hibernia* steamer arrived in Boston, in January, 1847, with the news of the scarcity in Great Britain, Ireland, and other parts of Europe, and with heavy orders for agricultural produce, the farmers in the interior of the state of New York, informed of the state of things by the magnetic telegraph, were thronging the streets of Albany with innumerable team-loads of grain almost as quickly after the arrival of the steamer at Boston as the news of that arrival could ordinarily have reached them. I may add, that, irrespectively of all its advantages to the general community, the system appears to give already a fair return of interest to the individuals or companies who have invested their capital in its application.

"The larger number of the members of this Association have probably already seen in London an exhibition of a patent telegraph, which prints *alphabetical* letters as it works. Mr. Brett, one of the proprietors, obligingly showed it to me; and stated that he hoped to carry it into effect on the greatest scale ever yet imagined on the American continent. Prof. Morse, however, does not acknowledge that this system is susceptible of equality with his *telegraphic* alphabet for the purpose of rapid communication; and he conceives that there is an increased risk of derangement in the mechanism employed.

"I cannot refer to the extent of the lines of the electric telegraph in America without an increased feeling of regret that in our own country this great discovery has been so inadequately adopted. So far, at least, as the capital is concerned, the two greatest of our railway companies have not, I believe, yet carried the electric telegraph further from London than to Watford and Slough: an enterprise measured in the United States by hundreds of miles being measured by less than scores in England.

"In England, indeed, we have learnt the value of the electric telegraph as a measure of police in more than one remarkable case: as a measure of government it is not less important;—from the illustration which I have drawn from America, it is equally useful in commerce; but as a measure almost of social intercourse in the discharge of public business, it is not without its uses also. The day before yesterday I had an opportunity of examining the telegraph in the lobby of the House of Commons, by which communications are made to and from some distant committee-room. As a specimen of the information conveyed from the House is the following:—'Committee has permission to sit until five o'clock;' and among the questions sent down from the committee are the following:—'What is before the House?' 'Who is speaking?' 'How long before the House divides?'

"Even if I possessed in myself, or had collected from others, the materials for the most rapid sketch of the progress of other sciences, the time would fail me in the attempt to convey it to you. I abstain from any reference to geology, principally from my own ignorance of its later progress. I can as little endeavor to bring before the Association the discoveries during the past year by which science has ministered to the arts or to commerce; yet I cannot leave altogether unnamed—though I can hardly do more than name—the discovery of the gun-cotton, and the application of electricity to the smelting of copper.

"For that process, I believe, a patent has been recently taken out. As yet, perhaps, sufficient time has not elapsed to test its full value. We all know that an experiment succeeds perfectly in the case of a model, or in a laboratory, which may not succeed so perfectly when the miniature steam-engine, for example, is extended to its ordinary size in a manufactory, or when the operation is transferred from ounces to tons. But if the hopes, expectations, and confidence of the discoverers be realized, their plan will be of the greatest value to this country, and of even greater proportionate value to some of the Queen's most important colonies. It has been said that 10,000 tons of copper were sent last year from Australia, to be smelted in England; and that they produced no more than 1,600 tons of copper. It is evident, therefore, that, if by this process of smelting by electricity, the refuse, namely, 8,400, can be left on the spot, 8,400 tons of shipping are liberated for other purposes of commerce between the colony and the mother country; and the saving of coal in England, an object not wholly devoid of interest, is immense.

"From the sciences cultivated, extended, or encouraged, I advert to a consideration of the Association itself. The importance of these meetings is national. Their direct results have been eminently beneficial to science; their indirect effects in uniting men of the same pursuit from different parts of our common country, and not less in bringing together those whom seas and empires divide, but whom the same zeal for knowledge happily associates as in this place, are equally remarkable. Those antipathies (I hardly use too strong a word) which once separated us from our brethren in other realms—and from which even men of science were not always exempt—are, year by year, vanishing; and we have met cordially on common ground to assist and encourage one another in the pursuit of objects honorable and serviceable to the whole family of man.

"While, however, this effect is produced, whether our meetings be in Oxford or in Cambridge, in Edinburgh or in Dublin, in Liverpool or in Cork—or again whether they be in England or in Genoa, in Milan or in Naples—let us not forget, that if we raise the standard of science in our own country, we raise the national character also, and its just influence in other countries; and that while individual benevolence is promoted by personal intercourse in these re-unions, the benefit of the labors of every such association is national also. None can doubt that the reputation of our country depends far more on its intellectual strength than on its military glory. Without for a moment undervaluing those to whom in past ages as in the present, England is, humanly, indebted not merely for her empire but for preservation also, I cannot doubt that the European reputation of England is owing far more to Newton than to Marlborough. I believe that every new discovery of science which England is permitted to make, while it adds perhaps directly to her wealth or indirectly to the development of her resources, adds also to her influence in the scale of nations. Our government has exercised a prudent and sagacious liberality in adopting thus far the suggestions of this Association for the advancement of science; and it may be well assured that such suggestions, made cautiously and disinterestedly by this Association, will continue to advance the public interests as well as the mere incidental honor of the body from which they proceed, and which, from past experience, may justly claim the confidence of the state.

"The interest of our nation in science has kept pace with the encouragement given by public authority to the cultivation of science.

"Our national collection may now be compared, not ostentatiously, but thankfully, with those of other countries; remembering, also, that our collections are little more than half a century old.

"The ornithological, the conchological, the mammalian departments in the British Museum are equal, I believe, to those of any other capital: greatly owing to the talents and labor of the eminent head of that department, Mr. Gray, whom I see here. The fossil divisions, under the care of my zealous, laborious, and able friend, Mr. König, are perhaps superior—in some classes beyond comparison. Last year there was added to the palæontology of the museum the unique specimens of the Holitherium of Kaup, the Cephalaspis of Lyell, the Lepidote of Fitton; and the collection of osteology is, as it ought to be, the first in England. The number of visitors, which six years ago was 319,000, was last year above 700,000—and the collections of comparative anatomy in the Hunterian Museum are, as they ought to be, the first in the world.

"With these indications of the state of science and of the taste for science diffused in our own country—sometimes as the fruit of the labors of this Association, sometimes as collateral and incidental, and even distinct results, but all showing the progress of physical knowledge or the means of extending or familiarizing it amongst us—I might finish my Address.

"But I cannot conclude without congratulating the University and the Association alike on this assemblage.

"We can never forget that the earliest, and in every sense the first, of the scientific bodies of England, the Royal Society, derived, as we learn from Bishop Sprat, its original and contemporary historian, its foundation in this place. We can never forget that Bishop Wilkins, the predecessor of my honored friend the Vice-Chancellor of Oxford in the government of Wadham College, was the chief promoter of its designs; that Sir W. Petty, the Wrens, Seth Ward, and Wallis, were his associates; and that here, for fourteen years, our own great and good Robert Boyle, preëminent amongst early observers, and ever eminent for Christian principle and devotion, cultivated natural science; and, without for a moment undervaluing the mighty names which do honor to Cambridge—which do more, which do honor to England and our common nature—we may claim in Oxford the distinction of having nourished and sent forth the men who first laid the basis of the greatest of the scientific associations of the world.

"Here, then, the British Association gladly accepts the welcome now tendered to it within this venerable University. It was cordially received fifteen years ago, when this chair was worthily occupied,—and far more appropriately than by me—by my very reverend friend Dr. Buckland. I hope and believe that the feeling of good-will and respect will be mutual, enduring, and cordial; that the University will see with pleasure the progress of the natural sciences, and of the observations which the British Association has eminently encouraged;—and that the members of our Association will look with kindness and respect at the venerable seats of ancient learning, whence have been diffused through the land for many centuries the benefits of a large and liberal education, and the blessings of Christian instruction; where it is the earnest and habitual endeavor of those who teach—may it be alike the desire of those who learn—to sanctify the acquirements of the mind by the graces of the Spirit.

"I feel that I have very inadequately discharged the duties of the station in which I have been placed. Wherever the failure is less apparent, I unfeignedly desire you to attribute such partial success to the aid which I have received from Dr. Robinson, Prof. Owen, Mr. Robert Brown, and Colonel Sabine; since nothing which is derived from them can be unworthy of your notice. Lest you should have forgotten my earlier mention of them, I repeat this statement; and add again, that it is enough for me to be allowed to call such men my friends. My own avocations in later years have withdrawn me, as I have said, from the active pursuits of science; yet it was necessary for me to attempt some review of its later progress. I will only add my firm belief, that every advance in our knowledge of the natural world will, if rightly directed by the spirit of true humility and with a prayer for God's blessing, advance us in our knowledge of Himself, and will prepare us to receive his revelation of his will with profounder reverence.

"The improvements of modern arts have greatly facilitated the progress of science. Here how have they brought together from distant regions men of other tongues and other families, but not of other minds!—men whom I name to honor them; the Prince of Canino, Van der Hoeven, Langberg, Ehrenberg, Leverrier, Struvé, and Gautier, united here in one common object. In the words of the Prophet Daniel, if they may be applied without irreverence, 'men travel to and fro, and knowledge is increased.'

"May that knowledge be guided aright—may every acquisition of it be sanctified—as the circle widens, may every eye be still directed to the centre of all truth—and may every science, whether cultivated in connexion with this great Association or in the elder establishments of this great University, willingly, gladly, and cheerfully, lay its tribute on the altar of God."

Art. XXI.—*Theory of Transit Corrections;* by Enoch F. Burr.

An accurate determination of the element of time is so essential to the purposes of astronomy, that whatever may serve to to simplify or illustrate the modes of obtaining it, may justly be deemed of importance.

In expounding the theory of the transit instrument, the reasoning necessarily partakes much of a metaphysical character. From this cause, combined with limited space, a specific object or the necessities of a popular exhibition, arise certain assumed principles and partial demonstrations in our ablest treatises on the subject. This fact gives occasion for a few supplementary reasonings on the principles of the transit corrections.

There are four prominent corrections to be made in the applications of the transit instrument. These are for errors of observation, inequality of the intervals between the wires, the time of passing over these intervals, error of collimation and deviation of the optical axis from the plane of the meridian. A few suggestions will be made with reference to these corrections in their order.

An observer is liable to error in estimating the instant at which a star transits the wire which indicates the plane of the meridian. To correct for this error, and reduce its probable amount, other wires are introduced into the focus of the instrument, and a mean taken of the times of the transits over them all; and the reduction is proportional to the number of wires introduced. Let $e=$ error of one observation and $\frac{e'}{n}=$ the mean of a number of observations. Then $\frac{e'}{n}$ is probably less than e. There is no probability that e is less than $\frac{e'}{n}$ when all the errors denoted by e' are of the same sign, and one expression in this case has no advantage over the other. But these errors probably have *not* all the same sign; but some are negative while others are positive, and thus tend to cancel each other. This constitutes an advantage of the latter expression and renders it probably less than the first.

The diminution of error by taking a mean, is probably in proportion to the number of observations. Let $\frac{e}{n}=$ the mean error of a number of observations, and $\frac{e\pm e'}{n+1}=$ the mean error when the number of observations is increased by unity. Then $\frac{e\pm e'}{n+1}$

is probably less than $\frac{e}{n}$. For if the numerator of the first expression is not probably greater than that of the second while its denominator is greater than the denominator of the other, then the first expression is probably the smallest. But there is no probability that the numerator of the first is greater than that of the second, since there is as much chance that e will be negative as positive.

As the probable reduction of the error of observation is in proportion to the number of wires, it becomes important to connect as many with the instrument as possible. All the advantage, however, of an additional wire to the transit, in the use of the common method of taking a mean, may be gained by adding the times at all the wires to the time at the middle wire and dividing by the number of wires increased by one. This method gives a result probably as accurate as that which would be given by the other with a new wire added to the instrument. Let $e=$ error at the middle wire and $e'=$ sum of errors at all the wires. Then according to the method just stated, $\frac{e \pm e'}{n+1}$ is the mean error: a result just the equivalent of that given by the common method with an additional wire, inasmuch as there is no probability that the error at an additional wire will be more favorable in respect to amount and sign to the diminution of the numerator of the fraction expressing the mean, than the error at the middle wire. Indeed, the error at the middle wire is probably less than at an extreme one.

When the intervals between the wires of the transit are unequal, a correction must be applied for this inequality. It is given by eminent authority, that this correction is most perfectly applied by reducing the time at each of the wires separately to the middle wire and then taking a mean, thus requiring as many separate reductions as there are wires less one. But this process is tedious, and may be avoided with advantage in the following manner. Find the place of the mean of the wires. The product of the equatorial distance of this from the middle wire into the secant of the declination, applied with its proper sign to the time of the transit over the mean of the wires, gives the time of the transit over the middle wire. The time of the passage over the mean is found by dividing the sum of the times of the transits by the number of wires, and found with as much probable accuracy as would be connected with the time over the middle wire, obtained in the usual manner, when the intervals are equal.

Let $\gamma=$ true time at the mean of the wires.

d, d_1, d_2, etc. $=$ equatorial distances of the wires from the mean.

e, e_1, e_2, etc. $=$ errors of observation at the wires.

$\delta=$ declination of the star.

Then the observed times for a transit with five wires will be

$$\begin{array}{l} \gamma \pm d\ .\ \sec\delta \pm e \\ \gamma \pm d_1 .\ \sec\delta \pm e_1 \\ \gamma \pm d_2 .\ \sec\delta \pm e_2 \\ \gamma \mp d_3 .\ \sec\delta \pm e_3 \\ \gamma \mp d_4 .\ \sec\delta \pm e_4 \\ \hline \end{array}$$

and their sum, $5\gamma \pm \mathrm{D}.\ \sec\delta \pm \mathrm{E} = 5\gamma \pm \mathrm{E}$ since $\mathrm{D}=0$.

Dividing by 5 we have $\gamma \pm \frac{\mathrm{E}}{5}$ (1).

Now it is evident that if γ is taken to represent the time of the transit over the *middle* wire, and the equatorial intervals be equal, the sum of the coefficients of sec δ is zero, and there is a liability to just as large an error of observation at each wire. Hence the time of transit at the middle wire would be found $\gamma \pm \frac{\mathrm{E}}{5}$ (2): a result no more accurate for the middle wire than was the previous one for the mean of the wires.

If to expression (1), the product of the equatorial distance of the mean of the wires from the middle wire be applied with the proper sign, γ, which represents the true time of passage over the mean of the wires, will become the true time of passage over the middle wire, and the expression (1) will become identical with expression (2): the same result will be obtained as if the equatorial intervals had all been equal.

The correction for the inequality of the intervals may also be made, by reducing the times of the transits on one side of the middle wire, to what they would have been, if each wire had been as far from the middle as is the one corresponding to it on the other side, and then using these reducing times in obtaining a mean.

Let $\gamma=$ true time of passage at the middle wire d', d'', etc.$=$ true times between the middle and other wires.

Then

$$\begin{array}{lll} \gamma & \pm d' & \pm e \\ \gamma & \pm d'' & \pm e_1 \\ \gamma & & \pm e_2 \\ \gamma & \mp d''' & \pm e_3 \\ \gamma & \mp d'''' & \pm e_4 \end{array}$$

will be the *observed* times of the transits. Now conceive a quantity $\pm b$ added to d'', such that $d'' \pm b = d'''$, and also another quantity $\pm b'$ added to d', such that $d' \pm b' = d''''$. In this case, when the quantities are added, the second column will disappear, and dividing by 5, we have $\gamma \pm \frac{\mathrm{E}}{5}$: as accurate a result as is obtained when the intervals between the wires are all equal; since the observer is liable to just the same errors at the wires.

It is well known that the time occupied by a star in passing over a given part of the field of view, is not accurately expressed by the product of its equatorial value into the secant of the declination. This arises from the inequality of the arcs of different diurnal circles, intercepted between the same limits. The formula which is strictly accurate, is, in its common form,

$$\gamma x = \frac{\text{arc}\,.\,\sin\,(15\,.\,\gamma y\,.\,\text{arc}\,1''\,.\,\sec\delta)}{15}$$

Where $\gamma x =$ time of passage from one wire to another,
$\gamma y =$ equatorial interval between them.

But there is another known form, which, while it indicates the operations to be performed more clearly than the last, is sometimes otherwise more convenient for use. It may be thus demonstrated.

Let $x =$ arc of a diurnal circle intercepted between two wires.
$y =$ arc of equator intercepted between the same.
$x' =$ a part of x equal to y.

Then $\gamma x = \gamma y\,.\,\sec\delta$.

$$\gamma x' : \gamma x :: x' : x$$

$$\gamma x = \frac{\gamma x'\,.\,x}{x} = \frac{\gamma y\,.\,\sec\delta\,.\,x}{y}.$$

But $y = \sin x = \sin\left(\frac{180\,.\,x}{\pi\,.\,\cos\delta}\right)\cdot\cos\delta = \sin\,(m\,.\,x\,.\,\sec\delta)\,.\,\cos\delta$

And arc $(m\,.\,x\,.\,\sec\delta) = \sin\,(m\,.\,x\,.\,\sec\delta + \frac{\sin^3.(m\,.\,x\,.\,\sec\delta)}{2\,.\,3}$ +etc.

$$= y\,.\,\sec\delta + \frac{y^3\,.\,\sec^3\delta}{2.3} + \text{etc.}$$

But arc $(m\,.\,x\sec\delta) = x\,.\,\sec\delta$

$$\therefore x = y + \frac{y^3\,.\,\sec^2\delta}{2\,.\,3} + \text{etc.}$$

And $\gamma x = \gamma y\,.\,\sec\delta\left(1 + \frac{y^2\,.\,\sec^2\delta}{2\,.\,3}\right)$.

$$= \gamma y\,.\,\sec\delta + 37\,.\,5\,.\,\text{arc}^3\,1''\,.\,\gamma y^3\,.\,\sec^3\delta.$$

The two corrections of the time for error of collimation and deviation of the transit axis from the plane of the prime vertical, are given respectively by the expressions $c\,.\,\sec\,.\,\delta$ and $a\,.\,\sin\,(\varphi-\delta)\,.\,\sec\delta$; so that the equated error of the clock becomes $Æ - \gamma - a\,.\,\sin\,(\varphi-\delta)\,.\,\sec\delta - c\,.\,\sec\delta$. In these expressions φ is the latitude of the place of observation, Æ the right ascension of a star, and a, c, the deviation and error of collimation. It is plain that the values of a and c might be determined from any three equations of the error of the clock, but this method is much less accurate, on account of errors of observation, than another which is sometimes employed. This latter method may be exemplified with reference to *c*, and consists in subtracting two equations, one of which is the sum of several such equations of the error of the clock as contain large coefficients of *c*, and the other the sum of an equal number of such equations as contain small coefficients of *c*, and such coefficients of *a* that their sum will nearly balance and cancel the other coefficients of *a* in the subtraction. Then the error of the clock disappears, the term into which *a* enters being very small, may be neglected, and *c* becomes known. The superior accuracy of this method, which we find assumed, it may be well to establish.

Before proceeding farther, however, it should be observed that while the expression for the effect of the error of collimation upon the time, needs in strictness of theory to be subjected to the same modification as that which commonly expresses the time of a star between two wires, the difference between the value of this expression and the true correction, is always practically inappreciable. The time occupied by a star in passing from a small circle of the sphere parallel to the meridian, to the meridian, is equal to the space passed over, expressed in time, into the secant of the declination; but this space or the arc of the diurnal circle intercepted between the two circles, is different for different declinations, and hence the constant *c* can only represent it approximately. In practice, however, the difference is of no consequence. Let $0''\cdot05$ be the greatest allowable error in the value of the correction arising from the use of the form $c\,.\sec\delta$. Then at 88° 30′, the declination of Polaris, the error of collimation must be 10^s; which is greater than it will ever be when any sort of care is used in making the adjustment.

The value of *c* as found by the common method, is much less affected by errors of observation than that found from any three equations. The effect of these errors on the value of *c* as determined by the common method, is expressed by the algebraic difference of two sets of errors into a coefficient which is a very small fraction, and which may be made of any degree of smallness, while the effect of the errors of observation on *c* as found by the other method, is expressed by two terms each of which is the algebraic difference of two single errors into a coefficient which is probably integral. Now, since there is no probability that the sum of these two errors is less than the greatest, if it can be shown that the coefficient of either is integral, and that there is no likelihood that its factor is any less than the corresponding factor of the term which expresses the effect of the errors of observation in the common method, it follows that this effect is probably much less than that incident to the other method.

$$\begin{aligned}\text{Let } x &= \text{Æ} - \gamma - a\,.\,m - c\,.\,n\\ x &= \text{Æ}' - \gamma' - a\,.\,m' - c\,.\,n'\\ x &= \text{Æ}'' - \gamma'' - a\,.\,m'' - c\,.\,n''\end{aligned}$$

be three equations of the error of the clock, the transit axis being assumed perfectly horizontal. Then if c is sought, the coefficient of one part of the effect of the errors of observation on its value is

$$\frac{1}{(n-n')-\frac{(n'-n'').(m-m')}{(m'-m'')}}.$$

But $n-n'$ is always a proper fraction in our latitude for instruments having only a southern exposure, and is in fact as far as the latitude whose tangent is $\sqrt{3}$. The same is true of $n'-n''$, $m-m'$, and $m'-m''$. But $\frac{n'-n''}{m'-m''}$ is also a fraction, since the numerator is a less fraction than the denominator.

For $m'-m''=\sin(\varphi-\delta').\sec\delta'-\sin(\varphi-\delta'').\sec\delta''$

$$=\cos\varphi\,(\tan\delta'-\tan\delta'')$$

$$n-n''=\sec\delta'-\sec\delta''.$$

Differentiating $\cos\varphi.\tan\delta''$ we have $\cos\varphi.\sec^2\delta''.d\delta''$, and $\sec\delta''$ we have $\sin\delta''.\sec^2\delta''.d\delta''$.

Hence we have $\cos\varphi.\sec^2\delta''.d\delta'' > \sin\delta''.\sec^2\delta''.d\delta''$ when $\delta'' < 90^\circ-\varphi$. From this we have

$$\cos\varphi.(\tan\delta'-\tan\delta'') > (\sec\delta'-\sec\delta'').$$

The same is true when one of the declinations is negative, since observations will not be made near the horizon. Then $m'-m'' > n'-n''$ when the greatest declination is less than the complement of the latitude of the place of observation. Hence it follows that the reciprocal of $(n-n')-\frac{n'-n''}{m'-m''}\cdot(m-m')$, which is the coefficient of one part of the effect of the errors of observation, is integral when the transit has only a south exposure.

If the instrument commands the whole meridian, we may show that the coefficient of one part of the effect of the errors of observation, cannot be largely fractional without making the coefficient of the other part integral. The denominators of the two coefficients are

$$(m-m')\left(\frac{n''-n'}{m''-m'}-\frac{n-n'}{m-m'}\right). \quad . \quad . \quad 1.$$

$$(m'-m'')\left(\frac{n''-n'}{m''-m'}-\frac{n-n'}{m-m'}\right). \quad . \quad . \quad 2.$$

If the first expression is largely integral, $m-m'$ must be so also, inasmuch as the compound factor can never exceed 2.6.

$$\frac{n''-n'}{m''-m'}=\frac{\sec\delta''-c'}{\tan\delta''.\cos\varphi-c''}.$$

Differentiating and establishing the condition of a maximum, we find $\sec \delta'' - c' = (\tan \delta'' . \cos \varphi - c'') . \frac{\sin \delta''}{\cos \varphi} \cdot$ Substituting in the original expression, it reduces to $\frac{\sin \delta''}{\cos \varphi}$; the greatest possible value of which in our lat. is 1·33. Taking this twice we have 2·6. Making, then $m - m'$ very large in expression (2), let us ascertain its greatest value. It is evident that this expression is the greatest, other things being equal, when $\frac{m'' - m'}{n'' - n'}$ is the greatest, i. e. when δ'' is the greatest and δ' is the least. Taking $\delta'' = 88^\circ\, 30' =$ declin. of Polaris and $\delta' = 0$, we find $\frac{n'' - n'}{m'' - m'} = -1{\cdot}29$. Now the maximum value of expression (2) is when $\sin \delta'' = \frac{n'' - n'}{m'' - m'} . \cos \varphi = -, 97$ in the lat. of New Haven, i. e. when $\delta'' = 76^\circ\, 56'$, and may be found by calculation to be 76. Hence it appears that if one of the two coefficients is a small fraction, the other must be integral.

The remaining point is evidently established, if we show that there is no likelihood that either set of errors is greater than the corresponding single error of the other expression. Each set of errors in the expression which gives the effect of the errors of observation in the common method, is the algebraic sum of a number of errors. Let us conceive two of these errors to be taken at hazard. Then there is no probability that their algebraic sum is greater than the greatest of them, inasmuch as there is no probability that both have the same sign. Now let another error be taken in the same manner. Then there is no probability that the sum of the *three* is greater than the sum of the two first, for the same reason as before: and, as there is no likelihood that the sum of the two is greater than the greatest of them, there is none that the sum of the *three* is greater than the greatest of the two errors taken at hazard. In the same manner we might go on adding single errors and reasoning reversely, and thus prove that there is no probability that the algebraic sum of any given number of errors is greater than the greatest of any two of them, taken at random. But now there is no probability that this greatest of the two is greater than the error corresponding to the set in the first factor of the second expression, and therefore none that the algebraic sum of all the errors constituting the set, is greater than this error.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On Ozone;* by M. Berzelius, (Berzelius's Jahresbericht, xxvi; Chem. Gazette, 109, p. 71.)—After detailing the results of Marignac's experiments in thirteen propositions, M. Berzelius goes on to say, "From these experiments Marignac has drawn the conclusion that ozone is most probably a peculiar modification of oxygen; but considering the circumstance that it is not produced by absolutely dry gases, he has left it undecided whether it may not perhaps contain some hydrogen.

"The last uncertainty, however, has been removed by an experiment of De la Rive. Chlorate of potash is fused to remove all moisture, and then a slow current of dry oxygen disengaged from it; this is passed through a glass tube of about one line internal diameter, into which two pieces of platinum wire have been fused, so that they are a small distance from and opposite to each other. Now when a current of electricity is conveyed to the earth through the wires of the conductor of an electrical machine in action, a succession of sparks results between the wires, and the oxygen is thereby converted into ozone, which is recognized by its powerful odor and its reactions, especially towards iodide of potassium and starch, which is most readily observed. As soon as the electric current ceases, unaltered oxygen again issues from the tube.

"We have thus arrived at the highly important result, that ozone is no peculiar element, and likewise that it is not an unknown combination of known elements, but that it is oxygen in a different allotropic condition, from the ordinary oxygen gas, as this is contained in the atmosphere or obtained in chemical experiments. Our knowledge of the dissimilar allotropic states of the elementary substances has thus obtained an unexpected and highly remarkable addition. In accordance with the other elements, we may represent it by the symbols $O\alpha$ and $O\beta$. $O\alpha$ is distinguished from $O\beta$ by its odor, and by the tendency it has to form combinations in circumstances under which the latter is perfectly inactive, similar to what likewise occurs with other elements. Whether these modifications are preserved in the combination or only one of these states, and which belongs to the oxygen in combination, are questions which still remain to be answered. We have seen that the electrical spark converts a certain quantity of $O\beta$ (probably corresponding to the capacity of the spark) into $O\alpha$, and this satisfactorily explains the electric odor. We have, moreover, learned that those bodies which become oxydized at low temperatures, for instance phosphorus, are likewise capable of producing a change, but that in this case the presence of another gas besides oxygen is absolutely requisite, as hydrogen, nitrogen, or carbonic acid; but whether these gases take an active part, or remain passive and merely dilute the oxygen, is not yet known. I may call to mind the effects of phosphorus upon oxygen by mere rarefaction under the air-pump, which have not yet been satisfactorily explained. Is Oα likewise formed under these circumstances?

There still remains to examine the comprehensive field of extremely interesting comparisons between the different properties of these two allotropic modifications, a subject of inquiry of the greatest importance for science. We have already become acquainted with the mysterious statement of Leuch, according to whom Oα (galvanized air) can be used with considerable advantage for bleaching purposes, and indeed surpasses all other bleaching materials.*

2. *On the relations of Glycocoll and Alcargene;* by T. S. Hunt, (communicated for this Journal.)—The similarity which exists between the compounds of nitrogen and arsenic is such, that they are regarded as belonging to the same natural group and capable of replacing each other in combination. Kakodyle and its derivatives are as yet the only organic bodies known which contain arsenic; of these, M. Gerhardt has shown that alcarsine is to be regarded as an alkaloid in which arsenic takes the place of nitrogen, but the parallel substance containing nitrogen is as yet unknown; and hitherto we have been unable to complete the analogy between these elements, by the discovery of two corresponding compounds, the one containing nitrogen and the other arsenic.

The substance known as glycocoll, or gelatine-sugar, is shown by the recent researches of Horsford and Laurent,† to have the composition before suggested by Gerhardt and declared by Dessaignes from the results of the decomposition of hippuric acid. Its equivalent is represented by the formula $C_4H_5NO_4$. The alcargene or kakodylic acid of M. Bunsen is produced by the slow oxydation of kakodyle or alcarsine; one equivalent of alcarsine and eight of oxygen, yield two of alcargene and two of water.‡ $C_8H_{12}As_2O_2+8O=2C_4H_5AsO_4+2HO$. The equivalent of this substance then is represented by $C_4H_5AsO_4$, which differs from the formula of glycocoll only in the substitution of As for N.

A notice of some of the characters of the two substances will serve to show their close affinity. Both glycocoll and alcargene are capable of exchanging one equivalent of their hydrogen for a metal; and in addition to this character in which they resemble acids, act the part of organic bases by combining directly with acids to form definite crystallizable compounds. Some of these corresponding combinations are here represented.

Glycocoll,	$C_4H_5NO_4$	Alcargene,	$C_4H_5AsO_4$
Argentic "	$C_4(H_4Ag)NO_4$	Argentic "	$C_4(H_4Ag)AsO_4$
Hydrochloric "	C_4H_5NO,HCl	Hydrochloric "	$C_4H_5AsO_4,HCl$

To these characters we may add that both glycocoll and alcargene are readily soluble in water, sparingly soluble in alcohol, crystallize with

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* For a notice of the history and nature of ozone, see this Journal, vol. ii, ii Series, 103.

† This Journal, ii Series, vol. iii, pp. 267–258 and 369.

‡ See the corrected formula for this substance in M. Gerhardt's Précis de Chimie Organique, vol. ii, p. 445.

facility, and are not volatile without decomposition. They also resemble each other in having no deleterious action upon the animal system, a property that is very remarkable in a body which like alcargene contains more than 72 per cent. of arsenic. From these facts the conclusion seems unavoidable, that alcargene is the arsenical species of a genus of which glycocoll may be regarded as the type.

Glycocoll is isomeric with the hyponitrous ether of Liebig. This substance which is regarded by M. Gerhardt as the nitric species of acetene C_4H_6, is, like many other bodies of a similar constitution, decomposed by the action of sulphuretted hydrogen. When a current of this gas is passed into an alcoholic solution of the ether, previously mixed with a little solution of ammonia, it is rapidly absorbed, while the liquid assumes a dark orange-red color, and deposits a large amount of sulphur. In this process a volatile substance of a powerful alliaceous odor and pungent taste is formed, but the small quantity which I obtained in a single experiment, did not allow me to determine its nature. It may perhaps be a body corresponding to alcarsine, of the formula $C_8H_{12}N_2O_2$, or a sulphuretted species of it. Four equivalents of the ether, and eight of the sulphuretted hydrogen, would yield one equivalent of this compound with the separation of six equivalents of water and eight of sulphur; the tendency of the bodies of the acetic series to unite and double their equivalent, is well known. This however is merely a probable conjecture, and I shall take the earliest opportunity to determine its truth or falsity. The substance $C_8H_{12}N_2O_2$ should yield glycocoll by oxydizing agents.

It will be very important to examine the action of reducing agents and sulphuretted hydrogen upon glycocoll, as alcargene, by these means, affords alcarsine, and a species in which its oxygen is replaced by sulphur. I have commenced some researches upon these, the results of which I will send you as soon as they are completed.

Montreal, May 25th, 1847.

3. *Varrentrapp and Will's Method for the Determination of Nitrogen: An Improved Apparatus;* by Prof. E. N. Horsford, (communicated for this Journal.)—The excellence of the method of MM. Varrentrapp and Will, in the combustion of bodies whose per-centage of nitrogen is low, has secured its almost universal adoption.

Two objections have been made to it, and both of them by the gentlemen to whom we are indebted for the labor of removing the practical difficulties which necessarily surround this and every new process.

The first is in the determination of nitrogen in bodies, where nitric acid is present. The per-centage is uniformly too low. No plan has yet been suggested by which to surmount this difficulty.

The other is, generally, with bodies in which the proportion of nitrogen is large. It arises from the impossibility of perfectly controlling the current of evolved ammonia and other gaseous products. When from any cause the combustion proceeds for a moment slower than it should, or the first bulb of the apparatus becomes suddenly cooled, the hydrochloric acid retreats into this bulb, occasioning with the suddenly and greatly increased surface, as the acid issues from the neck, an instantaneous absorption of the ammonia—a partial vacuum and a consequent rush of the acid in jets into and across the bulb. Not unfrequently the jet extends into the combustion tube sometimes cracking it, and otherwise, without this issue, causing the loss of the whole determination.

This catastrophe is especially to be feared toward the conclusion of the combustion, when little except pure ammonia occupies the interior of the tube. MM. Varrentrap and Will suggested the mixture of sugar or tartaric acid with the body to be analyzed, that other gases in quantity might be furnished and the ammonia thus diluted. The difficulty to some extent still remained, and gave rise to Schlossberger's apparatus.

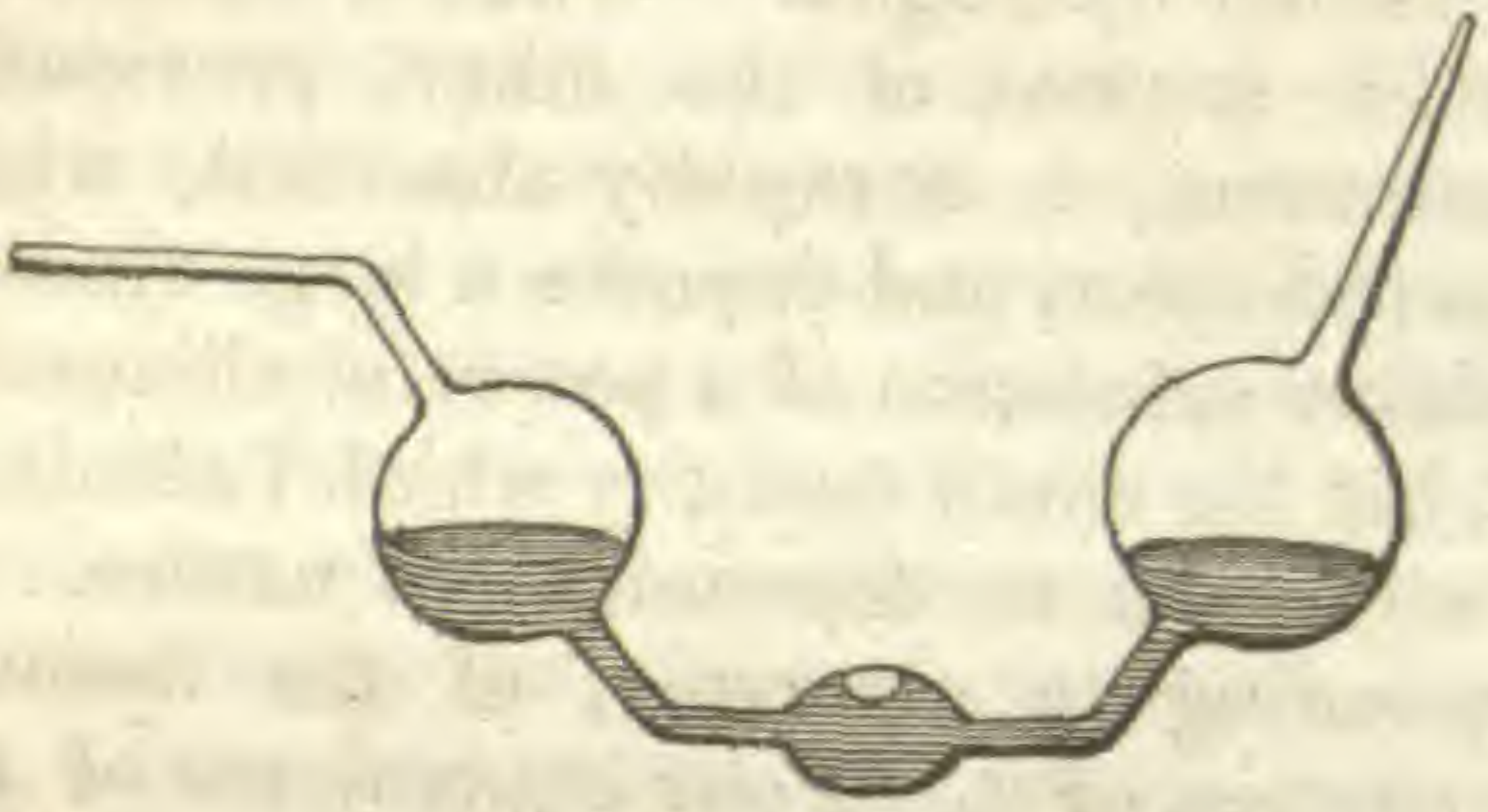


Fig. 1.—Varrentrapp and Will's Apparatus.

Fig. 2.—Schlossberger's Apparatus.

It consisted of two little flasks, of the size used in alkalimetry by Fresenius and Will, connected by tube and corks, and so disposed as to admit air from without, in the event of condensation, without the possibility of the acid ascending into the combustion tube. This improvement most effectually removed all liability to danger.

It had however two objections:—*complication* and *cork surfaces.* It is composed of seven pieces, while the apparatus of MM. Varrentrap and Will consists of but one.

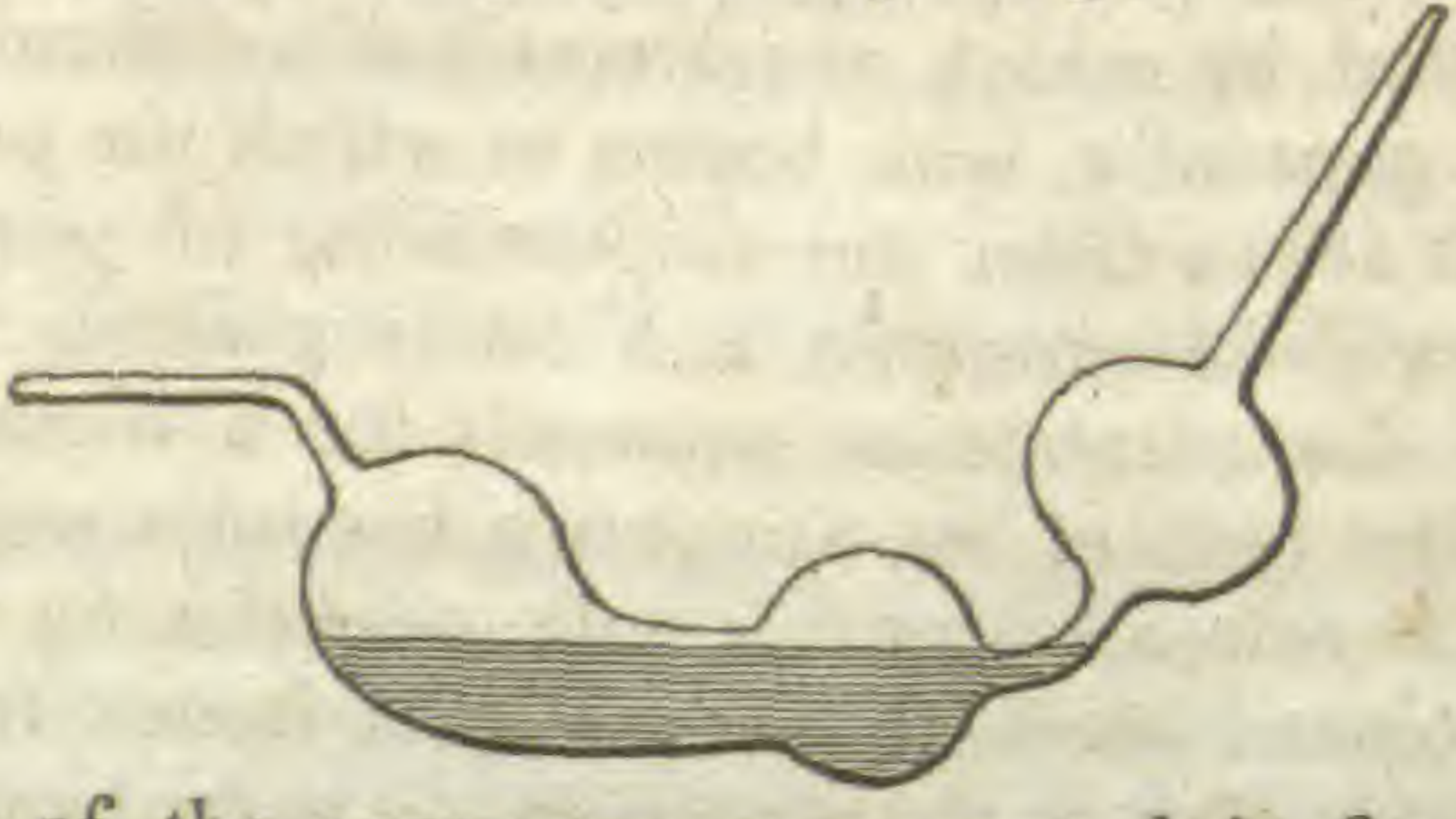
To unite the safety of the former with the simplicity of the latter, was a great desideratum.

An examination of the conditions of the problem, renders its solution easy.

The starting back of the acid follows an absorption more rapid than the evolution. The fluid that had been driven forward into the second and third bulbs, slowly returns toward the first. As the acid enters the bulb nearest the combustion tubes, the sudden expansion of its surface occasions such rapid absorption that a partial vacuum is produced. The liquid comes in so fast, that with the rush of air and vapor into the condensation tube, some of the acid is carried with it.

The causes of the difficulty are the too rapid increase of absorbing surface, and the smallness of the bulb. These are removed in the

Fig. 3.—Improvement upon Fig. 1.



slight modification of the apparatus represented in fig. 3. Its use has realized all the expectations entertained. It is entirely safe.

Cambridge Laboratory, May, 1847.

4. *On a quick Method of determining the quantity of Nitrogen in Organic Substances;* by Eug. Peligot, (Comptes Rendus, March, 1847.)—The method of Varrentrapp and Will was considered a great improvement in the determination of nitrogen, particularly on account of the saving of time, &c. But this process although requiring only a short combustion, needs a prolonged manipulation of the platinum salt, and is liable to several species of error.

The method of Peligot is a simple alteration of that of Varrentrapp and Will. The combustion is performed in the same manner, but the ammonia is condensed by a known quantity (by volume or weight) of sulphuric acid. After the combustion, this acid is transferred to a cylindrical vessel, the washings added, and the strength of the acid determined by the volumetric method. The difference between this and the original strength gives the quantity of acid saturated by the ammonia, and consequently the ammonia.

For this last determination, the author prefers the solution of caustic lime in syrup. This solution preserved in close vessels undergoes no change, and even after absorbing carbonic acid from the air, it needs only a filtration to fit it for use. The strength of the alkaline solution must be previously ascertained by the usual methods.

The results are accurate—an analysis of oxamide gave 31·3 per cent. nitrogen, theory requiring 31·7. By this method a determination of nitrogen may be made in less than half an hour, with an accuracy at least equal to that obtained by the usual methods which require never less than three hours.

M. Peligot considers this method peculiarly useful in the case of physiological investigations, as the determinations, being useless unless comparative and therefore numerous, may be multiplied almost without trouble or expense. G. C. Schaeffer.

5. *Preparation of Sulphocyanid of Ammonium;* by J. Liebig, (Liebig's Annalen, Jan., 1847.)—A small quantity of sulphuret of ammonium in the presence of excess of sulphur produces the unlimited conversion of cyanid of ammonium into sulpho-cyanid—hence the following process: 2 oz. sol. caustic ammonia, sp. gr. 0·95, are saturated into sulphuretted hydrogen, and then mixed with 6 oz. of the same solution of ammonia; 2 oz. flowers of sulphur are next added, and then the product of the distillation of 6 oz. prussiate of potash, 3 oz. sulphuric acid and 18 oz. water. The mixture is digested in the water bath until the sulphur is no longer acted upon and the liquid becomes yellow; it is then boiled till the sulphuret of ammonia is driven off and the liquid has again become colorless. The excess of sulphur being removed, the liquid yields on evaporation over 3 oz. pure white sulphocyanid, which may be used as a reagent instead of the sulphocyanid of potassium.

This reaction of prussic acid with the higher sulphurets of ammonium affords a very good test for the acid, as the sulphocyanides and persalts of iron are more delicate tests for each other than the component cyanides and iron salts forming prussian and other blues. G. C. S.

6. *On the Decomposition of Nitrite of Ammonia;* by E. Millon, (Ann. de Chem. et de Phys., Feb., 1847.)—Heat decomposes the solution of nitrite of ammonia, water being formed and nitrogen given off; but if a drop of caustic ammonia is added to some of the solution in a

thin glass tube, it may be boiled for hours without decomposition. Acids produce the contrary effect, causing the immediate destruction of the nitrite.

The author proposes the following easy process for nitrate of ammonia. An excess of caustic ammonia in a platinum crucible is placed in a cooling mixture. Into this is to be passed very gradually the nitrous vapor, from the dry distillation of nitrate of lead. The solution must be evaporated in an atmosphere of ammoniacal gas, over lime.

The decomposition by sulphur, has been previously noticed by Pelouze. G. C. S.

7. *On a new Mode of estimating the Nitrates, and particularly Nitre;* by J. Pelouze, (Comptes Rendus, Feb., 1847.)—The solubility of all the nitrates preventing any application of the usual methods, and yet the large quantity of nitre consumed annually in the manufacture of gunpowder requiring some mode of determination approaching accuracy, many ingenious processes have been devised, and of these a very complete history is given in the first part of the paper.

A method has been recently proposed by M. Gossart, which consists in mixing the salt with sulphuric acid and decomposing it by a normal solution of protosulphate of iron—the completion of this action being determined by ferridcyanid of potassium, for when this indicates the presence of protoxyd of iron, it is known that all the nitre has been consumed. The quantity of solution used, gives by a simple calculation the quantity of nitric acid or nitre.

M. Pelouze considers the process as original with M. Gossart, and happy in its invention. Certain difficulties however, have led to improvements by Pelouze, which seem to give the method a high degree of accuracy. He first determined the quantity of pure nitrate of potash requisite to peroxydize a known weight of pure iron, (piano wire being selected as the purest and most convenient.) 2 grms. of wire dissolved in an excess of hydrochloric acid, on an average required 1·216 grms. of nitrate. This decomposition involves 6 equivs. iron and 1 equiv. nitrate, the acid being decomposed into deutoxyd of nitrogen, which is given off, and into oxygen, which produces the perchlorination of the iron. Thus:

$$6\mathrm{FeCl}.+\mathrm{NO_5KO}+4\mathrm{HCl}=4\mathrm{HO}+\mathrm{KCl}+\mathrm{NO_2}+3(\mathrm{FeCl_3}).$$

(This reaction is proposed as an excellent method of preparing the deutoxyd of nitrogen.) As the presence of chlorids and sulphates in the crude nitre does not interfere, it is only necessary to operate upon 2 grms. iron and 1·216 of nitre, and by a standard solution of chameleon mineral (permanganate of potash), ascertain how much iron remains to be peroxydized. The method of preparing and using this last solution will be found in this Journal for September, 1846, p. 257.

In an actual analysis, 2 grms. of wire are placed in a suitable flask with 80 to 100 grms. strong hydrochloric acid; the flask is closed by a cork having a fine tube in it. After dissolving the iron with a gentle heat, 1·216 grms. of the nitre to be examined, are added, the flask closed and the whole boiled. As soon as the gas has escaped, and the brown color disappears, the liquid becomes clear and yellow—after boiling five or six minutes it is poured into a quart flask, the wash water added and water to fill the vessel. The normal solution of permanganate is then applied until after agitation a faint rosey hue remains.

In the first part of the process the continual escape of vapor and gas prevents the entrance of the oxygen of the air—after this there is no further danger, as iron in a strongly acid solution is peroxidized with much difficulty, even by exposure to the air.

In general it is best to use the nitrate in a solid form—but to prevent variations in small samples of crude nitre, it is best to dissolve a large quantity and take the proper proportion of the solution for analysis. Of course this process only indicates the quantity of nitrate and does not show the adulteration of nitre by nitrate of soda. G. C. S.

8. *On the Composition of Quinoidine;* by J. LIEBIG, (Liebig's Annalen.)—Quinoidine has been considered by some chemists as a mixture of quinine and cinchonine with resin, which prevents crystallization. Others regard it as a distinct alkaloid. Liebig however found it to yield on distillation as much quinoleine as pure quinine, and on analysis it proved to have the same composition and atomic weight. Quinoidine is therefore nothing more than amorphous quinine. G. C. S.

9. *On the Fat Acids of the Oil of Ben;* by P. WALTER, (Comptes Rendus, June, 1846.)—The oil of ben is the produce of the *Moringa aptera*, and was formerly much used in perfumery as a vehicle for odors, being in itself perfectly scentless. Walter found on examination no volatile acid, but stearic, margaric, and two new fat acids. The one, *Benic* acid, is very small in quantity, its formula $C_{30}H_{30}O_4$ standing between nysistic and ethalic acids. Melting point about 127°. Benic ether is a readily fusible solid.

The other acid is named from the plant, *Moringic* acid—its formula $C_{30}H_{23}O_4$. This is a colorless or yellowish oil, solidifying at 32°, soluble in alcohol, and decomposed by sulphuric acid when heated with it. G. C. S.

10. *On the Fermentation of Tartaric Acid;* by I. NICKLÈS, (Comptes Rendus, Aug., 1846.)—Noeldner described as a peculiar acid that which results from the fermentation of tartrate of lime containing impurities. Berzelius pronounced this acid, called the pseudo-acetic by Noeldner, to be a mixture of acetic and butyric acids.

M. Nicklès does not decide upon this point, but states that an acid is formed containing the elements of acetic and butyric acids, having the composition $C_6H_5O_4$. This would be isomeric with Gottlieb's metacetonic acid.

The experiments given by the author are not quite conclusive as to the separate existence of this acid. G. C. S.

11. *On the Preparation of Ferridcyanid of Potassium;* by A. and C. WALTER, (Buchn. Rep., xliv, p. 42; Chem. Gaz., June 1, 1847.)—Yellow prussiate of potash is boiled with 12 to 15 parts of water, and while boiling, good chlorid of lime added until a filtered sample appears red, or no longer yields a blue precipitate with persalts of iron. It is then quickly filtered, a little carbonate of potash added to the solution until it has a faintly alkaline reaction, and then evaporated to crystallization; the crystals obtained are purified by recrystallization.

12. *On the Method of separating Cobalt from Manganese, proposed by Barreswil;* by A. STRECKER, (Liebig's Annalen, Feb., 1847; Chem. Gaz., May 15, 1847.)—A short time since M. Barreswil* proposed a

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* See this Journal, vol. ii, ii Series, p. 260.

very simple method of separating these two metals, by adding carbonate of baryta to the solution containing them, and then passing sulphuretted hydrogen into it. The author, before employing it, wished to ascertain whether in reality no manganese would be precipitated, as stated by M. Barreswil, and mixed for this purpose solutions of the protochlorid and of the protosulphate of manganese with pure carbonate of baryta, and passed sulphuretted hydrogen into them. It was found that nearly the whole of the manganese was precipitated, and the filtered alkaline liquid became turbid on heating to boiling, and contained now not a trace of manganese. This is readily explained by the behavior of carbonate of baryta towards sulphuretted hydrogen. When a current of this gas is passed into water containing carbonate of baryta in suspension, a portion of it is decomposed in the same way as the alkaline carbonates, and the liquid contains a considerable quantity of baryta in solution, partly in the form of carbonate dissolved in carbonic acid, partly as hydrosulphuret of barium and hyposulphite of baryta. The very alkaline liquid is rendered turbid by boiling, with separation of carbonate of baryta, and on evaporation to half its volume constantly disengages sulphuretted hydrogen; upon the addition of muriatic acid, this gas and carbonic acid escape, and the liquid is rendered turbid by sulphur; sulphuric acid indicates the presence of a large amount of barytic salts. It is to be hoped that when M. Barreswil next imagines a method, he will test its correctness before publishing it.

13. *Occurrence of Arsenic in Vinegar*, (Journ. de Chim. Méd., ii, p. 334; Chem. Gaz., June 1, 1847, p. 213.)—M. DESCHAMPS found, on preparing pure acetic acid from wood-vinegar, that the latter contained arsenic, which he ascribes to arseniferous sulphuric acid having been used in the manufacture of the pyroligneous acid. As wine-vinegar is frequently strengthened with pyroligneous acid, M. Chevalier was induced to examine several samples of ordinary vinegar, and found some of them to contain very perceptible quantities of arsenic.

14. *Mode of detecting the Adulteration of Olive Oil with Rape or Poppy Oil;* by M. DIESEL, (Archiv. de Pharm. in Chem. Gaz.)—Common nitric acid colors pure olive oil green; a mixture of olive and rape oil produces a yellowish grey color, and with poppy oil a yellowish white. After about twelve hours, pure olive oil is itself colored; the determination must therefore be made before that time has elapsed.

G. C. S.

15. *On a Ready Method of determining the Amount of Nicotine in Tobacco;* by M. SCHLOESING, (Comptes Rendus, Dec., 1846.)—Ten grammes of tobacco are to be exhausted with ammoniacal ether, in an apparatus for continued distillation, the ammonia expelled by boiling, the solution decanted and the ether evaporated. The amount of nicotine is then determined by sulphuric acid of known strength, according to the usual alkalimetric method.

This process was found to give results closely agreeing with the amount determined by a careful separation of nicotine.

Tobacco containing a large per cent. of nicotine seems to be that generally preferred for the manufacture of snuff. The snuff itself contains but about one-third of this nicotine, the remainder having been destroyed by the fermentation. This increases the quantity of ammonia, which together with the nicotine and their salts, give the snuff the power of exciting the mucous membrane of the nose.

The following per-centages of nicotine in several French and American tobaccos, were determined by the above mentioned method.

Lot, - -	7·96	per cent.	of nicotine	in the dry tobacco.
Lot Garrone, -	7·34	"	"	"
Nord, - -	6·58	"	"	"
Ile et Vilaine, -	6·29	"	"	"
Pas de Calais, -	4·94	"	"	"
Alsatia, - -	3·21	"	"	"
Virginia, -	6·87	"	"	"
Kentucky, -	6·09	"	"	"
Maryland, -	2·29	"	"	"
Havana, less than	2·00	"	"	"

G. C. S.

16. *On the influence of Ammonia upon the Nutrition of Animals;* by FRED. KUHLMANN, (Comptes Rendus, Feb., 1847.)—While engaged in the researches of which we have already made mention, M. Kuhlmann was led to doubt the commonly received opinion that ammonia is injurious to animal life. He had observed the growth of large numbers of freshwater shells in a ditch which received the washings of animal black at his establishment. This water was found to hold in solution bicarbonate of ammonia and carbonate of lime. Insects too are often produced in vast numbers amid ammonia exhalations. In order to test the direct effects of this substance, the author determined to try the experiment of mixing ammonia with the food, and the carbonate was chosen as being less modified in its effects than any other salt, by the action of its acid.

Two pigs of nearly equal weight were fed with the same kind and quantity of food, with this exception, that one took 100 grammes of carbonate of ammonia in solution, each day. This diet was continued for two months, during which time the health of the animal receiving this singular treatment seemed not in the least affected. Repeated weighings showed no very great difference in their increase, and at the end of the two months, the animal fed in the usual manner had gained 3½ kilogrammes on 78, while the other had gained 1 kil. on 76, although the latter had consumed more than 6 kil. (over 13 pounds) of carbonate of ammonia.

The most curious effect of this diet was upon the urine; that from both animals was acid when fresh, but after fermentation the urine from the ammoniacal diet contained one-fifth more of carbonate of ammonia than the other—showing the presence of an increased quantity of urea. The author suggests that other changes in the digestion must have attended the transformation of the carbonate into urea, and proposes a further investigation of the subject.

The experiment is certainly curious, and deserves repetition under a variety of conditions; but we cannot deny that the results are susceptible of quite a different interpretation from that given by the author. G. C. S.

17. *On several Detonating Compounds formed by the action of Nitric Acid upon Sugar, Dextrine, Lactine, Mannite and Glycerine;* by Ascagne Sobrero, (Comptes Rendus, Feb., 1847.)—Several of these compounds have been found by the author and MM. Flores Domonté and Ménard, simultaneously. The sugar compound on analysis, showed a replacement of 2 equiv. hydrogen. The glycerine compound requires care in its formation, or oxydation takes place. When the mingled nitric and sulphuric acids are kept in a freezing mixture and the glycerine is added slowly, with stirring, it dissolves entirely with no visible reaction. The addition of water precipitates a heavy oily looking liquid, which may be washed in water, dissolved in alcohol and separated by the addition of water. It resembles light yellow olive oil, is heavier than water, in which it is quite insoluble—it dissolves freely in alcohol and ether, is without smell, and of a sweetish pungent and aromatic flavor. It must be tasted with great caution, as a quantity sufficient to moisten the end of the finger, when applied to the tongue produces the most unpleasant effects of nausea and headache, which last for several hours. No analysis of this compound has been made. G. C. S.

18. *On the Exhalation of Bicarbonate of Ammonia by the Lungs;* by Lewis Thompson, (Phil. Mag., Feb., 1847.)—The moisture exhaled from the lungs, on examination was found to contain bicarbonate of ammonia—the quantity for each individual rather more than three grains per day. To prove the presence of ammonia in the breath, the author directs us to breathe for an hour or two, air which has passed through dilute sulphuric acid. The exhalation is condensed by passing through a tube cooled to 32°. The fluid collected is to be acidulated with a drop or two of pure muriatic acid, and evaporated to dryness. Treatment of the residue by potash, produces the usual reactions of ammonia. G. C. S.

19. *Analysis of a Concretion from a Horse's Stomach, performed by Mr. Charles M. Wetherill and Dr. Boyé,* (Proc. Amer. Phil. Soc., iv, p. 330, Jan., 1846.)—This concretion, for a fuller description of which, in connection with its history, Dr. B. referred to his friend, Dr. B. H. Coates, by whom it was handed to him for examination, is remarkable for its size, weighing 11¾ lbs. It is of an oval shape, smooth surface, brownish-grey color, and breaks in concentric layers of different degrees of thickness, exhibiting a fibrous or radiated structure. The outer layer alone was analyzed. The concretion was found by Dr. Coates, to contain a nail in its centre.

By a qualitative examination, it was found to consist of phosphoric acid, magnesia, ammonia, chemically combined water, a small portion of organic matter, and silex. It contained no lime. In order to determine quantitatively these ingredients, a portion was dissolved in dilute hydrochloric acid; the insoluble residue collected on a counterpoised filter, dried and weighed; after incineration and weighing, it yielded *insoluble inorganic matter* 0·45 *per cent.*, which, deducted from its former weight, gives *insoluble organic matter* 0·64 *per cent.*

To the filtered solution was added a weighed portion of iron wire, dissolved in nitro-muriatic acid, and the whole then precipitated by ammonia. Having previously ascertained the amount of peroxyd of iron yielded by an equal portion of the same iron wire, the difference in weight of these two precipitates gave for the *phosphoric acid* 32·40 *per cent.*

To the filtered solution from the phosphoric acid, was added caustic potash in excess, and the whole boiled until the ammoniacal vapors were effectually expelled, and the solution gave a strong alkaline reaction. The magnesia thus obtained was collected upon a filter, washed with boiling water, incinerated and weighed; it yielded *magnesia* 14·45 *per cent.*

Another portion of the powdered concretion dried over sulphuric acid in vacuo at ordinary temperatures, yielded *hygrometric moisture*, 1 *per cent.;* incinerated, it yielded *volatile matter* (*water and ammonia*), 51·70 *per cent.*

In order to ascertain the amount of ammonia, another portion of the powder was introduced into a small tubulated retort, with carbonate of soda and water. The neck of the retort was adapted to a small tubulated receiver containing dilute hydrochloric acid, and having adapted to its tubulure a nitrogen bulb, such as is used in ultimate organic analysis; this also contained dilute hydrochloric acid. The mixture in the retort was evaporated to dryness; and at the close of the operation, air was drawn through the apparatus to insure the absorption of the last portion of ammonia. The *ammonia* thus obtained was estimated by precipitation by chlorid of platinum, as in organic analysis, and yielded 0·71 per cent.

Hence the composition of the concretion is as follows:—phosphoric acid 32·40 per cent., magnesia 14·45, water 50·35, ammonia ·71, insoluble inorganic matter ·45, insoluble organic matter ·64, hygroscopic moisture 1·00=100·00.

It will be seen from this, that the ammonia is too small to be considered an essential ingredient of the concretion. Assuming it to exist in the state of double phosphate of ammonia and magnesia with water ($NH^4O, 2MgO, PO^5+2HO+10HO$), and deducting the amount of this salt from the rest, (omitting the insoluble matter and hygroscopic moisture,) it will be seen that the concretion is composed mainly of the phosphate of magnesia and water, according to the following formula, $3MgO+3HO+2PO^5+24$ aqua, as will be seen from the following comparison:—

By Experiment.		By Calculation.	
Phos. acid,	33·56	$2PO^5$,	33·70
Magnesia,	14·55	$3MgO$,	15·20
Water,	51·89	24Aq.	51·10
	100 00		100·00

20. *Acetate of Lime formed in Coal Pits*, (Proc. Amer. Phil. Soc., Jan., 1846, iv, p. 239.)—Dr. Boyé stated that by a visit to Colemanville Iron Works, Lancaster County, Pa., he had found on the outer surface of the coal pits for charring wood, a yellowish white deposition.

On examining this deposition, it was found to consist of acetate of lime. By dissolving it in water and treating it with animal charcoal, the acetate of lime was obtained perfectly colorless. Dr. Boyé remarked, that the lime was probably derived from the soil, but as acetate of lime was not volatile, it must be carried up mechanically by the vapors of pyroligneous acid and other volatile substances, given off by the process of charring.

21. *Reducing Copper Ores by Electricity*, (London Mining Journal.)—Having published several communications on this subject, inquiring the nature of the process, and also descriptive particulars from our respected correspondent, Mr. John Mitchell, of Napier's patent, we now give the general particulars of the French invention, mentioned by "J. H." of Cornhill—that of MM. Dechaud and Gualtier de Claubry. These gentlemen have long been engaged on the effect of weak electrical currents on copper ores; and the following is an account of the results at which they had arrived before taking out their patent. The process consists of two operations—viz: roasting the ore, and the precipation of the copper. The roasting is effected in a reverberatory furnace, either by the conversion of the sulphuret into sulphate by the action of the air; or in the transformation of the oxyd of copper into sulphate, by calcining it with sulphate of iron, at a dull red heat in a current of air—the iron being left in a state of peroxyd. Washing, then, extracts the sulphate of copper—so that the most impure minerals will afford copper equally pure with the carbonates or oxyds. In the precipitation by galvanism, batteries would be far too costly; and they have obtained the same results without the use of exterior batteries. The principle is as follows:—If two solutions are placed one over the other, one of sulphate of copper very dense, and the other sulphate of iron less dense, and in the first is placed a plate of copper, and in the second a fragment of cast iron, and then these two metals are united by a conductor, the precipitation of copper commences at once, and is completed in a long or short period, according to the temperature, the concentration of the liquids, and the extent of metallic surfaces—the state of the copper becomes greatly changed as the liquor becomes weaker. To obviate this, they take advantage of the following phenomena: After some minutes' action, there exist four strata in the liquids; at the bottom is a dense solution of sulphate of copper, then a less dense solution of the same salt; next, a sulphate of iron, and on the surface a less dense solution of the same. If, therefore, we arrange at the level of each of these liquids, suitable apertures for the addition or removal of the liquid, they can be kept at a uniform state of density, and thus the copper is always pure, and in the same physical condition.

For convenience, the liquids are now arranged in vertical, instead of horizontal, layers; they are then to be separated by a diaphragm very permeable to electricity, but not to liquids—pasteboard answers perfectly well for this, and lasts for months. The apparatus is then arranged as follows: A chest of wood, lined with lead or some suitable mastic, contains the solution of sulphate of iron; into this chest a number of cases are plunged, made of a frame having its ends and bottoms formed of iron plates coated with lead, the sides being of pasteboard. The strong solution of sulphate of copper enters through a pipe near the bottom, and escapes in its weak state through an opening at the top; in each case is placed a sheet of leaded iron, and between each are plates of cast-iron; separate rods connect each plate with the common conductor, which is supported over the apparatus, and the copper is precipitated on both sides of the sheets of metal, the pasteboard preventing the immediate contact of the two liquids; the sulphate of iron thus floats above the sulphate of copper, and the apparatus fulfils all that is required. At a temperature of 68° Fah., 10·73 feet of surface will receive 15·444 grs. of copper in 24 hours, perfectly pure, and immediately fit for hammering or passing through the rolling-mill. This manufacture of copper presents no difficulties, requires no refining, and gives no scoria. The patentees consider that as a metallurgical result 50 per cent. of the copper is obtained in sheets; 25 per cent. in fragments, which require fusion; and 25 per cent. of powder requiring subsequent refining. The application of galvanism to smelting appears to be reduced to the simplest form, and electrotypes on the largest scale can be obtained.

II. MINERALOGY AND GEOLOGY.

1. *M. Nordenskiöld upon Diphanite, a new Mineral Species from the Emerald Mines of the Ural in the neighborhood of Catherinenburg*, (translated from Poggendorff's Annalen, Vol. 70, p. 554, and communicated for this Journal, by W. C. LETTSOM.)—His excellency the minister of the interior, M. Porowsky was so good as to transmit to me for examination a specimen of considerable size from the well known Emerald mines of the Ural, upon which in addition to a white mineral resembling mica, there were several blueish, transparent prismatic crystals, very similar in their appearance to apatite.

Upon closer examination it turned out that these two substances, different as they are in appearance, are one and the same mineral, and one that both by its superior hardness and by the difference of its behavior before the blowpipe, is quite distinct from either of those substances.

The mineral in question, as I shall presently show, is one of the order of hydrous double silicates and I propose for it the name Diphanite, from δις and φανὴς, with reference to its presenting in different directions a totally different appearance.

Diphanite occurs in regular six-sided prisms with a remarkably distinct foliated cleavage at right angles to its principal axis, and belongs therefore to the rhombohedral crystalline system. No other terminal planes than those due to the foliated fracture were noticed.

The prisms when viewed sideways are of a blueish color, they have a vitreous lustre and are transparent; but when viewed perpendicular to the cleavage, the mineral appears white with a pearly lustre, and is no longer transparent unless indeed it is a very thin film that is under examination. Its hardness ranges from 5 to 5·5 at most, upon a perfect cleavage-plane it is somewhat less. It is exceedingly brittle. Surfaces due to mere fracture were not observed in consequence of its great facility of cleavage. Its specific gravity varies from 3·04 to 3·07.

Its behavior before the blowpipe is as follows. In the closed tube it assumes a deeper color, giving off an empyreumatic odor with a deposition of moisture, which upon turmeric paper gives no indication of the pressure of fluorine. Alone, it becomes opaque, swells up and becomes scaly, and in the inner flame fuses to an enamel without bubbles. With bisulphate of potash it does not tinge the flame red. With borax it fuses readily to a transparent glass, which upon cooling partakes somewhat of a yellowish tinge. Salt of phosphorus dissolves it readily, with a residue of silica, to a clear glass, which upon cooling becomes yellower than might be expected from the white color of the mineral. With a little soda it gives a bubbly glass, dark colored externally; upon the addition of more soda it gives an infusible enamel somewhat colored by manganese.

Lieut. Colonel von Jewreinoff has analyzed this substance with great care and accuracy. The most complete analysis of three, all agreeing however closely, gave the following results.

		Oxygen.		Oxygen.	
Silica,	34·02	-		17·66	(15)
Alumina,	43·33	-		20·23	(18)
Lime,	13·11	3·66	(16)	4·57	(4)
Protoxyd of iron,	3·02	0·68	(3)		
Protoxyd of manganese,	1·05	0·23	(1)		
Water,	5·34	-		4·73	(4)
	99·87				

Hence we deduce for the composition of this mineral,

$$2\dot{C}a^2\dddot{S}i+3\dddot{\mathbf{A}}l^2\dddot{S}i+4\dot{\mathbf{H}},$$

the $\dot{C}a$ representing or comprising the compound equivalent

$$\dot{M}n+3\dot{F}e+16\dot{C}a.$$

In accordance with this formula, the result of the analysis would be

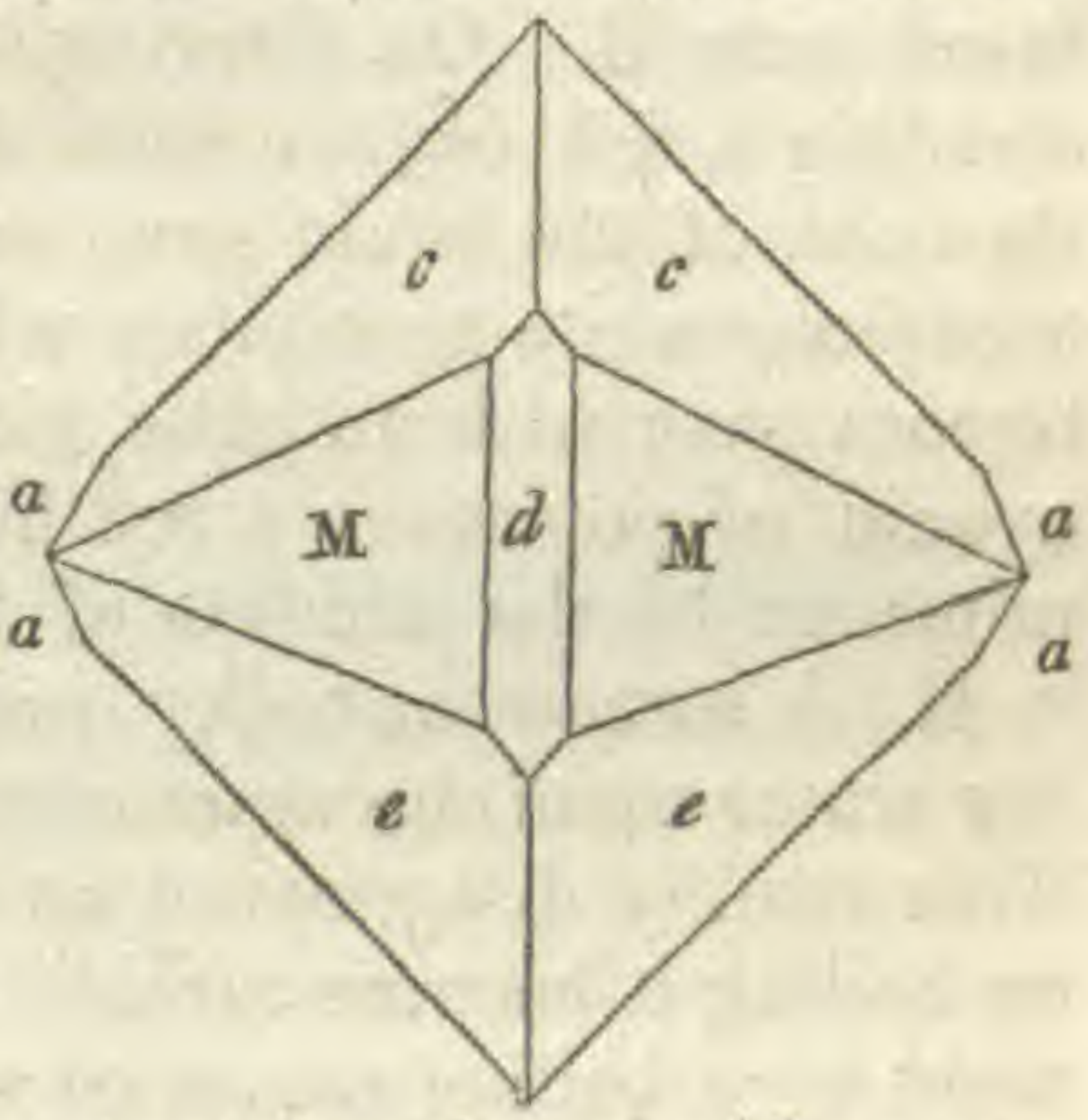
Silica,	33·21
Alumina,	44·33
Lime,	13·11
Protoxyd of iron,	3·04
Protoxyd of manganese,	1·13
Water,	5·18
	100·00

2. *Mineralogical Notices;* by Charles Upham Shepard, M.D. (Communicated for this Journal.)

Tautolite on the north shore of Lake Superior.—This singular, trappean obsidian was presented to me by Mr. Thomas R. Dutton, on his return from a tour of mining explorations on the north shore of Lake Superior. He informed me that it occurs in veins from one to six inches wide, traversing a stratified greenstone or amygdaloid, situated upon Simpson's Island, as well as upon Fluor Island, which is two miles west of St. Ignas. The mineral has a velvet-black color, a subconchoidal fracture, and a shining vitreous lustre. Its Hardness = 6·5 . . . 7·0. Gravity = 3·86. It breaks with the greatest facility, being more brittle than obsidian. Before the blowpipe it fuses into a black glass, attracted by the magnet.

It forms in its color and tenacity a striking contrast with the dysclasite, a mineral found on the south side of the lake in connexion with the trap and the copper, in large sized masses of a pure snow white, or pale rose color, specimens of which were two years ago presented to me by Prof. Forrest Shepherd.

Farther account of the Arkansite.—Mr. W. S. Clark, a student in Amherst College, having recently furnished me with a good sized specimen of this mineral,* in which it presents itself in very beautiful crystals as well as massive, (the whole resembling a mass of Elba specular iron ore,) I am able to add a few particulars to my first account of the species.† The crystals differ considerably in the relative size or development of the planes, from the modification first described, and besides in presenting the new faces *a*, which result from the truncation of the acute angles of the primary form. The planes M are here better adapted to measurement than in the first specimens examined, though still obliging us to employ the reflexions of a lamp light in place of the ordinary window bar. The value obtained for M was constantly between 101° and 101° 15′, and that for *a* on *a*, 123°.



In my first account, I accidentally omitted to give the specific gravity. It is 3·854. This result I have confirmed by fresh trials.

The chemical examination has been so far extended by the present supply of material, as to establish the conclusion that the before discovered titanic acid in it is possessed of those traits which have induced Prof. Rose to distinguish it as an acid of a new metal, called by him Niobium.

In a perfectly powdered state, the mineral is decomposed by four hours boiling in concentrated sulphuric acid, its color gradually changing during the digestion from dark ash grey to a pale yellowish white. It was transferred to a Berlin porcelain crucible and ignited. After full ignition for ten minutes, it was removed from the fire, when it was observed that it still emitted fumes of sulphuric acid. On a farther heating however, these fumes ceased to be evolved. It was found to have lost only 1·89 p. c. of its original weight, and to possess a yellow color while hot, which faded out to white on cooling.

A. It was now treated with dilute sulphuric acid and boiled for half an hour; after which the liquid was poured off, and the insoluble matter was again thoroughly heated and weighed. It had lost scarcely more than 1 p. c. by the process. The acid liquid gave with ammonia a slight flocculent precipitate.

B. A portion of the insoluble powder A was fused with three parts of carbonate of soda for half an hour. It melted perfectly, and had on cooling, a faint bluish tinge in spots. Water loosened it from the crucible, but dissolved it only in the slightest portions. On dropping into this solution either hydrochloric or sulphuric acid, a white precipitate was produced, which did not disappear by boiling. The liquid gave with alcoholic solution of nutgalls, a rich red brown or orange precipitate.

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[*] Mr. Clark received his specimen from Dr. Hitchcock, to whom it had been sent by Dr. W. B. Powell, of the Medical College of Memphis, Tenn. Rev. Mr. Beadle, of New Orleans, from whom I obtained my first specimens of Arkansite, informs me that he received them from Dr. Powell, who was the original discoverer of the locality at Magnet Cove.

[†] This Journal, ii Ser., vol. ii, p. 250.

C. The insoluble matter B (which the water would not dissolve) was rapidly taken up by hydrochloric, as well as by sulphuric acid, and on boiling became troubled. In these solutions also, the nutgalls produced a rich, orange red precipitate.

D. A portion of the powder A was fused with hydrate of potassa in a silver crucible. Water dissolved the mass freely, compared with the fused mass B. On filtering, the solution soon became turbid, (and on standing a few days, a most abundant white precipitate had subsided.) Portions of the liquid gave with either of the acids above mentioned, a copious white precipitate which did not dissolve by boiling. The acid liquors gave with nutgalls, rich orange red precipitates, and with ferrocyanid of potassium a red brown precipitate, which was somewhat diminished by the addition of hydrochloric acid.

E. A somewhat bulky precipitate was left after the affusion of boiling water upon the mass obtained by fusing the powder with potassa. This readily disappeared on being treated with sulphuric acid, though on boiling it became turbid. It was filtered, and subsequently precipitated by a boiling saturated solution of sulphate of potassa. On cooling, the liquor became heavily clouded with a white precipitate, which on boiling cleared up, but returned as it cooled. The white precipitate was separated by a filter, and across this, boiling water was poured, which dissolved out nearly all its contents. From this solution, potassa threw down a bulky precipitate which dissolved in sulphuric acid, which solution was turbid when boiled, and cleared up, to a certain extent, in cooling.

F. The clear sulphate of potassa, solution E, was also precipitated by potassa. The precipitate was ignited, after which it freely dissolved in sulphuric acid, and the solution remained clear on boiling.

My conclusion from the foregoing is, that the Arkansite is a Niobate of yttria and thorina?

Native Platinum in North Carolina.—In November last, I received in a letter from Hon. T. J. Clingman, of Asheville, N. C., a small reniform grain of native platinum, with the following remark.—"The enclosed metallic grain was given me by a friend, who says it was found among the gold of one of his rockers. It looks like native platinum." Its weight was 2·541 grs. There was no difficulty, by means of its physical and chemical properties, in identifying it with the substance above suggested. Its specific gravity = 18. In a subsequent letter dated Jan. 3d, (written before receiving my reply,) Mr. C. adds still farther, "Mr. T. T. Erwin, who presented it to me, says that his overseer, in whose veracity he has the fullest confidence, gave it to him with the gold obtained from the rocker, and that he (Mr. Erwin) does not entertain the smallest doubt of its having been found in his mine in the north part of Rutherford Co. Should it prove to be platinum, it is a matter of interest to me, as the first specimen of that mineral found in the United States."

Fearing however that the grain might have originated in a foreign locality, I addressed particular inquiries to Mr. C. on this head, and received from him the following additional statements.—"The platinum specimen formerly sent you, was taken from the gold rocker by Mr. Lyon, the overseer of Mr. Erwin. Mr. L. is a man of good character, and all persons who know him entertain no doubt whatever of his having obtained the specimen as represented. Mr. L. had no suspicion of its being any thing more than silver, which was known to be found with the gold. The place at which he obtained it, was in Rutherford Co., near the line of the new county of McDowell. I would have sent you his certificate, but I had no doubt that other specimens would be found. In fact, almost every miner to whom I described it said, he had seen just such specimens, but they had supposed them to be fragments of steel or iron that had been broken from the edges of the mining tools."*

3. *Oxyd of Cobalt with the Brown Hematite Ore of Chester Ridge, Pa.*, (Proc. Amer. Phil. Soc., Jan., 1846, iv, 239.)—Dr. Boyé exhibited to the Society a specimen of brown hematite ore from Chester Ridge, three-fourths of a mile west of Chester furnace, Huntingdon County, Pa., containing a small quantity of *oxyd of cobalt*,—the surface of the ore is in some places covered with a thin film of oxyd of cobalt. It also contains a moderate proportion of manganese.

The ore was dissolved in chlorohydric acid, the solution neutralized by ammonia, and then the iron precipitated by boiling after previous dilution with water. The oxyd of cobalt which remained in the solution with the manganese, was discovered both by its reaction in the moist way, and by the blue bead it yielded with salt of phosphorus.

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* *Bismuthic Gold.*—In the letter from which the above is extracted, was forwarded to me a few grains, of which the largest weighed only 0·907 gr., of an alloy of bismuth and gold, to which faint traces of mercury were adhering. Concerning their origin, Mr. C. observes, "They were brought to me by a friend, Mr. Willis, under the impression that they might be platinum. They were mixed with the gold of several days work, and I assisted him in picking them out from a parcel that he brought to the bank in this place. They are evidently not grains of platinum."

In structure they are hackly, or sub-fibrous. Hardness = 2·5 . . . 3·0. Gr. = 12·44 . . . 12·9. Color that of palladium. Malleable, but when thinned out under the hammer it becomes brittle. Scarcely acted upon by nitric acid, or by hydrochloric alone; but in the two, slowly dissolves save traces of a heavy white precipitate. Heated before the blowpipe on charcoal, it melts as soon as touched by the flame into a globule which gives off a white smoke, at the same time coloring the support of a bright yellow, while the charcoal remains hot, but turning white, when cold. If allowed to cool, the globule crystallizes beautifully, with a coarsely indented surface, and has its color changed from grayish white to a distinct golden yellow tinge. By continuing the heat, the globule gradually wastes away to less than half its original bulk, crystallizes less distinctly, grows less fusible, and finally it puts on the appearance of pure gold.

The foregoing notice is introduced here in the form of a note, on account of the suspicion entertained that the substance may prove to be only a product of the miner's process of separating his gold by means of amalgamation, instead of being a true mineral production. Dr. Gibbon, the Superintendent of the U. S. Branch Mint at Charlotte, N. C., whose opinion on the subject I solicited, assures me, that bismuth has repeatedly been detected in several of the gold districts of the southern states, and that he thinks the substance in question is probably a natural production. Mr. Clingman also observes in reference to the same point, "It is my opinion that the grains sent to you were in their natural state. I have seen gold coated so as to be blackened by a film of lead supposed to be obtained from the mercury, but it was only superficial and could easily be rubbed off; but the grains sent you were of a steel grey color, and when fractured were seen to have the same color within as externally. Some of them indeed had a color more nearly inclining to yellowish, and yielded slightly before breaking."

4. *Note by M. D'Orbigny on the Orbitolina*, (mentioned by Mr. Lyell, at p. 186, this volume.)

Paris, 18th June, 1847.

To C. Lyell, Esq.

Dear Sir,—I have been long acquainted with the fossil body, which you forwarded to me, and at this moment I am printing in an elementary work, all the mistakes concerning it; it is, in fact, of all genera that perhaps which has been most often misunderstood, and I should call it the greatest culprit in geology. It is a genus nearly allied to *Orbitolina*, and which I have named, in consequence of this analogy, *Orbitoides*. It has always been taken for a nummulite, though it differs from it by the most marked characters. I have known many species such as the *O. media*, *papyracea*, and that which you have forwarded to me, and which I had designated by the name of *Americana*. The *Orbitoides* are found in the cretaceous and tertiary formations, the Nummulina in the tertiary only. Such at least is the result of my numerous investigations on this subject. The species that you have forwarded to me, had been sent me from North America with a great number of tertiary and cretaceous shells; it came to me without any information respecting it, and I am anxious to know where you found it.

Yours, &c. Alcide D'Orbigny.

5. *Observations on the Drift Furrows, Grooves, Scratches, and Polished Surfaces of the Rocks of Lake Superior;* by Forrest Shepherd, (in a letter to Prof. Silliman.)—I have noticed, both on the northern and southern shores of Lake Superior, innumerable longitudinal furrows, grooves, scratches and also smoothly polished surfaces, upon granite, sienite and greenstone. These grooves run generally in a direction north and south, varying occasionally with slight obliquity. When the surface of the lake is quiet, these marks may be seen at a considerable depth beneath the transparent water corresponding with those seen on the same rocks at the present level of the lake. You may thence ascend upwards on the banks and hills, on the islands and shores of the lake, and by removing the moss and vegetation, you will find these marks continue with remarkable uniformity until you reach the summits of the Huron Mountains, which according to the measurement of Capt. Bayfield, are situated eight hundred feet above the present level of the lake. While standing on the summit of these mountains, in some places I found the compact undecomposed feldspar, as smoothly polished as if it had been soft wood recently subjected to the carpenter's plane or drawing knife; while in other places were to be seen marks and furrows as above mentioned. These appearances, which I have described, are all upon rocks in place, and could not, I think, have resulted from natural structure. Nor could they have resulted from causes now in operation on the shores of this great body of fresh water; for there is no perceptible difference between the marks on the same kind of rock at the present level of the lake, and those at a greater height or lower depth. By enumerating the concentric circles of the largest trees (Pinus abies) which are now standing on the shores of the lake, only three or four feet above the surf, and comparing them with the decayed trunks of similar ones whose stumps have been preserved by having been charred by the fire passing over them, it is perfectly

evident that the present level of the lake has not varied materially during the last six or seven hundred years. Such trees may be seen on Portage Lake, Point Keeweenon, and also near the old trading post on the north shore, north of Montreal River. Such a lapse of time or even half its duration, would certainly enable present agencies to render the above marks particularly conspicuous at the present water level. But such does not appear to be the fact.

I would here remark that the main body of the lake never freezes, and that ice only forms along the shore and in the bays. Nor are there any appreciable tides or currents in this lake except those produced by winds, and the unequal pressure of the atmosphere. There are, however, a great many water worn and furrowed boulders with longitudinal marks and scratches, at different heights all along from the summits down to the level of the lake. Among them I have noticed large blocks and boulders of conglomerate lodged on the summit of greenstone ridges high above the conglomerate in situ, showing evidently that the drifting current moved from the north to the south. There are also vast beds of diluvium filled with such boulders, and particularly on the northern shore eastward of the Les Petits Ecrits, repeated terraced banks for miles in length, maintaining a horizontal line with all the regularity of the present shore. These terraces ascend like steps to the height of three or four hundred feet at least whilst receding about two or three miles. There can be no reasonable doubt that the waters have at different successive periods prevailed at these several different heights. The present level of the lake is reported to be six hundred and twenty seven feet above the tide of Hudson's Bay. I presume the drift furrows will be found on all the prominent rocks between these two bodies of water. So far as I had opportunity to examine, I invariably discovered them on the mountains intermediate.

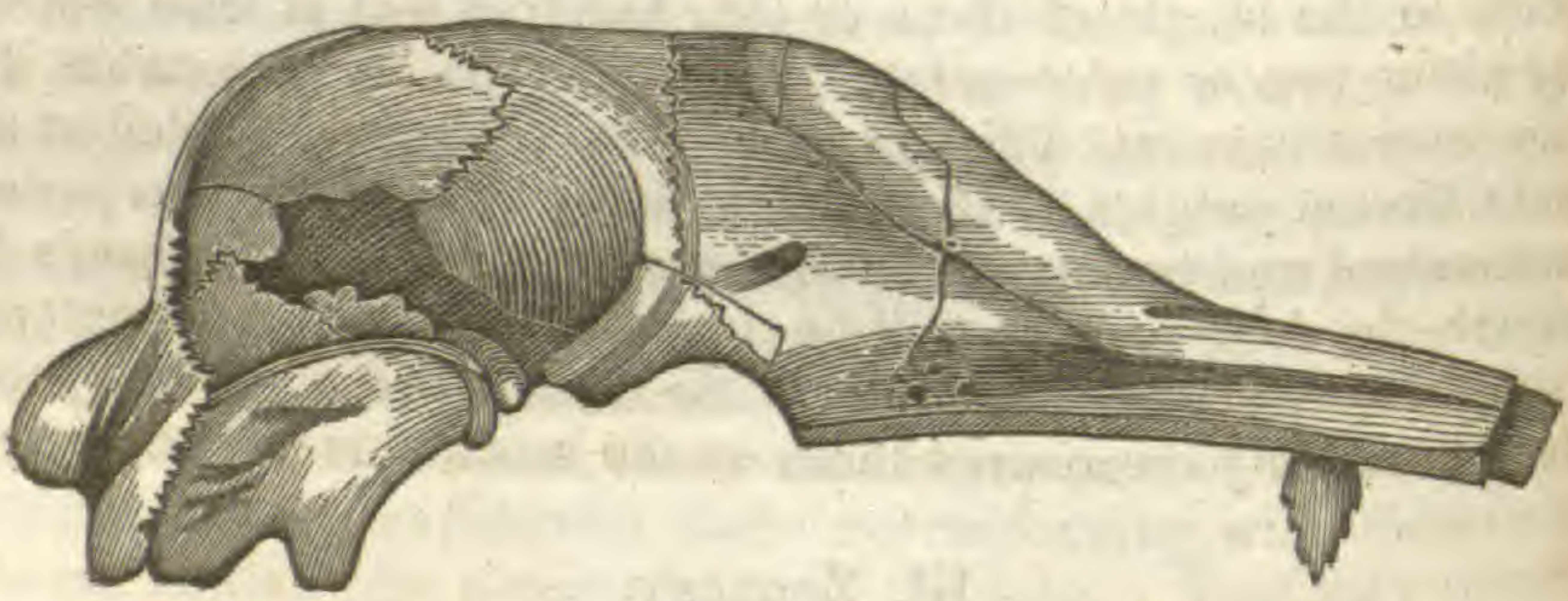
III. ZOOLOGY.

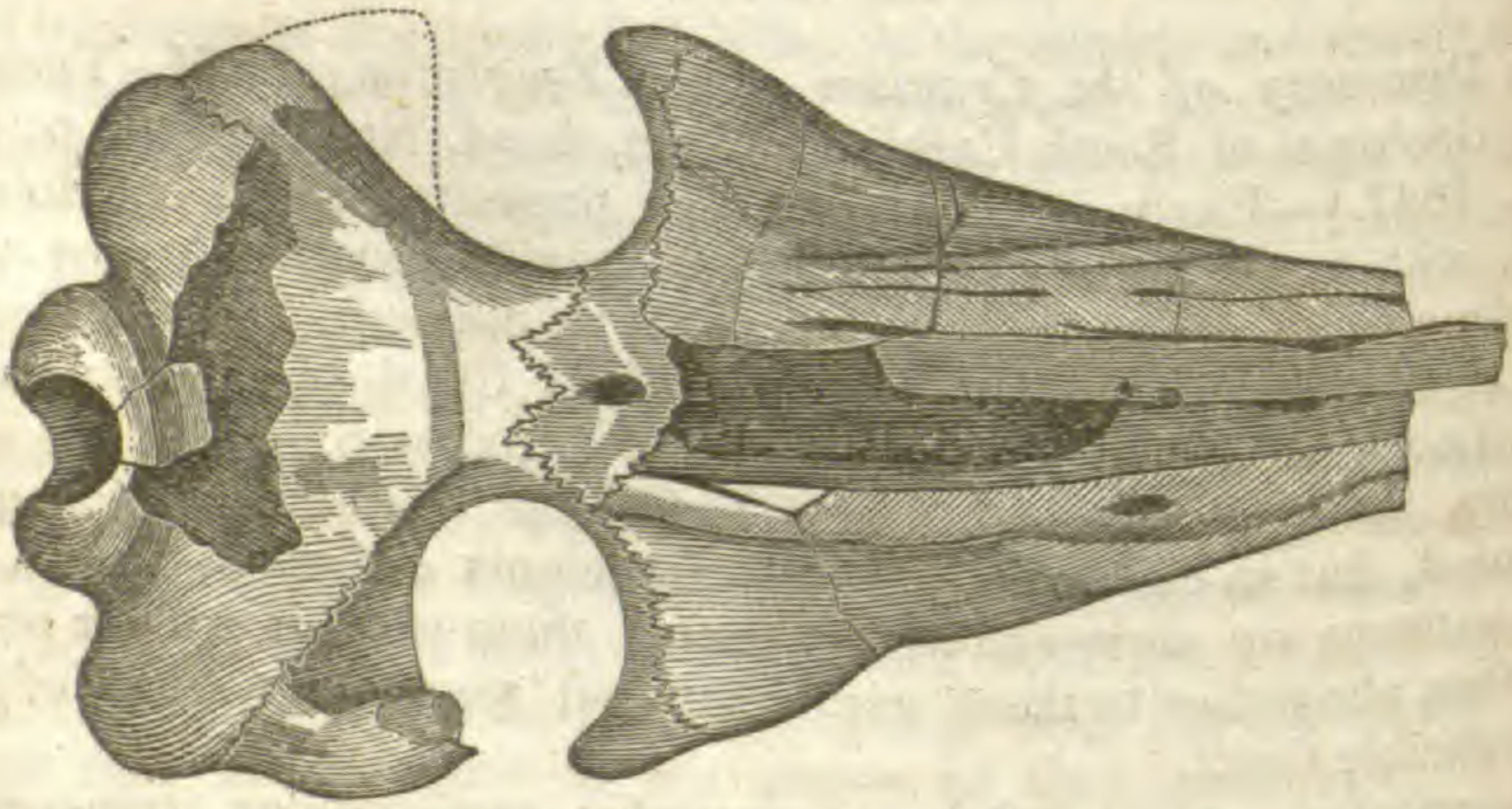
1. *Discovery of the Cranium of the Zeuglodon;* by M. TUOMEY, State Geologist of South Carolina, (Proc. Acad. Nat. Sci., iii, p. 152, Feb., 1847.)—Early in January I was presented by F. S. Holmes, Esq., with a portion of the left upper maxilla, containing one tooth and the alveolæ of several others, which he discovered in the Eocene beds of Ashley river, about ten miles from Charleston. Soon after, Prof. Lewis R. Gibbes, of the College of Charleston, visited the same locality, and had the good fortune to find the rest of the skull, much fractured, but so carefully were the fragments collected, that with a little patience we were enabled to restore them to their proper places. It is then altogether to these gentlemen that we owe the knowledge of this valuable fossil.

Description.—Occipital bone somewhat semicircular, transversely flat or slightly concave, central portion thin; a crest-like ridge surrounds the superior portion terminating in the suture with the temporal bone. Condyles two, articulating surfaces lunate, and almost enclosing the foramen magnum. Foramen magnum oval; transverse diameter 1½ inches, vertical diameter 1 inch; transverse processes thick, spreading, making the breadth of the base of the cranium equal to its diameter across the zygomatic processes; jugular foramen $\frac{1}{2}$ inch in diameter; temporal bones small, mastoid portion thick and strong but not prominent; articulating cavities for condyles of lower maxillæ large, forming about 30° of a circle, inclining inwards and backwards; maxillæ thick and strong, vertical section triangular; a cavity for nerves and vessels runs within at the points of the roots of the teeth; alveolar process thick; palatal bone strong, anteriorly emarginate and horizontal, posteriorly descending below the alveolar process.

Frontal bone and anterior portion of maxillæ wanting; walls of the nasal canal smooth; sutures squamous; in the left maxilla one tooth remains, which is solid, spear-shaped, edges coarsely serrate, exterior side flattened, interior side convex; agreeing in this respect with the position of the teeth in the shark; roots double, nearly parallel, and inserted obliquely backwards; in the right maxilla are the alveolæ for eight teeth with double roots. In the solidity of the teeth and slight divergency of the roots, this specimen agrees with the figures of Dr. Harlan and Prof. Emmons.

This fossil is particularly interesting, as it removes every doubt, if any remain, of the true character of the animal to which it belonged. The double occipital condyle shows it to have been a mammal, while the squamous sutures and a symmetrical form refer it to the Cetacea.





Dimensions.—Length $14\frac{1}{2}$ in.; greatest breadth $7\frac{1}{2}$ in.; height $5\frac{1}{2}$ in.; length of enameled portion of tooth $\frac{7}{8}$ in.; breadth $\frac{5}{8}$ in. It was evidently a young individual.

Geological position.—The teeth described by Dr. Gibbes were found in the oldest of the calcareous beds of the eocene of South Carolina, which contain *Cardita planicosta* and other well-known eocene fossils, together with *Gryphea mutabilis* and *Terebratula Harlani*, which are also common to the cretaceous formation. And the fossil just described was found in upper beds of the eocene; so that the zeuglodon must have existed through the whole of the eocene period; a period which, in South Carolina, was at least sufficiently long for the deposition of three hundred feet of calcareous and sedimentary matter; a fact which was ascertained by boring at Charleston.

2. *The Beaver in Alabama;* by Prof. R. T. BRUMLEY, (from a letter to the editors dated University of Alabama, May 26, 1847.)—DeKay was certainly wrong, as Mr. C. B. Buckley states, in assigning the northern part of New York as the southern limit of the beaver.

Animals of this species are not uncommon in Alabama. They have been seen, recently, in several places; and, in 1838, they were discovered to be constructing a dam, &c. on Mr. Foster's plantation, ten miles south of Tuscaloosa, and west of the river. At that place, they cut down, in one night, a small tree ten inches in diameter, the stump of which, containing beautifully distinct impressions of their teeth, is now in the cabinet of this institution. They have not been disturbed, and may still be found there, though very wild.

There is, in the zoological collection of this institution, a well preserved skin of one, which was obtained in Alabama by Mr. McMillan, in 1831, while he was in the service of the University.

Beaver dams are still visible in several parts of South Carolina, where the animal was often seen in the early history of that state, and where, I believe, it still exists.

3. *Description of a new rapacious Bird in the Museum of the Academy of Natural Sciences of Philadelphia;* by JOHN CASSIN, (Proc. Acad. Nat. Sci. Philad., iii, 199, April, 1847.)—*Cymindis Wilsonii*, Nobis. ♂. Body above entirely dark brown, palest on the head, beneath white; every feather from chin to under tail coverts crossed by several bars of bright rufous chesnut, and these colors extending upwards into a collar around the neck; fourth, fifth and sixth primaries longest and nearly equal, external webs nearly black, internal webs of outer primaries white at base and for nearly half their length, the remaining part reddish inclining to chesnut, every primary (on its inner web) having two irregularly shaped black marks and tipped with black. Tail of the same color as the back but paler, white at base, and crossed by about four broad bars which are nearly black, the second bar from the tip accompanied by a narrow rather indistinct bar of rufous; tip of tail narrowly edged with white. Bill very large, (larger than in any other species of this genus,) yellowish white, inclining to blueish horn color at base.

♀. Body above entirely slate color, palest on the head, beneath barred with the same, the bars having a ferruginous tinge.

Total length of mounted specimen, from tip of bill to end of tail, 17 inches.

Hab. Island of Cuba.

The two specimens here described, were presented to the Academy by its esteemed member, Richard C. Taylor, Esq.

The bill in this species is very large in proportion to the size of the bird, and it agrees, moreover, tolerably well with the *written* description of Falco magnirostris, Gmelin,—so does the young Cymindis uncinatus, Illig. All authors, however, except Dr. Latham, clearly understand the F. magnirostris to be the bird figured in Enl. 464, which is a common South American species of the genus Astur.

Dr. Latham, in his article on F. magnirostris, Gen. His., vol. 1, p. 282, gives a description of a bird suspected by him to be the species intended by Gmelin, which applies very well to Cymindis cayanensis, Gm., in young plumage, but not to C. Wilsonii.

I have named this species in honor of Dr. Thomas B. Wilson, as a slight tribute to his merits as a man, and his munificence as a patron of zoological science.

4. *Chamæa, new genus of Birds allied to Parus;* by Wm. Gambel, (from an article on the Birds observed in Upper California, Proc. Acad. Nat. Sci. Philad., iii, 154, Feb., 1847.)—Bill short, tapering to the point, acute and compressed. Both mandibles entire, ridge of upper elevated, and curving nearly from the base; the depression for the nostrils large, oval and exposed; the nostrils opening beneath a membrane in the depression. Wings very short and much rounded. Tail very long and graduated. Tarsus long.

Chamæa fasciata, Nobis. Ground Tit.

Parus fasciatus, Nobis, Proceed. Acad. Nat. Sci., vol. ii, p. 265.

This interesting bird, placed provisionally among the Titmice, I have now made the type of a new genus, not being able as yet, to find a suitable place for it, among those already described.

For several months before discovering the bird, I chased among the fields of dead mustard stalks, the weedy margins of streams, low thickets and bushy places, a continued, loud, crepitant, grating scold, which I took for that of some species of wren, but at last found to proceed from this wren-tit, if it might so be called. It is always difficult to be seen, and keeps in such places as I have described, close to the ground; eluding pursuit, by diving into the thickest bunches of weeds and tall grass, or tangling bushes, uttering its grating wren-like note whenever an approach is made towards it.

But if quietly watched, it may be seen, when searching for insects, to mount the twigs and dried stalks of grass sideways, jerking its long tail, and keeping it erect like a wren, which, with its short wings, in such a position it so much resembles. At the same time uttering a very slow, monotonous, singing, chickadee note, like *pee pee pee pee peep;* at other times its notes are varied, and a slow whistling, continued *pwit, pwit, pwit, pwit, pwit, pwit*, may be heard. Again, in pleasant weather towards spring, I have heard them answering one another, sitting upon a low twig, and singing in a less solemn strain, not unlike a sparrow, a lively *pit, pit, pit, tr r r r r r r*, but if disturbed, at once resuming their grating scold.

IV. ASTRONOMY.

1. *New Planet.*—On the first day of July, 1847, at $10^h\ 30^m$ P. M., Mr. Hencke, (the discoverer of the planet *Astræa*,) residing at Driesen, in East Prussia, discovered a star of about the ninth magnitude, not marked on the Berlin Star Chart. Its place was 257° 6′ 7″ R. A.,

and S. Dec. 3° 42′ 5″. On the 3d July, at $11^h 45^m$, its place was 256° 40′ R. A. and 3° 51′ 5″ S. Decl. The new star was now in all probability, a planet hitherto unknown. At Berlin, July 5, 1847, at $10^h 48^m 28^s$, M. Encke found its place to be 256° 51′ 34″·5, S. Dec. 4° 8′ 27″·8.

The new planet was observed in London, by Mr. J. R. Hind, July 10th, and at Philadelphia, at the High School Observatory, by Mr. S. C. Walker, on the 4th August. In a notice in the N. Am. and U. S. Gazette, Prof. E. O. Kendall communicates the following elements of the new planet, computed by Mr. Hind, from Encke's observation of July 5, and his own of July 10 and 14, showing that the body belongs to the group between Mars and Jupiter.

Epoch, 1847, July 0.	283°	56′	54″	
Perihelion,	8	17	24·1	m. eqx. July 1.
Ascending node,	137	25	35·1	
Inclination,	15	2	56·1	
Angle of eccentricity,	13	49	20	
Mean distance,	2·5216			
Sidereal period,	4·004 years.			

2. *Neptune, its supposed Ring and Satellite.*—Several European astronomers have pronounced in favor of the existence of a ring around the planet Neptune. Mr. Lassell, of Liverpool, observing with his Newtonian reflector, of two-feet aperture, first announced its existence, in October, 1846; and in January last, Prof. Challis, of Cambridge, using the large Northumberland reflector, was disposed to believe Mr. L.'s assertion. The ratio of the diameter of the ring to that of the planet is about that of 3 to 2. The angle made by the axis of the ring with a parallel of declination, in S. preceding or N. following quarter, is about 65°. Other observers, however, with equal means, cannot detect any such ring.

Mr. Lassell has announced to the London *Times*, his verification of the existence of a satellite of Neptune, suspected last November.

3. *New Comet.*—A telescopic comet was discovered by Mr. G. P. BOND, at the Harvard Observatory, July 14th, 1847. Its place, July 14th, $11^h 45^m$, was $16^h 24^m$ R. A., N. decl. 85° 17′. Seen through the grand refractor, it exhibited a highly condensed central light, surrounded by a diffused nebulous appearance, with a faint tail stretching off in a direction opposite to the sun.

The same comet had previously been discovered by Mr. Mauvais, of Paris, July 4, 1847, its place being at $13^h 36^m 56^s$, R. A. $22^h 8^m 13^s$, and N. decl. 80° 26′.

4. *Vesta*, (from a letter from Prof. Mädler to Lieut. Gilliss, dated Dorpat Observatory, May 25; communicated for this Journal.)—"Vesta being very near to the earth in April and May, I undertook to measure its diameter, and obtained five sets of observations, which give sixty-six miles (fifteen to a degree). I have reduced the measured angles, by correcting them for 0″·3 irradiation, the angle of a fixed star given by the Dorpat refractor."

V. MISCELLANEOUS INTELLIGENCE.

1. *Fall of Meteoric Stones in Iowa;* by CHARLES UPHAM SHEPARD, M.D., Prof. of Chem. in the Med. Coll. of S. Car., and in Amherst College, Mass., (communicated for this Journal.)—The present notice is only for the purpose of announcing a few particulars respecting this last fall of stones in the United States: fuller details of the occurrence, together with a description of the meteorite, will be reserved for a future occasion. The facts here presented are derived from the Rev. REUBEN GAYLORD, of Hartford, Des Moines County, Iowa, who visited the locality at my request, and has collected for me whatever specimens could be procured, by far the greater part having been broken to small fragments, and lost as it is feared to the purposes of science. The fragments forwarded to me by mail, and which are referred to in the following letter, leave no doubt of the genuineness of the production described. They consist of little globules of nickeliferous iron dispersed through the greyish feldspathic mineral, so common in meteoric stones. The fall took place in Linn County, and is well described in the following letter of Mr. GAYLORD.

"Prof. C. U. SHEPARD:—I proceed now to give you the results of my investigation of the facts in relation to the meteor which fell in our state, in respect to which you wrote me some time since. Having learned particulars so far that I had full reason to credit the reports in the case, I repaired to the spot last week, and found the facts to be as follows. On the 25th day of Feb. 1847, at about ten minutes before 3 o'clock in the afternoon, the attention of the people in that region was arrested by a rumbling noise as of distant thunder; then three reports were heard one after another in quick succession, like the blasting of rocks or the firing of a heavy cannon half of a mile distant. These were succeeded by several fainter reports, like the firing of small arms in platoons. Then there was a whizzing sound heard in different directions, as of bullets passing through the air. Two men were standing together where they were at work; they followed with their eye the direction of one of these sounds, and they saw about seventy rods from them the snow fly. They went to the spot. A stone had fallen upon the snow, had bounded twice, the first time as was supposed about eight feet, and the second time about two feet. The stone weighed two pounds and ten ounces. The same persons heard another stone strike as it fell, supposed to be small, but they could not find it. Some time in the spring, another stone was found about one mile and a quarter west from the place where this fell. It was in two pieces lying together, weighing forty-six pounds. Another fragment, a portion of the same rock, was found about half a mile from the former, which from the description I had of it, I judged would weigh about fifty pounds. These were coated with a thin black covering. The principal ingredient in their composition seems to be sandstone. They are full of minute brilliant particles, and occasionally a small lump of some metal is to be found. Enclosed in this sheet I send you three or four small ones. Some were taken out as large nearly as a grain of corn. A man from whom I obtained a fragment insisted that they were silver. He had ground up a considerable portion of the rock to obtain this silver, and he thought he had saved enough to make fifty cents (half a dollar). The above stones are all that have been found, as far as I could learn. The atmosphere at the time of this phenomenon was mostly clear, somewhat hazy, so warm as to cause the snow on the ground to be somewhat soft. The noise was heard distinctly to a distance of fifteen or twenty miles in every direction. At a distance of ten miles in each direction the sound was like the rolling of a heavy waggon passing swiftly over frozen ground. Smoke was seen in the direction from which the sound seemed to proceed. The smoke appeared in two places, apparently about six or eight feet apart, above the elevation of light clouds, and having a circular motion. The motion of the meteoric body was supposed from the reports which were heard, to be towards the southeast, or rather south of east."

Hartford, July 12th, 1847.

2. *Gutta Percha*, (Lond. Jour. Bot., No. lxi, Jan., 1847, p 33.)—This is a vegetable substance, which though only known to Europeans for a few years, is now extensively used in the arts for various pnrposes, as a substitute for caoutchouc, because it has the valuable property of dissolving without being volcanized. But while thus frequently employed, and constituting an important article of commerce, the plant which produces it was unknown, until, by a lucky accident, during the residence of Mr. Thos. Lobb in Singapore, where he has been (and in other Malay islands) employed in a botanical mission by Mr. Veitch of Exeter, he detected this plant and sent home numerous specimens, which prove it to be a new sapotaceous plant, of which a figure and description will shortly appear in this Journal, under the name of *Bassia?* Hook. Accompanying numerous well dried specimens, (though unfortunately without corollas,) Mr. Lobb judiciously sent small sections of the wood, which is peculiarly soft, fibrous and spongy, pale-colored, and traversed by longitudinal receptacles or reservoirs, filled with the gum, forming ebony-black lines.

It appears that a gentleman, Dr. Montgomerie, was the person who first brought the *Gutta Percha* into public notice. He writes thus, in the Magazine of Science, 1845, "I may not claim the actual DISCOVERY of *Gutta Percha*, for though quite unknown to Europeans, a few inhabitants of certain parts of the Malayan forests were acquainted with it. Many, however, of their neighbors, residing in the adjacent native villages, had never heard of it; and the use to which it was applied was very trifling, for I could only ascertain that it was occasionally employed to make handles for *parangs*, (or wood-choppers,) instead of wood or buffalo horn. So long ago as 1822, when I was assistant-surgeon at Singapore, I was told of *Gutta Percha*, in connexion with caoutchouc; and some very fine specimens were brought to me. There are three varieties of this substance, *Gutta Girek*, *Gutta Tuban*, and *Gutta Percha*. I may here mention that the latter name is often erroneously pronounced in England. The *ch* is sounded by the Malayans like those letters in our word *perch* (a fish). And attention to this point is of some importance; for if our countrymen were to ask the natives for *Gutta Perca*, they would probably be told, that such a substance was unknown, while plenty of *Gutta Percha* might be procured by pronouncing the word correctly. The name is pure Malayan; *Gutta* meaning the gum, or concrete juice of the plant, and *Percha* (pronounced Pertcha) the particular tree from which it is obtained. I could not help thinking that the tree itself must exist in Sumatra, and perhaps derive its name from thence, the Malayan name for Sumatra being *Pulo Percha;* but though the Straits of Malacca are situated only one degree to the north of Singapore, I could not find that the substance has ever been heard of there or in Sumatra.

"But to return to the period when I first noticed the *Parang* handle that was made of *Gutta Percha*;—my curiosity being excited by the novelty of the material, I questioned the workman, a Malay woodsman, in whose possession I saw it, and heard that the material of which it was framed could be moulded into any other form, by dipping it into boiling water till it was heated through, when it became plastic as clay, regaining when cold its original hardness and rigidity."

Dr. Montgomerie goes on to say that he purchased the *Parang* handle and sent for more of the substance, and that on instituting experiments, he ascertained that *Gutta Percha* was likely to prove a most valuable material for making those parts of surgical instruments which had hitherto been formed of caoutchouc, the latter having the inconvenience of being easily injured by damp and hot weather in the tropics. The Medical Board of Calcutta highly approved of Dr. M.'s suggestion, and the Society of Arts in London awarded him its gold medal for the discovery.

Illness prevented Dr. M. at that period from visiting the forests where the tree grows. He, however, ascertained from the natives that the *Percha* is one of their largest trees, attaining a diameter of three or four feet, that its wood is of no value as timber, but that a concrete and edible oil, used by the natives with their food, is obtainable from the fruit. In many parts of the island of Singapore and in the forests of Johore, at the extremity of the Malayan peninsula, the tree is found: it was also said to grow at Coti, on the south-eastern coast of Borneo, and Dr. Montgomerie accordingly addressed his enquiries to the celebrated Mr. Brooke, resident at Sarawak, and was assured by that gentleman that it inhabits commonly the woods there also, and is called *Niato* by the people, who are not, however, acquainted with the properties of the sap. The tree is often six feet in diameter at Sarawak, and is believed by Mr. Brooke to be plentiful all over Borneo, and probably on the thousand islands that cluster to the south of the Straits of Singapore. Its frequency is proved by the circumstance that several hundred tons of the *Gutta Percha* have been annually exported from Singapore since 1842, when the substance first came into notice. There is reason, however, to fear that the supply must shortly decrease, and the price be raised, from the wasteful mode in which the natives collect it, often sacrificing a noble tree, of probably from 50 to 100 years growth, for the sake of 20 or 30 lbs. of gum, which is the largest quantity any one trunk ever affords. The juice might, in all likelihood, be obtained from the *Percha*, as from other trees, by tapping, and thus procuring a smaller portion for several successive years; but this process is too slow for the Malayans, and is also the less likely to be adopted because the forests are common property. The people fell the tree, strip off its bark and collect its milky juice in a trough formed of the hollow stem of the plantain leaf, when being exposed to the air, it soon coagulates.

Dr. Montgomerie suggests, among the less immediately obvious uses to which *Gutta Percha* is applicable, that of making raised type for the blind, and embossed maps for the same unfortunate beings: it takes a clear, sharp impression, and is also tough and durable: he thinks it would likewise be found serviceable in stopping decayed teeth.

In the abstract of the new patents, given in the October number of the *Magazine of Science and the Arts*, we notice that C. Hancock, Esq., has taken out a patent for improving the manufacture of *Gutta Percha*. He suggests several methods of purifying the substance, which generally comes home much mixed with extraneous matter:—it may be dissolved by heat and strained; or passed through a screw press; or melted by the addition of rectified oil of turpentine, and after filtering through flannel or felt the solvent may be evaporated. In every case, the *Gutta Percha* should form a residuum, of the consistency of dough or putty, this plastic state being gained by the maintenance of a suitable temperature during the above process.

Mr. Hancock would combine *Gutta Percha* with *Caoutchouc*, and a substance called *Jintawan*, (we have no clue to what this "jintawan" may be,) in order to form an elastic material, impervious to water; varying the proportions according to the greater or less degree of hardness or elasticity required. For making elastic bands, a compound is used, where 50 parts of *Gutta Percha* are combined with 24 of "jintawan," 20 of caoutchouc, and 6 of orpiment or sulphuret. From a mixture of these, Mr. Hancock also prepares a light porous and spongy material, suited for stuffing or forming the seats of chairs, cushions, matrasses, saddles, &c.; likewise, springs of clocks, clasps, belts, garters and string. Wherever the requisite is flexibility and elasticity, then the quantity of *Gutta Percha* should be diminished:—and increased where firmness is wanted. By prolonging the process, much hardness may be acquired, and moulds and balls of *Gutta Percha* will bear turning in the lathe, like wood or ivory. The material is also applicable to useful and ornamental purposes, as picture frames, door-handles, walking-sticks, chessmen, handles of swords and knives, buttons, combs, flutes, &c. &c.

By the admixture of sulphuric acid, or of a tenth or larger part of vegetable wax or tallow, any degree of solubility, pliancy and softness may be acquired: or the composition may be used as varnish, to cover other materials, concealing any odor, and imparting a surface, impervious to water. In printing and painting of silk or cotton, it seems applicable to many uses, for it amalgamates readily with colors; when interposed between two thin sheets of gold leaf or tin foil, it combines them firmly in one.

Numerous are the purposes to which Mr. Hancock proposes applying the *Gutta Percha;* but the above-named may suffice for our readers.

Gutta Percha.—E. Soubeiran; (Journ. de Pharm. et de Chim., Jan., 1847.)—The chemical relations of Gutta Percha are almost identical with those of caoutchouc. Separated from impurities by hot water, and from the accompanying resins by alcohol and ether, the substance was obtained in a state of purity by Soubeiran. Submitted to analysis, it gave carbon 87·8, hydrogen 12·2; while according to Faraday, caoutchouc gave carbon 87·2, hydrogen 12·8.

The action of solvents is also similar with the two substances. Water and alcohol have no effect: ether and most volatile oils produce only imperfect solution. The true solvent is oil of turpentine, which produces a clear and colorless solution, from which the Gutta Percha may be obtained unchanged, by evaporation.

The specific gravity of Gutta Percha is 0·9791, that of caoutchouc being 0·9355.

Prolonged exposure to a temperature of about 300°, produces translucence and a deeper gray color; but hot or cold water gradually restore the primitive appearance.

An application suggests itself to us which we have not as yet seen mentioned. We refer to its use as a substitute for cork and other materials for air-tight closure of chemical vessels, through which tubes, &c. are to be passed. There is no doubt that in the hands of the chemist, this substance will soon become one of his most valuable materials.

3. *Smelting Copper Ore.*—There are establishments for smelting copper at Boston and at Baltimore. At Boston the smelters have long been extensive refiners and manufacturers of copper, and they manufacture the product of their smelting works. At Baltimore the ores have been chiefly obtained from Cuba; at Boston, principally from Cuba and Chili. The Swansea (Welsh) method of smelting, with reveberatory furnaces, both for calcination and reduction, has been adopted, but they use equal parts of anthracite and bituminous coal. At Boston, the German method, with calcination in the open air, and reduction in the small upright blast furnace, with anthracite coal alone, is preferred. In Baltimore they have six or eight furnaces in operation, with an experienced manager from Swansea. In Boston the arrangements are on a much more extended scale. Freights from Cuba to Boston or New-York are much lower than from Cuba to Wales. It is suggested that the best method for smelting would be, as in England, to carry the ores to the coal. What is the nearest place to the mines on Lake Superior, where there are anthracite coal mines? It is estimated that a ton of anthracite coals will reduce two tons of 20 per cent. ore. About $55 are paid per ton, at Boston, for 20 per cent ore; freights from Cuba are over $6, and from Chili $15. We publish at page 276, an account of the process of smelting copper ores by means of electricity—a process which, however, cannot with any propriety be called smelting. It might more properly be called the reduction of copper by the wet method.

4. *On the Formation of Cylindrical Masses of Snow in Orkney.*—(A letter from Charles Clouston, dated Sandwick Manse by Stromness, Feb. 11th, 1847, to Richard Taylor, Esq., published in Lond., Edin. and Dub. Phil. Journ., April, 1847, p. 301.)

The following notice derives an additional interest from the circumstance that a similar phenomenon was described twenty-seven years ago, in this Journal, vol. ii, p. 132, by the late Rev. Daniel A. Clarke, as having occurred in Morris Co., New Jersey, in January, 1808. The author of this notice in describing the circumstances to me in the year 1825, remarked that he was led to consider the phenomenon as one of singular peculiarity, as the description of it by himself had the ill fortune to be treated very frequently with much incredulity. It will be interesting for the reader of the following remarks, to recur to Rev. Mr. Clarke's notice, since what in the one case is a matter of conjecture as to the origin of the cylinders, will be found in the other, to be a subject of direct observation. C. U. SHEPARD.

"A curious phenomenon in this parish has astonished and perplexed all, and filled the superstitious with no small degree of consternation. Since the 6th inst., we have had hail or snow-showers, on the 9th snow-drift, and yesterday a slight thaw with frost again in the evening.

"During the night a heavy fall of snow took place, which covered the plain to the depth of several inches. Upon this pure carpet there rest thousands of large masses of snow which contrast strangely with its smooth surface. A solitary mass may be seen in a field, but in general they occur in patches from one acre to a hundred in extent, while the clusters may be half a mile asunder, and not one mass to be seen in the interval. These fields appear at a distance as if cart-loads of manure had been scattered over them and covered with snow, but on examination the masses are all found to be cylindrical, like hollow fluted rollers or ladies' swan-down muffs, of which the smaller ones remind me, from their lightness and purity, but most of them are of much greater dimensions and weight than any lady would wish to carry, the largest that I measured being three and a half feet long and seven feet in circumference. The weight however is not so great as might be expected from the bulk; so loose is the texture, that one near this house which was brought in and weighed, was found to be only sixty-four lbs., though it measured three feet long and six and a half feet in circumference. The centre is not quite hollow, but in all there is a deep conical cavity at each end, and in many there is a small opening through which one can see, and by placing the head in this cavity in the bright sun, the concentric structure of the cylinder is quite apparent. So far as I am yet informed, they do not occur in any of the adjoining parishes, and they are limited to a space of about five miles long and one broad. They may occupy about 400 acres of this, and I counted 133 cylinders in one acre, but an average of a hundred would, at a rough computation, yield a total of about 40,000.

"Now the question naturally arises, what is the origin of these bodies? I believe the first idea was that they had fallen from the clouds, and portended some direful calamity, and I hear an opinion that one had fallen on a corn-stack and been broken to pieces. It is a pity to bring down such lofty imaginations, and to deprive these cylinders of their high descent, but I prefer truth, when it can be discovered, to the loftiest theory. I must at once, then, set aside the idea that they fell from the atmosphere in their cylindrical form, as the first one I examined satisfied me that its symmetry and loose texture must have been immediately destroyed in coming in rude contact with this earth.

"Farther observation has convinced me that they have been formed by the wind rolling up the snow, as boys form large snow-balls. This is proved by examination of the *bodies themselves;* their round form, concentric structure, and fluted surface all show this mode of formation. Again, it is proved by their *position:* none are found on the weather side of hills or steep eminences, where the wind could not drive them up, nor close to leeward of any wall or perpendicular bank from which they seem to have originated—the nearest well-formed small ones being sixty yards to leeward, and the large ones one hundred yards. All nearer than this are fragments that have not gone on to completion, but broken down in their passage, and the different portions of the wreck form the nuclei of others. Many however are found blown to the windward side of walls or over the lee side of banks. Indeed, they are found almost exclusively on the leeward side of hills and eminences, where both the wind and declivity assisted in rolling them along, or on plains so exposed that the wind alone operated without the declivity.

"I shall only add, that this mode of formation is proved by the *direction* in which these cylinders lie. The wind has been from the north for four days, and I believe that it was so all night, when I am told it blew strong. Now they are all lying with their ends east and west, and their side to the wind; and farther, in some cases, their tracks are still visible in the snow for twenty or thirty yards on the north side, from which they have gathered up their concentric coats; and I understand these were still more evident at an early hour before a snow-shower obliterated them in many places."

5. *Arts and Sciences at Harvard.*—In our last number mention was made of the munificent donation of Mr. Abbott Lawrence of Boston, towards establishing a school of Practical Science at Harvard. On account of the great importance of the plan proposed, and the able manner in which the subject is presented, we republish from the Boston Courier, the letter of Mr. Lawrence accompanying his donation, addressed to the Hon. Samuel A. Eliot, Treasurer of Harvard College.

"*Dear Sir*,—I have more than once conversed with you upon the subject of establishing a school for the purpose of teaching the practical sciences, in this city or neighborhood; and was gratified when I learned from you that the government of Harvard University had determined to establish such a school in Cambridge, and that a Professor had been appointed who is eminent in the science of Chemistry, and who is to be supported on the foundation created by the munificence of the late Count Rumford.

"For several years I have seen and felt the pressing want in our community, (and in fact in the whole country,) of an increased number of men educated in the practical sciences. Elementary education appears to be well provided for in Massachusetts. There is, however, a deficiency in the means for higher education in certain branches of knowledge. For an early classical education we have our schools and colleges. From thence the special schools of Theology, Law, Medicine and Surgery, receive the young men destined to those professions; and those who look to commerce as their employment, pass to the counting house or the ocean. But where can we send those who intend to devote themselves to the practical applications of science? How educate our engineers, our miners, machinists and mechanics? Our country abounds in men of action. Hard hands are ready to work upon hard materials; and where shall sagacious heads be taught to direct those hands?

"Inventive men laboriously reinvent what has been produced before. Ignorant men fight against the laws of nature with a vain energy, and purchase their experience at great cost. Why should not all these start where their predecessors ended, and not where they began? Education can enable them to do so. The application of science to the useful arts has changed, in the last half century, the condition and relations of the world. It seems to me that we have been somewhat neglectful in the cultivation and encouragement of the scientific portion of our national economy.

"Our country is rapidly increasing in population and wealth, and is probably destined in another quarter of a century to contain nearly as many inhabitants as now exist in France and England together.

"We have already in the United States a large body of young men who have received a classical education, many of whom find it difficult to obtain a livelihood in what are termed the learned professions. I believe the time has arrived when we should make an effort to diversify the occupations of our people, and develop more fully their strong mental and physical resources, throughout the Union. We have, perhaps, stronger motives in New England than in any other part of our country, to encourage scientific pursuits, from the fact that we must hereafter look for our main support to the pursuit of commerce, manufactures, and the mechanic arts; to which it becomes our duty, in my humble judgment, to make all the appliances of science within our power. We inherit, and are forced to cultivate a sterile soil; and what nature has denied, should be as far as possible supplied by art. We must make better farmers, through the application of chemical and agricultural science.

"We need, then, a school, not for boys, but for young men whose early education is completed, either in college or elsewhere, and who intend to enter upon an active life as engineers or chemists, or in general, as men of science, applying their attainments to practical purposes; where they may learn what has been done at other times and in other countries; and may acquire habits of investigation and reflection, with an aptitude for observing and describing.

"I have thought that the three great practical branches to which a scientific education is to be applied amongst us, are, 1st, Engineering; 2d, Mining, in its extended sense, including meteorology; 3d, the invention and manufacture of machinery. These must be deemed kindred branches, starting from the same point, depending in many respects on the same principles, and gradually diverging to their more special applications. Mathematics, especially in their application to the construction and combination of machinery, and chemistry, the foundation of knowledge and an all-important study for the mining engineer, and the key to the processes by which the rude ore becomes the tenacious and ductile metal. Geology, mineralogy, and the other sciences, investigating the properties and uses of materials employed in the arts, carpentry, masonry, architecture and drawing, are all studies which should be pursued to a greater or less extent in one or all of these principal divisions.

"To establish such a school as I have endeavored to describe in connection with the University, and under the care and general guidance of its government, requires buildings with suitable lecture-rooms and philosophical apparatus, with models and plans, and a place for their deposit and safe keeping, together with a *Cabinet*, where every description of wood, ores, metals, &c. &c., may be deposited for the use of the students. Without the above appliances the professors would be workmen without tools. The University has already appointed Mr. Horsford, Rumford Professor, who proposes to give instruction upon an enlarged plan in the science of chemistry. I have often heard Professor Horsford spoken of in terms of high commendation, and as in all respects competent to take charge of this important department of science, and to bring out the most favorable results. The testimony rendered at home to Mr. Horsford's capacity has been very agreeable to me, and had satisfied me that the selection made by the government of the college was fortunate ; but I have lately learned in addition to the high character given him by his friends here, that the great practical chemist of the age, (Liebig,) has given his most unqualified testimony to the ability and fidelity of Professor Horsford, who was the pupil of Baron Liebig for two years.

"I deem it of the highest importance, and in fact essential, that none but *first rate* men should occupy the Professors' Chairs in this School. Its success depends upon the characters of the instructors. They should be men of comprehensive views, and acknowledged talents, possessing industry and integrity, with an enthusiastic devotion to the great interests of science. They should love their profession, and work in it day by day. Such teachers will soon gather around them a large number of pupils.

"To carry out this course of education in its practical branches, there should be the most thorough instruction in engineering, geology, chemistry, mineralogy, natural philosophy, and natural history. Chemistry is provided for, and in the last two branches, instruction might perhaps be given by the present College Professors. In addition to these, it would be necessary to obtain the services at stated periods of eminent men from the practical walks of life. The law school is taught by distinguished lawyers of the highest reputation. The medical school by distinguished physicians. In like manner, this school of science should number among its teachers men who have practiced, and are practicing the arts they are called to teach. Let theory be proved by practical results.

"To defray the expenditures, means must be procured for the erection of suitable buildings, (not including dwelling houses) the purchase of apparatus, furniture, &c. &c., and provision must be made for the comfortable support of the professors and other teachers employed. For this purpose, let the students be invited freely from all quarters, at a moderate charge for tuition. Let the numbers be only limited by the size of the lecture-rooms, and I cannot entertain a doubt that a large revenue would be derived from tuition fees. I would suggest three permanent professors, viz : one of chemistry (already appointed), one of engineering in its various branches, and one of geology. The support of the first is for the present provided for. For the other two a moderate fund must be obtained, as a nucleus of a farther sum which should be added to it, to make the capital equal to that of the Rumford Professorship. The professors in this school should depend, to a considerable extent, upon fees : it is the best guaranty to exertion and fidelity, and the permanent prosperity of the institution. I will, therefore, further suggest, that each of the above professors shall receive, after all ordinary expenses shall have been paid, one half of the tuition fees till they amount to a sum annually not exceeding three thousand dollars, including their stated salaries; and that the government of the college pay such sums to other teachers, whether temporary or permanent, as they may deem expedient, and that the other half of the said tuition fees be reserved and added to any fund that may be hereafter contributed to establish and found the two professorships before mentioned.

"I have now, my dear sir, given you a brief and very imperfect sketch of such a school of science as I believe the condition of our extensive and growing country requires, and you will ask how the means are to be obtained to carry out the plan, when we shall soon have an appeal made to our liberality, as well as to the sense of our best interests, to contribute a large sum of money for the purpose of finishing the astronomical department so auspiciously commenced in Cambridge. This department of science has already engaged the public sympathy, and will, I doubt not, be taken up at an early day, and placed in an independent and useful position. I cherish a wish to see the observatory, the telescope, and every instrument required to prosecute the heavenly science, ready for use, and do not intend to interfere with the claims the world has upon our community to accomplish this great and important object. Nor do I mean to occupy the ground of another branch of science that will, I suppose, at a future time, present strong claims upon the public bounty. I allude to natural history now in charge of that accomplished naturalist, Dr. Gray. I wish to see all these branches of science prosecuted with vigor, and moving forward in perfect harmony at Cambridge.

"I therefore propose to offer, through you, for the acceptance of the President and Fellows of Harvard College, the sum of fifty thousand dollars, to be appropriated as I have indicated in the foregoing remarks. The buildings, I have supposed, without having made estimates, could be erected, including an extensive laboratory, for about thirty thousand dollars. If so, there will remain the sum of twenty thousand dollars; and I suggest, that whatever sum may remain, after the erection and furnishing of the buildings, should form the basis of a fund, which, together with one-half of the tuition fees, till the amount shall yield the sum of three thousand dollars annually, shall be equally divided between the professor of engineering and the professor of geology, and be made a permanent foundation for these professorships. The object is, to place the three professors in this school in the same pecuniary situations. I beg to suggest further, that the whole income of this school be devoted to the acquisition, illustration, and dissemination of the practical sciences forever.

"The details, however, and conditions of this donation, may be hereafter arranged between the Corporation and myself. I now leave the whole subject in the hands of the gentlemen composing the Corporation, in the hope and faith that the plan may be adopted, and executed with as much expedition as may be consistent with economy; and that it may prove to be honorable to the University, and useful to the country.

"I pray you, dear sir, to believe I remain, most faithfully, your friend, ABBOTT LAWRENCE."

Boston, June 7, 1847.

6. *On some New Researches in Animal Chemistry*, (extracted from a letter from Professor Liebig to Dr. A. W. Hofmann, Phil. Mag., xxx, 412, June, 1847.)—I am at present occupied with the investigation of the constituents of the animal fluids which are found without the blood and lymphatic vessels. The fluid from flesh, for example, reacts strongly acid, and the question was, whence arose this acidity? After overcoming more difficulties than I have ever experienced in any investigation, I have for the first time indisputably proved that free lactic and phosphoric acid exist in the whole organism wherever muscle is found. How curious, that in the absence of all proofs on the part of the opponents of lactic acid, I should now demonstrate to them its existence in the flesh of oxen, fowls, calves, and sheep, by preparing and analyzing the most beautifully crystallized zinc and lime salts! How wonderful, that in the animal organism, acids and alkalies are found separated by a membrane, constituting myriads of little galvanic circles, which, as such, must produce chemical and electrical effects! To the latter class I refer all the observations of Matteucci, which can now be easily explained.

I have further found that the flesh of the muscles of oxen, fowls, sheep, calves, and the carnivorous pike, contain creatin, prepared by Chevreul eleven years ago, and which, from Berzelius's not being able to reproduce it, has since then, in a measure, disappeared from the field of science. Creatin is a beautiful substance, having the formula $C_8N_3H_{11}O_6$. At the temperature of 100° C. it loses 2 equivs. of water, and becomes $C_8N_3H_9O_4 =$ glycocoll + ammonia or caffein + amidogen and water. Heated in a stream of hydrochloric acid, creatin loses four equivs. of water and takes up one of hydrochloric acid. By this treatment, however, its nature is entirely altered, being now converted into a beautiful organic base, the properties of which are totally different from those of creatin. It becomes now soluble in water, and forms with bichlorid of platinum a fine crystallized double salt.

I have, finally, discovered two other new bodies in the same fluids, of which one crystallizes in needles, the other in plates of the lustre of mother-of-pearl. Unfortunately, I have obtained scarcely sufficient for two analyses from forty lbs. of the flesh of oxen and twenty of that of fowls.

I see a boundless field before me, and doubt not that for every *quality* of the animal body, something which can be estimated *quantitatively*, will also be discovered to which it is indebted for its properties.

I have also satisfied myself as to the part which common salt plays in the bodies of animals. I have found that the fluids without the blood and lymphatic vessels contain only potash-salts, viz. chlorid of potassium and phosphate of potash, with phosphate of magnesia, whilst the blood and lymph contain merely those of soda, (phosphate of soda.) If, therefore, the latter are indispensable to the formation of blood and the processes of life, it is evident that an animal on the continent, which finds in plants only potash-salts, should have chlorid of sodium given to it, by means of which the phosphate of potash of the seeds and the rest of the plant is transformed into chlorid of potassium and phosphate of soda. I found further that the salt brine which flows from salted meat contained certainly alkaline phosphates, and that scurvy is hence easily explained by the deficiency in the salted meat of the alkaline phosphates necessary to the formation of blood. The soup from boiled meat contains the soluble phosphates of the flesh, and the meat itself the insoluble. Neither the soup nor the flesh alone can maintain the processes of life, but both must be taken together. The English have in this respect hit upon the proper practice. In a theoretical point of view their food is more correctly combined than that of the Germans.

Still more wonderful results have been obtained by the oxydation of casein by means of peroxyd of manganese and sulphuric acid, by M. Gugelberger. Three products are obtained : the first of which is aldehyde, the second oil of bitter almonds, and the third a fluid ethereal body with a composition similar to metacetone. The aldehyde was analyzed as aldehydite of ammonia, of which a considerable quantity was obtained. From oil of bitter almonds the most beautiful benzoic acid was produced by the action of chlorine.

From these results a sort of conception may be obtained how and wherefore many medicines have a certain deleterious or useful action.

Urea, creatin, glycocoll, leucin, cystin, &c., are organic bases, and only products of the animal body or its elements, and organic bases are partly poisonous, partly beneficial in their action. I have caused the new experiments of Mulder on his protein to be repeated. The substance prepared by Fleitmann in this laboratory, according to his new method, and supposed to be free from sulphur, still contains 1·5 per cent., as does likewise a similar preparation by Laskowski.

7. *Palæontographical Society of London.*—The Palæontographical Society has been instituted the present year, and as organized, Sir Henry T. De La Beche, is President, and Prof. Bell, Prof. Forbes, Charles Lyell, Esq., Prof. J. Phillips, and other men of distinction are the Council.

From the Prospectus we observe that it is the object of the Society to figure and describe as complete a stratigraphical series of British fossils as can be accomplished, including both the published and the unpublished species. It is proposed that the work shall be quarto, and that each plate shall, on the average, contain about twenty figures, illustrating half as many species, or more, according to circumstances. The work will be produced in the form of monographs, by various authors. As a commencement of the series, the whole of the British tertiary fossils are in course of being described and figured, under the superintendence of Mr. Searles Wood, Mr. F. E. Edwards, Mr. Flower, Mr. Smith, of Jordan Hill, and other gentlemen of well known geological experience. No precise order of publication will be adhered to, but it is proposed that monographs of portions of the secondary series shall also be produced as early as the nature of such undertakings will permit. The copper-plates are being executed by the Messrs. Sowerby, and other artists of eminence in this department of engraving.

Calculations have been carefully made, which show, that if 1000 members be acquired, and 1250 copies be printed, sixty plates and letter-press may be given annually to each member for his subscription of £1 1*s*.

8. OBITUARY.—*Ithamar B. Crawe*, M.D., of Watertown, was *drowned* in Perch Lake, Jefferson Co., N. Y., June 2, 1847. Suddenly called from life, he was deeply lamented by the public and affectionately mourned by his particular friends. He fell a sacrifice to his ardor in the pursuits of natural history. In the study of geology, mineralogy and botany, he had long been successfully engaged, and had accumulated a rich treasure of specimens in these departments, while he had made himself by his own discoveries and by exchanges, the friend of many of the naturalists of our country and of Europe. He was returning from a successful botanical excursion in a *leaky* boat, which sunk; and thus was closed his valuable life, when he had nearly attained the age of fifty-four years. A wife and three children receive the cordial sympathies of numerous friends over the land.

Dr. Crawe was born in the state of Connecticut, and was descended from one of the Pilgrim fathers of Plymouth rock. His father was a soldier in our revolution, a man of sterling integrity and firmness. The son inherited these manly virtues, and distinguished himself in his profession and pursuits. At the close of his medical studies, he received his diploma from the hand of Dr. Mott. He settled in Watertown soon after his graduation, and, having made it his residence most of the time since, he had endeared himself to a wide circle of his fellow citizens, who have given public evidence of their high estimation of his worth and attainments in his profession and in those studies to which he gave the strong powers of his mind. To that part of the state his loss is a source of public sorrow; to us all deeply afflictive. C. D.

Rochester, N. Y., June, 1847.

VI. BIBLIOGRAPHY.

1. I. *Geology: Introductory, Descriptive, and Practical.* II. *The Ancient World, or Picturesque Sketches of Creation.* By D. T. ANSTED, M.A., F.R.S., F.G.S., Professor of Geology in Spring's College, London, &c. &c.

The geological works of Prof. Ansted have been for some years before the world. The Geology was published in 1844, in two beautiful 8vo volumes, of more than 1000 pages. It is divided into three parts.—I. Introductory. II. Descriptive Geology. III. Practical Geology.

I. The Introduction, in four chapters, explains the object of the work, the action of present causes, the classes of rocks and the powers concerned in their production, the nature and value of fossils and of Palæontology, and of the results which it affords.

II. The Second Part, in forty-eight chapters, describes, I. The fossiliferous or stratified rocks—under the heads of the older and the newer Palæozoic period. The secondary period. The Tertiary period. II. The description of crystalline and unstratified rocks.

III. The Third Part, in seventeen chapters, describes Practical Geology, with its applications to mining, engineering, architecture, agriculture, &c.

The practical geology occupies more than half of the second volume.

These volumes are illustrated in all, by three hundred and sixty-seven figures. The illustrations are all done on wood, and being executed with great skill and carefully copied upon the printed page of the most beautiful paper, they are at once effective for instruction and highly ornamental.

This work contains a lucid and judicious summary of the facts of the science, with cautious indulgence in theory. We perused it soon after it appeared, and with much instruction and pleasure: nor have we remained silent regarding it from any want of a just appreciation of its merits. We have not observed Prof. Ansted often among the active explorers of geology with whom Great Britain abounds; but he has proved himself to be a very diligent student of the science, and one of its attractive and successful historians. His learned and elegant work we can therefore recommend to the student of geology as an important addition to his library. It is worthy of a much fuller review and analysis; but as much time has elapsed since its appearance, and it has been extensively noticed in other journals, we now hasten to his very recent work,

II. *The Ancient World*, named at the head of this article. The first thing that struck us a month since, on the opening of the package from London, was, that a volume had actually dropped down upon us from the ancient world, and that it is quite a mistake that the art of printing is only four hundred years old.

In strict keeping with its subject, the covering and external adornments of the volume are in a style of ultra antiquity, while its interior presents fine paper, the best typography, and finished illustrations in one hundred and forty-seven wood-cuts, besides two vignettes—one of which is a restoration of the vegetation of the cold period as it existed at that era in England.

The volume is in the form of a large duodecimo of more than four hundred pages. It is divided under three periods:

The First, or Ancient Epoch; the Second, or Middle Epoch; and the Third, or Modern Epoch.

There are in all sixteen chapters; and (1.) an Introductory chapter unfolds the general structure and physical laws of the planet.

Under the first epoch the principal subjects are presented in the following order:

2. The period of the præzoic, or non-fossiliferous or primary rocks.
3. That of the invertebratæ and Silurian rocks.
4. Early fishes and Devonian rocks, or the old red sandstone.
5. Earliest terrestrial plants and the era of coal.
6. The magnesian limestone, or Permian system.

Under the second epoch:

7. The new red sandstone, or Triassic system.
8. Lias and marine reptiles.
9. Wealden and land reptiles, and flying reptiles, &c.
10. The Cretaceous period, with its animals.
11. General considerations on the secondary epoch and its termination.

Under the third epoch:

12. The introduction of land animals, and the early tertiary.

13. Europe, between the early tertiary and the historic period.
14. India, Australia, and New Zealand, during the tertiary period.
15. South America in the same era.
16. General results of geological investigations.

If then our readers are disposed to enquire for the *cui bono?* of the present work, the answer shall be given by the author himself in his Preface, which has the rare excellency of brevity as well as truth and candor. "The object of this work is to communicate, in a simple form, to the general reader, the chief results of Geological Investigation. No detailed account of particular districts, no minute statements with regard to peculiarities of structure, exhibited in various formations, or in their fossil contents, must therefore be expected; and on the other hand, the reader will be spared as far as possible, the mere technicalities of the science, while being informed of the views deduced from the study of them. The author hopes that if in thus endeavoring to communicate definite ideas concerning the ancient history of the earth and its inhabitants, he shall be found not to express with perfect accuracy, the whole amount of what is known in any department of geological science, his attempt may yet be viewed favorably, as a fair sketch of such history, at least in its broad outlines."

An attentive perusal of Prof. Ansted's work, satisfies us that he has ably fulfilled his own views. He has produced an attractive and valuable volume, in which he has posted up the most recent discoveries, and presented also some peculiar views of his own, differing in some respects from those generally received.

2. *Natural Philosophy for the use of Schools and Academies, illustrated by numerous Examples and appropriate Diagrams;* by HAMILTON L. SMITH, A.M. Cleveland, Ohio, 1847. 12mo, pp. 352.

This is a very meritorious production, marked by sagacity and sound science. Designed for the purposes of elementary instruction, it claims no other merit than that of a successful inculcation of the established principles of natural philosophy: and this merit it possesses. The author has a happy faculty of presenting his subject in an attractive and lucid form, and the method of the book is very well suited to the object in view. He is obviously familiar with the present state of his science, and teaches only a selection of his knowledge. Only one who is thoroughly acquainted with a science, is able to write a useful elementary work upon it. No notion is more absurd, than that one who knows little of a subject is fit to write books for those who know nothing. Such is not our present author.

3. *Hints to Young Architects, calculated to facilitate their Practical Operations;* by GEORGE NIGHTWICK: and with Additional Notes to persons about building in the Country; by A. J. DOWNING. New York and London. Wiley & Putnam: 1847. 8vo, pp. 157.

Mr. Downing has established so desirable a reputation in all that relates to rural life and domestic architecture, that his works have become standards not only in this country, but in Europe also. The object of the present work is purely practical, and it contains much useful information and specific detail of construction for those about to build. The American editor has added among other things a well written introductory chapter, entitled, "When to build, what to build, and how to build," which unfolds in an attractive form, the principles of good taste and good sense involved in these considerations. The book will be well appreciated by all who are about to indulge their architectural taste, as well as by professional architects.

P. H. Gosse: The Birds of Jamaica. Post. 8vo. *London*, 1847. 10*s.*

D. T. Ansted: The Ancient World, or Picturesque Sketches of Creation; Post. 8vo, with 149 illustrations. *London*, 1847. 12*s.*

Taylor's Scientific Memoirs. Part 17. Containing Schmidt's Contributions to the Comparative Physiology of the invertebrata, being a Physiologico-chemical investigation; Fresnel on the colors produced in homogeneous fluids by polarized light; Jamin on Metallic Reflection; Dove's Researches on the Electricity of Induction.

Transactions of the Entomological Society of London, 4th part of 4th volume. 5*s.* The 5th part, completing the volume, will shortly appear.

Report of the Sixteenth Meeting of the British Association, London. 15*s.*

Catalogue of 47390 stars for the beginning of the year 1800, from the observations of Lalande in the Histoire Celeste; reduced at the expense of the British Association for the Advancement of Science, under the immediate superintendence of the late Francis Bailey, Esq. *London*, 1847.

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G. Johnston, M.D.: History of British Zoophytes. 2d ed. *London*, 1847, 8vo, 2*l.* 2*s.*; or large paper, royal 8vo. 4*l.* 4*s.*

H. C. Watson: Cybele Brittanica; or British Plants and their Geographical Relations. 8vo. *London*, 1847.

G. Munby: Flore de l'Algérie. pp. 120, 6 pl. *Paris*, 1847.

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Proc. Amer. Philosophical Society, Philadelphia, iv, No. 38. *April, May* and *June*, 1847.—p. 327. On the reproduction of the Didelphis virginiana; *C. D. Meigs.*—pp. 332, 339. On the planet Neptune and its identity with the Lalande star; *S. C. Walker.*

Proc. Acad. Nat. Sci. of Philadelphia, iii, No. 9. *May* and *June*, 1847.—p. 210. Numerous minute crystals in the cellular structure of several species of Parmelia, supposed to be oxalate of lime; *J. Leidy.*—p. 212. Remarks on an aboriginal cranium from the Western Mounds; *S. G. Morton.*—p. 216. Hydrarchus of Dr. Koch acknowledged by Prof. Müller of Berlin to be the Basilosaurus of Harlan and Zeuglodon of Owen.—A cutaneous gland near the root of the tail of the Fox emitting an agreeable odor, detected by Prof. Retzius, and considered by him characteristic of the genus Vulpes.—p. 220. Distoma Helicis, a new Entozoon from a Helix; *J. Leidy.*—p. 221. Observations on a Mexican Quail, the Ortyx squamata; *J. W. Abert.*

Proc. Boston Society of Nat. History, *March, April*, 1847.—pp. 210, 214, 222. Descriptions of Shells of the Exploring Expedition, (genera Ancylus, Dombeya, Limnea, Planorbis, Physa, Melania); *A. A. Gould.*—p. 217. Observations on some analyses of snow.—p. 218.—*Dr. C. T. Jackson* exhibited beautiful crystals in cinders from the copper works at Point Shirley, which proved on analysis to be a bisulphate of Copper and Zinc.—Dr. Jackson described an interesting experiment of Mr. Blake at the gas-works, as follows:—" He placed a mass of compact feldspar in a crucible, hermetically sealed, in a furnace flue at the gas-works, where it was exposed for 108 hours to a uniform temperature considerably below the degree necessary for the fusion of the mineral. On being taken out, it was found to be perfectly limpid, and as transparent as quartz: showing that long continued heat, though not to a degree sufficient to melt the mineral, produces effects similar to those resulting from fusion."—p. 218. New shells from Burmah (Gen. Melania, Neritina, Nerita, Nematura, Unio); *A. A. Gould.*

ANN. AND MAG. OF NAT. HISTORY, *Vol.* xix, *No.* 127, *May*, 1847. Formation of Flints; *J. T. Smith.*—British shells; *J. G. Jeffreys.*—On the Genus of Insects *Omias*, with descriptions of new species; *J. Walton.*—Development of the Lycopodiaceæ; *K. Müller.*—Silurian rocks in Cornwall; *R. I. Murchison.*—Invertebrata of the coast of Northumberland and Durham; *W. King.* LINNÆAN SOCIETY: *D. Hooker* on the vegetation of the Galapagos; *G. B. Sowerby*, on a new Cowry; *G. Newport*, Anatomy, &c. of Meloë. ZOOLOGICAL SOCIETY: *J. Gould*, on new Australian Birds.—*J. E. Gray* on a new rat from South Australia; *G. R. Gray*, on new genera of Certhinæ.

No. 128, *June*, 1847. On Chelura terebrans, an amphipodous crustacea; *G. J. Allman.*—Ornithological Notes; *J. Blackwall.*—New British Coleoptera; *J. Hardy.*—New Labyrinthi-bronchial fish from Quellimane; *W. Peters.*—New Lepidoptera; *E. Doubleday.*—A species of Pelagia in the British Seas.—New Chalcidites from N. America; *F. Walker.*—Two new genera of shells; *Philippi.*—ZOOLOG. Soc. *J. Gould's* arrangement of Trochilidæ, with descriptions of some new species; *J. E. Gray*, on six new genera of Bats; *A. Adams*, on certain molluscous animals; *L. Reeve*, new shells from the Eastern Archipelago; *T. Bridges* on S. American Ornithology; *A. D. Bartlett* on a new Fuligula.

No. 129, *July*, 1847. Development of the Ophiuridæ and Echinidæ; *J. Müller.* New species of insects of the genus Otiorhynchus; *J. Walton.*—LINNÆAN SOCIETY: *Dr. Falconer*, on Gamoplexis, a new genus of Orchideous plants; *L. Reeve*, on the structure, &c., of Chiton and Chitonellus; *W. Griffith* on the impregnation of Dischidia; *Dr. Arnott* on Samara læta, L.; *G. Newport* on Cryptophagus cellaris.—ZOOL. Soc. *J. Gould*, on eight new Australian Birds; *J. E. Gray*, on a new Amphioxus from Borneo; *W. Denny*, on the Geographical Distribution of Birds in the W. Indies; *J. E. Gray*, on the skull of Phascolomys vombatus.

Vol. xx, *No.* 130, *July*, 1847. New genus and species of Entomostraca; *G. J. Allman.*—On conjugation in the Diatomaceæ; *G. H. K. Thwaites.*—Canada Plants; *P. W. Maclagan.*—Two Asiatic species of Carabus; *T. Tatum.*—Notices of British Shells; *J. G. Jeffreys.*—New Chalcidites of N. America; *F. Walker.*—Plants of Iceland; *C. C. Babington.*—On the power of the living plant to restrain the evaporation of the cell sap; *H. v. Mohl.*—On the relative duration of the power to germinate in seeds belonging to different families; *A. DeCandolle.*—New genus and species of Tracheary Arachnidans; *G. J. Allman.*—ZOOL. SOC.: Notices of rare birds of N. Zealand and Australia; *W. Yarrel*, on the Eggs of some of the birds of Chili; *J. E. Gray*, on a new genus of Emydæ; *A. White*, on new Crustacea from the Eastern Seas; *E. Doubleday*, on new Lepidoptera; *G. R. Gray*, on Strigops habroptilus; *J. E. Gray*, on the genera of the family Chitonidæ.

ARCHIV FÜR NATURGESCHICHTE. *Fünftes Heft*, 1846.—On the Acanthocercus rigidus, a new Entomostraca of the group Cladocera; *J. E. Schödler.*—General review of Works and Memoirs on Insects, Spiders and Crustacea, for the year 1845; *W. F. Erichson.*

Erstes Heft, 1847. On the organ of the Sepia having the function of the kidney; *E. Harless.*—Zur Lehre von der Furchungen; *A Kölliker.*—On the Sepiola vulgaris; *R. Leuckart.*—On Tiedmannia, Octopodoteuthis and Alciopa; *A. Krohn.*—On the family Ecpleopoda; *J. J. v. Tschudi.*—Two new genera of shells, Dibaphus and Amphichæna, with remarks on Cyamium, Ervilia and Entodesma; *R. A. Philippi.*—Peruvian Coleoptera; *G. F. Erichson.*

ASSOCIATION OF AMERICAN GEOLOGISTS AND NATURALISTS.

THE 9th Annual Meeting of this Association, will be held pursuant of adjournment, at Boston, during the week commencing September 20th.

A large and interesting meeting is expected.

ERRATA AND ALTERATIONS.

P. 28, l. 16 from top, for "one hundred and twenty," *read* "twenty."
P. 93, l. 2 from bottom, for "practical relation," *read* "particular reaction."
P. 95, l. 17 from top, insert "the" before "action."
P. 96, l. 2 " " read first formula "O" for "O_2."
P. 96, l. 28 " " for "these," *read* "their."
P. 97, l. 15 from bottom, for "CH_2O," *read* "CH_4O."
P. 99, Note, l. 2 from bottom, for "copsic" *read* "capric."
P. 100, l. 9 from top, for "formics," *read* "formic."
P. 177, l. 7 " " " ("$2+0)-0=1$," *read* "$2+0-1=1$."
P. 177, l. 13 " " " "acids are often found," *read* "acid are often formed."
P. 177, l. 17 " " " "heat," *read* "treat."
P. 177, l. 2 from bottom, for "$C_6(NHO_2)_3=O$," *read* $C_6(NHO_2)3O$.
P. 180, l. 5 from top, for "hydride," *read* "anhydride."
P. 180, l. 6 " " insert "the" before "anhydride."
P. 181, l. 8 " " insert "an" before "amide."
P. 181, l. 14 " " insert O_2 after H_2.
P. 181, l. 18 " " for "sulphamephylane," *read* "sulphamethylane."
P. 181, l. 18 from bottom, after similarity, *insert* "a."
P. 182, l. 1, after derivatives, *insert* "of."
P. 182, l. 10 from top, insert "this" before "ether."
P. 184, *dele from* "Urea" *in 4th line to* "artificially" *in the 6th.*
P. 184, l. 10 from top, for "acesenic," *read* "arsenic."
P. 184, l. 13 " " " "chlorainline" and "bichlorainline," *read* "chloraniline" and "bichloraniline."

The next No. of this Journal will be published on the first of Nov.

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SCIENTIFIC INTELLIGENCE.

(*For remainder of Contents, see third page of cover.*)

Am. Journal Med. Science
to Isaac Hayes. M.D.

VOL. IV. NOVEMBER, 1847. No. 12.

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No. 12.—NOVEMBER, 1847.

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The American Journal of Science, Second Series, which was commenced in January, 1846, is published on the 1st of January, March, May, July, September, and November, of each year, in Nos. of 152 pages each, making Two Volumes a year, fully illustrated by Engravings, and containing a comprehensive bulletin of Scientific Intelligence. Subscriptions $5 per year. Remittances should be forwarded to B. Silliman, New Haven, Conn.

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November, 1847. [3tp]

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[SECOND SERIES.]

ART. XXII.—*A brief Notice of the Life, Researches, and Discoveries of Friedrich Wilhelm Bessel;* by Sir J. F. W. HERSCHEL.*

FRIEDRICH WILHELM BESSEL was born at Minden, July 22, 1784. His father held an office of local administration under the Prussian government (Justiz-Rath). His mother was the daughter of a clergyman, Schrader by name, at Rehme. Being one of a family of nine children, his education, though not neglected, was in no respect calculated to fit him for his future distinguished career. It is said that he showed an early disinclination for the elements of classical literature; most probably from the repulsive form in which they are usually administered to children. Be that as it may, he manifested a decided preference for, and early expertness in, arithmetic; which his father perceiving, placed him, at the age of fifteen, as an apprenticed clerk in a considerable commercial house at Bremen, (Kuhlenkamp and Sons.)

A boyish story is told of his grinding a glass with emery in a saucer, and remarking, with delight, that it in some degree concentrated the rays of the sun; perhaps in rude imitation of some process he had read of, or been told. A more decidedly characteristic anecdote is recorded, of his having in his thirteenth year, remarked, while comparing the constellations in the heavens with their representation on a planisphere, that *ε Lyræ*, marked as one

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[*] Extracted from the Annual Report of the Royal Astronomical Society, London, 1847.

star in the chart, consists of two, which his eye was sharp enough to distinguish separately, though at so small an interval as 3′ 32″. This must certainly be regarded as an uncommon proof, not only of acute vision, but of close and careful attention in a boy so young, and as manifesting that capacity for becoming earnestly interested in a subject to which the natural faculties of the mind are best adapted, which is all that can be understood by an early bent of genius.

Earnest attention and zealous occupation with the business before him, of whatever nature, seems, however, to have been a primary feature of his character. In his new situation he speedily mastered, not merely the routine of his own subordinate position, but gained a thorough insight into the general nature of the business of his firm; and, entering into all his duties with uncommon diligence, rapidly acquired the approbation and confidence of his employers; leading him to hope that the more responsible situation of supercargo, in a voyage to the French and Spanish colonies and China, might be offered to him. To prepare himself for this great object of his ambition, he commenced the study of the French and Spanish languages, and of navigation, taking for his guide in that branch, the old work of Hamilton Moore. The rules and processes of nautical reckoning delivered in that work as precepts, without their theoretical grounds, induced him to seek the latter elsewhere. He procured a popular treatise on astronomy. This directed him in the right course; and proceeding from book to book, and mastering their difficulties as best he might, he found at length an effectual bar to further progress in his entire unacquaintance with mathematics. He immediately entered on a course of mathematical reading, and now we hear no more of commercial projects, or of the voyage he had so ardently desired. Every leisure hour (and they were chiefly in the night) was devoted to astronomical and mathematical reading. Practice was also combined with theory. By the aid of a rude wooden sextant, which he got constructed by a carpenter, and a common clock, he began to make observations for time; and great was his joy when the occultation of a considerable star by the moon, which he was fortunate enough to observe, gave him the longitude of Bremen with considerable approximation. The rapidity of his progress from this time was truly astonishing. Trains of original research and learned inquiry opened out before him at an age when the generality of students, under the most favorable circumstances, hardly advance beyond the elements of science. Already in his twentieth year, he had executed the reduction of Harriott's and Torporley's observations of the comet of 1607, which has become so celebrated by the great discovery of its periodical return by Halley. These observations had been but recently rescued from oblivion by Baron Zach, in his search among Harriott's papers, in the possession of the Earl of Egremont; and, being the first observations of this remarkable body made with any kind of instrumental aid, their reduction was an object of undeniable importance. This task Bessel executed in so masterly a manner, as to call forth the warmest eulogies from Olbers to whom he communicated them, and to excite the strongest desire in him to secure for astronomy one whose future eminence in that science he clearly foresaw, and in no sparing or measured terms predicted. This performance, his first public work, appeared in Zach's *Monathliche Correspondenz*, and was immediately followed by a theoretical memoir, of great importance, "On the calculation of the true anomaly in orbits nearly parabolic." So expert had he become in cometic calculations, that Olbers, having placed in his hands, on the night of the 1st of November, 1805, four observations of the comet of that year, he returned them to him the next morning, with the elements, whose calculation had occupied him only four hours.

His seven years' engagement with Messrs. Kuhlenkamp was now terminated; but, instead of entering on the mercantile world on his own account, we find him placed forthwith, at the recommendation of Olbers, as assistant to Schröter, at Lilienthal, and successor to Harding. Astronomy thus became his profession; he gave himself wholly to it, with an energy and success which very speedily placed him in the first rank of its cultivators.

The instruments of Schröter were better adapted for physical examination than for precise astronomical determinations. Among the more especial objects to which his attention, *as an observer*, was there directed, may be mentioned a series of micrometrical measures of the distances of the sixth, or Huygenian, satellite of *Saturn* from the ring, made with a Newtonian reflector by the aid of the projection micrometer, with a view to the better determination of the mass of *Saturn* and of its ring, by means of the perturbations caused thereby in the satellite's motions. This work, so begun, was never subsequently lost sight of. It forms the subject of several elaborate memoirs, the first of which appeared in the *Königsberger Archiv für Naturwissenschaften*, No. 2, in which all the observed conjunctions and oppositions of the satellite, and all the recorded disappearances of the ring, are subjected to a rigorous and systematic calculation; the position of the ring itself normally determined, together with elements of the orbit of the satellite in question, and even the perturbations of its motion by the attraction of the ring and by the sun are made objects of minute inquiry. The subject was resumed as observations accumulated, especially those made with the celebrated heliometer of Fraunhofer, in three admirable papers, Nos. 193–5, No. 214, and No. 242 of the *Astronomische Nachrichten*. At Lilienthal, also, were made his observations of the comet of

1807, the investigation of whose elements, taking into account its perturbations, was published in 1810, and gained him the prize founded by Lalande, from the Institute of Paris.

In 1810, he removed from Lilienthal to Königsberg, being appointed to the direction of the observatory about to be established there by the King of Prussia, and whose construction and provision with instruments he was called on to superintend. This observatory will ever remain a monument to his glory, no less than to the munificence of the sovereign, who, amidst the alarms of war and the desolation of his country, still mindful of science, ordained its institution. The building was completed and the observations commenced in 1813, from which time to the conclusion of his life, an uninterrupted series of the most valuable and important observations continued to emanate from it. Soon after his appointment to this situation, (in which, besides the duties of an observer, he had also those of a professor in Königsberg University to fulfill, by giving a course of lectures on astronomy and mathematics,) he married the daughter of Professor Hagen, by whom he had one son and two daughters. The death of the former, however, in 1841, a fine and talented young man, who already, at an early age, gave the promise of eminent distinction in astronomy, proved to him a most severe trial; which, however, he bore with resignation, taking refuge from his grief in increased exertions. These brought on, or at least exasperated, an internal complaint, arising, in the opinion of his physicians, afterwards verified on actual examination, from the abnormal and fungous growth of some intestinal organ, under which, after much protracted suffering, he at length succumbed, and expired on the 7th of March, 1846, in the 62d year of his age.

An extensive and minute account of the labors of this illustrious astronomer cannot be expected in a notice of this nature: all that can be done is to touch, and that briefly, on some of the principal among them.

Of his early and successful devotion to the improvement of our knowledge of comets, something has been already said. This ever continued a favorite subject with him; and in 1835, he had the great satisfaction to observe, with all the means which modern instruments afford, the wonderful phenomena of Halley's comet, the reductions of whose early observations (in preparation for this return of it to its perihelion) had signalized his first entry into his astronomical career. His observations of its physical appearance previous to its perihelion passage, and especially of the apparent oscillations to and fro of those singular jets of light from its head, which created so much astonishment among European observers, from day to day, and even from hour to hour, led him to conclude the inherence in the cometary matter of a polar or magnetic energy, and even to make (*Astronomische Nachrich-*

ten, No. 310) the effect produced on a comet's orbit by the reaction of the matter of these jets, so projected forth from the nucleus into space, a subject of mathematical calculation. And it may not be irrelevant here to notice that other phenomena, of a totally different nature, exhibited by the same comet subsequent to its perihelion passage, as observed in the southern hemisphere, appear to authorize conclusions, which, though not precisely identical with those of Bessel, have yet so much in common with them, that the assumption of repulsive forces as a means of accounting for cometary phenomena, must henceforward take its place among hypotheses which cannot be lightly rejected, but must come to be tested by the combined aid of rigorous mathematical deduction and increased refinement of observation.

In a note appended to one of the numbers of the *Astronomische Nachrichten* (No. 175), the following remarkable expression of Schumacher occurs:—"It may almost be said that one exact and able calculator is capable of doing better service to astronomical science than two new observatories." It was in the capacity of such a calculator (taking the word in that enlarged and eminent sense in which the writer doubtless understood it,—a calculator thoroughly master of every resource of theory, and capable of bringing them all to bear on the subject of discussion) that Bessel undertook and completed, while yet young as an astronomer, his great work, the *Fundamenta Astronomiæ*, a work which it is difficult for any astronomer, and least of all an English one, to speak of in measured terms. It affords the first example of the complete and thorough reduction of a great series of observations, grounded, in the first instance, on a rigorous investigation, from the observations themselves, of all the instrumental errors, and carried out on a uniform plan, neglecting no minutiæ which a refined analysis and a perfect system of computation could afford, and resulting in a model catalogue, such as (without disparagement to the far more extensive catalogue of Piazzi, published four years antecedently) the world had not before imagined. As Englishmen, we cannot but be proud to have furnished from our national observatory, in the twelve years' work of a single British astronomer, that "one entire and perfect" mass of precious material, from which has been sculptured forth in so masterly a manner, and in all its classical proportions, the fair form of modern sidereal astronomy. Independent of the deduction of the places of the stars, of the instrumental reductions, and of the local data, the disquisitions which this work contains on the several uranographical corrections are, and ever must remain, models of delicate and powerful research, monographs of their respective subjects, embodying in a succinct and perspicuous point of view, so far as their complexity will admit, the totality of our knowledge of their theory brought into the most practical forms for application. In the reduction of these observations, however, his final improvement, which does away altogether with the necessity of using special tables for the several uranographical corrections, and for individual stars, and renders it practicable, by the calculation of a system of constants for each star, and an annual table common to all the stars, to provide for the reduction of all meridional observations, was not yet adopted. That capital step, which has so infinitely facilitated all subsequent reductions, was not made till somewhat later, and had nearly been anticipated by Mr. Baily, who, on his part, and independently, had been occupied about the same time on a similar simplification.* In furtherance of the important object of facilitating the reduction of observations of the planets, as well as of the fixed stars, on a uniform system, he prepared and published, in 1830, his *Tabulæ Regiomontanæ*, a work of the greatest utility and influence on the practice of astronomers in this respect.

The principal instruments at first supplied to the Königsberg Observatory were two, a transit by Dollond, and a meridian circle by Cary. This last instrument, though not itself of a very high order of excellence, may be considered as having been rendered so by the masterly and elaborate investigation of its errors of division which Bessel bestowed upon it. The complete investigation of instrumental error was a subject on which he was at every period remarkably scrupulous, and not without reason, as the dreadful consequences which have followed its neglect in more than one instance clearly demonstrate. In *his* opinion, the reputation of no artist, however distinguished, could be held to dispense with the most careful and searching scrutiny into the errors of his workmanship; or, with the most refined application, both of experience and theory, into the amount and laws of its flexure, whether of the telescope or limb, by its own weight in different positions. In fact, no astronomer has ever gone deeper into the theory of instruments, or exemplified that theory by more elaborate experimental inquiries. The finishing hand was put to a most remarkable memoir on the effects of flexure, but a very short time previous to his death, which has only just seen the light (see *Astronomische Nachrichten*, No. 577, *et seq.*), its publication having been directed in his will.

The improvement of Carlini's tables of the sun was the object and result of the first five years' observations with Cary's circle and Dollond's transit; though other objects of interest were not neglected, especially that of an exact determination of the places of those stars in which large proper motions had been remarked. But when in the year 1820, the circle of Cary was

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* See the Memoir of Mr. Baily, *Mem. Astron. Soc.*, vol. xv, p. 324, where, in line 7, for "*precession*" read *nutation*.

replaced by the larger and more accurate meridian circle of Reichenbach, a wider field of inquiry was opened out, and a task undertaken and completed of which astronomy is only now beginning to reap the fruits. This was no less than a determination of the places of all the stars, down to the ninth magnitude, in a zone of the heavens extending from 15° south to 45° north declination. Previous to entering upon this great work, however, the new instrument was subjected to a more severe and rigid scrutiny into the divisions of its circle, and the accurate adaptation of its parts (by the aid of a microscopical apparatus contrived and executed by Pistor), than that which its predecessor had undergone. It sustained the ordeal to admiration. The zone observations were commenced on the 19th of August, 1821, and completed on the 21st of January, 1833, in 536 zones, comprehending upwards of 75,000 observations. The arrangement of the work, as printed in the Königsberg observations, is in the highest degree convenient for reference. Every zone is accompanied by a small table, by means of which the reduction of any one of the observed objects to a fixed epoch may be performed at once, and in the shortest possible time ; so that the observations themselves, by the aid of an index to the zones, have nearly all the advantage of a catalogue, and that of a very high degree of precision. Their actual reduction and arrangement as a catalogue was commenced in 1830 by Professor Weisse ; but the promised work has not, we believe, yet appeared. Bessel was assisted in the observation of these zones by M. Argelander, who, since his removal to the direction of the observatory at Bonn, has continued them from the 45th to the 80th degree of north declination, the observations being very recently published in the first volume of the transactions of the Bonn Observatory, in 204 zones. It will be a matter of no small interest, when the elements of the new planets which have so recently been added to our list shall have become sufficiently known to admit of a retrospective ephemeris being calculated, to search the Königsberg zones for missing stars lying in their paths, and corresponding to former places of them. The detection of such will be of inestimable value in the correction of their elements and the theory of their perturbations.

Future astronomers will reap the rewards of this laborious work ; but there was one subject of astronomical research, of a practical nature, which Bessel was destined to commence and carry out to its completion, terminating in a discovery of first-rate importance, in the determination, beyond the reach of reasonable doubt or cavil, of the parallax of a fixed star. The star, 61 *Cygni*, pitched upon for his attack upon this difficult question, which had so long bid defiance to the attemps of astronomers, and which seemed destined constantly to afford fresh proofs of the imperfections of our instruments and the inadequacy of our methods, was one which combined, with distinct grounds of *à priori* probability in favor of its proximity to our system, peculiar advantages for the application of the mode of observation contemplated. The proper motion is remarkably large,—the greatest, with one exception, yet observed. This of itself affords some presumption of proximity. Another, less equivocal, is found in the fact, that it is demonstrably a binary double star, whose orbitual motion is remarkably rapid when compared with the apparent angular distance of its individuals, indicating a large angular dimension of the orbit mutually described about each other as seen from the earth. As regards its adaptation for micrometric observation, two minute stars, at the respective distances of 8′ and 12′ from the middle point of the pair, situated with respect to that point in positions differing by very nearly a right angle, permit no parallactic movement to take place without effecting a change of apparent distance from one or other of them; so that the maximum rapidity of change with respect to one shall correspond to the minimum and near evanescence of such change with respect to the other, a very important circumstantial character of the *reality* of any observed movement supposed to arise from parallax.

The only obstacle in the way of the detection of any minute parallactic motion, by means of these stars, consisted in the difficulty of measuring distances so large as 8′ or 12′ to the precision of a very small fraction of a second. Thanks to the perfect workmanship of the Munich opticians, this precision was rendered attainable by the heliometer constructed for the Königsberg Observatory, and there erected in 1829. The observations in question were made in the years 1837–1840; and their result as is well known, has satisfied every astronomer of the reality of the parallax attributed by Bessel to this star, and of the near approximation to its true amount.

The discussion of these observations involved considerations of very great delicacy, chiefly turning on the effect of temperature on the focal distances and metallic mounting of the lenses, as well as on an infinity of minute considerations as to the effects of refraction, &c., and of instrumental errors on the measures of angles of such magnitude in various positions with respect to the vertical. Every thing of this nature has been made the subject of minute and careful inquiry in four very elaborate papers forming part of the first volume of a series of essays (*Astronomische Untersuchungen*), of which we shall have further occasion to speak. The first of these enters in its fullest extent into the general theory and formulæ of an equatorially mounted heliometer. The second is devoted to a special application of this theory to the Königsberg instrument. Among the remarkable features of this second memoir, deserves to be noticed a happy application of the general resolution, by continued fractions, of an equation of finite differences of the second order, to the expression of the course of a ray refracted through any combination of spherical surfaces. The third of these memoirs relates to the elimination of the influence of refraction; and the fourth to that of the several effects of precession, nutation, and aberration, from measures so taken, and from micrometric measures generally.

The exceeding precision of micrometric measurement of which the heliometer proved capable, was also brought to bear upon other objects, such as the measurement of distances of the Huyghenian satellite of *Saturn* from the ring, and those of *Jupiter* from the limb of the planet, with a view to the more perfect determination of the masses of these planets. The results of the latter observations, as compared with their theory, and the improved tables of the motions of the satellites themselves, concluded from the whole inquiry, are to be found in the Ninth Essay, Vol. II. of the *Astronomische Untersuchungen*, already referred to.

In the year 1824, in a paper communicated to Schumacher's *Astronomische Nachrichten*, No. 49, Bessel recalled the attention of astronomers to the great and peculiar advantages in the determination of latitudes, and of the declinations of such stars as pass near the zenith, offered by a mode of observation whose first idea seems to have been due to the celebrated Römer, viz. by the use of a transit instrument at right angles to the meridian, and therefore describing the prime-vertical. By the use of this method, the differences of declination of two stars passing near the zenith of any given places, or the change of declination of one and the same star at different times, comes to be measured upon a vastly increased scale by the interval of its two transits over the vertical, expressed in time. It is therefore independent of the errors of division of any circle, and, as Bessel has also shewn, of a variety of other influential causes of error, and is especially adapted for those inquiries in which the zenith sector has been usually employed. A large instrument constructed upon this principle has been since erected in the Imperial Observatory at Pulkowa, with the express object of affording normal results as to the constants of aberration, nutation, &c., and the investigation of parallax; and from the terms in which the illustrious astronomer at the head of that establishment speaks of its performance, the views of M. Bessel in recommending it for general adoption appear to be fully borne out.

Intent on fully providing the observatory under his direction with the most perfect instruments which art can execute, Bessel obtained permission to order for that institution a new and improved meridian circle from the Brothers Repsold, of Hamburg, with peculiar adaptations, devised by himself, for facilitating the handling, setting, and reading of the circle. On the reception of this instrument, which was erected in the observatory about the end of 1841, a mode of determining the nadir point proposed by Bohnenberger, by reflexion of the wires of the instrument itself in mercury, by which the instrument is made its own vertical collimator, was adopted and brought into constant use; a full account of which, and of the extreme precision so attained, will be found in Nos. 480 and 481 of the *Astronomische Nachrichten*. The possession of this admirable instrument enabled him to resume, with every advantage he could desire, an inquiry of the greatest importance, but at the same time of the utmost delicacy, which had long engaged his attention. The first suspicion of a want of perfect uniformity in the proper motions of certain fixed stars, among which *Sirius* and *Procyon* may be especially particularized, occurred to Bessel in 1834. Pond appears also, at an earlier period, to have become impressed with the same idea. The observations of declination made at Königsberg, previous to the erection of the Repsold circle (see *Astron. Nachr.* 422), had tended greatly to confirm this suspicion; but it was not until a series of observations of considerable extent had been made with the new circle, that Bessel thought himself authorized to announce it as a positive astronomical fact, no longer to be confounded with possible error of observation and reduction, but as a thing to be accounted for by some distinct physical cause. On the nature of this cause be even hazarded a speculation, doubtless a very bold one, viz. that *Sirius* and *Procyon*, in which the observed deviation from uniformity is regarded by him as fully established, are really double stars, one of the individuals only, however, being luminous; and that the variability in question arises from their relative orbitual motion about their common centre of gravity. Time only, and assiduous observation, can elucidate this curious subject.

Though very far from having exhausted the catalogue of Bessel's purely astronomical discoveries and researches, the limits of this notice require us now to pass to the mention of his highly important investigations on subjects connected more immediately with our own globe, viz. geodesical measurements, the determination of standards of weight and length, the length of the pendulum, and the train of subjects therewith connected; all which afforded him opportunities of displaying a skill not less consummate as a physical experimenter, than he had already shewn as a mathematician and astronomer.

His first step in this career was the determination of the length of the simple pendulum at his own observatory. The principle of this determination is the observation of the times of vibration of two pendulums whose difference is precisely equal to a given standard of length; for which purpose a fac-simile of the toise of Peru was chosen, being a measure *aux bouts* which the principle of construction of the apparatus rendered a necessary condition. The actual vibrating pendulum was a ball suspended by a wire, the suspending apparatus being made to rest alternately on the upper end of the toise and on the flat support of its lower end, the tangent plane of the lower surface of the ball being brought to a constant level by the use of the lever of contact. The series of experiments made with this apparatus was published in the volume of *Memoirs of the Berlin Academy* for 1826, though the date of their communication and reading was two years later, the publication of the Memoirs being so much in arrear. This investigation will always be considered as forming an epoch in the history of pendulum experiments, on account of the peculiar mode in which the subject of the resistance of the air to the motion of the suspended body is taken into consideration; this renders it necessary to estimate as part of the mass set in motion the weight of the air dragged along with it. The researches of Mr. Baily and Col. Sabine have fully confirmed the necessity of taking into account this essential though small correction.

The determination of the same important element for the then newly erected observatory at Berlin followed in 1835. The method employed, with some slight improvements, was the same as that practiced at Königsberg, and the whole process will be found in the *Memoirs of the Berlin Academy* for 1835.

The interim between these two determinations, was occupied with a series of pendulum experiments of very especial physical interest and importance—a rigorous inquiry, namely, into the fundamental question whether gravity be really, in all kinds of bodies, proportional to their inertia *solely?* or, in other words, whether or not there be any thing specific or dependent on the intimate nature or chemical constitution of a body which determines the energy of its gravitating power,[*] the *inertia* being given? The experiments of Newton, though they preclude all idea of any considerable or palpable amount of such specific difference among bodies, could by no means be regarded as sufficiently exact to settle a point of such vast importance with that decision which modern science requires. All idea of such specific attraction is, however, completely done away with by the result of the elaborate series of experiments set on foot by M. Bessel for this purpose, which form the subject of a Memoir pre-

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[*] It is so easy to misunderstand the true gist of this inquiry, that it may be not amiss to state it otherwise. Suppose *a pound* of gold, *a pound* of lead, and *a pound* of ice to be formed into three spheres, and placed with their centres at the three angles of an equilateral triangle,—will they or will they *not*, taking two by two, attract *each other* with equal forces? The *earth* is here considered as an impartial mixture of all elementary substances.

sented to the Berlin Academy in 1832, and printed in their Memoirs for 1830; every substance examined, including meteoric iron and stony masses, having given exactly the same coefficient of gravitating intensity as compared with its inertia.

Immediately connected with the length of the seconds' pendulum is the determination of standards of weight and measure. The fixation of the Prussian standard of length, ordered by law in 1816, after remaining nineteen years in abeyance, was committed to M. Bessel in 1835, who completed the task assigned to him, in 1837. The account of this operation, and of the comparison of the new standard with the Peru toise, which had served for the measure of the pendulum, forms the subject of a Memoir printed in 1839 by order of the Prussian government.

Eminent as were his mathematical resources, and his aptitude for bringing them to bear in the most advantageous and effective manner upon every point of practical application, there is, perhaps, no subject, among the multitude of those which at different times engaged his attention, in which these qualities were more singularly called into action, in combination with his skill as an astronomer and his perfect knowledge of instruments, than in the geodesical operations which he was about this period called upon to conduct, in conjunction with General Baeyer, for the triangulation of Eastern Prussia. Though the actual extent of this triangulation was not considerable, the extreme points connected being only about 120 English miles distant, still few trigonometrical operations have been executed of greater circumstantial importance, inasmuch as it had for its especial object to connect the operations of Struve in the north of Russia and Finland, and those of von Tenner in the south of that empire, with those of Western and Southern Europe, from which they previously stood altogether disjoined. The triangulation of Hessia, Thuringia, Brandenburg, and Silesia, under the direction of General Müffling, had connected the Hanoverian and Danish measurements on the one hand, and those of France (and consequently also of Britain) on the other, with the Bavarian and Austrian surveys. The chain of connexion had, moreover, been carried on by the triangulation of Western Prussia and the Grand Duchy of Posen, as far as the borders of the Frische Haff, on the Baltic; and one link only was wanting between Trunz, the furthest point of this last-mentioned operation, and Memel, to bring together these detached masses, and bind them into one vast European combination. Bessel's conduct of this operation was marked, like every thing which he undertook, by the adoption of new and refined processes, both of observation and computation. The astronomical latitudes of his stations, for instance, were ascertained by the application of that peculiar mode of using the transit instrument to which allusion has already been made, to the exclusion of the zenith sector and repeating circle, which had hitherto been used for that purpose. As respects the calculation of the triangles, also, a general mode of treatment was now, for the first time, adopted, combining the whole system of observations in all the triangles, so as to lead to a single conclusion as to the final results of the total work, and not (as had been the practice in all previous cases) to derive by several distinct combinations several distinct conclusions, either as to the whole or to subordinate parts. In the method pursued, each triangle is supposed affected with unknown or rather indeterminate errors in all its angles. The observations of the angles in each, with the application of the spheroidical excess, gives a sum to which all the errors must conform *as nearly as possible.* In the language of modern computation, it affords an *equation of condition* which takes its place and acquires its due influence as an element of a final system of similar equations, whose joint solution is then accomplished by the application of that powerful process, the method of least squares, to which our knowledge of physical truth is so much indebted. In the measurement of the base, also, much ingenious contrivance and many peculiar features occur; and the operation, taken all together, will ever be regarded, apart from its adventitious circumstances of interest, as one of the most instructive geodesical measurements which has ever been performed.

These occupations unavoidably drew the attention of Bessel to the general subject of the figure of the earth, as resulting from geodesical measurements, and more especially to the best and most effectual means of availing ourselves of the vast accumulation of data obtained at such enormous cost and labor, in India, in France, in Britain, and elsewhere. To grasp the whole of this mass under one general and systematic process of reduction and calculation appeared to him an object worthy of his powers, and this design was carried out in that powerful, regular, and at the same time highly artificial mode which had now become habitual to him, in a series of Memoirs communicated to the *Astron. Nachr.*, 333–6, 338. The first of these contains the general exhibition of the most advantageous mode of combining the several independent measures of meridian arcs, so as to obtain by the method of least squares the most probable result as to the dimensions of the terrestrial spheroid, and applies that method to the received values of the arcs, as given by their several measurers, taking for granted the correctness of their computation of their own triangles, and the latitudes of their extreme points. But he did not stop here. On the contrary, engaging deeper in the inquiry, he was led to enter upon a recomputation of the latitudes of all the principal stations in the British and Indian arcs, and finally to recompute entirely, according to the same principle of combination used in his own East Prussian triangulation, the whole system of French triangles between Montjouy and Formentera. There is, perhaps, hardly one of his numerous and laborious works calculated to give a better idea of the extreme scrupulousness of all his proceedings, and his contempt of labor where the object is to elicit truth in its most absolute form from a mass of observations of undoubted excellence, than this last computation. A mistake, as is well known, had been committed in one part of the computation of the French triangles, by which the total distance between the parallels of these two points had been rendered erroneous to the extent of nearly seventy toises. The mistake, however, had been rectified by the independent calculations of four eminent French geodesists, and their conclusions agreed within three or four toises of each other. This, however, did not satisfy Bessel, and he actually recalculated the whole of the work by his own method, producing a result agreeing with the mean of the four determinations alluded to within a fraction of a toise.

We are still very far from having exhausted the long catalogue of Bessel's astronomical labors. His memoir on the precession of the equinoxes, honored with a prize by the Berlin Academy, and his researches on the planetary perturbations, might well demand some especial notice, did not our necessary limits forbid it, and oblige us also to pass unmentioned, otherwise than generally, the astonishing host of contributions with which, from time to time, he enriched the periodical literature of astronomy. The greater proportion of these are contained in the *Astronomische Nachrichten*—so great a number indeed, and many of them of such extent, that perhaps it is not exaggerating to say that at least a fifth part of that collection, (now consisting of twenty-four volumes,) has emanated from his pen. The *Zeitschrift für Astronomie*, the *Königsberger Archiv für Naturwissenschaften*, the *Monathliche Correspondenz*, and the Supplements to the *Berlin Ephemeris*, contain also many and valuable communications from him.[*] And when it is recollected that many of these papers are essays of great length and deep interest, abounding in profound research and new conceptions on almost every subject with which astronomers are conversant, we shall see cause to admire no less the indefatigable industry of the man than the extent and versatility of those powers which produced such a profusion of valuable matter. Some of these essays, retouched and enlarged, form part of a work entitled *Astronomische Untersuchungen*, or Astronomical Researches, two volumes of which have appeared, and a third was understood to be in preparation when his labors were arrested by illness.

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[*] In Poggendorff's *Annalen der Physik*, occur occasional communications by Bessel: among others, a long and interesting one in vol. lxxxii, (vi, N. S.,) on the adjustment of thermometers.

In the year 1842, Bessel for the first and last time, visited England, and was received in a manner befitting the high estimation in which his merits were held. His unaffected and pleasing deportment, the charm of his conversation, and the rich fund of information and instruction it afforded, will be remembered with pleasure and regret by all who had the good fortune to be in his company.

There can be little doubt that he was preparing, on his return to Germany, and perhaps even before his visit to England, for an attack upon that great problem whose solution has done so much honor to Le Verrier and Adams. He had, in fact, with a view to this undertaking, engaged a young and promising astronomer, Mr. Flemming, to reduce anew, with the utmost rigor, all known observations of *Uranus*, including the Königsberg observations of that planet, and to compare them with the tables. This was the groundwork of his intended researches. Mr. Flemming completed the reductions, which are in the possession of Mr. Schumacher, and died soon afterwards, and the fatal malady of which, after two years of continually increasing suffering, Bessel himself died, made its appearance, and interdicted every serious labor.

The scientific character of Bessel will have been easily collected from what has been said of particular branches of his extensive labors. One leading feature of it was the concentration of all known data on each particular subject of inquiry, with the view of expressing from them, by the highest and most refined application of mathematical and computistic power, the utmost they are capable of affording in the direction of numerical precision; and as a means to this end, to satisfy this earnest longing after precise results, an equally earnest and successful endeavor to improve to the utmost all formulæ and systems of computations *as such;* that is to say, to put them before the computist in a state ready for immediate use, and to give the last precision which the state of science admits to every fundamental and every derivative coefficient. In the preface to his *Untersuchungen*, he says of himself, that he at no time felt any especial predilection for one rather than another particular branch of astronomical occupation, but that one idea was continually present to his mind—that of always working up to an *immediate* and *definite* object; either that of arriving at some positive result, more perfect than what before had been obtained, or that of removing some acknowledged obstacle which opposed at once the improvement of more than one subject. And in this remarkable passage he goes on to declare, that the desire of merely accumulating data by observation, without the intention of using them to such ends, was altogether alien to his tastes; and that the deduction of actual results from observations, by the observer himself, with a distinct view to the improvement of knowledge, appeared to him, at all times, an essential condition of success in all astronomical research.

As a mathematician, Bessel takes, undoubtedly, a high rank; not, indeed, as an original inventor in the abstract walks of the pure analysis, but always with a view to applications, in which, whatever occasion required its exertion, his skill was never found unequal to the task on hand, no matter what its difficulty. As a practical astronomer, his knowledge of what may be called the theory of instruments—the mode of detecting, compensating, and eliminating their errors; the influence of flexures of their limbs, tubes, and other parts; and his acquaintance with, and constant practice of, every delicacy in their use, were such as has never been surpassed. Equally great in perfecting old methods of observation and in suggesting new, the practice of the modern German school of astronomers is almost emphatically Bessel's practice; and he was deservedly looked upon as a guide and model, not only in Germany but by Europe.

Bessel was, of course, elected into almost every academy in Europe as an Associate. He became a Foreign Member of this Society in 1822. As he advanced in years and in reputation, distinctions of a different kind were conferred upon him; among others, the order of the Dannebrog by the King of Denmark, and that of the Red Eagle, with the title of "Geheimer Regierung's Rath," and the order of Civil Merit by his own sovereign, whose favor he constantly experienced, and whose attentions during his last illness were of the most benignant kind, and soothed, though they could not alleviate his sufferings.

ART. XXIII.—*On the Properties of Ozone;* by C. F. SCHÖNBEIN.*

BY a number of experiments made by myself and repeated by others, it has been demonstrated that ozone (which I take for a peroxyd of hydrogen, and Berzelius for pure oxygen in a peculiar condition) is the most powerful oxydizing agent we at present know of. A most striking instance of its exalted chemical powers is the fact, that metallic silver being in a state of minute mechanical division and put in contact with ozone, is readily transformed into the peroxyd of the metal even at very low temperatures. The several facts I have lately ascertained, and which I am going to state, will give further proofs of that power.

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* Communicated for this Journal, by Prof. Schönbein, in a letter to Prof. Silliman, dated Bâle, July 15, 1847, and received through Prof. Beck of Cambridge, Mass.

1. Ozone has the property of decomposing the protoxyd salts of manganese, throwing down that metal in the shape of the hydrate of peroxyd of manganese and setting at liberty the acids of the said salts. If aqueous solutions of sulphate, nitrate and muriate of manganese be shaken with atmospheric air which has been strongly ozonized in the usual manner, (by means of phosphorus,) ozone rapidly disappears, the saline solutions become turbid, hydrate of peroxyd of manganese is precipitated in the shape of little scales of a brownish color, and sulphuric, nitric or muriatic acid set at liberty. To cause the decomposition described, it is not required to dissolve the salts, the latter being acted upon by ozone even in their solid state. I make use of this remarkable property of ozone to prepare a specific and delicate test for that curious substance. Small strips of the whitest filtering paper are drenched with a weak solution of sulphate of protoxyd of manganese, suffered to dry, and kept in stoppered bottles.

On introducing such paper into ozonized air, it rapidly assumes a brownish tint, growing darker and darker, the longer the test paper is left suspended within the air. If the atmosphere happens to be strongly ozonized, the discoloration makes its appearance after a few seconds suspension. I hardly need mention that the test paper turns brown when exposed to the action of oxygen, which has been obtained by the electrolysis of water, and exhibits the peculiar electrical smell. The said paper may also be used to prove that ozone is formed by electrical discharges taking place either in oxygen or atmospheric air. By exposing a bit of test paper to the action of the electrical brush, (playing in air or oxygen,) it undergoes the same change of color as it does within air ozonized by phosphorus, or within the oxygen produced by electrolysing water. But as under the first mentioned circumstances, only very small quantities of ozone are generated, it requires rather a long action of the electrical brush to turn the test paper brown.

Electrical discharges continually taking place in our atmosphere, and ozone being invariably produced by them, it necessarily follows that some small portions of that oxydizing agent are present in atmospheric air. The correctness of that conclusion is most easily proved by the means of my test paper; for on being exposed to the action of free circulating air, it gradually assumes a brown tint, whilst the paper remains perfectly white, when kept inclosed within a bottle filled with atmospheric air. According to the state of the atmosphere, the test paper is comparatively more or less rapidly turned brown, but always slowly. I have strips of paper which have been very perceptibly turned brown, after a week's exposure to the open air.

I have tried to produce images by drawing with a solution of sulphate of manganese upon paper, and exposing the latter (when dry) to the action of atmospheric air which has previously been strongly ozonized by the means of phosphorus; and I may say that I have obtained very pretty results. The drawing or writing comes out within a few minutes, first exhibiting a yellowish tint and afterwards a deep brown shade. Gaseous sulphurous acid, readily uniting with the hydrate of peroxyd of manganese to form colorless sulphate and hypo-sulphate of manganese, these manganese images or writings may be almost instantaneously destroyed by introducing them into a bottle containing some gaseous sulphurous acid. And it is a matter of course that the images thus extinguished are restored by reëxposing them to the action of ozonized air. These reactions may be used for making very pretty class-room experiments to show the action of ozone upon manganese salts, and that of sulphurous acid upon peroxyd of manganese. They will perhaps also allow of a practical application. I may add that my test paper after having been turned slightly brown by ozone serves as a test for sulphurous acid.

2. Ozone enjoying so many properties in common with chlorine and bromine, I suspected the two latter bodies would act like ozone upon the solutions of manganese salts, and found my conjecture confirmed by experiment. If aqueous chlorine or bromine is mixed up with a solution of sulphate, nitrate or muriate of manganese, a very slight action takes place in the dark, but no sooner has the mixture been exposed to the action of solar light than a reaction begins and peroxyd of manganese is thrown down.

3. Sufficient quantities of ozonized air being treated with a solution of basic acetate of lead (extractum Saturni), throw down all the excess of oxyd of lead in the shape of the brown peroxyd transforming the basic salt into a neutral one. Chlorine and bromine act in a similar manner. If aqueous chlorine or bromine be added to a solution of the subacetate mentioned, until the whole precipitate first formed has disappeared, and the mixture becomes limpid again, very soon after, the liquid will become turbid, peroxyd of lead being thrown down. To show these reactions in the most simple manner, I drench strips of white filtering paper with a solution of the subacetate and suspend them in bottles, containing some ozone, chlorine or bromine. After a certain time these strips will have assumed a brown color resulting from the peroxyd of lead formed under these circumstances.

4. Ozone has the power of forming permanganic acid under the following circumstances. If the bottom of a large bottle filled with atmospheric air be covered with a solution of sulphate of manganese and a bit of phosphorus having a clean surface be placed

in the solution so that about half its bulk rises above the fluid, the formation of ozone will immediately ensue, provided the temperature be 15° to 20° R. Part of the ozone formed, acts upon the saline solution and transforms part of its protoxyd of manganese into permanganic acids, whose presence is indicated by the beautiful deep red color which the solution assumes in the course of a few hours. The same richly colored fluid is obtained by shaking a solution of sulphate of manganese or any other manganese salts in dilute phosphoric acid with ozonized air.

Having drawn up a detailed account of these and other experiments, which before long will be published in "Poggendorff's Annalen," I take the liberty to refer the readers of your periodical to that Journal.

Enclosed you will find some specimens of manganese drawings and writings produced in the manner above described. By exposing them for a short time to the action of gaseous sulphurous acid, you may easily destroy the image, &c., and restore them, by ozonized air.

ART. XXIV.—*Ancient Sea Margins;* by ROBERT CHAMBERS.

TO THE EDITORS OF THE AMERICAN JOURNAL OF SCIENCE AND ARTS.

1 Donne Terrace, Edinburgh, July 9, 1847.

Gentlemen:—I beg, through the medium of your pages, to call the attention of American geologists to a line of investigation, from which I have been led by inquiries of my own in this country, to expect some important results. It is that of natural terraces, *benches* of land, and other forms of the surface, which appear to indicate the former presence of the margin of the sea. Hitherto ancient beaches have been chiefly inferred from the presence of shells, but I am satisfied from my researches here, that they can be detected with equal certainty from the configuration of the ground and the presence of sand, gravel, and other materials, such as are usually found on beaches. In Scotland, I have by this means ascertained the existence of a series of ancient beaches, from 64 to 616 feet above the level of the sea at high water of ordinary tides, besides a few at inferior elevations, but too much huddled to be described with precision. And these are not marked at one place only, but many of them appear at various places all around the island. In each several place they are perfectly horizontal in the line of the ancient coast. In some places, two, three, and four, may be distinctly traced on one hill-face towards the sea, or in a valley which had formerly been the bed of an estuary. Precisely the same group seldom appears in two such places—though several of them are remarkably persistent. More generally, one of those present at place A is wanting at place B, while another is perhaps substituted. There is no difficulty, however, in seeing that those common to the two situations are the memorials of one set of pauses of the sea, as they always appear at certain elevations, with intervals which, though in some cases small, are always peculiar and characteristic. In short, there is here evidence that the process by which the relative level of sea and land has changed in our island at the era of the superficial formations, was one which did not move the land in the slightest degree off the plane which it had previously occupied.

I need scarcely remark, that, in consequence of what we have heard for some years, of the unequal changes of relative level in South America and Scandinavia, every step of this investigation was attended by a battle with my prepossessions. The facts, however, are of so clear and palpable a nature, that there is no gainstanding them. And perhaps there is no necessary inconsistency between them and the observations of Messrs. Darwin and Lyell. Any how, it has appeared to me exceedingly desirable to learn how far this uniformity has prevailed, and I have therefore visited France and Ireland, in order to search for terraces and ascertain their heights. You may believe it was with no common emotions that I found in these countries terraces broadly marked and characteristically grouped as in Scotland, and at precisely the same elevations,—proving that France and Ireland stood in the same predicament as the island of Great Britain with respect to the change of the sea level, by whatever means that had been brought about.

Since then I have been led to inquire after the heights of the terraces of more distant regions, particularly Scandinavia and North America; and certain it is, however startling and unexpected, that there are appearances as if the uniformity extended even thus far. I am anxious to speak on this point with caution, and with full preparation for evidence to a different effect. Yet amidst all the obscurity of observations made with no regard to this point, and which coming from different minds must needs bear some incompatibilities, there does appear enough at least to awake a strong suspicion of the uniformity in question, and to make me feel quite unjustifiable in refraining from further enquiry. For instance, a *sixty feet beach* is described at Fossum in Norway, and in the Mindar islands in the Gulf of the St. Lawrence. The phrase might describe a geognostic feature of this island, than which I do not know any more remarkable. I find also, in a paper by the Profs. Rogers, on the tertiary formations of Eastern Virginia, (*Trans. Am. Soc.*, 1839,) a description of what they call a *bench* of land (one of my own phrases) between the rivers

Potomac and Rappahannock, which, besides being *from sixty to seventy feet high* over several miles, is in the main lithologically a perfect counterpart to many examples of the terrace at the same height on the British coasts. There are even more striking coincidences than these. The gravel plain at West Point, if it can be considered as connected with the sea margin of a former era, is in harmony with one of the greatest of the British terraces. Nay, among the elevated terraces which Mr. Roe has described as stretching along the sides of Lake Ontario, there are some which come surprisingly near to certain similar formations which others have described in this country. There may be nothing here but accidental coincidence; indeed it may be admitted that most probably there is nothing else in the case. It were well, nevertheless, to make sure.

For this purpose, I now beg to suggest to the geologists of America, the propriety of examining such examples of ancient beaches as may be within reach in their several districts, with a view to settling the question one way or another. To all in America who have written on kindred subjects, I would respectfully recommend this inquiry, than which none could be more easily conducted. The first point should be, to find other instances of the sixty-four feet beach; in this country it is usually a broad terrace of sandy or gravelly materials, presented towards the sea or along the banks of tidal rivers. If really a general feature of America, as of Britain and Ireland, I should expect it to be found in many situations along the banks of the Hudson. An examination of the form and constitution of this terrace will fit the enquirer for discovering the higher beaches; to which, however, I do not think it proper to attempt affording any guide by the elevations of those found in Scotland, as obviously, if there be any correspondences these will have more force as evidence, if we can say that the two sets of facts were arrived at independently. I shall only remark that terraces between one hundred and fifty and three hundred feet are more likely to be efficient as tests than any of lower altitude excepting only the sixty-four feet beach, because in that higher range of elevations the intervals are wide and more characteristic. Accurate measurements by levelling from a certain specified datum are of course desirable, and the results should be published from time to time. I need scarcely say how much gratified I should feel by any communications to myself upon the subject.

ART. XXV.—*Glycocoll (Gelatine Sugar) and some of its Products of Decomposition;* by Prof. E. N. HORSFORD.

(Concluded from p. 70.)

PRODUCTS OF DECOMPOSITION OF GLYCOCOLL.

Action of Sulphuric Acid.

As glycocoll contains the elements of fumarate of ammonia,

$$C_4\,H_4\,NO_3, HO = NH_4\,O, C_4\,HO_3,$$

it was conceivable that the employment of the appropriate agencies might effect a simple decomposition into these two members. Neither potash nor baryta, however, were found capable of expelling the ammonia. But upon dissolving in diluted sulphuric acid, and evaporation by heat to syrup consistence, redissolving with water, again evaporating, and repeating this process several times, at a certain stage, not definitely ascertained, the whole crystallizes in forms of great beauty;—which when washed with alcohol and pulverized, with addition of potash yield ammonia.

Some of the crystals were nearly cubic, reminding one of chlorid of sodium, others were rhombic with feathered margins. They taste and react acid, and do not change upon exposure to the air.

Dried over sulphuric acid and analyzed, they gave the following results.

I. 0·4302 grm. of sub. gave 0·2031 carb. acid and 0·2099 water.
II. 0·3526 " " " 0·8062 platin-salammoniac.
III. 0·3574 " " 0·8300 platin-salammoniac.
IV. 0·4958 " " 0·6090 sulphate of baryta.

Expressed in per cents.

	I.	II.	III.	IV.
Carbon,	12·87	. .	. .	. .
Hydrogen,	5·42	. .	. .	. .
Nitrogen,	. .	14·40	14·63	. .
Sulph. acid,	. .	. .	. .	41·85

These numbers give the formula:

$$C_4\,H_4\,NO_3, SO_3, HO + NH_4O, SO_3\,HO,$$

as the juxtaposition of the per cents. of analysis and those derived from direct estimate will show:

		Theory.	Experiment.
Carbon, - - - -	4 equiv. = 24	12·36	12·87
Hydrogen, - - -	10 " = 10	5·26	5·42
Nitrogen, - - - -	2 " = 28	14·73	14·52
Oxygen, - - - -	6 " = 48	25·04	25·58
Sulphuric acid, - - -	2 " = 80	42·10	41·85
	190	100·00	100·00

This result supported the view that glycocoll contained not only the elements of fumaric acid and ammonia, but contained them in such form or arrangement, as would yield to an active affinity aided by heat.

It was highly probable, therefore, that galvanic action alone would be adequate to the task of decomposition.

To submit this query to the test of experiment, a solution of glycocoll was exposed to the *action of a galvanic battery*, consisting of four of Bunsen's pairs. The solution was separated by a membrane from the water. Upon closing the circle and plunging the poles terminated with platinum plate, one into the solution of glycocoll and the other into the water without, an instantaneous evolution of gas bubbles, at each pole succeded. After the action had continued a short time the fluid about the negative pole gave an alkaline reaction, while that about the positive pole gave an acid reaction. There could then scarcely a doubt remain, that glycocoll was a salt of which the base was ammonia and the acid a body identical in constitution with fumaric acid.

To obtain this acid, glycocoll was treated several hours, over a moderate heat with sulphuric acid, in the manner above described—repeatedly diluting and evaporating. The sulphuric acid for the most part was thrown down with oxyd of lead, and the last traces accurately removed with solution of baryta. The filtrate was then evaporated to concentration over sulphuric acid. In a few hours rhombic prisms of unexampled beauty and perfection, of the combination, ∞P, OP, crystallized from the solution.

Their taste was exceedingly sour. In water they dissolved with difficulty and in ether and alcohol they were absolutely insoluble. With potash, ammonia was evolved from them.

Combustion with chromate of lead, gave the following results.

I. 0·1922 grm. of sub. gave 0·1048 carb. acid and 0·1008 water.
II. 0·2350 " " " 0·5700 platin-salammoniac.

or in per cent.:	I.	II.
Carbon,	14·86	. .
Hydrogen,	5·82	. .
Nitrogen,	. .	15·28

With these results it was found impossible to construct any formula, containing only the elements of glycocoll, that could have been derived from the action of sulphuric acid. The first action of the acid would be the abstraction of ammonia.

$$C_4\,H_5\,NO_4 - NH_3 = C_4\,H_2\,O_4.$$

If in excess it was conceivable that the remaining member would be subdivided, giving oxalic acid and an oxyd of the radical of Dumas' alcohol and ether series.

$$C_4\,H_2\,O_4 = C_2\,O_3 + C_2\,H_2\,O.$$

The latter uniting with sulphuric acid would give a compound that might not be thrown down by baryta and which with the ammonia, after the precipitation of oxalic acid would give—

$$C_2\ H_2\ O, SO_3, NH_4\ O.$$

Upon heating the body with potash—dissolving in hydrochloric acid and adding baryta, a copious precipitate followed, establishing the presence of sulphuric acid. The small quantity prepared, prevented a determination of the quantity of acid. This formula requires 13·86 p. c. of carbon, 16·36 of nitrogen, and 6·81 p. c. of hydrogen.

It is not considered as established but merely as indicating approximately the action of sulphuric acid.

A concentrated solution of the crystals gave with baryta a crystalline precipitate that redissolved in hydrochloric acid.

With chlorid of calcium, upon the addition of ammonia, a crystalline precipitate was thrown down.

Want of time as well as of substance, postponed the further examination of this interesting body.

*Action of Chlorine.**

When a moderately concentrated solution of glycocoll is subjected to a current of chlorine gas, the latter is rapidly absorbed, and an instantaneous and copious evolution of carbonic acid succeeds. Heat and sunlight both facilitate the action. A convenient method was found in connecting with a stream of dry chlorine gas, a Liebig's potash apparatus, filled, as far as is usual for a combustion, with a solution of glycocoll. It is only necessary that the rapidity of evolution equal that of absorption.

At the end of the third day the process was interrupted, and the liquid evaporated to a syrup consistence. A drop of this syrup yielded, upon the addition of ammonia, a white crystalline precipitate with both chlorids of barium and calcium.

Upon saturating with baryta, filtering and washing with absolute alcohol, it was found that but a small fraction of the glycocoll had been oxydated.

It was again returned to the potash apparatus, and exposed to a slow but uninterrupted stream of chlorine gas for a week. At the conclusion of this period there was still glycocoll unchanged. Chlorid of barium gave the precipitate from the concentrated solution after neutralization with ammonia. This precipitate redissolved in water. It also redissolved in nitric acid, from which it was not thrown down by ammonia.

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* Mulder did not observe any action of chlorine upon glycocoll; a circumstance attributable possibly to the presence of an impurity rich in hydrogen, or to the action not being continued sufficiently long.

When washed and dried the baryta compound was no longer soluble in water, not even with long continued boiling. It was however promptly dissolved in dilute hydrochloric acid. It contains neither chlorine nor nitrogen.

The baryta salt alone was analyzed.

Combustion with chromate of lead gave from—

I. 0·3218 grm. of sub. 0·1544 carb. acid and 0·0547 water.
II. 0·6627 " " 0·5210 sulphate of baryta.

The only formula which can be derived from these determinations is—

$$C_3\,H_3\,O_6+\text{BaO}.$$

Which requires:

		Estimated.	Found.
Carbon, - - - -	3 equiv. = 18	12·36	13·08
Hydrogen, - - - -	3 " = 3	2·05	1·89
Oxygen, - - - -	6 " = 48	32·99	33·38
Baryta, - - - -	1 " = 76·6	52·60	51·65
	145·6	100·00	100·00

The same remarks are applicable to this formula that have been made concerning the preceding.

It is recorded chiefly to show that chlorine does not act upon glycocoll as upon many other bodies, by which a certain number of atoms of hydrogen are replaced by an equal number of atoms of chlorine.

The action may be conceived to be the following:—

$$C_4\,H_4\,No_3+5HO+3Cl=C_3\,H_3\,O_6+NH_4\,Cl+Co_2+2HCl.$$

The same body was obtained by direct addition of a solution of *permanganate of potassa* to an aqueous solution of glycocoll.

After boiling a length of time with *nitric acid*, the same product of decomposition was formed.

When pulverized *chlorate of potash* in small quantity and at intervals is added to a solution of glycocoll in hydrochloric acid, a slow oxydation goes forward, and a product is obtained, in which, as in the cases above noticed, baryta gives apparently the same white crystalline precipitate.

Action of Caustic Potash.

The brilliant fire red color assumed by glycocoll when heated with caustic potash, has already been noticed. If the solution be evaporated to extreme concentration, the evolution of ammonia and hydrogen continues, until at length the mass becomes solid. When treated with hydrochloric acid, hydrocyanic acid is evolved, and if iron salts be present Berlin blue is formed. When dissolved in water the addition of chlorid of calcium is followed by an instantaneous white precipitate, which does not dissolve in acetic acid—a precipitate of oxalate of lime.

The decomposition may be illustrated by the following scheme:—

1	equiv.	cyanogen, . .	C_2	. .	N	. .
1	"	ammonia, . .	. .	H_3	N	. .
2	"	oxalic acid, . .	C_4	. .	. .	O_6
2	"	carbonic oxyd, .	C_2	. .	. .	O_2
7	"	hydrogen, . .	. .	H_7	. .	. .
2	"	glycocoll, . .	C_8	H_{10}	N_2	O_8

Glycocoll and Hydrosulphuric Acid.

The readiness with which glycocoll enters into combination, and the interest attaching to sulphur compounds in the products of decomposition in the organism, suggested the treatment with hydrosulphuric acid.

Taurin, according to Redtenbacher,* is—

$$C_4\,H_7\,NO_6\,S_2$$

which he observed contained the elements of two atoms of sulphurous acid, aldehyde, and ammonia:

$$C_4\,H_7\,NO_6\,S_2 = C_4\,H_3\,O,\ NH_4\,O,\ S_2\,O_4.$$

The union of these several ingredients he succeeded in effecting.

Taurin also contains the elements of hydrated glycocoll, two atoms of water and two of sulphur:

$$C_4\,H_7\,NO_6,\ S_2 = C_4\,H_5\,NO_4,\ 2HO,\ S_2.$$

It was conceivable that by treating a solution of glycocoll with hydrosulphuric acid, and exposing the product to oxydation, a compound, consisting of glycocoll, water, and sulphur in the above relations, might be obtained.

Two atoms of Cystine:

$$2(C_6\,H_6\,NO_4\,S_2)$$

contain the elements of three atoms of hydrated glycocoll, from which ammonia has been withdrawn, and in which four atoms of oxygen have been replaced by an equal number of atoms of sulphur:

$$C_{12}\,H_{12}\,N_2O_8\,S_4 = C_{12}\,H_{15}\,N_3\,O_{12} + S_4 - NH_3 - O_4$$
$$= 2(C_6\,H_6\,NO_4\,S_2).$$

The evolution of the latter product was also not impossible.

Long continued and repeated efforts, however, gave no awaited result; the hydrated glycocoll recrystallizing from the solution with neither accession nor loss.

To obtain either of the above results another experiment was made.

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* Liebig's Annalen, Bd. lvii, s. 170.

Glycocoll was dissolved in quinqui-sulphid of potassium, spirits of wine added, and the solution evaporated through several weeks, over sulphuric acid, to dryness.

An efflorescence had crept up the sides of the containing vessel and the bottom was covered with crystals. Upon treating the whole with hot water, sulphur was separated, which was filtered off and the filtrate slowly evaporated to syrup consistence, from which the whole became a solid crystalline mass.

To a solution of the crystals, addition of sulphuric acid caused the evolution of sulphurous acid and the separation of sulphur. Here was the usual product of exposing the quinqui-sulphid of potassium to the air—hyposulphite of potash.

Upon adding bi-chlorid of platinum to a second portion, a precipitate of platin-chlorid of potassium followed, without the evolution of sulphurous acid or separation of sulphur. There was then left in the solution—

$$C_4\ H_4\ NO_3,\ HO,\ S_2\ O_2,$$

which equals,

$$C_4\ H_7\ NO_6\ S_2 - H_2.$$

Constitution of Glycocoll.

The enquiry presses itself, where in the general subdivisions of chemistry does glycocoll belong? Is it a base? Is it an acid? Or is it a salt?

The combinations into which it is capable of entering seem only to embarrass reply.

The following table of the principal compounds of glycocoll that have been analyzed, and the adjoining table of corresponding compounds, chiefly from inorganic chemistry, will not be without interest in the determination of this question.

As an Acid.

$C_4\ H_4\ NO_3$, CuO (Aq)	SO_3, CuO
$C_4\ H_4\ NO_3$, PbO "	SO_3, PbO
$C_4\ H_4\ NO_3$, AqO "	SO_3, AgO

As a Base.

a.

$C_4\ H_4\ NO_3,\ SO_3$	$AgO,\ SO_3$
$C_4\ H_4\ NO_3,\ NO_5$	$AgO,\ NO_5$

b.

$C_4\ H_4\ NO_3,\ SO_3,\ HO$	$ZnO,\ SO_3,\ HO$
$C_4\ H_4\ NO_3,\ HCl,\ HO$	$BaO,\ HCl,\ HO$
$C_4\ H_4\ NO_3,\ \bar{O},\ HO$	$KO,\ \bar{O},\ HO$

c.

$$\mathrm{C_4\ H_4\ NO_3,\ HO,\ \bar{A},\ 2HO\ |\ NH_3,\ \bar{A},\ 2HO}$$

As a Haloid Salt.

$$\mathrm{C_4\ H_4\ NO_3,\ KCl\ |\ Hg\ Cl,\ KCl.}$$

As a Bi-chlorid of Platinum.

$$\begin{array}{l|l} \mathrm{C_4\ H_4\ NO_3,\ \overset{+}{Ber},\ \ HCl} & \mathrm{Pt\ Cl_2,\ \overset{+}{Ber},\ HCl} \\ \mathrm{C_4\ H_4\ NO_3,\ BaCl,\ (2aq)} & \mathrm{Pt\ Cl_2,\ Ba\ \ Cl} \end{array}$$

As Ammonia.

$$\begin{array}{l|l} \mathrm{C_4\ H_4\ NO_3,\ PtCl_2\ (2aq)} & \mathrm{H_6\ N_2,\ PtCl_2\ \ (Gros.)} \\ & \text{or as haloid salt,} \\ & \mathrm{NH_4\ Cl,\ PtCl_2} \end{array}$$

As an Amphid Salt.

$$\begin{array}{l|l} \mathrm{C_4\ H_4\ NO_3,\ AgO,\ NO_5} & \mathrm{HgO,\ NO_5+AgO,\ NO_5} \\ \mathrm{C_4\ H_4\ NO_3,\ KO,\ NO_5} & \end{array}$$

As of the Magnesia Series.

$$\begin{array}{lr} \mathrm{C_4\ H_4\ NO_3,\ SO_3,\ KO,\ SO_8}\ \ .\ \ .\ \ .\ \ .\ \ . & 1 \\ \mathrm{C_4\ H_4\ NO_3,\ SO_3,\ NH_4\ O,\ SO_3+(2aq)}\ \ .\ \ .\ \ . & 2 \\ 1\ \ .\ \ .\ \ .\ \ .\ \ \mathrm{MgO,\ SO_3\ KO,\ SO_3+(6aq)} & \\ 2\ \ .\ \ .\ \ .\ \ .\ \ \mathrm{MgO,\ SO_3\ NH_4\ O,\ SO_3+(6aq)} & \end{array}$$

Basic Salts.

$$\left.\begin{array}{l} \mathrm{C_4\ H_4\ NO_3,\ HO} \\ \mathrm{2\ CuO} \end{array}\right\} \mathrm{NO_5\ HO\ |\ 3\ CuO,\ NO_5\ HO}$$

$$\mathrm{2\,(C_4\ H_4\ NO_3)\ HCl,\ HO\ |\ 2NH_3,\ Zn\ Cl,\ HO}$$

$$\mathrm{3\,(C_4\ H_4\ NO_3),\ 2SO_3,\ 2HO\ |\ 3Hg_2\ O,\ 2NO_5,\ 3HO}$$

And further:

$$\mathrm{C_4\ H_4\ NO_3,\ HO,\ AeO,\ SO_3\ |\ SO_3\ HO,\ AeO,\ SO_3}$$

$$\mathrm{C_4\ H_5\ NO_3,\ \bar{U}\ NH_4O,\ \bar{U}\ |\ HO,\ \bar{U},\ NH_4O,\ \bar{U}}$$

In the above tables we have representatives from almost every class of compounds in the domain of chemistry, and yet they are severally typified in the combinations of glycocoll.

We have it uniting with bases;—a characteristic of acids: uniting with acids;—a characteristic of bases: uniting with amphid salts; a characteristic of amphid salts.

We have it replacing a haloid salt in a binary chlorine compound; playing the part of bichlorid of platinum in another; now appearing in the magnesia series and again replacing water.

It will not be out of place to trace this relationship to other bodies in chemistry a little further, if it may aid in arriving at a nearer conception of the place glycocoll should hold.

The great truth that *the distinguishing properties of bodies depend upon the form, volume and density of their atoms*, or to use another form of expression, that *with every change of these attributes of the atoms, there is a corresponding change in the distinguishing properties of the masses*, is every day acquiring a more profound significance.

The chemical and physical differences between *phosphoric, pyrophosphoric* and *metaphosphoric* acids, are but the counterparts of different forms, volumes and densities assumed by the same elements in the same relative proportions.

The same is true of *cyanic, fulminic* and *cyanuric acids: of oxyd of methyle* and *alcohol:* of *hydrated acetic acid* and formate of *oxyd of methyle.*

It is well known that the several members of groups of isomorphous bodies;—the *alums* for example, have many chemical and physical attributes in common. They have also common *form* and *volume.*[*]

It requires but a little expansion of the thought naturally arising from the consideration of these facts, to come upon the enquiry: *are not acids as such, indebted for their distinguishing characteristic to a common peculiarity of form among their atoms; and bases to another for theirs, and salts to another for theirs?*[†]

Let this conception be entertained for the moment, and connect with the peculiarities of glycocoll the following considerations.

1. We have already seen that glycocoll contains the elements of *fumarate of ammonia;*

$$C_4\ H_4\ NO_3 = NH_3,\ C_4\ HO_3.$$

2. It may also be regarded as *cyanate of hydrated oxyd of methyl:*

$$C_4\ H_4\ NO_3 = C_2\ H_4\ O_2,\ C_2\ NO,$$

a sugar in which alcohol and carbonic acid are replaced by wood-spirit and cyanic acid.

The effort to obtain methyl alcohol by slow distillation of glycocoll from a solution in strong potash, failed.

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[*] Mitscherlich and Kopp.

[†] The following interesting relationship may be worth recording.

$$C_4\ H_3\ \genfrac{}{}{0pt}{}{H}{N}\ O_3 = \text{glycocoll.}$$

$$C_4\ H_3\ \genfrac{}{}{0pt}{}{H}{O}\ O_3 \times 3 = \text{grape sugar.}$$

$$C_4\ H_3\ \genfrac{}{}{0pt}{}{Pb}{O}\ O_3 = \text{sugar of lead.}$$

$$C_4\ H_3\ \genfrac{}{}{0pt}{}{H}{H_{\frac{2}{3}}O_{\frac{1}{3}}}\ O_3 = \tfrac{2}{3}\ \text{oxyd of glyceryle.}$$

$$C_4\ H_3\ \genfrac{}{}{0pt}{}{H}{N}\ O_3\ HO = \text{nitrous ether.}$$

These bodies have similar taste. Is it dependent upon the similar arrangement of their smallest particles?

One is here reminded of the large number of acids of this formula $(R) + O_3$. Is the sourness of this class dependent upon a common peculiarity of form?

Dumas has suggested that the compound produced when anhydrous sulphuric acid is conducted into an atmosphere of dry ammonia, may be considered *hydrated sulphite of amidogen:*

$$NH_3, SO_3 = HO, NH_2, SO_2.$$

Kane on the other hand, suggests that it be regarded as *hydrated sulphuric acid,* in which one atom of oxygen is replaced by one atom of amidogen.

$$NH_3, SO_3 = S \left\{ \begin{matrix} O_3 \\ NH_2 \end{matrix} \right\} H.$$

3. Glycocoll may be regarded as a *succinate of amidogen,*

$$C_4\,H_4\,NO_3 = NH_2, C_4\,H_2\,O_3,$$

4. Or as *malic acid* in which one atom of oxygen is replaced by amidogen.

$$C_4\,H_2\,O_4 = \text{atom of malic acid.}$$

$$C_4\,H_4\,NO_3 = C_4\,H_2 \left. \begin{matrix} O_3 \\ NH_2 \end{matrix} \right\}$$

5. If doubled it becomes *asparagin.*

$$2\,(C_4\,H_4\,NO_3) = C_8\,H_8\,N_2\,O_6.$$

Since the atom of water in crystallized glycocoll is replaced by both acids and bases, it may not be impossible to obtain from glycocoll a body identical in elementary composition with asparagin. Instances of metamorphosis of this description are not infrequent in the records of chemical investigation.

The conversion of *styrol* into *metastyrol* by heat* and by vibratory motion† in connection with machinery, is among the most remarkable. The spontaneous change of cyanate of ammonia into urea:‡ of aldehyd into metaldehyd:§ of hydrated cyanic acid into cyammelide:|| and the reconversion by distillation of cyammelide and cyanuric acid into cyanic acid: the change of alloxan into alloxanic acid: the metamorphoses of phosphoric acid by heat, and other similar phenomena by *contact* with alkalies, lend support to the supposition, that it may yet be possible to effect some of the metamorphoses above suggested—or some which follow.

6. It would not be more unexpected, than was the artificial preparation of urea, to make glycocoll by combining *urea* and *grape sugar.*

$$\underbrace{C_2\,H_4\,N_2\,O_2}_{\text{Urea.}} + \underbrace{C_6\,H_6\,O_6}_{\text{Half atom of grape sugar.}} = \underbrace{2(C_4\,H_5\,NO_4)}_{\text{Hydrated glycocoll.}}$$

7. The circumstance that in the preparation of the bisulphate of glycocoll and ammonia, fumaric acid is driven out, leads to

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* Blythe and Hoffman, Liebig's Annalen, Bd. liii, s. 311.

† Sullivan, Phil. Mag., 1845.

‡ Wöhler. § Liebig. || Liebig and Wöhler.

the following consideration. If upon separating the fumaric acid, it were to unite with uncombined glycocoll, there would arise a compound containing the elements of *asparaginic acid.*

$$\underbrace{C_4\,H_4\,NO_3+C_4\,HO_3}_{\text{Fumarate of glycocoll.}}=\underbrace{C_8\,H_5\,NO_6}_{\text{Asparaginic acid.}}$$

8. Two atoms of glycocoll contain also the elements of *allophanic ether.**

$$\underbrace{2\,(C_4\,H_4\,NO_3)}_{\text{Glycocoll.}}=\underbrace{C_4\,H_5\,O,}_{\text{Ether.}}\,\underbrace{C_4\,H_3\,N_2\,O_5}_{\text{Allophanic acid.}}$$

9. Hydrated glycocoll contains the elements of *nitric ether.*

$$C_4\,H_4\,NO_3,\,HO=C_4\,H_5\,O,\,NO_3.$$

Here are two bodies of the most opposite properties, one fluid and volatile, the other solid and cannot be sublimed.

We have a similar instance in the two forms of chlorid of cyanogen; the volatile discovered by Gay Lussac and the solid by Serrullas.

We have another in aldehyd and metaldehyd—a liquid and a solid body.

10. Two atoms of glycocoll and one of ammonia contain the elements of the *creatine* of Chevreul, recently analyzed by Liebig.

$$\underbrace{2(C_4\,H_4\,NO_3)}_{\text{Glycocoll.}}+NH_3=\underbrace{C_8\,H_{11}\,N_3\,O_6}_{\text{Creatine.}}$$

11. The base derived, by Liebig, from creatine, by boiling with baryta water, which separates urea (as CO_2 and NH_3), contains the elements of glycocoll and oxyd of methyl. It contains also the elements of the Lactamide of Pelouze.

$$\underbrace{C_8\,H_{11}\,N_3\,O_6}_{\text{Creatine.}}-\underbrace{C_2\,H_4\,N_2\,O_2}_{\text{Urea.}}=\underbrace{C_6\,H_7\,NO_4}_{\text{New base.}}=\underbrace{C_4\,H_4\,NO_3,}_{\text{Glycocoll.}}$$

$$\underbrace{C_2\,H_3O}_{\text{Oxyd of methyl.}}=\underbrace{C_6\,H_5\,O_4,\,NH_2}_{\text{Lactamide.}}$$

It will no longer seem strange that a body having so many relationships as are here exhibited, should find its place in the established classes of chemical compounds with difficulty.

The conclusion to which we have arrived in the progress of the investigation above recorded, is, that glycocoll may at the same time be an *acid*, a *base*, and a *salt*, since it has properties in common with each, that distinguish each from the other two.

In the possession of such a variety of attributes as attach to these three classes of bodies, glycocoll is without example in chemistry.

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* Liebig's Annalen, Bd. lix, s. 292.

Constitution of Hippuric Acid.

It has long been observed that in the preparation of hippuric acid, if the heat be too high or the evaporation too rapid, benzoic acid alone is obtained.*

If it be treated with sulphuric acid and peroxyd of manganese, carbonic acid is evolved, benzoic acid crystallizes from the hot filtered solution, and in the filtrate from the crystals sulphate of ammonia is formed.†

Berzelius‡ has remarked that sulphuric acid may be considered as a compound of benzoic acid and a body of this constitution:—

$$C_4\,H_4\,NO_3.$$

Pelouze had attempted to prove that hippuric acid consisted of one atom of hydrocyanic acid, one of oil of bitter almonds, and one of formic acid:

Hydrocyanic acid	=	C_2	H	N	. .
Hydrobenzoylic acid	=	C_{14}	H_6	. .	O_2
Formic acid	=	C_2	H	. .	O_3
Hippuric acid	=	C_{18}	H_8	N	O_5

Fehling§ entertained the view that it consisted of benzamide and fumaric acid.

Benzamide	=	C_{14}	H_7	N	O_2
Fumaric acid	=	C_4	H	. .	O_3
Hippuric acid	=	C_{18}	H_8	N	O_5

Over all this field of speculation Dessaigne's discovery has thrown the most grateful light.

Hippuric acid contains benzoic acid and glycocoll. With the aid of heat and a strong acid or alkali, the two members may be separated.

$$C_{18}H_9NO_6+HCl+2HO=C_{14}H_5O_3,HO+C_4H_4NO_3,HCl,HO.$$

or $C_{18}H_9NO_6+KO+HO=C_{14}H_5O_3,\ KO+C_4H_4NO_3,\ HO.$

By treating glycocoll with caustic potash, we obtain, among other products, cyanid of potassium and ammonia. If a stronger acid be applied to the former it yields hydrocyanic acid, which with water falls apart into formic acid and ammonia:

$$C_2\,NK+3HO+HCl=KCl+NH_3+C_2\,HO_3.$$

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* Schwartz, Annalen der Chem. u. Phar., liv, s. 30. Erdmann, Jour. für Practische Chemie, xiii, s. 422. Dumas, by treating hippuric acid with hypochlorous acid, Annales de Chem. et de Phys., lvii, p. 327.

† Berzelius Jahresbericht, 1840, s. 701.

‡ Jahresbericht, 1836, s. 462. In the Bericht for 1831, s. 240, a similar suggestion from a less perfect analysis of hippuric acid, is to be found. It is again repeated in the Bericht for 1840, s. 704.

§ Leibig's Annalen, Bd. xxvi, s. 60.

Glycocoll contains the elements of fumaric acid and ammonia. If the former alone be taken from hippuric acid there remains benzamide.

$$\underbrace{C_{18}H_8NO_5}_{\text{Hippuric acid.}} - \underbrace{C_4HO_3}_{\text{Fumaric acid.}} = \underbrace{C_{14}H_7NO_3}_{\text{Benzamide.}}.$$

Physiological Relations of Glycocoll.

Ure* observed that when benzoic acid is taken into the alimentary canal, it reappears in the urine as hippuric acid. This at the time startling announcement, has been verified in the most satisfactory manner by Garrod,† by Keller,‡ in the laboratory of Prof. Booth, Philadelphia, and in the Giessen laboratory.

Pettenkofer§ found in the medical examination of the urine of a girl, who suffered from St. Vitus' dance, and ate nothing but apples and bread, an unusually large quantity of hippuric acid. With the return to animal food, the abnormal proportion of this ingredient diminished.

The occurrence of this acid in the urine of horses and cattle, and of men who live chiefly upon vegetable food, is well known.

These facts taken in connexion with the newly developed constitution of hippuric acid, suggest an inquiry that may not be without interest, viz :—

Are glycocoll and benzoic acid, as such, a part of the tissues of the animal body?—of the albumen, caseine, and fibrine, supplied to it as food? and finally of the corresponding bodies in the seeds and juices of plants.

1. Braconnot obtained glycocoll by treating glue with sulphuric acid; Mulder and Boussingault by treating glue with caustic potash; and Keller obtained it by treating the tissues or the fluids of the body with benzoic acid.

The group of atoms constituting glycocoll resisted more firmly the destructive action of sulphuric acid and potash with the aid of heat, than the remaining members composing glue. These were for the most part oxydated or consumed.

The albumen, fibrine, and caseine received into, and secreted from the blood, no sooner become parts of the living organism, than they commence their return to the original carbonic acid, ammonia, sulphates, phosphates, water, etc., from which they were derived. They commence oxydation. This, however, does not affect all members of the complex compounds alike. In some instances glycocoll *escapes oxydation*, appearing in the urine

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* L'Institut, No. 399, 279, and No. 401, 294. Journal de Pharmacy, xxviii, p. 646.

† Phil. Mag., xx, p. 501.

‡ Pogg. Ann., Bd. lvi, 638. Liebig's Ann., Bd. xliii, s. 108. Central Blatt. 1844, s. 879.

§ Liebig's Ann., Bd. liii, s. 86.

as a member of hippuric acid, as it escaped oxydation with the potash and sulphuric acid.

2. Fumaric acid is present in a great variety of plants.* In asparagine† we have the elements of fumaric acid and ammonia, which with the requisite metamorphosis would become glycocoll.

$$2(NH_3, C_4\,HO_3)=C_8\,H_8\,N_2\,O_6=2(C_4\,H_4\,NO_3).$$

3. Schlieper‡ by treating isinglass with chromic acid, obtained among a variety of products benzoic acid.

It is found frequently in the vegetable kingdom, for example in gum-benzoin.

We have then benzoic acid and glycocoll (asparagine) in the vegetable kingdom, in the tissues of the animal body, and in the form of hippuric acid in the urine.

It remains to be ascertained if they be present in the *animal and vegetable albumen, fibrine, and caseine.*

Formation of Uric Acid Concretions.

Keller observed both urea and uric acid in the urine after the separation of hippuric acid, and therefrom concludes that Ure's suggestion that benzoic acid might be employed to prevent the formation of uric acid concretions, is too hasty.

The following experiment may have in connection with this subject sufficient interest to justify its being recorded.

The morning urine from mixed animal and vegetable diet, was evaporated over a water bath to thick syrup consistence, and tested for glycocoll. Neither in the alcoholic extract, nor in the residue, could a trace be recognized with the oxyd of copper test. Nitric acid gave a precipitate of urea, not, however, in large quantity.

At ten o'clock the next evening, four grammes of glycocoll were dissolved and taken in water. No consciousness of having taken any thing unusual was felt. The next morning urine reacted acid. Its color was the same as that of the previous day. Upon evaporation to syrup consistence, it presented a much larger quantity than before. One portion was supersaturated with concentrated oxalic acid, accurately neutralized with carbonate of soda and extracted with spirits of wine. Another portion was supersaturated with acetate of lead and treated with hydro-sulphuric acid. Upon evaporating to syrup the extract of the first, and the filtrate of the second, and testing both with the oxyd of copper, no trace of glycocoll was discovered. The glycocoll had

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* If we include malic acid, the number will be greatly increased. Buchner's Report, Bd. xxxiv, s. 368. Liebig's Ann., Bd. xxxi, s. 241; Bd. xxxviii, s. 257; Bd. li, s. 246.

† Geiger's Mag., xxxv, 42.

‡ Liebig's Annalen, Bd. lviii, s. 1.

then disappeared. In its place were urea and uric acid, both in larger proportion, as compared with the quantities of the previous day.

If we deduct, as has already been shown, half an atom of grape sugar from two atoms of hydrated glycocoll, we obtain urea:—

$$C_8 H_{10} N_2 O_8 - C_6 H_6 O_6 = C_2 H_4 N_2 O_2.$$

It is conceivable that glycocoll should thus divide, and that the sugar should disappear in the products of oxydation.

By treating it with nitric acid, with this view, no such result was obtained. Concentration or dilution, a strong heat or a moderate and long continued heat, gave no urea and no oxalic acid. One of the products is noticed on page 329.

Uric acid (as bibasic) may be contemplated as a cyanurate of glycocoll:—

$$C_{10} H_4 N_4 O_6 = C_6 N_3 O_3, C_4 H_4 NO_3.$$

If benzoic acid be capable of withdrawing glycocoll from uric acid, the remaining member, in the presence of water, would furnish the materials for carbonic acid and ammonia:

$$C_6 N_3 O_3 + 9HO = 6CO_2 + 3NH_3.$$

No great confidence can be placed in a single result of this description. Still whatever worth it has, seems to support the suggestion of Ure. Uric acid is found where the products of decomposition are too imperfectly oxydated.* Those who suffer from uric acid concretions are principally sedentary persons. Exercise by increasing the supply and furthering the action of oxygen, more perfectly secures the oxydation of the products of decomposition.

Could a part of the products destined to consume oxygen be withdrawn, the usual supply through the lungs might be adequate to the complete oxydation of the remainder, and thus the formation of uric acid concretions be rendered impossible. Glycocoll is one of these products. If united to benzoic acid, a consumer of oxygen is withdrawn from the blood.

A series of experiments upon given diet, with and without benzoic acid, could not fail to solve this important question.

With this investigation, and particularly with the products of decomposition of glycocoll, which so far as here recorded, may be considered rather as qualitative than quantitative, it is our purpose to proceed with as little delay as possible.

Note.—It may not be improper to state that Baron Liebig employs his own time and that of his assistants, and the appliances of his private laboratory, in great part, in labors to ascertain methods of cheap and expeditious preparation, that he may spare

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* Liebig's Thier Chimie, 2e. Ausg. s. 125.

the time, means, and patience of the young chemists in his school. He brings to bear his vast experience in this most difficult of all chemical labor—the preparation in their purity of chemical substances.

He had been employed six months in finding out a better method than that of Braconnot or Mulder, for obtaining gelatine sugar, when in the winter semestre of 1845–46, I expressed a wish that he would give me, for a change from the labors in which I had been for some months engaged, a crystalline body, whose study would increase my knowledge of organic chemistry. In compliance with this request he gave me some three ounces of exquisitely beautiful transparent prismatic crystals, whose analysis I employed myself immediately in making. He remarked to me of the method of preparation and of some of its properties, and of much more that I could not retain, and I went to the back journals to ascertain what investigation of it had been made; at the same time making repeated analyses of the pure body, its hydrochlorate and anhydrous sulphate.

The result of this labor and a review of Boussingault's analyses, satisfied me that the constitution of the body, combining with acids, bases, and salts, was—

$$C_4 H_4 NO_3.$$

When I had come to this conclusion I had not read the article in the Comptes Rendus, containing Dessaigne's discovery, and felt indebted to no one for the constitution of the body.

Gerhardt's suggestion that the body was—

$$C_2 H_5 NO_2 = C_4 H_{10} N_2 O_4 \cdot \tfrac{1}{2}$$

with his annotation, or $C_4 H_5 NO_4 \cdot \frac{1}{2}$, according to that of Liebig and Gmelin, I could not reconcile with the analysis of the anhydrous sulphate; and this also came under my eye after my opinion of the constitution had been formed.

Dessaigne had the honor of having made one of the most brilliant of recent discoveries, but he made no analysis. Laurent made an analysis in the wake of Dessaigne's announcement, confirming the suggestion of Dessaigne, that hippuric acid was a compound of benzoic acid and gelatine sugar. The latter however is not *the body*, glycocoll, but its *hydrate.*

After my paper went into the hands of the conductor of Liebig's Annalen, Mulder's paper, giving the constitution as

$$C_8 H_{10} N_2 O_8$$

in Erdmann and Marchand's Journal, appeared. This however was not the body, but its *hydrate* doubled.

ART. XXVI.—*Singular Property of Caoutchouc, illustrating the value of Latent Heat in giving Elasticity to solid bodies, and the distinct functions in this respect of latent and free or sensible heat;* by CHARLES G. PAGE, M.D., Prof. Chem. National Medical College, Washington, D. C.

THE fact is familiar that if a strip of India rubber is forcibly stretched, it becomes quite hot from the development of latent heat, owing to the compression which the particles undergo in one direction, by distention in another; and on suffering the strip to relapse, the heat thus developed is absorbed or becomes latent, and the strip appears with its original degree of sensible heat. While thus much has been known nearly as long as the article caoutchouc has been in common use, yet I believe no special observations have been made upon this point, and the following interesting fact, first noticed by me about ten years ago, has excited no particular attention. If when the strip of rubber is in the stretched condition, it be quickly cooled, which can be readily done by wetting it, and evaporating the moisture by vibrating or moving it rapidly in the air, it will be found to have lost its elasticity, and may be left for an indefinite time without regaining its elastic property. It resembles a piece of frozen rubber in some respects, although not quite so rigid. A piece of this substance, which has become stiff and inelastic by exposure to a a great degree of cold soon regains its elasticity by immersion in an atmosphere of 70° Fahr., or even much below this. But the rubber deprived of its latent heat by compression, I have kept in an atmosphere of 80°, for several weeks, without its returning to its normal condition. If the heat be raised much above 80°, or if it be placed in contact with a good conductor at 80°, it gradually recovers its latent heat, and in a few minutes is restored to its original dimensions. A curious sensation is experienced if it be inclosed in the hand, like the creeping of an insect. If successive portions of the inelastic strip be pinched between the thumb and finger, it contracts powerfully in these parts, leaving the others unaffected, and presenting the appearance—as in the figure—of a string of knots or beads, which may be preserved in this state for any length of time, if not handled, and kept at a moderate temperature. Upon examination by a sensitive thermometer, the portions *a* and *b* are found to be of the same temperature. As regards the amount of heat contained, the portions *a* and *b* differ considerably, and in respect to latent heat, *a* may be said to be positive and *b* negative. The junction of the two portions continues abrupt and well defined, as

seen in the figure, showing that there is no tendency to distribution or equilibrium of latent heat between the two portions. When the inelastic strip is inclosed in the hand, a slight degree of coolness is felt from the rapid absorption of heat.

I have been led to revive these interesting facts, in consequence of a recent observation of the difference, in this respect, between the native and the artificial rubber. The artificial rubber is at present prepared in two ways; first, by solution in turpentine and subsequent drying, and chiefly now without the aid of any solvents, by merely grinding the native rubber to a pasty mass, and reducing it to thin sheets between a succession of heated rollers.* In both of these preparations, the peculiarity of the native rubber, above noticed, is hardly perceptible. It is somewhat remarkable that the interesting substance, gutta percha, appears very much like the India rubber when rendered inelastic as above, or by exposure to cold. This valuable modification of caoutchouc, gives according to Dr. Maclagan, by ultimate analysis, carbon 86·36, hydrogen 12·15; and caoutchouc, according to Faraday, gives carbon 87·2, and hydrogen 12·8. The gutta percha yields by destructive distillation similar products to caoutchouc. Like caoutchouc it is soluble in coal naphtha, in caoutchoucine, and in ether, and insoluble in water and alcohol. "Its most remarkable and distinctive peculiarity, as stated by Dr. Maclagan in his communication to the Scottish Society of Arts, is the effect of heat upon it. When placed in water at 110°, no effect is produced upon it, except that it receives the impression of the nail more readily; but when the temperature is raised to 145° or upwards, it gradually becomes so soft and pliant, as to be capable of being moulded into any form, or of being rolled out into long pieces or flat plates. When in the soft state, it possesses all the elasticity of common India rubber, but it does not retain this property long. It soon begins again to grow hard, and in a short time, varying according to the temperature and the size of the piece operated upon, regains its original hardness and rigidity." May not this be a case of isomerism, in which the different arrangement of atoms determines these physical distinctions? The specific heat of gutta percha, I presume, has not yet been determined, but it would be interesting to compare the two substances in this respect.

August 31st, 1847.

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* **During the operation of rolling, great quantities of electricity are developed.**

ART. XXVII.—*Caricography;* by Prof. C. DEWEY, M.D.

(Continued from Vol. iii, ii Ser., p. 356.)

No. 213. *C. intermedia*, Good. Schk., No. 18, Tab. B, fig. 7.

Spicis androgynis distigmaticis ovatis confertis alternis, superioribus et inferioribus pistilliferis vel rarò superne staminiferis, intermediis staminiferis perrarò diœcis; bracteis ovato-lanceolatis; fructibus ovatis rostratis bidentatis convexo-concavis margine ciliato-serratis vel serrulatis, squama ovata acuta paulo longioribus; culmis erectis inferne foliatis.

Culm 12–18 inches high, triquetrous, leafy towards the base, rough on edges above; leaves linear, flat, striate, rarely as long as the culm; spikelets many, ovate, clustered, alternate, the highest and lowest pistillate with often a few staminate florets at the apex, the intermediate often wholly staminate, and sometimes all the spikelets staminate entirely or the plants diœcious; stigmas two; fruit ovate, rostrate, serrulate on the margin, convex on the upper side and concave on the lower; pistillate scale ovate, acute, a little longer than the fruit.

Common in the north of Europe, and by some considered a variety of *C. arenaria;* first recognized in the plants of Arctic America by Dr. Boott; lately found in Wisconsin by I. A. Lapham, Esq. The fruit of *C. arenaria*, L., is broader, less lanceolate. From *C. Sartwellii*, Dew., which has also lately been found by Dr. Cooley in Mich., this is clearly different.

No. 214. *C. maritima*, Vahl. Schk, Tab. W, fig. 74.

Spicis staminiferis 1–3 cylindraceis sub-pendulis cum squamis ovatis longo-aristatis; spicis pistilliferis 1–3 cylindraceis *distigmaticis* bracteatis recurvatis; fructibus suborbiculatis brevi-rostratis vel apiculatis ore emarginatis nervosis, squama ovata oblonga acuta aristata vel emarginata aristata brevioribus.

Culm 10–18 inches high, erect, triquetrous, leafy towards the base; bracts long and leafy, scarcely sheathing; staminate spikes commonly two or more, with ovate and awned scales; pistillate spikes 1–3, cylindric, close jointed, pendulous, and the peduncles scarcely sheathed at the base; stigmas two; fruit ovate, roundish, compressed, obtuse, apiculate or very short beaked, nerved; pistillate scale ovate, acute and awned, or oblong emarginate and long awned, longer that the fruit.

Common in Norway. Found by *Mr. Drummond* at Hudson's Bay and Cumberland House, (Boott,) and by *Dr. Richardson.* (Torrey.)

No. 215. *C. salina*, Wahl. Schk. Tab. Cccc, fig. 185.

Spicis staminiferis 1–2 erectis cylindraceis, inferiori sessili; spicis pistilliferis 2–3 cylindraceis erectis subdistantibus brevi-pedunculatis bracteatis densifloris *distigmaticis;* fructibus ellipticis brevi-apiculatis utrinque convexis ore integris, squama oblonga acuta brevi-aristata brevioribus.

Culm 8–16 inches, leafy towards the base, with long and leafy bracts often undulate at their origin; staminate spikes about two, erect, oblong, with oblong and obtuse scales or varying to lanceolate, the lower one often with some fruit; pistillate spikes 2–3, erect, cylindric, scarcely sheathed at base, rather close-fruited; stigmas two; fruit ovate or elliptic, roundish, short-apiculate or rostrate, convex on both sides; pistillate scale ovate, oblong, acute, short-awned and longer than the fruit.

Found in Arctic America by *Beechy* and *Drummond*, (Boott,) and common on the shores of Norway.

No. 216. *C. aperta*, Boott. Boott in Hook., Fl. Bor. Am., No. 82, Tab. 219.

Spicis staminiferis, 1–2, cylindraceis erectis; spicis pistilliferis, 2–4, *distigmaticis* oblongis supernè approximatis cylindraceis sessilibus apice staminiferis, inferiore subremota pedunculata; fructibus ovatis orbiculatis stipitatis brevi-rostratis ore bidentatis, squama acuta lanceolata brevioribus.

Culm 12–18 inches high, erect, triquetrous, rough on the edges, with sheathing leaves towards the root which are shorter than the culm; bracts leafy below and auriculate; staminate spikes 1–2, long, cylindric, lower sessile, with obtuse darkish scales; pistillate spikes two to four, oblong, erect, close-fruited, approximate above, often staminate at their apex, and the lowest rather remote and pedunculate; stigmas two; fruit roundish, short apiculate, or rostrate, stipitate, bidentate; pistillate scale lanceolate, acute, larger and much narrower than the fruit.

Found at Columbia river by *Douglas* and at Columbia river by *Richardson*,—Boott. Resembles one form of *C. cespitosa*, but appears different.

No. 217. *C. glareosa*, Wahl. Schk. Tab. Aaa, fig. 97.

Spica terminali androgyna inferne staminifera oblonga pedunculata; spicis pistilliferis binis (1–2) oblongis sessilibus approximatis distigmaticis densifloris; fructibus oblongis acuminatis ore integris nervosis convexis, squamam ovatam acutam paulo superantibus.

Culm 6–10 inches high, smooth, triquetrous, leafy at base; leaves linear lanceolate much shorter than the culm; spikes 2–3, ovate, oblong, upper one staminate below and with staminate scale ovate and oblong and acutish; pistillate spikes 1–2, approximate and sessile; stigmas two; fruit ovate-oblong, acuminate, slightly nerved, convex above, and longer than its ovate and acute scale.

Found in Greenland by Horneman, (Boott,) and not uncommon in Norway.

No. 218. *C. elongata*, L. Schk. Tab. G, fig. 25.

Spica composita; spicis 6–12, ovatis oblongis subsessilibus subapproximatis *distigmaticis* inferne staminiferis erectis subdensifloris; fructibus ovatis tereti-acutis convexis ore brevi-dentatis vel subintegris, margine subscabris, subpatulis, squama ovata obtusa longioribus.

Culm 12–20 inches high, erect, leafy below, triquetrous and scabrous; leaves linear often surpassing the culm; spikelets numerous, six to twelve, ovate, oblong, sub-remotish, nearly sessile, staminate at the base; fruit ovate, acute or long acuminate, convex, fine serrulate on the edge, nearly entire at the orifice or slightly toothed, slightly diverging; pistillate scale ovate and obtuse, about half as long as the fruit; plant yellowish-green.

Found in Russian America by Bongard, (Boott,) and common in Europe.

No. 219. *C. Heleonastes*, L. Schk. Tab. Ti, fig. 97.

Spicis subquaternis ovato-globosis sessilibus confertis inferne staminiferis; fructibus ovatis acutis convexis subbidentatis subpatulis vix margine serrulatis, squamam ovatam oblongam obtusam vix superantibus.

Culm near a foot high, erect, with linear leaves about half as long as the culm; spikelets 3–4, ovate, sessile, approximate, staminate at their base; stigmas two; fruit ovate, acute, convex, compressed, slightly two-toothed, some diverging, very slightly scabrous on the edge; pistillate scale ovate and oblong, obtuse, or sometimes slightly apiculate, a little shorter than the fruit; plant light green.

Found in Arctic America by *Drummond and Richardson*, Boott; and common in the marshes of Sweden.

Dr. Boott refers *C. Carltoniana*, D., to this plant, and if that had more than one androgynous spike, the reference would be correct. C. Carltoniana seems very diverse from the other, and far remote from the figure of *C. Heleonastes*, Schk.

No. 220. *C. amplifolia*, Boott. In Hook. Flor. Bor. Am., No. 158, Tab. 226.

Spica staminifera solitaria perlongo-cylindracea longo-pedunculata; spicis pistilliferis *tristigmaticis* longo-cylindraceis distantibus foliaceo-bracteatis; fructibus ovato-lanceolatis rostratis bidentatis, squamam lanceo-aristatam multo superantibus; foliis latis longisque.

Culm two feet high, scabrous-triquetrous; leaves long and broad in the middle and much shorter at the root and smaller; bracts long and leafy, scarcely sheathing; one staminate spike, very long, and pecundulate, with brown and lanceolate scales; pistillate spikes 4–5, long cylindric, loose-flowered, erect, highest sessile, all remote, pedunculate; pistillate scale lanceolate, and the lower long and rough awned, about twice as long as the first.

Found at Columbia River by *Douglass*,—Boott. This splendid Carex is indeed *amply furnished with leaves.*

No. 221. *C. paradoxa*, Willd. Schk. Tab. E, fig. 21.

Spiculis superne staminiferis ovatis oblongis arctè ramoso-paniculatis, ramis inferioribus subremotis, superne aggregatis; fructibus *distigmaticis* ovatis subrotundis convexis compressis tereti-acutis vel rostratis bidentatis margine serrulatis, squamam ovatam oblongam acutiusculam sub-æquantibus; culmo subtriquetro scabro inferne foliaceo.

This species, not uncommon in wet places in Germany, and found by Dr. Richardson in Arctic America, is closely related to *C. paniculata*, L. It differs in being a smaller plant, and much less branching-paniculate, and its fruit is less broadly ovate and lengthened into a beak, while its scale is less broad and less acute.

No. 222. *C. nardina*, Fries.—*C. Hepburnii*, Boott in Hook. Fl. Bor. Am., No. 6, Tab. 207.

Spica solitaria androgyna apice staminifera ovata *distigmatica*; fructibus ovatis vel ellipticis acuminatis compressis brevi-bidentatis margine scabris, squamam ovato-oblongam sub-æquantibus; foliis setaceis hispidis culmum brevem æquantibus.

Culm 3–5 inches high, with rough setaceous leaves sheathing the base and long as the culm; staminate flowers 3–4 at the apex of the spike with narrow lanceolate scales; stigmas two; fruit ovate, acuminate, acutish, convex, compressed; pistillate scale oblong, broad, about as long as the fruit.

Found on the Rocky Mts. by *Drummond*—Boott.

No. 223. *C. Pyrenaica*, Wahl.

Spica unica androgyna apice staminifera *tristigmatica* oblonga per-densiflora; fructibus numerosis angusto-oblongis conico-triquetris brevi-rostratis divergentibus, squamam ovatam oblongam vix superantibus.

Culm 3–5 inches high, triquetrous, with leaves towards the base linear and flat and nearly as long as the culm; spike single, ovate and oblong, tapering above, at the summit staminate, with lanceolate staminate scales; stigmas three; fruit numerous, oblong, tapering or lanceolate, short rostrate, diverging; pistillate scale oblong, acutish, nearly equalling the fruit.

Inhabits the Pyrenees, and was found on the Rocky Mountains by *Drummond*,—Torry and Boott. The plant from the Pyrenees has rather smaller spikes and other parts. Schk. refers *C. Pyrenaica* to his *C. spicata;* but *C. spicata*, Schk., Tab. D, fig. 15, seems to be *C. Pyrenaica*, Wahl., var. *acutissima* as given by Persoon, on which the flowers are erect and often chiefly staminate.

No. 224. *C. æstivalis*, Curtis. Gray, Am. J. of Sci., xlii, 28.

Spica terminali androgyna superne stamenifera pedunculata cum squamis numerosis staminiferis oblongis subobtusis; spicis pistilliferis 2–4 gracili-cylindraceis suberectis laxifloris bracteatis, infima pedunculata inferne distanti-flora; fructibus *tristigmaticis* elliptico-triquetris utrinque teretibus ore integris glabris, squama ovata obtusa sæpe mucronata longioribus.

Culm 16–24 inches high, slender, triquetrous, leafy towards the base; leaves linear, flat, pubescent, nearly equalling the culm; bracts leafy, long at the lower spikes, scarcely sheathing; spikes 3–5, slender, cylindric, suberect, the terminal spike androgynous with numerous staminate flowers below; pistillate spikes sessile except the lowest, which has remote fruit at the lower part; stigmas three; fruit ellipsoid and slightly tapering to each end, slightly nerved; pistillate scale ovate, obtuse, sometimes acutish or with a mucronate point, shorter than the fruit; grows in tufts.

Found on the Mountains of North Carolina, by Rev. M. A. Curtis of Hillsboro', and named from its long period of flowering in July and August. Its resemblance to *C. gracillima*, Schr., was early pointed out by its accurate discoverer, and its difference also noticed, and as finely by Dr. Gray. It belongs in the same group as *C. virescens.*

Note.—In the Transactions of the Lin. Soc., England, for 1845–6, Dr. Boott described *fifty new* or rare species of Carex. Among them is *C. comosa*, Boott, which had in the United States been placed under *C. pseudo-cyperus*, L., from its near resemblance and unwillingness to multiply species, and thus had been the plant described as the Linnæan species, as it was also more common and more striking. The differences have long been remarked; and Mr. Elliott, in his plants of South Carolina, named it *C. furcata*, Ell. As that specific name had already been appropriated, Dr. Boott has described it under *C. comosa.* This form was described in this Journal, Vol. xi, p. 71, under the Linnæan name. Omitting the references there made, the correct reading would be, No. 36, *C. comosa*, Boott. As the plant of Linnæus also inhabits our country, it becomes necessary to give its characters and distinguish it from *C. comosa*, Boott.

No. 225. *C. pseudo-cyperus*, L. Schk. Tab. Mm, fig. 102.

Spica staminifera solitaria longo-cylindracea erecta pedunculata bracteata; spicis pistilliferis subternis cylindraceis densifloris (immaturis suberectis) pedunculatis pendulis *tristigmaticis*, superioribus subapproximatis, infima distanti longo-pedunculata subvaginata, omnibus foliaceo-bracteatis; fructibus divergentibus demum retroflexis ovato-lanceolatis brevi-stipitatis rostratis nervosis ore bidentatis vel brevi-furcatis, squamam ovato-lanceolatam scabro-aristatam paulo superantibus.

Culm two feet high, sharp-triquetrous, very rough on the edges; leaves linear, flat, nerved, rough, longer than the culm; bracts long and leafy, the lower especially longer than the culm and more or less sheathing; staminate spike single, bracteate, with long lanceolate, hispid-awned scales; pistillate spikes 2–4, long-cylindric, long pedunculate, suberect when young, at length recurved and pendulous, the lowest distant and longer pedunculate; stigmas three; fruit ovate, lanceolate, rostrate, nerved, diverging and finally reflexed, bidentate or with diverging forks; pistillate scale ovate lanceolate, rough awned, and scarcely equalling the fruit; bright green, in tufts on the borders of ponds and streams.

On the specimens of this species from England and Germany, the scales are shorter than the fruit, contrary to the figure of Schk. and most of the descriptions, and the teeth of the fruit vary also, as on our plant, from short and straight to longer and some diverging or furcate.

C. comosa, Boott, has larger and thicker stem, leaves and spikes; fruit longer rostrate and more stipitate; and the teeth or forks are longer, deeper, much spreading and partially recurved, producing a *hairy* or *comose* appearance. Its staminate spike not unfrequently has some fruit at its apex. It is a more common plant, though not very abundant. When compared, the two are readily distinguished by the fruit, though so much alike in very many characters.

N. B. The Carex, Vol. xlix, p. 48, should be *C. Tuckermani*, Boott.

Note.—As several species of Carex, which have been described as having stigmas 2 or 3, have been found to be different species, it is probable that more extended observations will prove all such to be different species which have a different number of stigmas, as they differ in the form of the seed or achenium.

Additional specimens have thrown much light on the following species.

C. Woodii, D. Vol. ii, ii Ser., p. 249.—*C. tetanica*, Muh., (not of Schk.)

With all his accuracy, Muh. confounded *C. plantaginea* and *C. anceps;* described as *C. conoidea*, a plant distinct from that species of Schk. already figured by the latter; and gave *C. tetanica* to a species very different from the description and figure of Schk., Tab. Oooo, fig. 207, which was also described in this Journal, Vol. xi, p. 312. Hence *C. tetanica*, Muh., must have another name, and I have given to it that of *C. Woodii*, clearly the plant of Muh., and as certainly not *C. tetanica*, Schk. Dr. Wood speaks of it as erect, bright green, slender, a foot to twenty inches high, growing singly or not in tufts, presenting a beautiful appearance, culm obtusely triquetrous, and having fruit in maturity frequently open and oblique at the orifice. It needs only to be added that Muh. himself doubted, as well he might, whether his plant was identical with the plant of Schk., as it clearly is not.

C. tetanica, Schk., has obovate fruit, with a short but distinct recurved beak, of the *lock-jaw* kind, as its name implies, and the surface is distinctly scabrous or short hirsute, with an ovate, short acute scale, the lower ones often mucronate, the upper ones of the form given by Schk., Tab. Oooo, fig. 207. The fruit of *C. Woodii* has no such beak as is given by Schk. to his *C. tetanica*, and is glabrous, growing on two pistillate spikes, sometimes one or three. It has undoubtedly been confounded with a narrow leafed *C. anceps*, though it differs so greatly from it in several respects.

No. 226. *C. oligocarpa*, Schk.

Spica staminifera unica pedunculata cum squamis oblongis obtusis; spicis pistilliferis subternis (2–4) 3–6-floris laxis distantibus tristigmaticis, superiore sessili, inferioribus pedunculatis brevi-vaginatis; fructibus subrotundo-triquetris obovatis rostellatis ore integris glabris, squama ovata oblonga mucronata subduplo-longioribus.

Culm a foot or more high, decumbent, slender, sometimes nearly prostrate in maturity, triquetrous, smooth, with short, nearly radical and lanceolate leaves; bracts leafy, lanceolate, about equalling the culm with short sheaths; staminate spike single, slender, without a bract, and having oblong and obtuse scales; stigmas three; pistillate spikes 2–4, usually three, with 3–6 fruit, distant, loose-flowered, upper one sessile, and the lower short pedunculate; fruit obovate, roundish three-sided, short rostrate or alternate, smooth, at the orifice entire; pistillate scale ovate, oblong, mucronate, white and membranous on the edges, shorter than the fruit; plant fine green.

The striking resemblance of this plant to the figure and language of Schk. is obvious. The difference also between it and *C. Hitchcockiana* is manifest. It is not at all pubescent, and the fruit of *C. Hitchcockiana* is much longer on plants of equal size, much longer and more conic rostrate, more terete at both ends, and when its beak is recurved the form is wholly different from this, and its scale and mucronate point long as the fruit. A sight of the two dissipates all notions of their identity or very close resemblance, though one form of it has been thus misplaced.

But *C. oligocarpa*, Muh., is not this plant. *That* was described Vol. x, p. 280, on the authority of Muh. as the *C. oligocarpa*, Schk., and which has for some years been known as *C. digitalis*, Willd., and its var. *C. Van Vleckii*, and of which *C. digitalis, Muh.*, is probably only a peculiar form. The description of Muh. does not accord with *C. oligocarpa*, Schk. The mistake about *C. oligocarpa*, Schk., the source of much difficulty in relation to some others, is now rectified.

ART. XXVIII.—*On the Action of Sulphuretted Hydrogen upon Nitric Acetene;* by T. S. HUNT.

IN my communication of May 29th,[*] on the relations between glycocoll and alkargene, I stated that nitric acetene (the hyponitrite of oxyd of ethyle of Liebig) is decomposed by sulphuretted hydrogen with the separation of sulphur, and suggested that from analogy we might expect the formation of a new alkaloid, which from the known tendency in bodies of the acetic series to polymorphosis[†] might be derived from the elements of two equivalents of the ether, and possess the composition $C_8 H_{12} N_2 O_2$, having the same relation to glycocoll that alkarsine has to alkar-

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[*] See this Journal, ii Ser., vol. iv, p. 266.

[†] M. Gerhardt has proposed to designate by the following terms the four kinds of metamorphosis which embrace all the chemical transformations of organic bodies. 1st. *Symmorphosis;* this includes those reactions which consist in the direct addition or fixation of another substance, as the combination of the alkaloids with acids and of chlorine with certain hydrocarbons. 2d. *Apomorphosis;* this denotes such changes as are produced by the subtraction or elimination of certain elements; thus salts of ammonia lose the elements of water and become amids, and acids in the same manner yield anhydrids. 3d. *Polymorphosis;* this represents a multiplication or combination of two or more equivalents of a compound. Thus three atoms of aldehyde unite to produce a new isomeric body, and under the influence of ammonia, three equivalents of benzoilol coalesce to form with it, one of hydrobenzamid. 4th. *Diamorphosis;* this implies a division or breaking up of a compound into simpler forms, as when an equivalent of cyanuric acid is resolved by heat into three of cyanic acid; or glucose under the influence of certain ferments, into carbonic acid gas and alcohol.

gene. Although my subsequent experiments have not verified this conjecture, they have led to the discovery of a new reaction which is not without interest.

The ether employed in the following experiment was prepared after Liebig's method, by passing the nitrous vapors, evolved by the action of nitric acid upon starch, into a carefully cooled mixture of alcohol and water, and condensing the volatile product in a tube surrounded by ice. It was washed two or three times with water and finally dried by chlorid of calcium. Thus prepared it had all the characters assigned by Liebig to the pure ether.

I. An alcoholic solution of the ether mixed with a little water of ammonia, was placed in a tubulated retort surrounded by ice and connected with a condensing apparatus. A slow current of sulphuretted hydrogen was now passed through the liquid which assumed a dark orange color and almost immediately began to deposit sulphur. Considerable heat was evolved and a portion of the ether distilled over unchanged. When the separation of the sulphur had ceased, and the deep yellow fluid gave evidence of the presence of hydrosulphuret of ammonia, a solution of the ether was added in small portions, until the mixture no longer discolored the salts of lead. It was now carefully neutralized by dilute sulphuric acid and distilled in a water-bath to one half. The residue in the retort was carefully examined and was found to be simply sulphate of ammonia. The alcoholic distillate had a slightly alliaceous odor like mercaptan. In one experiment, operating upon ether, probably impure, a liquid was obtained, with a powerful taste and odor recalling that of garlic.

II. About fifty grains of the ether were introduced into a glass globe and a stream of pure moist sulphuretted hydrogen was conducted to the bottom. The globe was immediately filled with a white cloud and the sides were soon coated with pure sulphur, which was precipitated in such abundance as to make the liquid at the bottom quite thick. When the reaction was finished, the contents of the globe were washed out with a little water; the liquid was alkaline to tumeric paper. A little hydrochloric acid was added, the liquid boiled, filtered, mixed with a solution of chlorid of platinum and evaporated to dryness in a water-bath. The residue washed with alcohol, left a quantity of yellow salt, which, under a magnifier, presented the form of brilliant octahedrons which were readily recognized as the ammonio-chlorid of platinum.

III. These trials led to the conclusion that the reaction resulted in the complete decomposition of the nitric acetene into ammonia and alcohol, and the following experiments placed this beyond a doubt. Having ascertained that the alkaline sulphurets and hydrosulphurets effected this decomposition, a solution of twenty grains of hydrate of soda was saturated with sulphuretted hydrogen. This was mixed with about two ounces of dilute alcohol and 300 grains of the ether, and the solution being carefully cooled by ice, a slow current of sulphuretted hydrogen was passed through until the decomposition was completed. An alcoholic solution of the ether was then carefully added to decompose the excess of the gas in the solution; it was then separated from the precipitated sulphur and neutralized by dilute sulphuric acid. The liquid gave an abundant yellow crystalline precipitate with chlorid of platinum and contained a large quantity of sulphate of ammonia, besides which, nothing but the salt of soda could be detected.

IV. *A dilute solution* of hydrosulphuret of ammonia was placed in a strong bottle with a well ground stopper, and cooled by a bath of ice and water. A small portion of the ether was then added, and the bottle immediately closed. The reaction was violent, and owing to the great volatility of the ether, it was necessary to confine the stopper; when the action was finished, another portion was introduced, until by successive additions of hydrosulphuret of ammonia, 250 grains were decomposed. The clear liquid was then separated from the precipitated sulphur, neutralized by dilute sulphuric acid, and agitated with oxyd of lead to remove the excess of sulphuretted hydrogen, it was then submitted to distillation in a water-bath until about 200 grains of liquid had passed over. This had the smell and taste of dilute spirit of wine; when warmed with a mixture of bichromate of potash and sulphuric acid, the latter was readily reduced with the evolution of aldehyde, which was at once recognized by its odor.

In this reaction one equivalent of nitric acetene and six of sulphuretted hydrogen yield one of alcohol, one of ammonia, two of water, and six of sulphur:—

$$C_4H_5NO_4+6HS=C_4H_6O_2+NH_3+2HO+6S.$$

As M. Laurent has lately confirmed the observations of M. Gerhardt, that nitric acetene is produced by the action of nitric acid upon brucine, we are enabled by this reaction to form alcohol by a new process, independent of the fermentation of glucose and from a compound much higher in the organic scale.

The nitric ether of wood-spirit, *nitromethol,* is also decomposed by hydrosulphuret of ammonia, although less rapidly than the nitric acetene; crystals of sulphur separate, and the liquid contains a volatile compound of a powerfully alliaceous odor, resembling that of mercaptan. I have not been able to examine it farther.

P. S. Since the above was written, I have received the Journal de Pharmacie et de Chemie, from which I learn that M. Emile Kopp has already investigated the action of sulphuretted hydrogen upon nitric acetene, and has arrived at the same result as myself. But as the remarks in my last communication (p. 266) require some explanation, I here publish my results, and an account of the processes employed. M. Kopp has also shown that the nitric ether (nitrate of oxyd of ethyle of Liebig) is decomposed in a similar manner by hydrosulphuret of ammonia with the production of ammonia and sulphur-alcohol or mercaptan.

Montreal, July, 1847.

Art. XXIX.—*Description of a Meteoric Stone which fell in Concord, New Hampshire, in October*, 1846; by Prof. B. Silliman, Jr.

My attention was called to this remarkable body by Mr. Abiel Chandler of Concord, N. H., who, in October, 1846, sent me some small fragments of it in a letter, requesting an opinion on its character, and stating the fact that J. S. Noyes, Esq. of that place, was witness to its fall and had retained the meteorite in his possession up to that time. The fragments sent by Mr. Chandler so little resembled, in physical character, any meteoric body which I had before seen, that a letter of particular inquiry was addressed to Mr. Noyes through Mr. Chandler, calling for all the circumstances of the fall and asking the privilege of examining the specimen in his possession. I received in reply, a letter from Mr. Noyes, from which I will make some extracts. The letter is dated Concord, New Hampshire, Oct. 19, 1846. After describing the isolated position of his house on a sandy plain, he goes on to say: "Some time in the month of October, 1840, about two hours after sunset on a bright starry evening, I stood in the road, south of my house some six rods, with my arm resting upon the fence, and facing the southwest, gazing at the stars. Whilst looking up almost perpendicularly, I saw a star, or fireball, fall a considerable distance and then become extinct. Some little time after, I heard a noise in the air, such as a falling body would make, and immediately after I saw a small body strike upon the top board of the fence, about fifteen feet before me, and glance into the road some six feet, then bounding and rolling along several feet farther. I immediately commenced a search, stooping down and feeling in the grass around where I last saw it. After some little search, I picked up the substance in my possession and carried it into the house and examined it. Its appearance being different from what I expected, caused me to make sure by visiting the spot early on the following morning and giving it a further search, the result of which was I found not the least movable substance in the place of its fall. From the circumstance here narrated, I came to the conclusion that I had obtained the body which fell, and that it had a connection with the star described above. I am well aware that it is an easy thing to be deceived, but sure I am that if mistaken in this instance, no man will be able to undeceive me. The pieces which broke out by the fall I gave to Rev. William H. Ryder, now of Nashua, N. H., about three years since. I have often exhibited the stone and related the manner by which I became possessed of it. There has never been any published account of it." * * * *

Accompanying this letter, I received the specimen in question, which if a meteorite, (as I have now no doubt,) can claim the distinction of being one of the smallest of these celestial fragments, which has yet reached our earth. The accompanying figure is a correct delineation and of the exact size. Some small fragments have been detached but the main portion weighs only 370½ grains.

Physical Description.—Its external surface is every where glazed with a brilliant enamel of a grayish white, with occasional patches of deep brown metallic stains. The glazing is found also on the cracked and broken surfaces which penetrate deeply into the mass. The interior is scoriaceous like the frit produced by the partial fusion of feldspar, blown up with extremely minute vesicles and occasional larger bubbles. The porous character of the mass rendered it impossible to procure a satisfactory determination of its density. Its hardness is about 6·5, and it easily scratches feldspar. The larger part of this stone is quite white in color and the fracture has a vitreous lustre. It has no dark colored crust, similar to that which is so characteristic of most meteoric stones, which is owing to the absence of metallic oxyds in its composition, the surface enamel which has been already mentioned, being for this reason without color, excepting in a few spots. The whole stone bears every mark of having been intensely heated. The portions which have the iron stain, are small, and the most careful search with a powerful eye-glass detected no metallic points; nor did the magnet attract the minutest particles.

The blowpipe indicated the presence of silica, soda and magnesia. It dissolved in carbonate of soda with effervescence, forming a glass which was nearly opake on cooling. Alone in platinum forceps it fused on the edges, and emitted a phosphorescent light, while the flame beyond the mineral was colored of a clear soda yellow. In a close tube no escape of water or empyreumatic odor was perceived, and the mineral was unchanged by heat. The bead produced by its fusion alone in the platinum forceps, was a clear and bubbly one, which had no metallic stain.

Chemical Composition.—So little of the mineral was at my disposition without breaking the principal mass, that no other qualitative examination was made than that with the blowpipe, and this was the less important from the fact, that the pyrognostic characters were so decisive as to the absence of all metallic oxyds. All the fragments which could be found were carefully ground in the diamond mortar and then in agate, and 390 millegrammes of this powder were attacked by hydrofluoric acid, after the manner recommended by Bunsen. When it was judged that all the silica had been removed as hydrofluo-silicic acid, the residue was dissolved in hydrochloric acid in the same platinum vessel in which the attack was made by hydrofluoric acid. The absence of alumina, iron, phosphoric acid, lime, &c., was easily ascertained by the want of any reaction with ammonia and oxalate of ammonia, which failed to produce any troubling in the solution after addition of a sufficient quantity of chlorid of ammonium.

Oxyd of mercury was next added to the boiling and concentrated solution, which was subsequently evaporated to dryness, ignited to expel the mercury, treated with pure hot water, and the magnesia, separated in this manner, from the double chlorid of magnesium and mercury, was collected on a filter and weighed ·0471 millegrammes.

The filtrate from the magnesia, which contained nothing but alkaline chlorids, was evaporated in a platinum vessel of known weight, and their quantity determined by the increase of weight observed on repeated trials, with a constant result. The alkaline residue had the taste only of chlorid of sodium, it was dissolved and treated with bichlorid of platinum, evaporated on a water-bath to dryness, and treated with alcohol. No double chlorid of potassium and platinum was obtained, and the consequent purity of the chlorid of sodium was inferred. The amount of chlorid of sodium obtained was equivalent to ·0106 mm. of soda.

The weight of the meteorite employed = ·390 grms. We have found,—

Magnesia, . . .	·0471 or	12·076 per cent.
Soda, ...	·0106 "	2·718 "

Now the known composition of tersilicate of magnesia $\dot{Mg}\,3\dddot{Si}$, is, magnesia 12·98, and silica 87·02 per cent. = 100. And the composition of simple silicate of soda, $\dot{Na}+2\dddot{Si}$, is, of soda 40·37, and of silica 59·63 per cent. = 100.

Then 12·98 : 87·02 : : 12·076 : 80·959 = the silica requisite to form a tersilicate with the magnesia:

And 40·37 : 59·63 : : 2·718 : 4·014 the silica needed to form a simple silicate with the soda.

We have then—

Silica 3 atoms, . . .	80·959	
Magnesia 1 atom, . . .	12·076	
Tersilicate of magnesia, . .		93·035
Silica 1 atom, . . .	4·014	
Soda 1 "	2·718	
Silicate of magnesia, . .		6·732
Per cent.		99·767

Or stating the analysis in the usual form we have—

Silica, ...	84·973
Magnesia, ...	12·076
Soda, ...	2·218
	99·767
Loss and hygrometric moisture, .	0·233
	100·000

This gives as the formula, $\dot{M}g\,\dddot{S}i^3+\dot{N}a\,\dddot{S}i$, which is unlike that of any known mineral of terrestrial origin, but which approaches the composition assigned by Prof. C. U. Shepard to a mineral first observed by him in the meteoric stone from Bishopville in South Carolina, and which he states,* "is a tersilicate of magnesia." For this mineral Prof. Shepard has proposed the name of *Chladnite.* It is believed that the mineral now under consideration is identical with that in the Bishopville stone, and should therefore be called by the same name. The analysis above given was commenced by myself, but being called away from home before its completion, I entrusted it to my friend and pupil, Mr. B. W. Bull of Hartford, to carry through, which he did in a very satisfactory manner.

In conclusion I would say that the chemical constitution of the body under consideration, in connection with the very satisfactory testimony of Mr. Noyes as to its falling from the atmosphere, as already described in the introduction to this article, leaves no doubt in the mind of the writer, that it is a meteorite.

Yale College Laboratory, July 24, 1847.

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* This Journal, ii Ser., vol. i, p. 381.

ART. XXX.—*Remarks on the Characters of several Species of Tertiary Corals from the United States, in reply to Mr. Dana.** (Extracted from a letter from W. LONSDALE, Esq. to C. LYELL, Esq.)

Kynsham near Bath, June 21st, 1847.

My Dear Lyell,—I am much indebted to you for sending me additional specimens of *Endopachys Maclurii.* They have been carefully considered; but they have not led to a change in the printed opinion; which is perhaps too briefly expressed. It states that, "the Alabama coral was progressively altered in aspect, by the development of tubercles, secreted through foramina connected with the internal structure." (Geol. Journ., Vol i, p. 514.) This remark refers especially to a difference between Endopachys and typical species of Turbinolia, in which no foramina had been noticed in the walls, nor any external changes: but in the generic characters of Endopachys, the boundary wall is said to be "progressively thickened by papillæ secreted from within," (515,) and in a note the generic name is shown to have been proposed in allusion to a "thickening from within." If you will kindly examine the specimens marked 1 and 2 from Claiborne, Alabama, the uppermost portions will be found to be externally imperfect, and in parts, least liable to abrasion, being protected by the bold ridges.† The structure in those portions of No. 1, is highly reticulated and there is apparently a perfect connection throughout by means of circular openings or foramina. These cancelli were evidently occupied with animal matter, which was intimately connected with the soft internal living structures; and which, it is believed, secreted the solid calcareous reticulations. In No. 2, the analogous portions are in a more advanced state externally, that condition having, it is inferred, been effected by secretions from the same animal tissues as built up the inner part of the fabric—the foramina, which are now distinct, having been the channels through which nourishment and calcareous matter were supplied *from within.* The beautiful sections of No. 2, are supposed to support the original inference. In the upper part, the channels leading from the interior outwards, are very numerous: but in the lower, they are less abundant, the exterior having been perfected and the want of such passages diminished.

Certain structural agreements between Endopachys and Dendrophyllia are alluded to in the notice,‡ though from the manner

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* Silliman's Journal, ii ser., vol. i, p. 220.

† Consult also wood-cut, fig. *a*, p. 514, and specific characters.

‡ Geological Journal, vol. i, p. 514, 515.

in which Mr. Dana mentions an agreement, a reader would infer that I had totally overlooked them. In *Dendrophyllia ramea*, a certain but limited connexion apparently exists, for a time at least, between the animal matter which occupies the interior of a stem or branch, and that which invests it. The great thickening of the coral, however, is effected by means of the mantle which covers the exterior and forms more or less concentric layers. This mantle often extends also over portions of an adjacent branch, which had, apparently, been deprived of vitality, and deposits additional layers on that branch. In such cases, there could be no connexion between the mantle and interior of the encrusted branch. This process Mr. Dana expressly alludes to in p. 385 of his work. No concentric depositions are visible in the sections of specimens No. 2, and it was with reference to the successive layers formed on the surface of Dendrophyllia by the external mantle; and the evidence in the Alabama coral of a totally different operation, that the term Endopachys was adopted, certain structural agreements having been shown to exist between the two genera.

I hope this explanation if clear will vindicate me from having inconsiderately named your coral.

Madrepora tubulata, Mr. Dana says, "is an Oculina," p. 221. Your specimens had only twelve lamellæ.* Oculinæ have more than twelve. Madreporæ have only twelve. This structural distinction is very generally accepted. Internally the American coral agreed far more closely with Madrepora than Oculina, so far as its state of preservation warranted an opinion. The chief objection to the generic assignment is in the mode of developing additional abdominal cavities, and this was felt at the time; but not mentioned because I was not certain that that process was universal throughout the genus. Mr. Dana in his work, p. 486, received long after the notice was printed, describes three species of Madrepora, in which the normal process is apparently deviated from. On this, however, I would not for a moment rest as a justification. I named the coral after a careful examination of the imperfect evidence before me, and placed it in the newest, allied, established genus, the specimens not justifying the proposing a new genus. The reply to the critic might be: It is not an Oculina.

Columnaria? sexradiata.—The note of interrogation should not have been omitted by Mr. Dana. It is stated† that the fossil is allied to *Astræa calicularis*, and Mr. Dana in his description of the latter, refers to Esper, pl. 16, Fig. 12. The coral there represented, is generically if not specifically allied to the fine zoophyte you kindly gave me, and is labelled "Caryophyllia—from Lieut. Holland, Prince's Island, west coast of Africa."

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* See notice, Geological Journal, vol. i, p. 520.

† Silliman's Journal, p. 221.

Astræa calicularis, (auct.) is found in the Mediterranean. If I am right in identifying Esper's figure with the African specimen, generically, and I have no doubt there is no agreement whatever between *Astræa* or *Astroitis calicularis* and the American fossil, every essential character being different, except that the additional stellated cavities are in the *Columnaria? sexradiata* interstitial, but even in this respect, there are many important differences—Mr. Dana should have thought a little more, or given fuller grounds for dissent.

Astræa hirto-lamellata? (it must be for the future, *Astræa Marylandica*, Conrad.) This fossil is said to be closely allied to the preceding. (Query, Col? sexradiata? or *Astroitis* calicularis?) In the notice of the fossil* allusion is made to a subdivided star, and though the statement is cautiously put, I had little doubt at the time of the inference being correct. That process is one of the leading characters of *Astræa* as rightly restricted by Ehrenberg, and it is totally wanting in Columnaria? or Astroitis. Of Mr. Dana's Pleiadia no full account has, I believe, been published.

I have troubled you with a long letter of personal justification, but it is due to yourself to shew, that I did not abuse the trust you kindly committed to my care.

Art. XXXI.—*Observations in reply to Mr. Lonsdale's "Remarks;"* by James D. Dana.

The ordinary coral Zoophytes have been so imperfectly studied in a zoological point of view, that no discredit whatever can properly attach to errors of judgment in the cultivators of this department of science. This is especially true with regard to Mr. Lonsdale, whose labors evince throughout, careful and assiduous study of the best authorities in this branch of science, and a success well worthy the honor conferred on him by the Geological Society of London.

The suggestions in the volume of this Journal referred to by him, made by me after protracted researches among living species of zoophytes, were thrown out to promote the interests of science, and if erroneous, will be as readily retracted, and for the same purpose. But several facts are believed to sustain my former conclusions which I will endeavor to explain.

Genus Endopachys.—The pores or foramina described as characterizing this genus, I have observed in the *Dendrophyllia nigrescens*,† (D.) from the Feejees, and also still more perfectly in the *D. scabrosa*,‡ (D.) closely resembling specimens I have seen

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[*] Geological Journal, vol. i, p. 500.

[†] Report on Zoophytes, p. 387.

[‡] Ib. p. 390.

of the Endopachys. This character according to my observations, is one of the least important among corals. In Astræa, Pocillopora as well as Dendrophyllia, (and also other genera,) there is every variety in this character, from the most solid, to the most cellular texture. The same species at times is full of pores in the early state and becomes quite solid in a more advanced condition.

From the manner in which the coral is secreted, it is also obvious that the character cannot be important. The secretions take place among the tissues, beneath the skin. They are sometimes so general as to form a solid texture without visible pores, and in other cases, where certain of the animal fibres do not add to the secretions, there are pores larger or smaller, occupied by these animal tissues. These tissues form a communication between the interior and exterior; they occur in the most compact coral, though not visible except in thinly polished fragments examined with a lens, or after digestion in an acid which removes the calcareous material. After the coral is begun in the young animal, it is constantly receiving addition to its surface. A common mode, illustrated in the species of the genera Madrepora, Dendrophyllia and others, consists *first* in the secretion taking place in points, so as to raise minute prominences on the surface; and *next*, after the points are more or less elongated, the secretion becomes more general, and all the points are connected by the calcareous secretions, which thus make a net-work or layer, over the whole. In a transverse section of most Madrepores, the successive series of minute columns are well shown. In the Dendrophyllias referred to, and even in some specimens of the *D. ramea*, the same structure is apparent. When the points are obsolete, the coral will consist of layers of lime, as is sometimes apparent. Often again there is no regularity or approach to layers in the porous structure, as in *D. scabrosa*, &c.

As the animals grow, the pores which contain living fibres in the young state, often gradually diminish by the secretions from the surface of these fibres, which themselves are gradually disappearing, and the coral which was before very porous may finally become solid. Almost every genus illustrates this point. The exterior fleshy part of the animal is in no sense "a mantle," (any more than the skin of an Actinia,) and it is not known ever to extend itself over a part once dead.

If Mr. Lonsdale means simply by "thickening from within," that nourishment and calcareous material are distributed outward from the visceral cavity, (which I suppose is not precisely his view,) then his character will apply to nearly all coral zoophytes; for all cellular coral species have free circulation of the chyloid fluids wherever there are tissues, and these fluids are derived from the stomach and visceral cavity; and the invisible fibres of the more solid species may also have this function; whether so or not, the character is of little importance.

There seems therefore to be reason for dissenting from Mr. Lonsdale, as to the importance of the characteristic upon which he has established his genus.

Madrepora tubulata.—The genus Madrepora, characterized by an apical polyp to each branch, graduates into Manopora (D.), when the distinction of apical polyp is lost. The latter are foliaceous and glomerate species having the cell of the Madreporæ in every particular, but with irregular calicles or none; they include the species of the genus *Montipora* of Blainville, based on the existence of warty prominences over the corallum between the cells, (a character without importance and of impracticable application;) and also a part of the *Porites* of Lamark, (*Porites spumosa*, &c.) And as the transition is very gradual there are intermediate species, two or three of which I have referred to Madrepora, since they have regular calicles although the apical polyp cannot be distinguished.* But the structure of Oculina is in no respect represented or approximated to. Indeed the mode of budding of this genus, allies it more nearly to the Astræa family, in which certain branching species show the alternate gemmation at apex characterizing Oculina. Hence the species referred to is far removed from Madrepora; and if it be not an Oculina (by having but twelve lamellæ, and twelve tentacles to the polyps) it must either belong to a new genus, or else the characters of Oculina should be so extended as to include it. I have been long convinced that the number 12, has been allowed too much authority, and have so far infringed upon it in my treatise on Zoophytes as to unite the genera Porites and Goniopora into a single family.

But from Mr. Lonsdale's figure, it is evident that the animal had normally more than 12 tentacles, and that the lamellæ are but 12 in number because part are obsolete. The striæ around the cell are a more correct indication of the character of the animal, than the lamellæ alone.

Columnaria? sexradiata, (L.) *Astræa hirto-lamellata*, (Mich.)—These species are still more ambiguous cases, about which there may be an honorable difference of opinion. Having examined the corals referred to, I came to the conclusion, which I still hold, that in one essential character, the species are rather allied to the Caryophyllia family, than the Astræa; notwithstand-

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* It is interesting to trace the transitions between these genera. In Madrepora, the horizontally growing species, form a series, in which the branches are more and more coalescent, till at last they form a solid plate, (*M. palmata*,) whose edges only here and there show the tips of the branches of which it is composed. The next step beyond this, is an absence wholly of the branchlets, and the species is a *simple leaf or folium growing at margin*. In all known species, when this step is reached, the calicles are very imperfect or wanting, and they are *Manoporæ*. In the same manner other Madreporæ pass into species with stout branches, in which the terminal polyp is hardly distinguishable (*M cuneata* and the allied); and the next step is a *glomerate Manopora*. Thus there are two lines of gradation from *Madrepora* into *Manopora*.

ing the structure of the coral. As in conchology, the calcareous secretions sometimes may entirely mislead.

The *Astræa calicularis*, and other species figured by Quoy and Gaymard, in the Voyage of the Astrolabe, are closely like Astræas in their corals. Yet the polyps are very prominent above the coral when expanded, each very much projecting, and attached to the adjoining *only at base.* They are like the Goniopore in this respect. An Astræa increases by a lateral summit growth and budding, the summit gradually extending, and at the same time forming young polyps as buds. When the polyps are connected only at base, as in the *A. calicularis*, the budding is lateral from near the base and not terminal, and the species are therefore excluded by this characteristic from the Astræa family, and most strikingly from the genus Astræa. From an examination of a recent coral on the coast, very near the Astræa Marylandica of Conrad, I have been led to refer the whole to a group characterized by exsert polyps. The correctness of this reference cannot be fully established until the animals of the recent species are known; and I have waited for an opportunity to make the examination before describing it.

In this species, and also in specimens of *A. Marylandica*, examined by the writer, the polyps do not appear to bud by subdivisions.

The relation of the species designated by Mr. Lonsdale *Columnaria* (?) *sexradiata*, to the genus Columnaria, is only in mode of growth and not in structure.

ART. XXXII.—*Notice of a Water-Spout;* by ELIAS LOOMIS.

ON Friday morning, Aug. 20th, 1847, it was my good fortune to witness a water-spout in unusual perfection. I left Erie, Penn., in a steamboat for Cleveland, Ohio, about seven o'clock, with a pretty fresh breeze from the west southwest. The sky was for the most part clear; but there were numerous floating clouds, and in particular one dark mass of clouds arose in the west affording some indications of a shower. These clouds passed nearly over our boat, but brought us no rain. As they moved off to the east, about half past eight, an imperfect water-spout was seen, in the form of a funnel-shaped cloud, suspended from the base of the black mass already mentioned. It bore some resemblance to an elephant's trunk, and curved downward towards the south. It appeared dangling in the air, and terminated at a distance from the water about equal to the length of the trunk. No particular agitation of the water was noticed beneath it. In a few minutes it had disappeared; but presently a second spout was noticed which attained to great perfection. This also might be compared to an elephant's trunk, reaching entirely down to the surface of the water. At the bottom it was quite small, and it expanded pretty uniformly until it united with the mass of clouds above. It was nearly straight, but by no means upright in position; the top inclining about twenty degrees towards the south. Around its base there rose a vapor which had the appearance of smoke, spreading out on all sides, and rising to a height about one-third that of the trunk. This occurred about forty minutes past eight in the morning. In about five minutes the trunk had contracted so that it no longer reached the surface of the water, but was left dangling in the air like the one first seen. It was soon reduced to one half its former length, and the part which remained was expanded somewhat in breadth. It now appeared to have no connection with the water, except that the same smoky appearance was observed beneath it. The trunk continued to contract in length, and in about ten minutes from its first appearance, it was entirely gone. The same smoky appearance rising from the water in this vicinity was noticed about ten minutes afterwards, and was at first suspected to indicate the commencement of a third spout, but no column of cloud was seen connected with it, and it is possible that this was but the remains of the second spout. The wind continued fresh all day, with numerous flying clouds, but although a good watch was maintained, no further spouts were noticed. The clouds were chiefly of that variety called *cumulus*, rising in high massive piles and spreading out at the top like a mushroom.

It is difficult to estimate the dimensions of this spout, on account of the uncertainty with regard to its distance. It was presumed to have been distant about five or six miles from our boat, in which case the length of the column could not have been less than half a mile; its diameter at the top must have been more than twenty rods, and at the bottom about half as great. As the column contracted in length, its diameter at one time must have been nearly forty rods.

The distance of the spout was such that it was impossible to distinguish any clear signs of rotation; but from its analogy with other phenomena, it is presumed to have been a whirlwind, precisely like the little whirls which are so common on land. When a whirl is formed over a bed of sand, the dust is raised in the centre, and presents the appearance of a solid column which travels slowly along with the current in which it is formed. When the whirl passes over a large body of water, the water is raised in the form of spray; and the result is a column of water instead of a column of sand. The quantity of water thus elevated is probably extremely small, the column consisting of little more than dense fog or cloud. In the case just described, the whirl was of very large dimensions, and rose to the height of the clouds, so that the spray elevated mechanically from the lake, was united with the condensed vapor of the clouds in the same column. The only danger therefore to be apprehended by a vessel from the passage of a water-spout, arises from the whirl, which often exhibits great violence. The whirlwind might prove destructive to a vessel, while the water which it carries with it might be barely sufficient to wet the deck.

ART. XXXIII.—*On Certain Laws of Cohesive Attraction*; by JAMES D. DANA.

Read before the American Association of Geologists and Naturalists, held at Boston, September, 1847.

FROM the account of cohesive attraction in works on Chemistry, we gather little more than what the term itself implies; and in the higher treatises on Physics, the subject is discussed on general mathematical principles, and mostly without reference to observed facts, excepting those of the most obvious character. This is especially true of the attraction in solidification. I propose to consider what observation teaches on this subject, and would ask the attention of the Association to a brief statement of a series of facts, and to certain obvious inferences from these facts.

The objects to which we appeal for illustration, are the rocks and minerals of the earth, and the ordinary forms of inorganic matter. The grand principle has already been recognized, that solidification and crystallization are the same process. As early as 1807, in the Lectures on Natural Philosophy by the learned Thomas Young,* this philosopher says, after some explanatory remarks, "It appears, therefore, consistent both with reason and experience, to suppose that a crystallization more or less perfect is the universal cause of solidity." Biot in his Précis† recognizes the same principle; and other names favoring this conclusion might be mentioned. The fact is obviously exemplified in nearly every inorganic solid around us. The freezing of water is known to be its crystallization, and snow is crystallized vapor. The coarse-grained structure of bar-iron is correctly called its crystalline structure; for the grains are all formed by the process of crystallization; and in steel we perceive the same texture, and may trace it through varieties, till the grains are too fine to be distinguished. Granite and all igneous rocks are made up of

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* Course of Lectures on Natural Philosophy and the Mechanical Arts, by Thomas Young, M.D., 2 vols. 4to. London, 1807. Vol. i, p. 628.

† Précis Elementaire de Physique, 2 vols. 8vo. Paris, 1824. Vol. i, p. 18.

crystallized material; and any one familiar with granite can pick out its mineral grains and exhibit their crystalline character; and if granite is crystallized in its intimate texture, so are all aggregate rocks made up of granite material. Indeed a general survey of the inorganic world develops the truth that here the power of crystallization rules, like vitality in the organic kingdoms. A crystalline texture may not always be apparent. This is the case internally with ice, or a fragment of quartz crystal, although there is no doubt that in each of these instances, the forces of crystallization were the cause of solidification. This is also true of the finest grained steel, as just observed, and some basaltic rocks. But we find, from the transitions in structure, that the apparent absence is owing to the extreme minuteness of the grains and the compactness of texture.

If then, crystallization and solidification are properly one and the same process, the laws that govern in crystallization are the laws of cohesive attraction. The science of crystals instead of treating only of certain singular polyhedral forms assumed by minerals, is the study of the fundamental agency by which inorganic matter is governed in its aggregations: and in place of occupying a short chapter in our text-books on physics, and there, as would often seem, in the way or out of place, it should be made to stand prominently forth as embodying and exemplifying some of the widest elemental truths of nature.

Let us then look at the facts, in order to arrive at these laws. Some of the deductions are by no means new. We commence with the simplest principles, in order to present a general view of the subject; and a few familiar facts in crystallography are illustrated with figures, as the subject may interest some who are not acquainted with them.

1. It is, in the first place, an established fact that the different kinds of inorganic matter have each a distinct mode of crystallization. Every species has certain fixed, determinate, angles, which characterize the structure, both of the crystal and the crystalline grains in a compact mass. Galena crystallizes with a cubical structure; and even in a granular mass, this structure may with care be detected by the rectangular cleavages. So in granular limestone, or common white marble, the oblique angles of the grains are precisely those of the perfect crystals of calc spar. As this is a general truth, *these fixed angles, for each species of matter, in some way characterize molecular or cohesive attraction.*

Again: crystals have plane surfaces, and are prisms or allied forms. Now if the attraction acted alike in every direction it would make only spheres; to produce polygonal forms there must, therefore, be specific directions in which the attraction acts more strongly than in others. For a cube or prism, there must be at least three such directions, corresponding with axes in the form; and if the prism has oblique angles instead of being rectangular, these lines of strongest attraction must have a corresponding obliquity. Hence *the angles referred to, as characterizing cohesive attraction, are angles between certain imaginary lines, or axes, in whose direction the attraction is strongest.*

Again: the crystalline forms in nature are well known to have fundamentally fixed relative dimensions, indicated by the modifications they undergo (producing secondary forms) though not necessarily apparent in the actual proportions of the crystal. Thus a cube, which is equal in its dimensions, shows it in all its modifications; and in a prism, the inequality in the dimensions is as exactly and precisely indicated by its modifications.* The relative dimensions belonging to the fundamental form of a substance, are often therefore easily calculated; and the whole science of crystals is thus based on rigorous mathematical laws.

From these facts we may conclude therefore with respect to solids, that *Cohesive Attraction is characterized by fixed angles, as regards the direction of its action, and by specific relations of force in certain axial directions; and it differs in these particulars for different substances.*†

These facts are the only hints which nature gives us respecting the axial dimensions of molecules. We proceed on the only possible grounds for any conclusion on this point, when we infer that *molecules have corresponding relative dimensions with the crystalline forms, and the same specific angles between the funda-*

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* A square prism and a cube as presented in nature, may have actually the same dimensions, owing to the distortion of the one or the other. But the fundamental nature of their forms, may, notwithstanding, be obvious to the eye. In the cube (having equal faces and axes) *all* the edges will have similar secondary planes (that is, these planes will be identical in their inclinations to the faces of the cube); in the prism, the secondary planes of the lateral edges will differ in their inclinations from those of the terminal. In the cube, there may be a plane on any edge equally inclined to the faces of the cube. In the prism, the plane on a terminal edge will always be unequally inclined to the including faces; such a plane removes a part of the two including faces, and these parts will in all cases have a definite relation to the height and breadth of the prism. These explanations are sufficient to render the general principle stated, intelligible to those unacquainted with the structure of crystals. Treatises on crystals should be studied for a full exposition of this subject.

† Apparent exceptions to this principle are supposed to exist in the case of glass, tabasheer and some other substances that do not polarize light. They are, however, not necessarily exceptions. For in these substances the molecules are either equiaxal or inequiaxal;—if *inequiaxal*, the solids prove that such molecules, with weak polar forces, may be so irregularly aggregated as to show no polarization; and if their form is *equiaxal*, no rings of polarization are to be expected.

We have no facts to determine the form of the molecules in glass. As glass, (common as well as volcanic,) when slowly cooled, produces a different material, with a different temperature of fusion, it must be a dimorphous or isomerous material, capable of taking two distinct forms, of which glass is one. We cannot, therefore, infer that the molecules of glass are inequiaxal from the forms of the crystallized silicates of an alkali. The rapid cooling, necessary to form glass, is the most unfavorable for an axial arrangement of the particles, even if the polar forces were strong.

mental axial lines or axes of attraction. Thus the molecule of a cube must have equal axes, like the cube itself; that of a prism, like axes with the prism in relative dimensions; and if oblique, the axes should have the same degree of obliquity. This statement with regard to molecules is *potentially* true; and in this sense, the only one in which we now speak of molecules at all, it is no hypothesis.

The actual *forms* of molecules constitute another consideration, and one for which we have less precise data. The molecule of a cube may be either a sphere or a cube, as either form would produce a cube by the same mode of aggregation; and that of a prism may be either a similar prism or a spheroid of like dimensions. This is illustrated in the annexed figures 1, 2, 3.

Fig. 1.

Fig. 2.

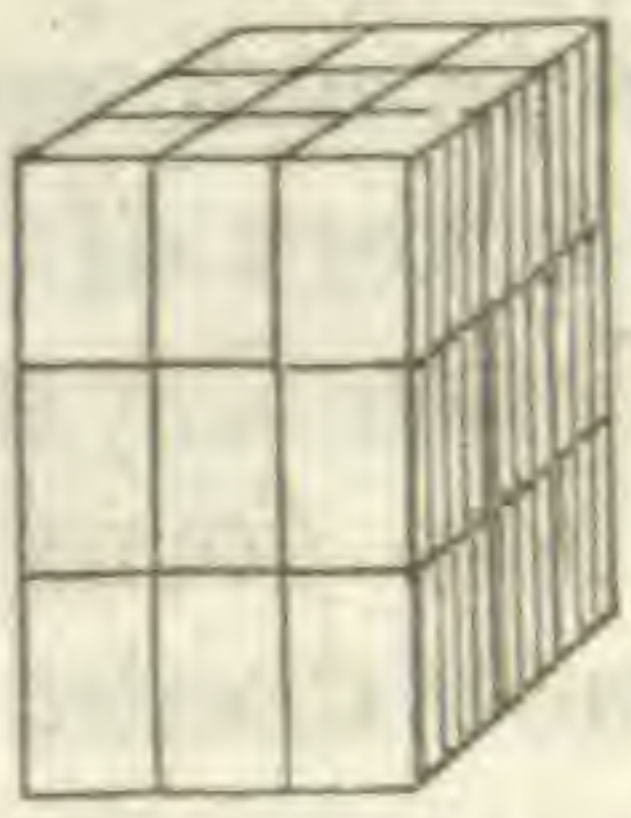

Fig. 3.

We cannot therefore determine absolutely the *form* of the molecule from the form of the crystal. But from the greater simplicity of the hypothesis that molecules are spheres and spheroids, its sufficiency to meet every case in nature, its necessity to explain optical phenomena, and other considerations we have presented elsewhere, we adopt in this place the view of their spheroidal forms.

By having some idea of a molecule in the mind, we may more easily conceive of the principles deduced with regard to cohesive or molecular attraction.

Our first *inference*, expressed with reference to the molecule will therefore be the following:—

I. *Molecules in solids have fixed relative dimensions for each kind of matter, and certain axial lines of cohesive attraction which are fixed in direction:*—and we add, as a necessary truth, *whose force is inversely related to their length.*

Viewing the molecules as spheres and spheroids, the three axes are the three conjugate axes or conjugate diameters of these forms.* The attraction is not supposed to be confined to the

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* If the conclusion be correct that the molecule of the *element* gold is a simple *sphere* because of its cubical crystals; and that of sulphur an *ellipsoid*, from the unequal axes of its crystals;—it is as good also with regard to *compounds*. Hence the molecule of pyrites (a compound of sulphur and iron), whose crystal is a cube must be a sphere; and that of alum, a spheroid, &c. It matters not whether we can conceive or not of two molecules of sulphur and one of iron, different in size and shape, uniting so as to make a simple sphere. The conclusion is one not dependent for its truth on our conceptions. The finite mind is an *interpreter* of nature and may not presume to the rank of dictator. Its conceptions will be as inane with regard to any kind of combination or mode of aggregation in the above case, which could produce out of such means a symmetrical cube with its faces similar in lustre and every other physical character.

axes, as these are only imaginary lines of concentration of force; the other parts of the molecule must necessarily have attracting force though to a less amount than along the axial lines.[*]

The fact that crystals are formed by the superposition of molecules by axial attraction, is a matter of observation. In an evaporating brine we may see the minute cube of salt enlarging without change of form, a fact which implies that ranges of particles are added regularly to each side. In a drop of sea water under the microscope, we may watch the growing crystal of gypsum, and see its rhombic and arrow-head forms as perfect in the smallest visible point, as afterwards when more enlarged; proving again that the particles are added in fixed lines, since in no other way could there be this constancy of angle. It is proved again by finding many instances in calc spar, quartz and other minerals, of crystals with internal layers of another mineral which were deposited on the faces of the crystal during an intermission in their progress; showing the form of the crystal in its earlier stages. Hence we may not doubt the reality of the axial lines of cohesive attraction.

Brewster, in the course of his splendid researches on the optical phenomena of crystals, has shown that in some instances the particles are in a state of tension, as by compression. In a recent article on the topaz,[†] he describes the occurrence, in certain crystals, of extremely minute cavities, which indicate by means of polarized light, that the parts adjoining have been acted upon by a compressing force. Long since he observed respecting the diamond that its crystals,—which are peculiar in having *convex faces*,—exhibit, as he states, "an imperfect, doubly-refracting structure, as if aggregated by irregular forces, and compressed or

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[*] The several axial conditions illustrated in crystals include all the possible variations of the three diameters of spheroids, as is mentioned by the author in an article in this Journal, vol. xxx, 1836, p. 282, and Mineralogy, 2nd edition, p. 79. They are as follows, (using the term *axes* for the diameters having rectangular intersections; and *diameters*, for the diameters having oblique intersections.)

I. *Sphere*—Three conjugate axes; equal,	(1.) *Cube.*
II. *Ellipsoid of revolution.*	
A. Three conjugate axes, the two lateral equal,	(2.) *Right square prism.*
B. Three equal conjugate diameters, [with equal oblique angles of intersection,]	(3.) *Rhombohedron.*
III. *Ellipsoid, not of revolution.*	
A. Three conjugate axes, unequal,	(4.) *Right rectangular prism.*
B. A vertical axis, and two equal conjugate diameters,	(5.) *Right rhombic prism.*
C. A vertical axis, and two unequal conjugate diameters,	(6.) *Right rhomboidal prism.*
D. Three conjugate diameters, two equal,	(7.) *Oblique rhombic prism.*
E. Three conjugate diameters, unequal,	(8.) *Oblique rhomboidal prism.*

[†] L. E. and D. Phil. Mag., August, 1847, xxxi, 101.

kneaded together like a soft gum or jelly." He concludes from the facts, that the topaz must have been in a soft and plastic state while it yielded to the compressing force which emanated from the cavities, and farther, infers (as in 1805 from his experiments on depolarization) "the existence of a new species of crystallization, which is the effect of time alone, and which is produced by the slow action of corpuscular forces."

If the facts prove a comparatively soft state of the topaz when first formed, as they appear to do, they indicate that the crystal while afterwards hardening, would undergo contraction, in which case such minute cavities or any foreign particle would become apparent centres of a compressing force. The regular form of the topaz crystal, presenting a perfect correspondence in every respect with other crystals, can be explained only on the supposition of axial attraction; and while the necessity of time and corpuscular forces must be admitted, we fail to see evidence of a new species of crystallization. In the diamond, the same principle may have operated. If the crystal when first formed is still imperfectly hardened, contraction would continue for a time in progress; and the contraction in this case acting with some reference to radii from the centre, and affecting most the prominent edges and angles, might give the convex form presented by the faces of the crystals, and the peculiar structure within.

The fact mentioned at the meeting of the British Association in June last, by Mr. H. F. Talbot, that a fused globule of nitrate of potash polarized light, like a regular crystal, only shows that some species may retain the axial forces and arrangement in the fluid state. It is known that certain fluids have the power of polarization. These facts extend instead of limiting our proposition, proving that the molecules of some substances, even in the liquid state, may have the inequiaxal forms, generally detected only in solids.*

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* Sir David Brewster, after mentioning his grand discoveries with regard to producing the polarizing structure in glass and other substances by tension, suggests that the polarizing structure of crystals arises from the mutual pressure of the elastic particles during crystallization. He concludes that the axes of crystallization are three in number and at right angles to each other, and observes, "that when any two molecules are brought together by the forces or polarities which produce a crystalline arrangement and strongly adhere, they will mutually compress one another, and each will have an axis of double refraction in the direction of the line joining their centres, in the same manner as if they had been compressed by an external force."

The facts are explained, as we believe, more simply and more in accordance with the laws of crystals, by attributing the character of ordinary polarization in crystals to the form of the molecule independent of pressure. The molecule in inequiaxal crystals must be inequiaxal. and this is a sufficient reason, without adding pressure as an additional cause. Pressure at the poles, would only flatten the poles, and this would make an irregular solid of the ellipsoid, inconsistent with the

After these observations, I continue with the statement of facts and the inferences they sustain.

2. In crystals which have unequal axes, the physical qualities of the crystal (such as color, hardness, lustre, &c.) are different in unlike directions; and they are uniformly alike in the direction of equal axes. This symmetrical character indicates that—

II. *In the aggregation of molecules by attraction, only equal or homologous axes unite.*

3. The electrical polarity of many crystals; the occasional dissimilarity of form in the opposite extremities of the same prism; the facts with regard to compound crystals, as well as direct experiments with magnets on the process of crystallization, show that—

III. *The axes of cohesive attraction in molecules have opposite polarity at opposite extremities;*—that is, *the opposite poles are positive and negative, or north and south, as these terms are ordinarily used.**

4. Many geniculated crystals, are geniculated alike at equal distances from the middle of the prism, (or, are like a column bent alike at two places equidistant from the middle.) They have be-

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character of the polarization in crystals. The effect of this flattening of the surface of the molecule by pressure is probably seen in the curious crystals of analcime,[a] whose structure has been developed by this distinguished philosopher. In the case of glass and other substances, that receive the power of polarization by pressure, it would seem from the facts just stated, that it depends upon a change by compression of the spherical molecule to a spheroidal or compressed shape; the shape is a result of pressure; but as in crystals, the polarization may be dependent on the shape.

The polarization of molecules will depend not only on their form, but also on their nature, whether uniform in character throughout, or differing in density from the centre to the circumference and with a definite inverse relation to the lengths of unequal axes. As the latter supposition is altogether the most probable, considering that molecules are centres of attraction, the form of the molecule and the form deduced from polarization should not be the same until this law of relation is understood and duly appreciated.

* By polarity we imply simply that relation between the diametrically opposite parts, A and B, of a molecule, by which the part A of one molecule unites to another molecule by the part B, and repels the part A. This property appears to be one of the fundamental qualities of matter or force, as no exhibition of force in nature is divested of it. In solidification this polarity is exerted most strongly along fixed axes.

[a] Crystals of the tesseral system to which analcime belongs, do not polarize light; but in specimens of this mineral, a peculiar system of rings has been detected by Brewster: they suggest at once, that like certain cooled cubes of glass, the structure has arisen from a change of form in the molecules dependent on tension.

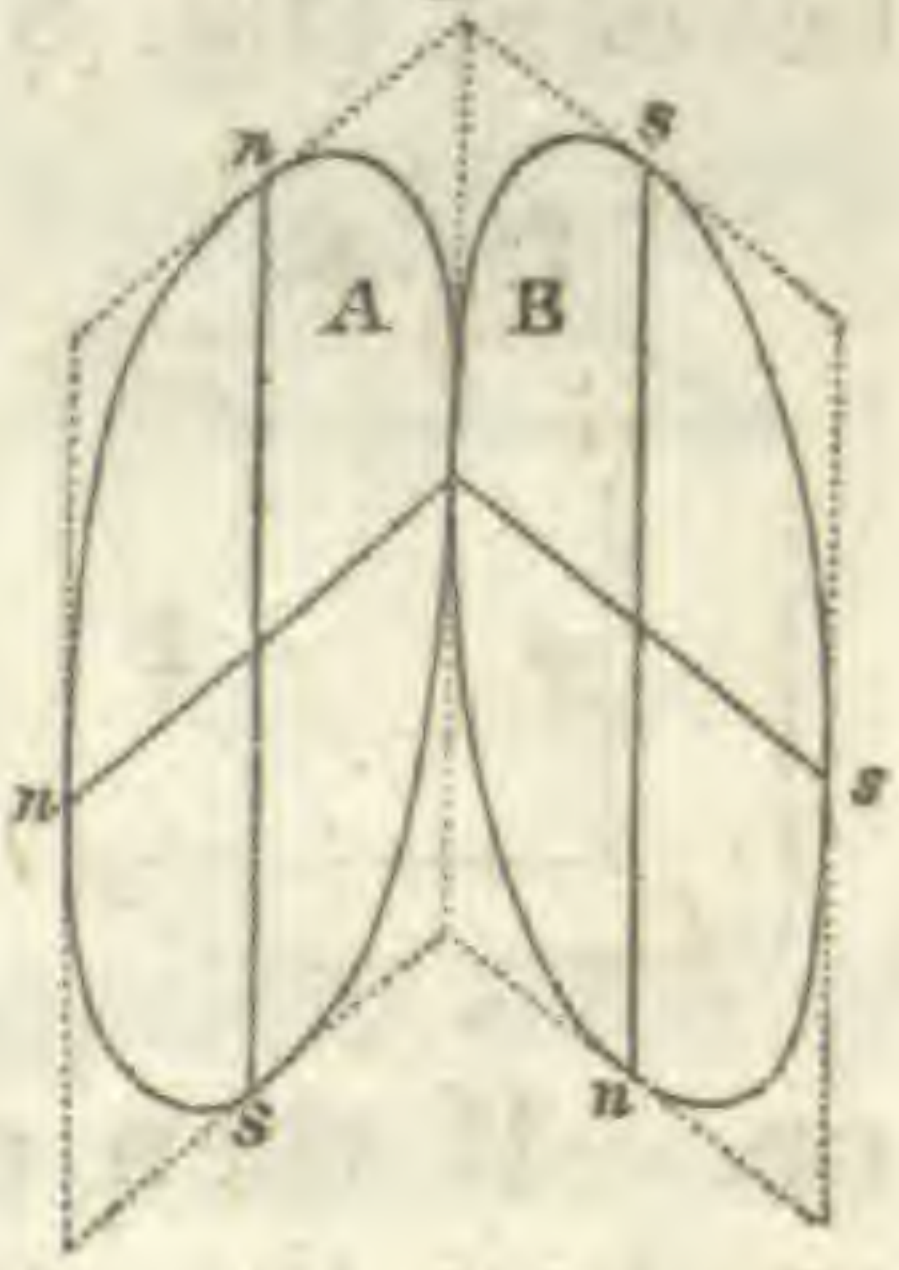
come thus geniculated simultaneously at both extremities, while they were enlarging, evincing that—

IV. *The polarity of molecules may be reversed by extrinsic influence.**

5. Twin crystals have one half of the crystal in a reverse position from the other.† This may be imitated by cutting a crystal in halves, and after a semirevolution of one half, applying the parts again together; an oblique crystal will thus have a reëntering angle, as in fig. 5. If in fig. 5, A be the position of the nucleal molecule for one half, B must be that for the other. The mode of aggregation for a simple crystal is that shown in fig. 4. The attraction between the two molecules brought them together in either case. But in one the position of the molecules when about uniting was favorable for the direct union in fig. 4; and in the other, the two were in opposite positions, yet so close in proximity that union took place by the adjacent poles without allowing of the change of position necessary for direct union. In the former, the same poles of the vertical axes, are in the same direction; and in the latter, they are in opposite directions. There could not be such an inversion of the molecules, if the axes were a *result* of the act of union. Hence,—

Fig. 4.

Fig. 5.



V. *The axes and polarity of cohesive attraction in solidification exist before the union of the molecules, instead of being a consequence of that union.*

6. The forms of inequiaxal crystals vary somewhat with a change of temperature; and at certain temperatures, specific in each case, some substances undergo abruptly a total change of form, both as to the direction and relative lengths of the axes. Hence,—

VI. *The axial lines of cohesive attraction, are not indefinitely fixed in position, but are some way modified in direction and force by temperature.*

Thus far we have considered the general polar condition of cohesive attraction in solidification, its liability to a reversion of the

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* See an article by the author, in the American Journal of Science, for 1836, vol. xxx, p. 275, and particularly p. 292; also Mineralogy, the chapter on Crystallogeny.

† We consider here but a single kind of twin crystals, in the briefest manner possible, as the facts are sufficient for our deductions. See farther, Amer. Jour. of Science, and Mineralogy, as just referred to.

poles like ordinary magnetic polarity, and its varying in direction with the changes of temperature. There are evidences of other modifications in the condition of the attracting force, which we now consider.

7. The same species of matter often presents a variety of forms in its crystals, built up on a fundamental type. For example, when the type is a cube (fig. 6), the species may occur as cubes; or as cubes with the edges truncated (fig. 7); or with the edges beveled (fig. 8); or with the angles replaced (figs. 9, 10), and so on. If then a certain state of the attraction in a molecule will produce the primary cube, some variation from this state is necessary to produce another form, and a different variation for every different secondary plane. Consequently,—

Fig. 6.

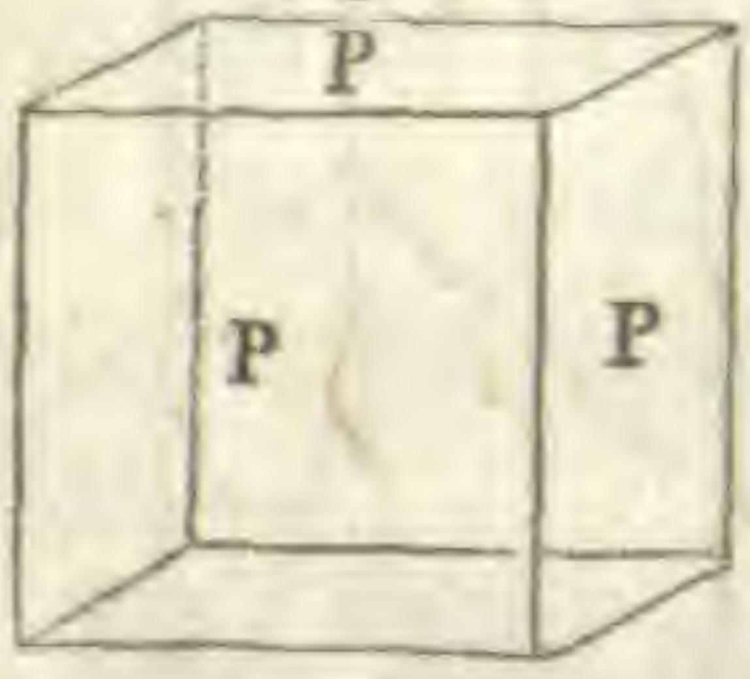


Fig. 7.

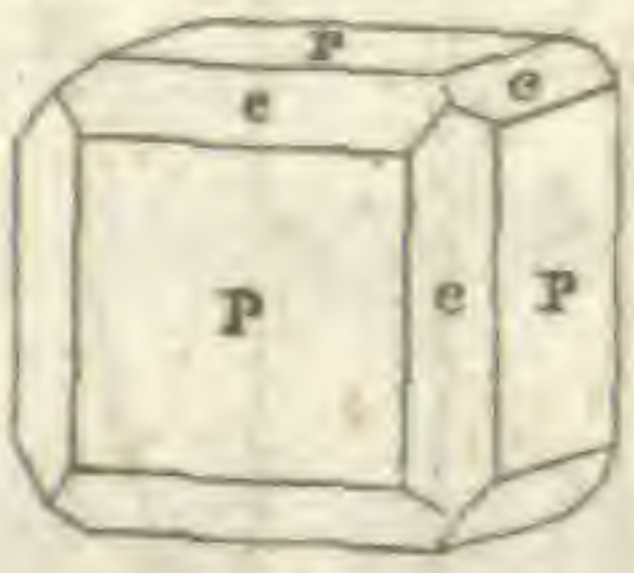


Fig. 8.

Fig. 9

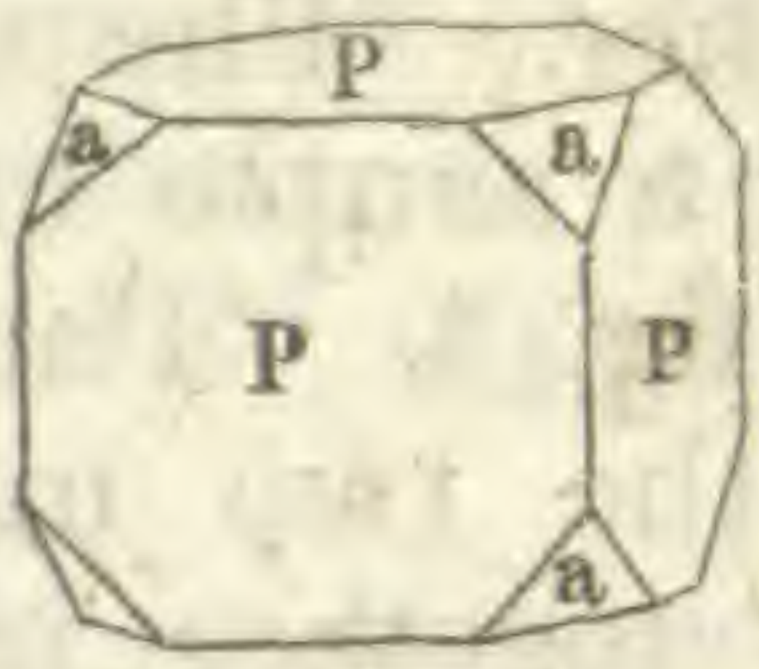


Fig. 10.

VII. *Attraction of cohesion in molecules of a given kind, is not an unchangeable force, but admits of variations of condition.*

8. The secondary planes of crystals, as related to the axes of the fundamental form, have fixed simple ratios. The plane truncating the edge (fig. 7) referred to the axes, has the simple ratio of 1 : 1 (fig. 11). Other planes (as in fig. 8) may have the ratios 1 : 2 (fig. 12), 1 : 3, 1 : 4, 2 : 3, and other simple ratios. Planes on the angles (figs. 9, 10) referred to the three axes, may have the ratios (indicating their positions) 1 : 1 : 1 (fig. 13), 1 : 2 : 2, 1 : 3 : 3, 1 : 2 : 4, 2 : 3 : 6, 3 : 5 : 15, and so on. Hence,—

Fig. 11.

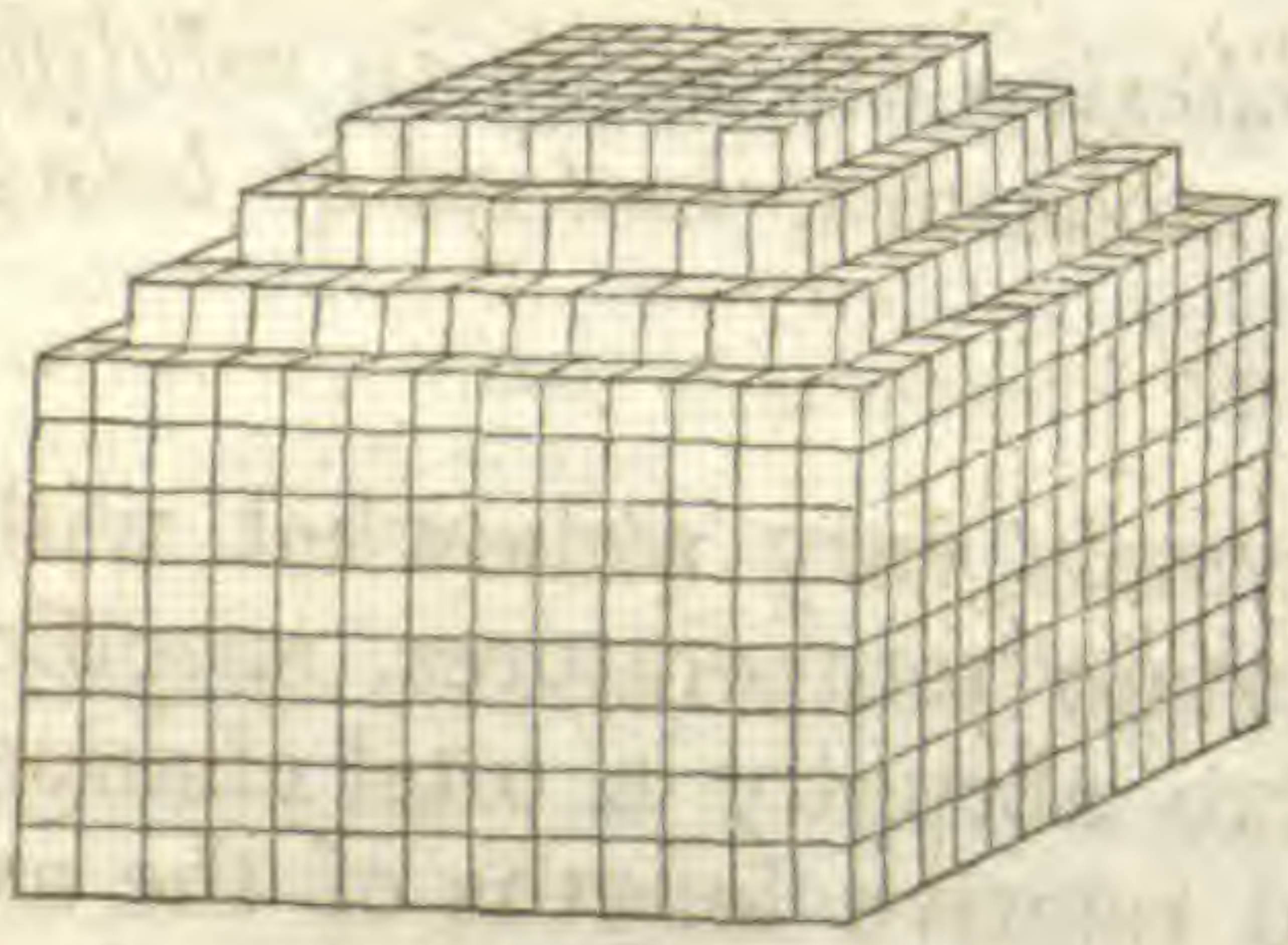


Fig. 12.

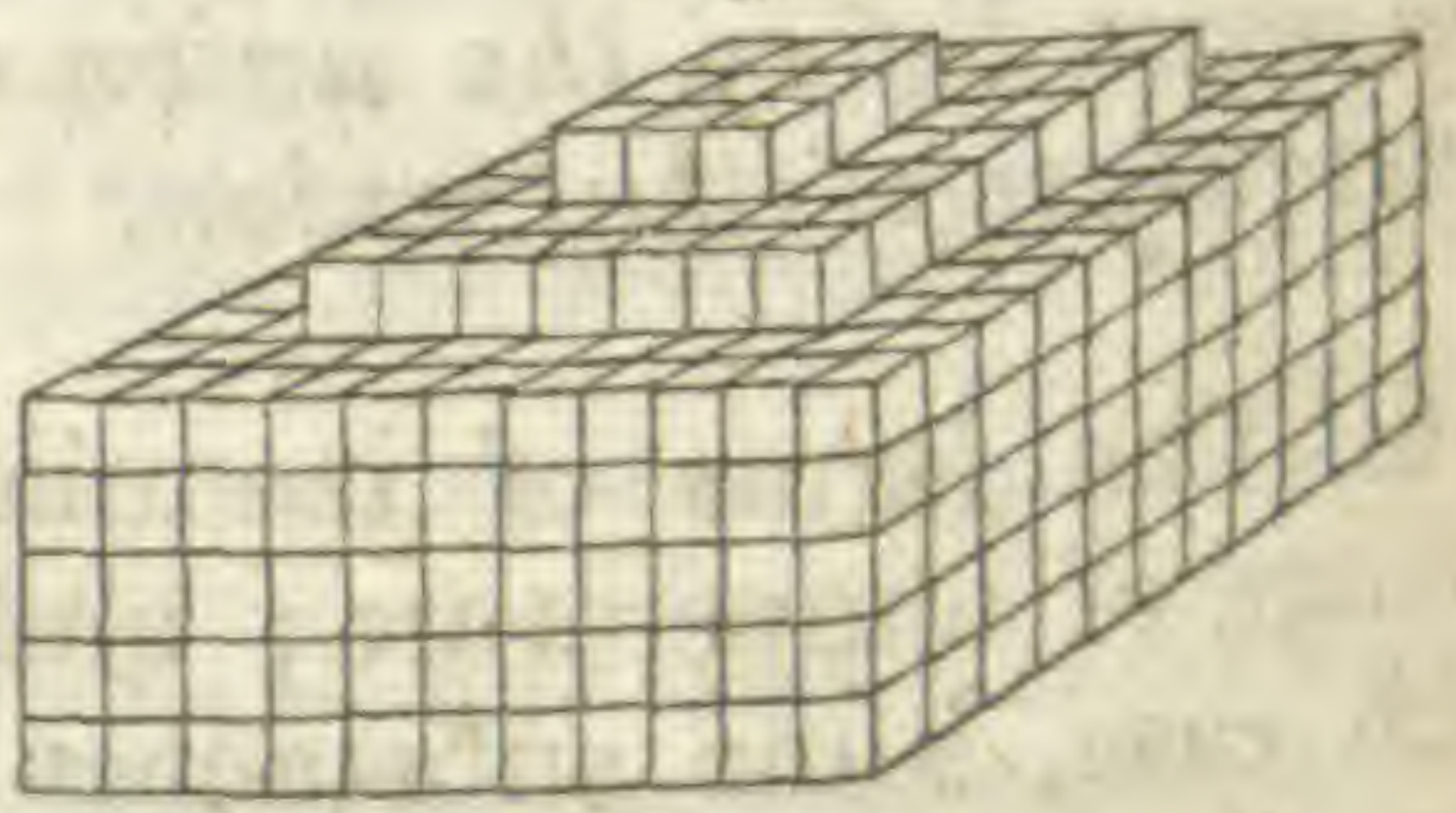
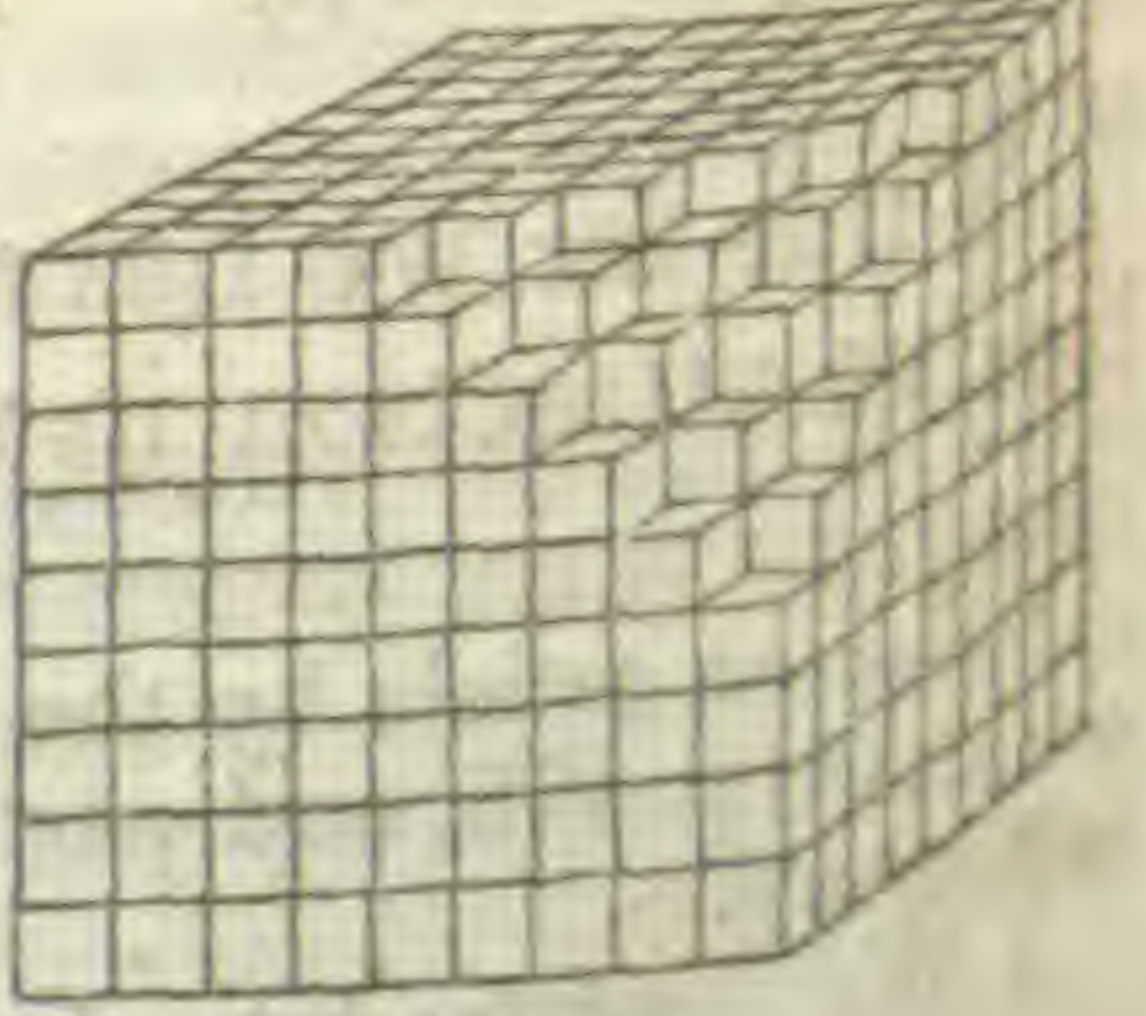


Fig. 13.



VIII. *The variations which the attraction of cohesion undergoes, take place according to some simple ratio.*

9. Similar parts of crystals, with a single class of exceptions, are similarly modified. Now as the similar parts are those similarly situated as regards like axes, it follows that—

IX. *The homologous parts of molecules similarly and simultaneously undergo this variation as regards the attraction.*

10. In the excepted cases just alluded to, only half the similar parts are modified alike. In the cube of boracite, only half the angles have similar secondary planes (fig. 15); in pyrites it is usual to find only one of the two beveling planes in fig. 8, on each edge, as in fig. 14; it is an alternate one throughout, so that the form is still symmetrical, and this is uniformly true. The right and left handed quartz are other examples. Consequently,

Fig. 14.

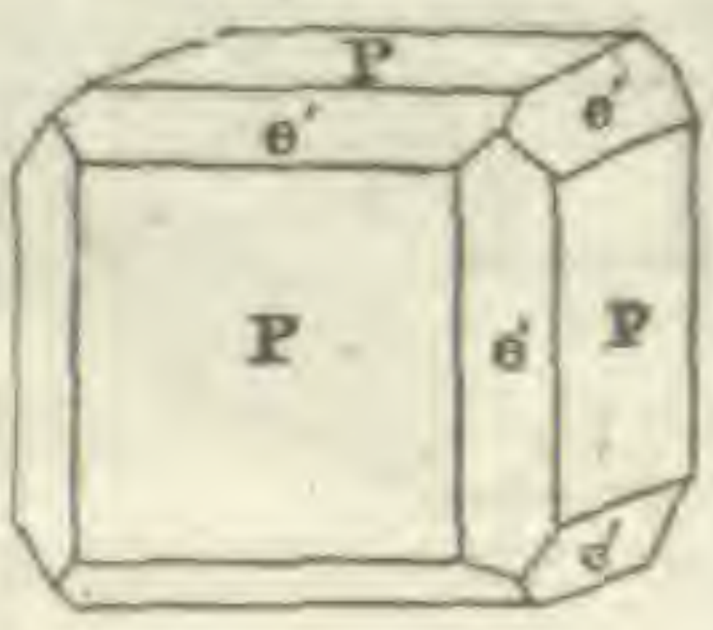
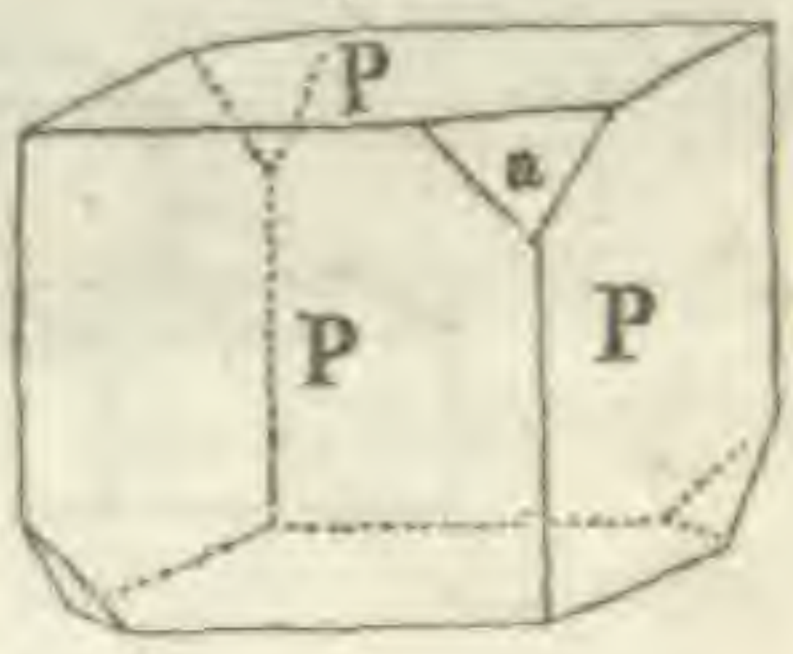


Fig. 15.



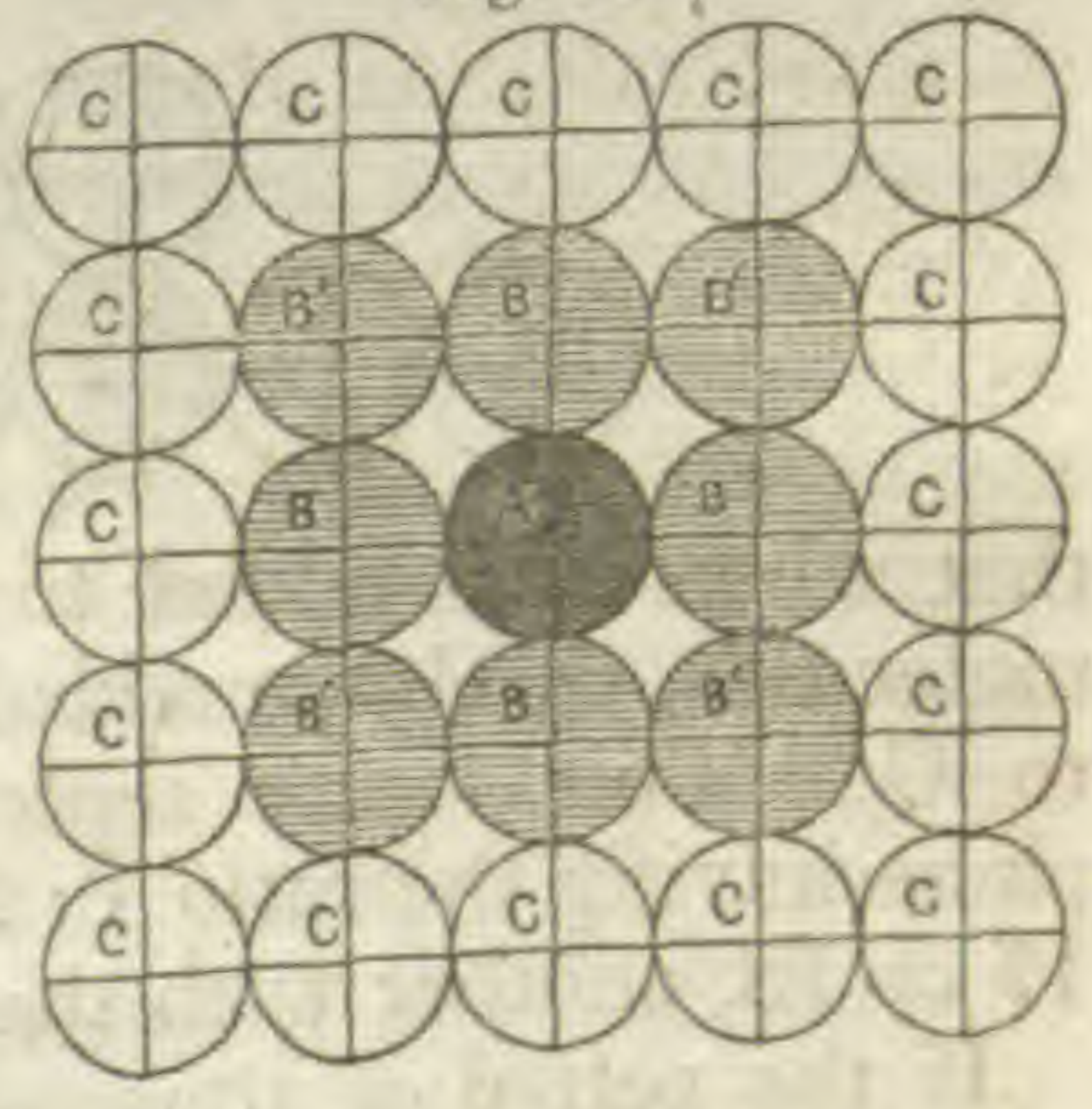
X. *In some cases, the parts of a molecule on opposite sides of a pole undergo a different amount of variation of attraction; this takes place symmetrically with regard to all the poles.*

11. In the formation of a cube with truncated edges, the cube is not finished out on the edges. There is therefore a diminution of the force of attraction in the line of the primary axes, since these axes fail of completing the cube. Hence,—

XI. *If the state of the attraction which produces a primary cube or prism is considered its normal state, when secondary planes are produced there is a decrease of force in the direction of the principal axes, and this decrease is in some simple ratio.*

12. In the enlarging cube, the molecules are added in planes of increasing breadth, as in this way only would the form continue to be a cube. If we consider the case, we find that the central molecule attracts a molecule by each of its poles, and also simultaneously the added molecules act by their lateral axes to complete the plane (fig. 1). We observe in the sectional view (through the centre) in fig. 16, when A by its axes unites with four B's, the B's, simultaneously, while in the act of union, unite with B′, B′, B′, B′; and thus the square form is retained. This is a simple statement of the process.

Fig. 16.



If now when the B's are uniting, their lateral axes do not act at the same time, then the forming cube will have the edges truncated as in fig. 11. To understand this we must study the steps in the process. Fig. 17 represents the same secondary planes as in fig. 11, without the primary faces. It is obvious that in the enlargement of such a secondary, when the summit molecule is annexed, its lateral axes do not act as they do when a cube is formed: when another molecule is added beyond, then they act laterally. This may perhaps be more clearly seen in the transverse section in fig. 18. When A attracts B, B does not act laterally as in fig. 16; it does not so act until B attracts C, when a C is added either side of B. So C acts laterally when a D is added to C, and not before.

Fig. 17.

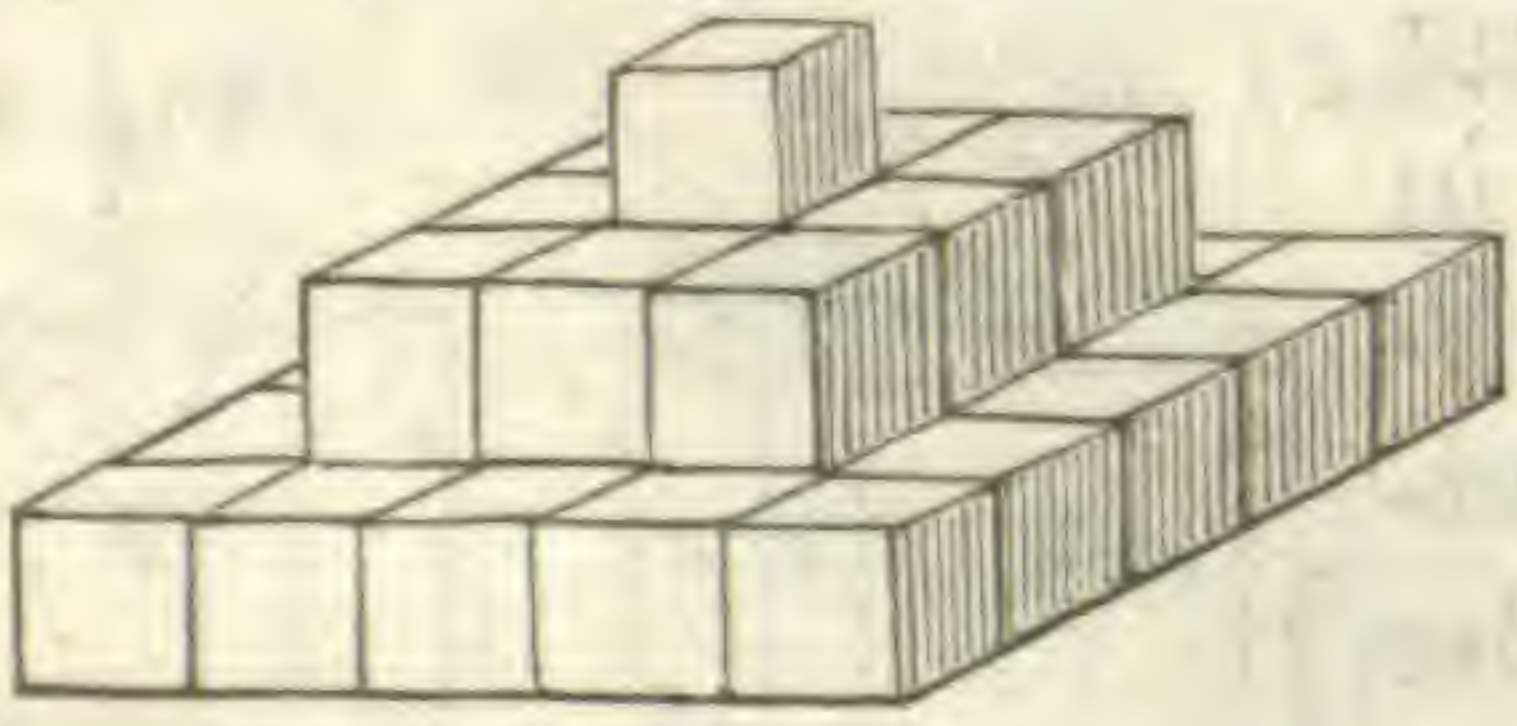
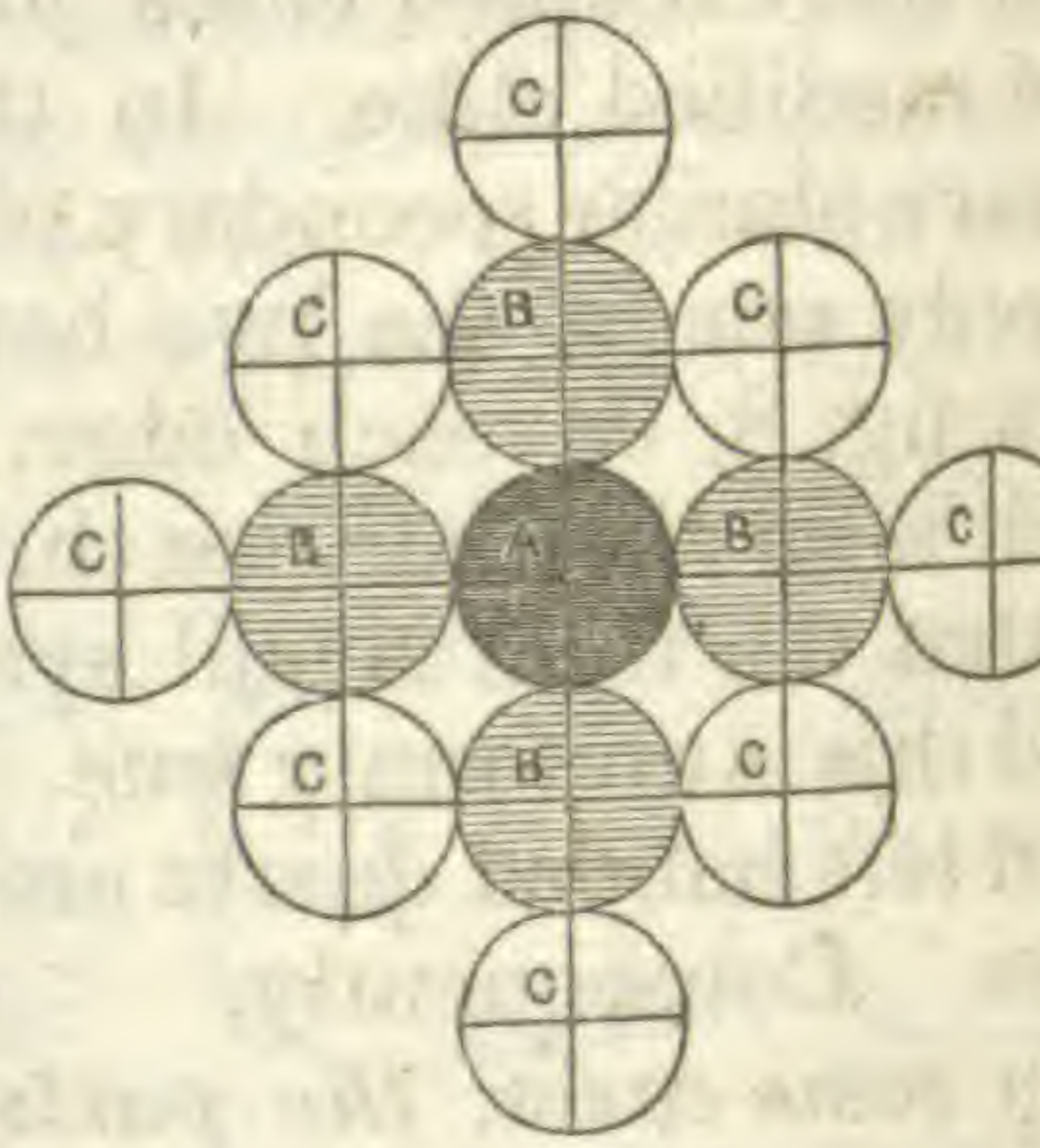
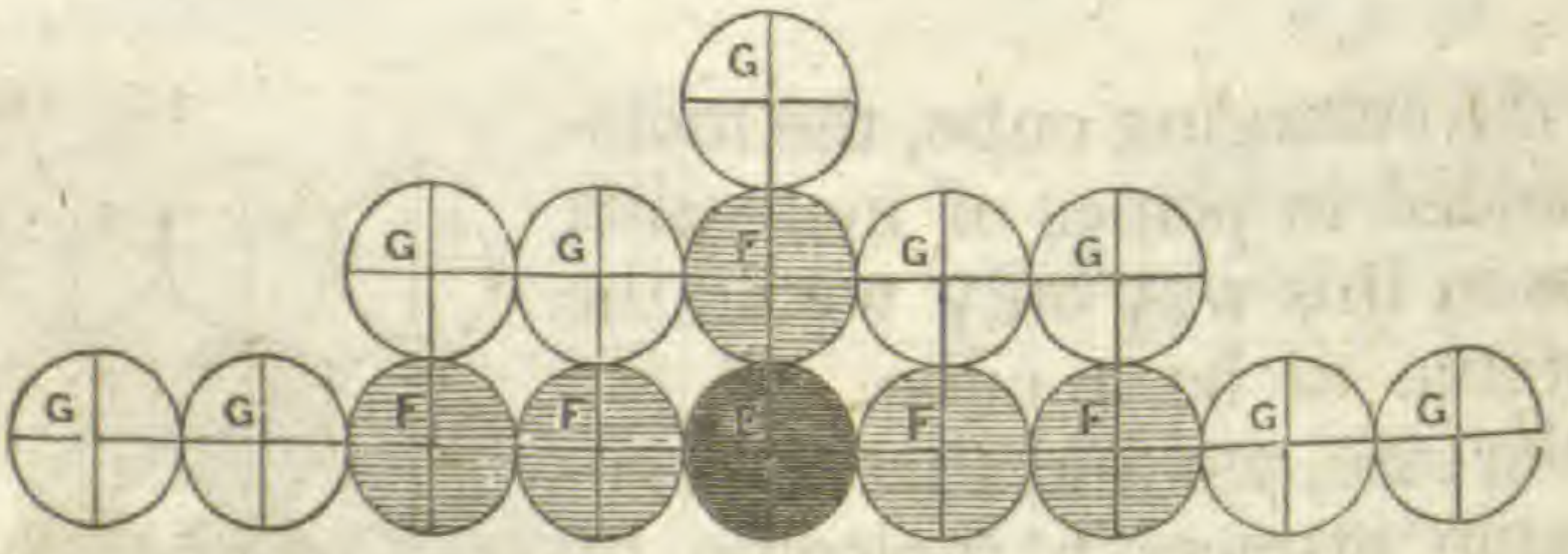


Fig. 18.



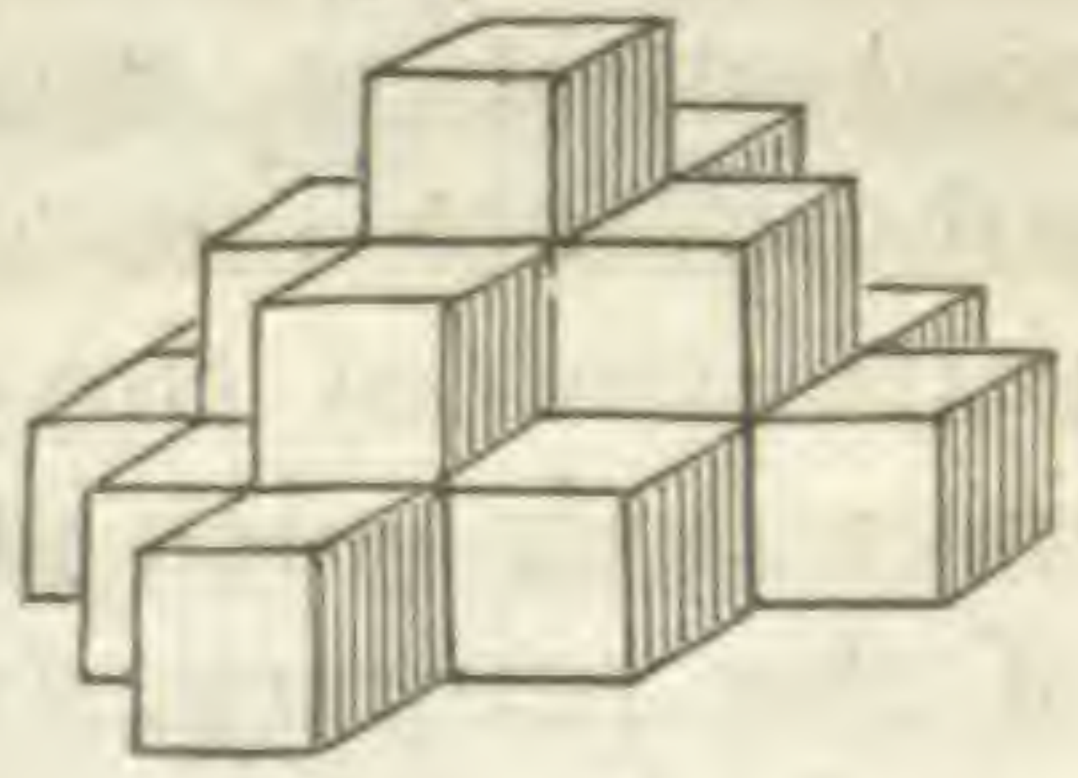
Again in fig. 19, we have a section of another figure, (the same secondary as in fig. 12,) showing the arrangement of molecules in a solid, presenting such a section. Examining it, we perceive that when G is added to the extremity of the central axis, two molecules, G, G, are added on either side of F, and none laterally to G. This figure represents the formation of the secondary plane having the ratio 1 : 2, as is evident from inspection, and fig. 17 or 18, another with the ratio 1 : 1.

Fig. 19.



If the period of time occupied by the union of a molecule be represented by p, then when the lateral axes act only after the period of time p, and then add a single row of molecules, the secondary plane is the truncating plane 1 : 1; for the plane having the ratio 1 : 2, in which two are added laterally to one terminally, or what is equivalent, one laterally for every half a one terminally, the time would be $\frac{1}{2}p$; for the plane 1 : 3, the time would be $\frac{1}{3}p$.

Fig. 20.



To understand the origin of planes on an angle, we must again consider the actual circumstances. Fig. 20 (the same secondary as in fig. 13) will aid the mind in conceiving of it. Here, when the summit particle unites itself, it adds nothing laterally, as was the case also in fig. 17; when another unites beyond, then four particles are united, one by each lateral pole; but these four add nothing, until still another particle is added to the summit. In this case there is an interval of time p, between the action of the terminal and lateral axes, and another interval p', between the adding of the four molecules and the action by *their* lateral axes. And this is the difference between the plane truncating an angle (figs. 9 and 13), and another truncating an edge of a cube, (figs. 7 and 11.) This plane truncating an angle has the ratio $1:1:1$. For a plane $1:2:2$, the times will be each $\frac{1}{2}p$, and for any plane $1:m:n$, the times will be $\frac{1}{m}p$ and $\frac{1}{n}p'$.

It appears that the lateral axes act less speedily therefore for the truncating plane of an angle, than for that of an edge; the centre of the former in a cube is 54° 44′ from the centre of a face of the cube,.and the centre of the latter from the same is 45°.

We have before observed, that the production of secondary forms depends on the fact, that the force of attraction in the axes of the molecules when secondaries are produced, is less than that which is exerted when the primary prism or cube is formed. But we cannot suppose the whole force of attraction in a molecule to be different in different circumstances. No facts nor reasoning would sustain this conclusion. We may admit that the attraction may be more concentrated in the primary axes, in some cases than in others. It is well known that the polar condition in bodies does not imply an addition of force, but simply an axial action or concentration of the force. This concentration or excited action may be induced by the condition of neighboring bodies or influences: and different bodies should differ widely in their susceptibility to it, as is evidently the fact. Now if the attraction is less concentrated in the primary axes, when a secondary plane forms, the *interval of time* above alluded to as characterizing the formation of different secondaries, will be longer or shorter according to the state of concentration in the primary axes. The more or less diffused state of the attraction is connected with the kind of secondary produced.

But when we observe in a complex crystal, the evenness of the faces, the neat regularity of the edges, and the perfection throughout, even when many secondary planes are combined, it appears clear that such forms could not result from simply a generally diffused state of the attraction, any more than a primary could be so produced. In each case there must be as many distinct axes as there are planes. When therefore the principal axes lose their concentration, this loss consists in a distribution of the force into subordinate axes intermediate between the primary axes. For a truncation of the edges of a cube, the intermediate axes would have their poles just at the middle point between every two poles of the primary axes; for a truncation of the angles, the poles would be at the middle point between every three poles. We have remarked upon the symmetrical arrangement of secondary planes in general, and this would follow from the necessary symmetrical arrangement of such axes. Moreover the length of time p, will be greater the farther the secondary pole is situated from the primary poles. And this is true in fact. The pole for the octahedron is the most distant, being at the central point between three primary poles.* The number of combined secondary forms may still seem mysterious. But a crystal, in its capacity as a unit, would necessarily have a corresponding character in its different parts to the molecules of which it consists, and consequently the attraction exerted by the molecules in these different parts would correspond, occasioning thus the secondary planes. Moreover the relative extent of the several different kinds of planes, will depend primarily on the relative force of action in the different sets of axes.

These considerations lead us to conclude, that—

XII. *The diminution of attracting force in the primary axes, on which the formation of a secondary depends, consists in the partial action of this force along intermediate axes, symmetrically situated with reference to the primary axes; and the greater or less amount of diminution, determines the kind of distribution.*†

13. The same crystalline forms, may have different cleavage in the case of different species of matter. Thus, cubes of galena have a cubical cleavage, while cubes of fluor spar have an octahedral cleavage or yield octahedrons when cleaved. In ordinary crystallographic language, the cube is therefore said to be the primary of galena, and the regular octahedron is the primary of fluor spar. These different circumstances would result, provided that in one case (for galena) the three primary axes of the molecule were dominant, and in the other the eight intermediate or octahedral axes. The arrangement of the molecules in each case would depend on the dominant axes, and so also would the direction of the cleavage. Hence,—

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* Here is evidently basis for mathematical calculations of some interest.

† In the case of substances that very seldom crystallize or never, we have evidence that the polar forces are very weak. The attractive force may be so diffused as to approximate to the ordinary state in liquids.

XIII. *The direction of cleavage may indicate in any species of matter which set of axes is dominant, the primary, or a secondary set.*

In the preceding paragraphs, after ascertaining the general polar action of cohesive attraction, we have pointed out the modifications of condition this attraction undergoes, the simple ratios presented by these modifications, and their dependence on the formation of intermediate axes. Cohesive attraction instead of being a constant force, as might be inferred from the ordinary definitions, appears therefore to be complex in its actions, yet simple in the general laws by which this complexity is produced.

14. The absence or presence of secondary planes, and their character, are known in some instances to depend on external circumstances. Electric currents, the nature of the supporting rock, or the condition of the solvent are determining causes. A floating crystal has been seen to form secondary planes on becoming attached. Crystallizing in a thick pasty mass as Beudant has observed, will generally afford the simpler forms. The most complex are usually the purest crystals, such as have been produced in the most quiet circumstances. Implanted crystals are sometimes rendered more complex during the last stages of their increase than they were before. These facts show some of the ways by which modifications in the condition of the attraction in the primary axes are produced. The presence of foreign material, sometimes, or whatever may sustain an excited state of polarity in the primary axes, will occasion the formation of simple forms. But if there is nothing to sustain or excite this concentration, or the action is quiet, or if bodies around induce it, owing to their own condition, the attraction becomes more diffused, and secondary axes multiply.* All the crystals of a locality or region have usually the same form. The constancy of certain forms in some species is evidence of the peculiar susceptibilities of the molecules of those substances. Thus the calc spar in the limestone of Lockport has the dog-tooth shape, the scalene dode-

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* The theory above offered with regard to the origin of secondary planes, is near that presented in 1839 to the Royal Society, by Prof. Necker. How far they are identical, I cannot decide with certainty from the brief notice of his paper, which I have seen in the Philosophical Magazine, vol. xiv. p. 216. M. Necker supposes that there is a tendency in crystals to take the spheroidal forms of their molecules; that when the secondary axes are destroyed by different causes, simple crystals are produced. According to the view here presented, there is no tendency of this kind recognized; the concentration of the primary axes producing simple forms is the ordinary condition of the molecules of some substances in solidification; and by this concentration, however produced, the secondary axes lose their force. The view I had gathered from the abstract of M. Necker's memoir, is given in a note to page 100 in the author's Mineralogy, 2nd edit., New Haven, 1844.

cahedron; that of Boonville, New York, occurs in short six-sided prisms. That of the Rossie lead region in complex combinations of different secondary planes with the primary.

XIV. These facts indicate, that *the variations of attraction, producing secondary forms, depend often on surrounding bodies favoring the concentration or diffusion of the attracting force; and the causes often act simultaneously in nature over wide areas.*

15. It is also a usual truth, that crystals are sometimes very much lengthened beyond their normal proportions, and in other cases, very much shortened. When attached, they are lengthened or shortened in the direction of the axis of attachment; and if obliquely attached, they are distorted in this direction. These facts, which are of common observation, show that—

XV. In an enlarging crystal, *one axis* (*or two*) *may have the action of attraction more accelerated or retarded than another by extrinsic influence, and this acceleration or retardation affects equally all crystals forming together under common circumstances.*

16. The peculiarities of cleavage give us information on another point respecting cohesive attraction. The facility of cleavage in prisms differs in the direction of unlike axes. Topaz cleaves easily parallel to the base of the prism, and not at all in other directions. This difference does not depend upon the relative strength of attraction in the unequal axes; for it is often the reverse of this. Again, while some of the hardest substances have perfect cleavage, other soft species have none.

If then this quality has no relation to the strength of the attraction which unites molecule to molecule, it must depend on some peculiarity in the manner in which this force acts. This force may act in two ways:—either *continuously*, or *intermittedly;* and the latter mode only, could produce the result in view. The action of force in nature appears to be generally intermittent. Alternate action and comparative inaction, with corresponding results, are every where exemplified in organic growth; and it is therefore no anomaly that it should be exemplified in the inorganic kingdom.[*]

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[*] The successive layers in wood, the periodical reproduction of leaves or flowers, and of young in animals, and the seriate arrangement of parts in many plants and animals all illustrate intermittent growth. In some zoophytes the buds form in successive series of two, four or six, or some other fixed number; in other cases opposite sides alternate in budding, or when there are several rows, the rows bud in succession; and these are examples of intermittent action.

The spiral arrangement of leaves in vegetation, as I have elsewhere observed, (Zooph., p. 89,) is another illustration of intermittent growth; for here the different sides of the growing plant (*five*, in many plants, and *six* in many others) bud

We infer therefore that when cleavage is produced, the union of layers of molecules takes place by an intermitted action; that is, with regular successive variations or pulses in the intensity of the force of attraction. This intermitted action when reduced to simply the adding of single layers in succession, becomes continuous. On these principles there might be every variety of this quality in nature, and there should be no necessary connection between cleavage and strength of attraction. We therefore infer that—

XVI. *The action of cohesive attraction is often intermittent, producing seriate results, (as exemplified in the cleavage of crystals,) and the specific rate of intermittent action is different for unequal axes.*[*]

17. Cohesive attraction may be partly controlled in its results by gravity, and by rate of solidification or of chemical combination. It is evident that in the cooling of a liquid mass, when the temperature of solidification is reached, there will be numberless points throughout the mass where the molecules will commence the process of crystallization; and acting together, they would produce an aggregation of small crowded crystals or grains, with no external regular forms, in other words, the *granular* structure. In cases of a crystallizing solution, the same result may happen, if the process be rapid.

Again, a thin solution spread over a large surface, would produce crowded minute points; and if the solution be gradually supplied, as the crystallization goes on, it is obvious that the minute points crowded together might elongate into crowded prisms,

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successively, for the simple reason, of universal application, that reproduction produces temporary exhaustion, or, that force is exerted intermittedly.

The *pulsation* of molecular force is also an example of intermitted action, and must lie at the basis of the universal principle on this subject to which we have alluded. The reality of this pulsation, insisted upon by Mr. J. D. Whelpley in 1845 before this Association,[a] and also by Faraday,[b] we cannot doubt. The undulatory theory of light must be received as fully demonstrated: and if it is an ether that pulsates, it is molecular force which makes it pulsate, and this implies pulsating action in molecular force itself.

The attraction of cohesion is shown by cleavage to be intermittent in *intensity;* we do not learn from it that there is any actual intermission of time in the exertion of the force, or a variation in rate of pulsation.

[*] Many crystals have their surfaces covered with parallel striations which consist of alternations of two or more sets of planes. Thus cubes of pyrites very generally have their faces marked with striæ which are oscillations between a plane replacing the edge, and either the face of the primary cube, or another plane of the same secondary. Some octahedrons of fluor spar have faces which consist of minute cubes. These facts, and they are common and well known, show frequent intermittent mode of action in the different axes of molecules, (or a seeming strife between different sets,) producing what has been called an "oscillatory combination" of planes.

[a] Rep. Proc. for 1845, and also this Jour., xlviii, 352, and ii Ser., ii, 401.

[b] Phil. Mag., May, 1846, and this Jour., ii Ser., ii, 401.

and produce a fibrous structure. Such a structure is common in narrow seams in rocks, proceeding either from this cause, or perhaps in part from the electric influence of the adjoining walls of the seams.

The concentric structure is another result depending on the rate of solidification connected often with the rate of chemical combination. In the first place the nucleus is always a cluster of molecules, instead of a single one as for a simple crystal. The structure sometimes commences around some foreign body as a centre, though the aggregation is often without any proper nucleus, except that of the cluster of molecules that first solidified. The second principle, on which the concentric structure depends, is the tendency of a body to communicate its own condition to other bodies within its influence. This law—the law of equilibrium, and contact, or catalysis in chemistry—is one of the universal laws of existence. According to it, either a collection of molecules entering the solid state, or any foreign body already solid will tend to bring adjacent bodies into the same or an intermediate condition. If susceptible to this influence, the particles adjoining become assimilated, and unite to the nucleus; these again act upon others adjoining, and thus a spherical form is produced, as a result of successive development. In glass that has cooled with extreme slowness, there are often spherical aggregations of crystals. Here, in some single point, the mineral of the aggregation first began to form; and once begun, the process was continued, according to this law of influence, around the point as a centre, and the aggregations are therefore spherical. In cooling basalt or granite, large spherical concretions are often formed. The process of solidifying is in these cases continued through a very long period of time; and from the relation often perceived between the thickness of a bed of basalt and the size of the concretions, this size is evidently greater the slower the cooling. In this prolonged cooling, after a while, here and there a spot reaches the solidifying condition, and the process commences. The particles adjoining, as explained, become solid about the spot; thence the process extends itself equally in every direction; and spheres are the result. The slower the cooling, the longer the time occupied in passing through a single degree of temperature; and consequently, when the cooling is most gradual, the centres would subordinate to themselves a large amount of material, and produce larger concretions.

In other cases, a solution is infiltrating through a clay or sand:—something (it may be a harder point or spot, or some organic object) determines the commencement of solidification at certain points in the clay, and from this, the process continues by simple propagation, as just described. The stratification of the clay, or texture arising from gravity, favoring infiltration laterally more than vertically, will often cause such concretions to be flat; and when they become very numerous, a bed of concretions is changed to a solid bed of compact rock.

In still other cases, a molecular change of the same general character and on the same principle, goes on after consolidation has taken place.

The structure of such concretions must depend on the material constituting them. The mode of formation, and the general property that attraction has a definite relation to distance from a centre, will give them a similarity of character, in corresponding parts. The constituent crystalline grains, when any are apparent, will have necessarily a corresponding position with reference to the centre. A foliated mineral which in one part had the foliation concentric in the spherical mass, would have for the reason stated, the foliation concentric throughout; and a fibrous mineral, with the fibres radiating from the centre, would retain this structure regularly.*

These considerations sustain the conclusion, that—

XVII. *Cohesive attraction produces spherical concretions, about a cluster of molecules as a nucleus, through the tendency of molecular action or condition to propagate itself; and concentric aggregations begun, act under the general influence of the radial action of attraction in a mass, which action, other things the same, is equal at equal distances from a centre.*

We might consider other effects of cohesive attraction, and extend our remarks to liquids and gases. But this paper has already reached an undesired length, although giving but the outlines of a subject that admits of great extension; and the consideration of liquids and gases in the present state of our knowledge would involve us in speculations that we have purposely endeavored to avoid.

We have thus endeavored to follow out the various facts presented by matter as it exists around us. Observation has proved more profitable than closet speculation in animal and vegetable Physiology; and so it will be with regard to the grand organizing force of the so-called inorganic kingdom,—the basis of Mineral Physiology. The fact that the attraction of molecules is liable to modifications of condition, and especially the simple yet fixed relations between these modifications, nothing but a crystal could make known to us. Yet the principle is as wide as the universe in its application; for we live in a universe of molecules, and all the grandeur of physical nature is the result of molecular forces.

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* The concentric structure here explained is analogous in many respects to the circular and spherical forms in vegetation. The growing lichen extends itself circularly, owing to progressive assimilation or development. This proves no similarity of nature between the organic forces and cohesive attraction; it only shows that different forces act under a common law.

Through the preceding pages I have intentionally avoided allusions to the actual nature of molecules, as the conclusions are independent of any views on that subject. Even form and size are not essential to the deductions, as what has been designated the lengths of the axes, may be viewed as the inverse ratio of the attracting force in the axial directions. If the existence of an ether be insisted upon as surrounding the molecules, the relations are none the less correct.

The facts however prove that in the action of cohesive attraction there is a limit to penetrability, fixed in different directions for given temperatures; and this limit is essentially a limit of form and size; and as the phenomena of light are dependent on molecular forces, we cannot deny to molecules color and other qualities of sensible objects.

The ether appealed to in order to explain the phenomena of light,—admitted to have none of the qualities of matter and yet often spoken of as a real existence,—is a kind of machinery, summoned for the sake of an explanation; and since we may now believe that instead of such an ether capable of pulsations, *pulsating molecular force* itself will afford as perfect an explanation of the phenomena of light, the necessity of the ether even as an hypothesis is done away with.* There is therefore no reason from this source for doubting the conclusion that the forms of molecules and their relative dimensions, as ascertained from crystals, are their real forms and relative dimensions.

The phenomena of heat as explained by received theories, seem to present a similar objection to the view we here take, since an ether or a mysterious imponderable agent is supposed to intervene between the molecules in the expansion of solids, and by its arrangement to cause the change of axial directions. But the assumption of this tertium quid gives us no aid in understanding the change of axial direction, and the general law with regard to attraction, on which we must fall back in either case, will be much simpler without it. Neither, as my friend Mr. J. D. Whelpley has argued, is this hypothesis necessary in order to explain expansion. Since molecules may undergo all the various modifications of condition and form which have been pointed out, it is not improbable that they should also admit of change of size. Size is known to be directly related to temperature: every degree of temperature in a given substance is connected with a specific size. To effect a change of size in molecules, attraction, the same which has been shown to vary in concentration and other particulars, must also vary in radial force. The variations which have been pointed out are caused by induction, according

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* See note, page 379. This principle, like the theory of gravitation when first presented, rose into view to simplify, just when theoretical science was becoming encumbered with rapidly increasing perplexities.

to the general law of mutual influence, or tendency to equilibrium, and no other law is required to explain a change of size. For if there were in existence molecules of the same substance of different sizes (or in other words of different temperatures), there would be between them a tendency to equilibrium of size (or in common language, to a mean temperature); and thus this simple law of mutual influence will explain enlargement or contraction from variations of temperature; and the variations from a mean size, (a mean temperature,) arrived at when two *different* substances mutually act on one another, will be specific heat. The change of form and axes in molecules dependent on change of temperature, will be a consequence of change of size, according to some law yet unascertained.

This view, for which we are indebted to Mr. Whelpley, explains expansion without recourse to any intervening ether, or any imponderable agent, excepting the general force of attraction. Admitting these conclusions, it will follow that the forms deduced for molecules are their actual forms. We confidently believe it will soon be shown that this change of size and attendant changes in pulsating force, will sufficiently explain the physical effects of heat.*

A *molecule* according to these views, is spherical or spheroidal in form:—

It exerts attraction in every direction; but this force on opposite parts is so related that one molecule attracts another by one side and repels it by the opposite (polarity):—

In solidification (and sometimes before?) this attraction is axially polar; it admits of various degrees of axial concentration or diffusion, (§ 7 to 12,) of acceleration or retardation of action, (§ 15,) and of different degrees of radial force, which variations take place under the general law of mutual influence, or tendency to an equilibrium:—

This attraction acts by pulsations; in solidification there are also compound pulses (undulations in intensity) consisting of a series of pulsations, and producing intermitted or seriate results (cleavage), which results are in all cases specific; the same pulsations (the optic nerve being sensible to them) produce the phenomena of light; they are also a means of producing chemical effects, especially when the pulsations exceed the rapidity of those for light, (the *chemical* rays being those beyond the violet ray or those which have been shown to be most rapid in vibration.) The α and β states of elements, or their passive and

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* The relations of heat and magnetism, are illustrated in a valuable article in this volume, by Prof. W. A. Norton, pp. 1 and 207; and some following pages contain an interesting memoir on heat and light by Prof. Draper.

active states,—the former changing to the latter under the action of light or the chemical rays,—will be different states induced by or through rapidity of pulsation, the rapid pulsation of molecular force (causing or constituting what we call chemical rays) inducing the same rapid action in molecules under their influence. Magnetism may be a condition in which the attractive force is in constant active onward transfer from particle to particle, and galvanism, a condition of similar transfer while an exciting cause is in operation.

In hemihedral prisms like those of tourmaline and topaz, the molecules must have been in this magnetic condition; for they exhibit polarity now when heated. In the *right* and *left handed quartz* and similar cases, where while forming one side of a molecular pole must have been differently affected from the opposite, we may believe that the pulsations were alternate along each axis, *a*, *b*, *c*; this would in fact be a spiral action and it would produce a right and left handed crystal, according as the spiral action was to the right or left.

We accord in many particulars here stated, with the general theory of molecules and molecular forces presented lately, with some important shades of difference, by Whelpley and Faraday, and based on that of Boscovitch.

The explanations offered show that very many of the phenomena of physical nature, may be understood on the idea that molecules are simply centres of attraction, the same attraction whose laws have been under consideration. But no property of cohesive attraction explains the *limits* and *proportions* observed in chemical combination. The ultimate nature of the molecule, or of the forces constituting them, (on which we forbear from remark in this place,) is our only appeal for an explanation of these chemical relations. When fully understood, it may appear that cohesive attraction with all its laws, is only a necessary result of this peculiar constitution. We need yet some facts to make it obvious how both classes of phenomena, those of aggregation and chemical combination, may be united in one continued series.

These theoretical suggestions on molecules are annexed to the preceding article, partly in elucidation of some facts before stated, but more especially to exhibit the bearing of the principles on different theories respecting the constitution of matter, and to show that what may seem to be discrepancies are not necessarily so.

There is a strange variance between the chemist and crystallographer. In treatises on chemistry, a theory of molecular forms is often presented as the truth in a chapter on crystals, the falsity of which is taken for granted in all the other parts of the work.

Nature with more consistency, points to a unity of truth. This truth cannot be reached through any one avenue of science. Chemistry teaches us the laws of combination governing molecules, and the attendant operations of molecular forces;—crystallography indicates to us the forms of molecules and the laws which govern in molecular aggregation;—the eye being sensible to the movement of molecular force, optics teaches us the rapidity, character, and physical effects of its pulsations:—and we add by our thermoscopic instruments, another sense, for ascertaining other laws of molecular action. When the mind is fully opened to all these several sources of light, their concentrated beams will enable us to see beyond doubt the minute molecule almost with the distinctness of visibility.

ART. XXXIV.—*Results of the Examination of several Waters from Hartford, Conn.;* by B. W. BULL.

THE different samples were taken from wells in the city of Hartford, Conn., May 28th, 1847. Their localities are as follows:—

No. 1 is from a well in the State House Yard, northwest corner.
No. 2 is from the well of H. Seymour, 16 Main street.
No. 3 is from a well on the grounds of the American Asylum.
No. 4 is from Lane's Coffee House, North Main street.
No. 5 is from the New England House, Front street.

The soil of Hartford is an alluvium of ferruginous clay, sloping toward the Connecticut River on the east, and overlying the red sandstone of the greater secondary of Connecticut. It is in fact derived entirely from the decomposition of the soft argillaceous and calcareous shales which characterize this part of that deposit. No. 3 is taken from the more elevated portion of the city. No. 1 is from the centre of the city, No. 5 from the eastern, and Nos. 4 and 2 from the northern and southern extremities respectively. The gases contained in the waters were not estimated, as the immediate object of the investigation was to ascertain the amount of solid matter; neither was their action upon lead observed, which would have been interesting if time had allowed, more particularly as the results obtained by Prof. B. Silliman, Jr., in his examination of waters for the city of Boston, show conclusively that the established opinion, that water containing sulphates in solution is without action upon lead, is not sustained by experience.

A peculiarity in all of the waters with the exception of No. 1, is the excess of bases in combination with crenic acid and probably with organic matter in other modifications; an opinion derived from the fact that those portions from which the crenic acid had been separated by neutral acetate of copper, were upon concentration and evaporation highly colored, the color disappearing upon ignition. This reaction was observed upon all the samples from which this acid was separated, but a deficiency of material precluded the quantitative estimation of it in all but No. 3, in which the amount was 2·6 grains in one gallon, a quantity not sufficient to saturate the excess of base. The large excess in most of the waters may appear to exceed the bounds of probability, but repeated and concurring experiments show the results to be correct. In the deficiency of knowledge in relation to the modifications in which organic matter exists in combination with bases in water, and the unsatisfactory methods which we possess for its determination, it was preferred to state the results as obtained without attempting to estimate the organic matter with which the excess of bases is supposed to be combined. Its presence was abundantly proved by the action of nitrate of silver in solution upon the specimen under examination.

There were no indications of phosphates, apocrenic acid, or of potassa. The soap test, as might be inferred from a glance at the table, indicates that they possess in an eminent degree the property of *hardness*, becoming, with the exception of No. 3, immediately and perfectly opaque upon the addition of the test to the waters contained in a wine glass, accompanied in Nos. 1 and 5 with the formation of a curdy precipitate occupying nearly half the bulk of the tested liquid. The order of succession, considering No. 3 the best, would be 3, 4, 2, 1, 5.

The following tables are the results of the analyses. Table I. shows the specific weights and the amount of solid contents as found by evaporation and ignition in conjunction with a known weight of pure anhydrous carbonate of soda, added to prevent loss by the decomposition of any chlorid of magnesium; the weight of No. 5 is that found by analysis. The weights and measures used were the French *gramme* and decimals, and the *litre*, but are reduced in the tables to standard Troy grains, and the U. S. gallon of 231 cubic inches, the weight of one gallon distilled water at 60° F. being taken as 58·328,886 grains.

Table II. gives the amount of the constituents as found by actual analysis, without reconstruction. The discrepancy between the footings of this and the next table, arises from the loss of oxygen which the bases undergo by the formation of haloid salts with chlorine.

Table III. In this table the results of the analyses are combined as they may be supposed to exist in the waters in their natural state. The method recommended by Fresenius has been followed in reconstructing them, and the conclusions, though liable to criticism from the well known impossibility of accurately reproducing their original combinations, are supposed not to vary essentially from reality.

Table IV. gives the relative proportion of water and solid contents in 1000 parts.

I would express my indebtedness to Prof. B. Silliman, Jr., for many valuable suggestions during the course of the accompanying analyses.

TABLE I.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific weight, . .	1·00081	1·00044	1·00010	1·00078	1·00106
Amount in grains of solid contents in one gallon, as found by evaporation,	41·479	32·157	19·334	37·102	69·046

TABLE II.

Constituents of one gallon in grains, as found by actual analysis, without reconstruction.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Chlorine, . . .	12·765	3·563	2·407	3·517	21·557
Sulphuric acid, . .	2·296	2·114	1·028	2·710	3·061
Carbonic acid, . .	6·449	3·429	·561	3·826	4·533
Lime, . . .	12·192	7·671	7·075	8·103	10·358
Magnesia, . . .	1·168	1·116	·555	4·621	5·293
Alumina and iron, .	·204	2·267	. .	·261	traces.
Alumina, . . .	. .	. .	·817	. .	. .
Soda, ...	7·437	6·362	6·893	13·764	23·718
Silica, . . .	1·052	3·474	·817	·261	·526
Ammonia, . . .	. .	traces.	. .	. .	. .
Nitric acid, . . .	. .	. .	traces.	. .	. .
	43·563	29·996	20·153	37·063	69·046

TABLE III.

Contents in one gallon as recombined.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Sulphate of lime, ...	3·902	3·538	1·744	4·606	5·208
Chlorid of calcium, ...	6·522	4·046	2·282	. .	10·498
Chlorid of sodium, ...	11·162	. .	. .	. .	15·481
Chlorid of magnesium, ...	2·396	1·309	1·272	4·757	2·419
Carbonate of lime, ...	13·149	7·581	1·260	8·350	. .
Carbonate of magnesia, ...	1·109	. .	. .	. .	8·815
Alumina and iron, ...	0·204	2·267	. .	0·261	traces.
Alumina, ...	. .	. .	0·817	. .	. .
Silica, ...	1·052	3·474	·817	·261	·522
Carbonate of soda equivalent to crenate of do.,	1·517	6·462	6·892	13·756	15·507
Magnesia combined with crenic acid, .	. .	0·783	. .	2·685	. .
Lime, ...	. .	. .	4·481	1·336	. .
	41·043	29·506	19·565	36·012	58·450

TABLE IV.

Relative proportions of water and solid constituents in 1000 *parts.*

	No. 1.	No. 2.	No 3.	No. 4.	No. 5.
Water, ...	999·289	999·449	999·669	999·364	998·818
Sulphate of lime, . . .	·069	·061	·030	·079	·089
Chlorid of calcium, . .	·112	·070	·039	. .	·179
Chlorid of sodium, . . .	·191	. .	. .	. .	·267
Chlorid of magnesium, . .	·041	·023	·022	·081	·041
Carbonate of lime, . . .	·225	·131	·021	·148	. .
Carbonate of magnesia, . .	·019	. .	. .	. .	·151
Alumina and iron, . .	·004	·038	. .	·004	traces.
Alumina, ...	. .	. .	·014	. .	. .
Silica, ...	·018	·060	·014	·004	·010
Carbonate of soda equiv. to crenate,	·022	·109	·119	·235	·267
Magnesia combined with do.	. .	·013	·076	·044	. .
Lime, ...	. .	. .	. .	·023	. .
Loss, ...	·010	·046	excess.	·018	·178
	1000·000	1000·000	1000·004	1000·000	1000·000

Yale College Laboratory, New Haven, Aug. 9th, 1847.

ART. XXXV.—*On the Production of Light by Heat;* by JOHN WILLIAM DRAPER, M.D., Professor of Chemistry in the University of New York.*

ALTHOUGH the phenomenon of the production of light by all solid bodies, when their temperature is raised to a certain degree, is one of the most familiar in chemistry, no person so far as I know has hitherto attempted a critical investigation of it. The difficulties environing the inquiry are so great, that even among the most eminent philosophers a diversity of opinion has prevailed respecting some of the leading facts. Thus Sir Isaac Newton fixed the temperature at which bodies become self-luminous at 635°, Sir Humphry Davy at 812°, Mr. Wedgwood at 947°, and Mr. Daniell at 980°. As respects the nature of the light emitted there are similar contradictions. In some philosophical works of considerable repute, it is stated that when a solid begins to shine it first emits red and then white rays; in others it is asserted that a mixture of blue and red light is the first that appears.

I have succeeded in escaping or overcoming many of the difficulties of this problem, and have arrived at satisfactory solutions of the main points; and as the experiments now to be described lead to some striking and perhaps unexpected analogies between light and heat, they commend themselves to our attention as having a bearing on the question of the identity of those imponderable principles. It is known that heretofore I have been led

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* Extracted from the London, Edinburgh and Dublin Philosophical Magazine, May, 1847.

to believe in the existence of cardinal distinctions, not only between these but also other imponderable agents; and I may therefore state, that when this investigation was first undertaken, it was in the expectation that it would lead to results very different from those which have actually arisen.

The following are the points on which I propose to treat:—

1. To determine the point of incandescence of platinum, and to prove that different bodies become red-hot at the same temperature.

2. To determine the color of the rays emitted by self-luminous bodies at different temperatures. This is done by the only reliable method—analysis by the prism.

From these experiments it will appear, that as the temperature rises the light increases in refrangibility; and making a due allowance for the physiological imperfection of the eye, the true order of the colors is red, orange, yellow, green, blue, indigo, violet.

3. To determine the relation between the brilliancy of the light emitted by a shining body and its temperature.

Here we shall find that the intensity of the light increases far more rapidly than the temperature. For example, platinum at 2600° emits almost forty times as much light as it does at 1900°.

As I prefer to give a complete description of the apparatus employed in these investigations after the general results are stated, it is sufficient here to understand that the source of light is in all instances a very thin strip of platinum 1·35 inch long and $\frac{1}{26}$th of an inch wide, brought to the temperature under investigation by a voltaic current. Platinum was selected from its indisposition to oxydize, and its power of resisting a high temperature without fusion.

The slip of platinum, thus to be brought to different temperatures by an electric current of the proper force, was fastened at one end to an inflexible support, and at the other was connected with a delicate lever-index, which enabled me to determine its expansion and thereby its temperature. For this purpose I have used the coefficient of dilatation of Dulong and Petit. The temperatures here given are upon the hypothesis of the invariability of that coefficient at all thermometric degrees; they are therefore to some extent in error.

By the aid of resisting wires of different length and a rheostat, I was able to vary the force of the electric current in the platinum, and thereby vary its temperature. My first attempts were to discover the point at which the metal begins to emit light.

The platinum and the voltaic battery were placed in a dark room, the temperature of which was 60°; and after I had remained there a sufficient length of time to enable my eyes to become sensible to feeble impressions of light, I caused the current to pass, gradually increasing its force, until the platinum was visible. In several repetitions of this experiment it was uniformly found that the index to which the platinum was attached, stood at the eighth division when this took place. The metal had therefore dilated $\frac{1}{222}$ of its length; the elevation of its temperature was about 917°, which added to the existing height of the thermometer, 60°, gives for the temperature of incandescence 977° F.

To the correctness of the number it may be objected, that owing to the narrowness of the metallic strip it is not well calculated to make an impression on the eye when the light it emits is so feeble; nor can we take the dilatations given by the index, as representing the uniform temperature of the whole platinum, which must necessarily be colder near its points of support, by reason of the conducting power of the metals to which it is attached.

Physiological considerations would also lead us to suspect that the self-luminous temperature must vary with different eyes. The experiments of Bouguer, hereafter to be referred to, indisputably show that some persons are much more sensitive to the impressions of light than others. So far as my limited investigation of this matter has gone, I have not however found appreciable differences in the estimate of the temperature of incandescence. Different individuals, observing the platinum, have uniformly perceived it at the same time.

Against the number 977° it may also be objected, that antimony melts at a much lower temperature, and yet emits light before it fuses. If this statement were true, it would lead us to believe that all bodies have not the same point of incandescence. But I think the experiments of Mr. Wedgwood on gold and earthenware are decisive of that question; and, moreover, I have reason to believe that the melting-point of antimony is much higher than commonly supposed.

With a view of determining directly whether different bodies vary in their point of incandescence, I took a clean gun-barrel, and having closed the touch-hole, exposed the following substances in it to the action of the fire:—platinum, chalk, marble, fluor spar, brass, antimony, gas-carbon, lead; each specimen was small; the platinum was in the form of a coil of stout wire.

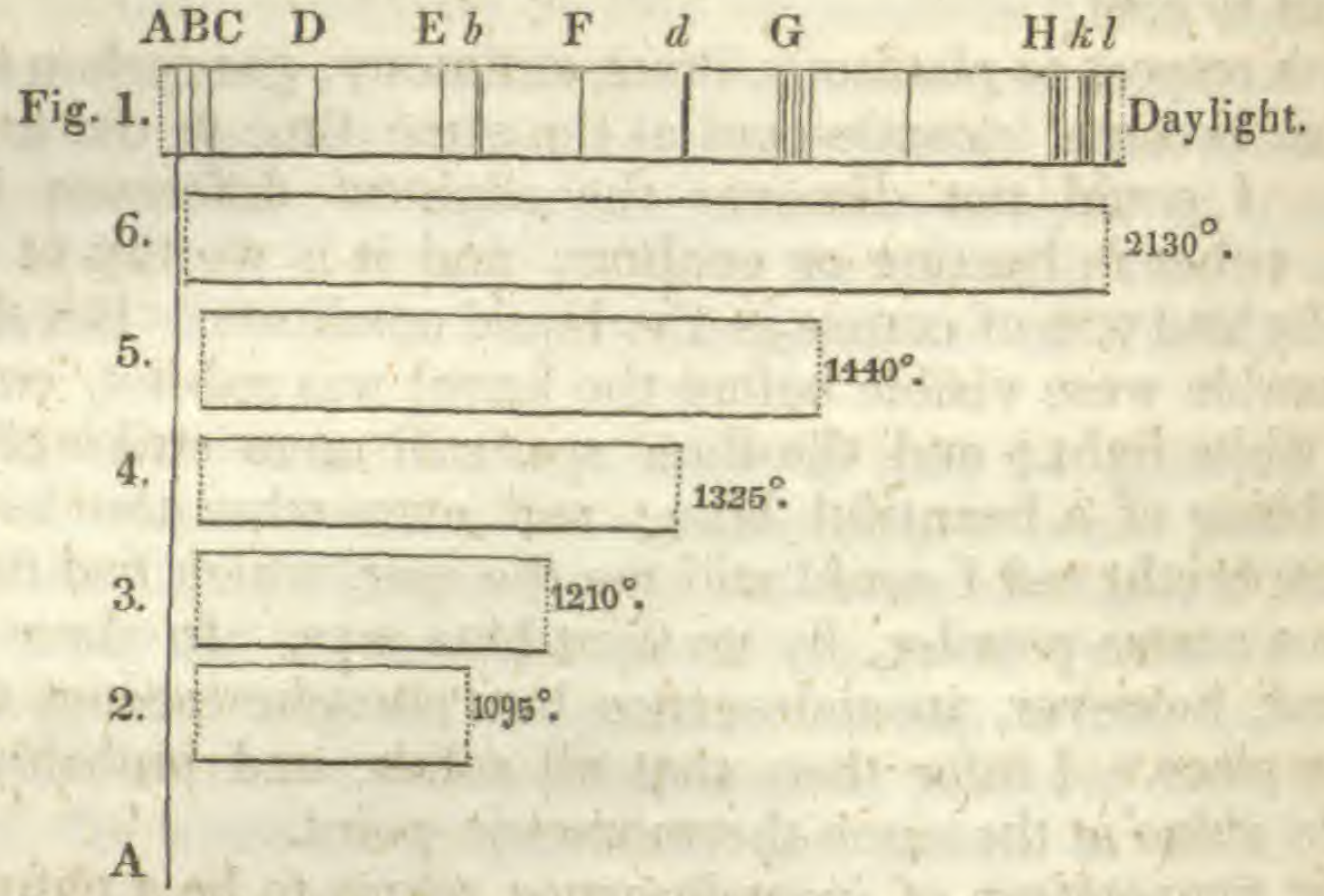
When one of these bodies was placed in the gun-barrel and the temperature raised, it is clear that any difference in their point of incandescence would be detected by the eye. Thus, if the ignition of platinum required a higher degree than iron, on looking down the barrel the coil of wire should be dark, when the barrel itself begins to shine; or, if the platinum was incandescent first, the wire should be seen before the barrel is visibly hot; and these results might be corroborated by observing the inverse phenomena, when the barrel is taken from the fire and suffered to cool.

With respect to platinum, brass, antimony, gas-carbon and lead, they all became incandescent at the same time as the iron barrel itself. I could not discover the slightest difference between them, either in heating or cooling; and it is worthy of remark, that the lead was of course in the liquid condition. But the chalk and marble were visible before the barrel was red-hot, emitting a faint white light; and the fluor spar still more strikingly so, its light being of a beautiful blue; and even when the barrel had become bright red I could still see the spar, which had decrepitated to a coarse powder, by its faint blue rays. In these cases it was not, however, incandescence but phosphorescence that was taking place. I infer then that all solids, and probably melted metals, shine at the same thermometric point.

The temperature of incandescence seems to be a natural fixed point for the thermometer; and it is very interesting to remark how nearly this point coincides with 1000° of the Fahrenheit thermometer, when Laplace's coefficient for the dilatation of platinum is used. Upon that coefficient the point of incandescence is 1006° F.

In view of these considerations, and recollecting that the number given by Daniell is 980°, and that of Wedgwood 947°, I believe that 977° is not very far from the true temperature at which solids begin to shine. It is to be understood, of course, that this is in a very dark room.

I pass now to the second proposition. The rays emitted by the incandescent platinum were next received on a flint glass prism, placed so as to give the minimum deviation, and after dispersion viewed in a small telescope. A movement could be given to the telescope, which was read off on an annexed scale. However, instead of bringing the parts of the spectrum under measurement to coincide with the wires stretched across the field of the instrument, I found it more satisfactory to determine them by bringing them to one or other of the edges of the field; a process well adapted to ascertain the position of the extreme rays, the faint light of which contrasted well with the darkness by which it was surrounded. They could not have been so accurately seen while the rest of the spectrum was in view; and as it was absolutely necessary to have fixed points of reference, that all the observations might be brought to a common standard of comparison, and as there are no fixed lines in the light of incandescence, such as are in the sunshine and daylight, I therefore previously determined the position of the fixed lines in a spectrum formed by a ray of reflected daylight which passed through a fissure $\frac{1}{20}$ of an inch wide and one inch long, occupying exactly the position subsequently to be occupied by the incandescent platinum. Fig. 1. represents the results of this observation.



Spectra of incandescent platinum at different temperatures.

The strip of platinum was now placed in the position of the fissure which had given the spectrum, fig. 1, and its temperature was raised by the passage of a voltaic current. Although I could distinctly see the metal when the heat had reached about 1000° by the naked eye, yet the loss of light in passing the prism and telescope was so great that I found it necessary to carry the temperature to 1210° before a satisfactory observation could be made. At this point the spectrum extended from the position of the fixed line B in the red, almost as far as the line F in the green; the colors present being red, orange, and a tint which may be designated as gray. There was nothing answering to a yellow. The first rays visible through this apparatus may therefore be designated as red and greenish gray; the former commencing at the line B, and the latter continuing to F. The magnitude and other relations of this spectrum are given in fig. 3.

The voltaic current was now increased, and the temperature rose to 1325°. The red end of the spectrum remained nearly as before, but the more refrangible extremity reached to the position of the little fixed line *d*. Traces of the yellow were now visible; and, with a certain degree of distinctness, I could see red, orange, yellow, green, and a fringe of blue. Fig. 4 shows the result.

The temperature was now carried to 1440°. I thought the red extremity was advancing more to the line A: the blue had undergone a well-marked increase. It reached considerably beyond the line G, as shown in fig. 5.

On bringing the platinum to 2130° all the colors were present, and exhibited considerable brilliancy. Their extent was somewhat shorter than that of the daylight spectrum, as is seen in fig. 6.

Having thus by repeated experiments ascertained the continued extension of the more refrangible end as the temperature rose, it became necessary to obtain observations for points below 1210°, the limit of visibility through the telescope. I therefore carried the prism nearer to the platinum, and looking with the unassisted eye directly through it at the refracted image, I found it could be distinctly seen at a temperature as low as 1095°. Under these circumstances the total length could not be compared by direct measurement with the other observations, and the result given in fig. 2 is from the best judgment I was able to form: the colors were red and greenish-gray.

The gray rays emitted by platinum just beginning to shine appear to be more intense than the red; at all events the wires in the field of the telescope are more distinctly seen upon them than upon the other color. I give them the designation of gray, for they appear to approach that tint more closely than any other; and yet it is to be remarked that they are occupying the position of the yellow and green regions.

Already we have encountered a fact of considerable importance. The idea, that as the temperature of a body rises it begins to emit rays of increasing refrangibility, has obviously to be taken with a certain restriction. Instead of first the red, then the orange, then the yellow, &c. rays, in succession, making their appearance, in which case the spectrum should regularly increase in length as the temperature rises, we here find, at the very first moment it is visible to the eye, it yields a spectrum reaching from the fixed line B to nearly F; that is to say, equal to about two-thirds the whole length of the interference spectrum, and almost one-half of the prismatic.

It is to be remarked, that while the more refrangible end undergoes a great expansion, the other extremity exhibits a corresponding though a less change. As very important theoretical conclusions depend on the proper interpretation of this fact, we must not forget that, to a certain extent, it may be an optical deception, arising from the increased brilliancy of the light. While the rays are yet feeble, the extreme terminations may be so faint that the eye cannot detect them; but as the intensity rises, they become better marked, and an apparent elongation of the spectrum is the consequence.

It is agreed by optical writers, that to the human eye the yellow is the brightest of the rays. In the prismatic spectrum the true relationship of the colors is not perceived, because the less refrangible are crowded together, and the more refrangible unduly spread out. But in the interference spectrum, where the colors are arranged side by side in the order of their wave-lengths, the centre is occupied by the most luminous portion of the yellow; and from this point the light declines away on one side in the reds, and on the other in the blues, the terminations being equidistant from the centre of the yellow space.

Now if the rays coming from shining platinum were passed through a piece of glass, on which parallel lines had been drawn with a diamond point, so as to give an interference spectrum, even admitting the general results of the foregoing experiments to be true, viz. that as the temperature rises rays of a higher refrangibility are emitted, it is obvious that it by no means follows that the first ray visible should be the extreme red. Our power of seeing that depends on its having a certain intensity. Even when it has assumed that extreme brilliancy which it has in a solar beam it is barely visible. We ought therefore to expect that rays of a higher refrangibility should first be seen, because they act more energetically on our organ of vision; and as the temperature rises, the spectrum should undergo a partial elongation in the direction of its red extremity.

I may here remark, that the general result of these experiments coincides exactly with that of M. Melloni respecting heat and lower thermometric points. In this second memoir,* he shows that when the rays from copper at 390° and from incandescent platinum are compared by transmission through a rock-salt prism, as the temperature rises the refrangibility of the calorific emanations correspondingly increases. Those philosophers who regard light and heat as the same agent, will therefore see in this coincidence another argument in favor of their opinion.

In view of the foregoing facts I conclude, that, *as the temperature of an incandescent body rises, it emits rays of light of an increasing refrangibility;* and that the apparent departure from this law, discovered by an accurate prismatic analysis, is due to the special action of the eye in performing the function of vision.

As the luminous effects are undoubtedly owing to a vibratory movement executed by the molecules of the platinum, it seems from the foregoing considerations to follow, that the frequency of those vibrations increases with the temperature.

In this observation I am led by the principle, that "to a particular color there ever belongs a particular wave-length, and to a particular wave-length there ever belongs a particular color;" but in the analysis of the spectrum made by Sir D. Brewster by the aid of absorptive media, this principle is indirectly controverted; that eminent philosopher showing that red, yellow, blue, and consequently white light, exist in every part of the spectrum. This must necessarily take place when a prism which has a refracting face of considerable magnitude is used; for it is obvious

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* Taylor's Scientific Memoirs, vol. i, p. 56.

that a ray falling near the edge, and one falling near the back, after dispersion, will paint their several spectra on the screen; the colors of the one not coinciding with, but overlapping the colors of the other. In such a spectrum there must undoubtedly be a general commixture of the rays; but may we not fairly inquire whether, if an elementary prism were used, the same facts would hold good; or, if the anterior face of the prism were covered by a screen, so as to expose a narrow fissure parallel to the axis of the instrument, would there be found in the spectrum it gave every color in every part, as in Sir David Brewster's original experiment? M. Melloni has shown how this very consideration complicates the phenomena of radiant heat; and it would seem a very plausible suggestion that the effect here pointed out must occur in an analogous manner for the phenomena of light.

I proceed now to the third branch of the inquiry,—to examine the relation between the temperatures of self-luminous bodies and the intensity of the light they emit, premising it with the following considerations.

The close analogy which is traced between the phenomena of light and radiant heat lends countenance to the supposition, that the law which regulates the escape of caloric from a body will also determine its rate of emission of light. Sir Isaac Newton supposed that whilst the temperature of a body rose in arithmetical progression, the amount of heat escaping from it increased in a geometrical progression. The fallacy of this was subsequently shown by Martin, Erxleben, and Delaroche; and finally Dulong and Petit gave the true law, "when a body cools *in vacuo*, surrounded by a medium whose temperature is constant, the velocity of cooling for excess of temperature in arithmetical progression increases as the terms of a geometrical progression, diminished by a constant quantity." The introduction of this constant depends on the operation of the theory of exchanges of heat; for a body, when cooling under the circumstances here given, is simultaneously receiving back a constant amount of heat from the medium of constant temperature.

Whilst Newton's law represents the rate of cooling of bodies, and therefore the quantities of heat they emit, when the range of temperature is limited, and the law of Dulong and Petit holds to a wider extent, there are in our inquiry certain circumstances to be taken into account not contemplated by those philosophers. Dulong and Petit throughout their memoir regard radiant heat as a homogeneous agent, and look upon the theory of exchanges, which is indeed their starting point and guide, as a very simple affair. But the progress of this department of knowledge since their times has shown, that precisely the same modifications as are found in the colors of light, occur also for heat; a fact conveniently designated by the phrase "ideal coloration of heat;"

and further, that the color of the heat emitted depends upon the temperature of the radiating source. It is one thing to investigate the phenomena of the exchanges of heat-rays of the same color, and another when the colors are different. A perfect theory of the exchanges of heat must include the principle of ideal coloration, and, of course, so too must a law of cooling applicable to any temperature.

There is another fact to some extent considered by Dulong and Petit, but not of such weight in their investigations, where the range of temperature was small, as in ours, where it rises as high as nearly 3000° F.; I mean the difference of specific heat of the same body at different temperatures. At the high temperatures considered in this memoir, there cannot be a doubt that the capacity of platinum for heat is far greater than that at a low point. This therefore must control its rate of calorific emission, and probably that for light also.

From these and similar considerations, we should be prepared to discover that as the temperature of an incandescent solid rises, the intensity of the light emitted increases very rapidly.

I pass now to the experimental proofs which substantiate the foregoing reasoning.

The apparatus employed as the source of the light and measure of the temperature was the same as in the preceding experiments,—a strip of platinum, brought to a known temperature by the passage of a voltaic current of the proper force, and connected with an index which measured its expansion.

The principle upon which I have determined the intensity of the light is that first described by Bouguer, and recently introduced by M. Masson. After many experiments I have been led to conclude that this is the most accurate method known.

Any one who will endeavor to determine the intensities of lights by Rumford's method of contrasting shadows, or by that of equally illuminated surfaces, will find, when every precaution has been used, that the results of repeated experiments do not accord. There is moreover the great defect, that where the lights differ in color it is impossible to obtain reliable measures, except by resorting to such contrivances as that described by me.*

Bouguer's principle is far more exact; and where the lights differ in color, that difference actually tends to make the result more perfect. As it is not generally known, I will indicate the nature of it briefly.

Let there be placed at a certain distance from a screen of white paper, a candle so arranged as to throw the shadow of a ruler, or other opake body, on the screen. If a second candle be placed also in front of the paper and nearer than the former, there is a cer-

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* Phil. Mag., August, 1844.

tain distance at which its light completely obliterates all traces of the shadow. This distance is readily found; for the disappearance of the shadow can be determined with considerable exactness. When the lights are equal, Bouguer found that the relative distances were as 1 : 8; he inferred therefore, correctly, that in the case of his eye, the effect of a given light was imperceptible when it was in presence of another sixty-four times as intense. The precise number differs according to the sensibility of different eyes, but for the same organ it is constant.

Upon a paper screen I threw the shadow of a piece of copper, which intercepted the rays of the incandescent platinum: then taking an Argand lamp, surrounded by a cylindrical metal shade through an aperture in which the light passed, and the flame of which I had found by previous trial would continue for an hour almost of the same intensity, I approached it to the paper until the shadow cast by the copper disappeared. The distance at which this took place was then measured, and the temperature of the platinum determined.

The temperature of the platinum was now raised; the shadow became more intense, and it was necessary to bring the Argand lamp nearer before it was effaced. When this took place the distance of the lamp was again measured, and the temperature of the platinum again determined.

In this manner I obtained several series of results, one of which is given in the following table. They exhibited a more perfect accordance among each other than I had anticipated. The intensity of the light of the platinum is of course inversely proportional to the square of the distance of the Argand lamp at the moment of the obliteration of the shadow.

Table of the Intensity of Light emitted by Platinum at different Temperatures.

Temperature of the platinum.	Distance of Argand lamp.		Mean.	Intensity of light.
	Experiment 1.	Experiment 2.		
980°	....	....	....	0·00
1900	54·00	54·00	54·00	0·34
2015	39·00	41·00	40·00	0·62
2130	24·00	24·00	24·00	1·73
2245	18·00	19·00	18·50	2·92
2360	14·50	15·50	15·00	4·40
2475	11·50	12·00	11·75	7·24
2590	9·00	9·00	9·00	12·34

In this table the first column gives the temperatures under examination in Fahrenheit degrees; the second and third the distances of the Argand lamp from the screen, in English inches, in two different sets of experiments: the fourth the mean of the two: and the fifth the corresponding intensity of the light.

From this it is at once perceived, that the increase in the intensity of the light, though slow at first, becomes very rapid as the temperature rises. *At* 2590° *the brilliancy is more than thirty-six times as great as it is at* 1900°.

Thus, therefore, the theoretical anticipation which we founded on the analogy of light and heat is completely verified; and we discover that as the temperature of a self-luminous solid rises, it emits light in a greater proportion than would correspond to the mere difference of temperature. To place that analogy in a still more striking point of view, I will here introduce some experiments I have made in relation to radiant heat. No chemist, so far as I am aware, has hitherto published results for high temperatures, or endeavored to establish, through an extensive scale, the principle of Delaroche, that "the quantity of heat which a hot body gives off in a given time by way of radiation to a cold body, situated at a distance, increases, other things being equal, in a progression more rapid than the excess of the temperature of the first above that of the second."

As my object on the present occasion is chiefly to illustrate the remarkable analogy between light and heat, the experiments now to be related were arranged so as to resemble the foregoing; that is to say, as in determining the intensities of light emitted by a shining body at different temperatures, I had received the rays upon a screen placed at an invariable distance, and then determined their value by photometric methods; so, in this case, I received the rays of heat upon a screen placed at an invariable distance, and determined their intensity by thermometric methods. In this instance the screen employed was in fact the blackened surface of the thermo-electric pile. It was placed at a distance of about one inch from the slip of incandescent platinum, a distance sufficient to keep it from any disturbance from the stream of hot air arising from the metal; care also was taken that the multiplier itself was placed so far from the rest of the apparatus, that its astatic needles could not be affected by the voltaic current igniting the platinum, or the electro-magnetic action of the wires used to modify the degrees of heat.

The experiments were conducted as follows:—The needles of the thermo-multiplier standing at the zero of their scale, the voltaic current was passed through the platinum, which immediately rose to the corresponding temperature, and radiated its heat to the face of the pile. The instant the current passed, the needles of the multiplier moved, and kept steadily advancing upon the scale. At the close of one minute, the deviation of the needle and the temperature of the platinum were simultaneously noted, and then the voltaic current was stopped.

Sufficient time was now given for the needle of the multiplier to come back to zero. This time varied in the different cases, according to the intensity of the heat to which the pile had been exposed: in no instance, however, did it exceed six minutes, and in most cases was much less. A little consideration will show that the usual artifice employed to drive the needles back to zero by warming the opposite face of the pile, was not admissible in these experiments.

The needles having regained their zero, the platinum was brought again to a given temperature, and the experiment conducted as before. The following table exhibits a series of these results.

Table of the Intensity of Radiant Heat emitted by Platinum at different Temperatures.

Temperature of the platinum.	Intensity of heat emitted.		Mean.
	Experiment 1.	Experiment 2.	
980°	·75	1·00	·87
1095	1·00	1·20	1·10
1210	1·40	1·60	1·50
1325	1·60	2·00	1·80
1440	2·20	2·20	2·20
1555	2·75	2·85	2·80
1670	3·65	3·75	3·70
1785	5·00	5·00	5·00
1900	6·70	6·90	6·80
2015	8·60	8·60	8·60
2130	10·00	10·00	10·00
2245	12·50	12·50	12·50
2360	15·50	15·50	15·50

In this table the first column gives the temperatures of the platinum in Fahrenheit degrees; the second and third two sets of experiments, expressing the arc passed over by the needle at the close of a radiation lasting for one minute, each number being the mean of several successive trials; and the fourth the mean of the two. It therefore gives the radiant effect of the incandescent platinum upon the thermo-multiplier for the different temperatures.

Of course it is understood that I here take the angular deviations of the needle as expressing the force of the thermo-electric current, or in other words, as being proportional to the temperatures. This hypothesis, it is known, is admissible.

It therefore appears that the quantity of heat radiated by incandescent platinum at 980° being taken as unity, it will have increased at 1440° to 2·5; at 1900° to 7·8; and at 2360° to 17·8, nearly: the rate of increase is therefore very rapid. Further, it may be remarked, as illustrative of the same fact, that the increased quantity of heat radiated by a mass of platinum in passing from 1000° to 1300°, is nearly equal to the amount it gives out in passing from common temperatures up to 1000°.

I cannot here express myself with too much emphasis on the remarkable analogy between light and heat which these experiments reveal. The march of the phenomena in all their leading points is the same in both cases. The rapid increase of effect as the temperature rises is common to both.

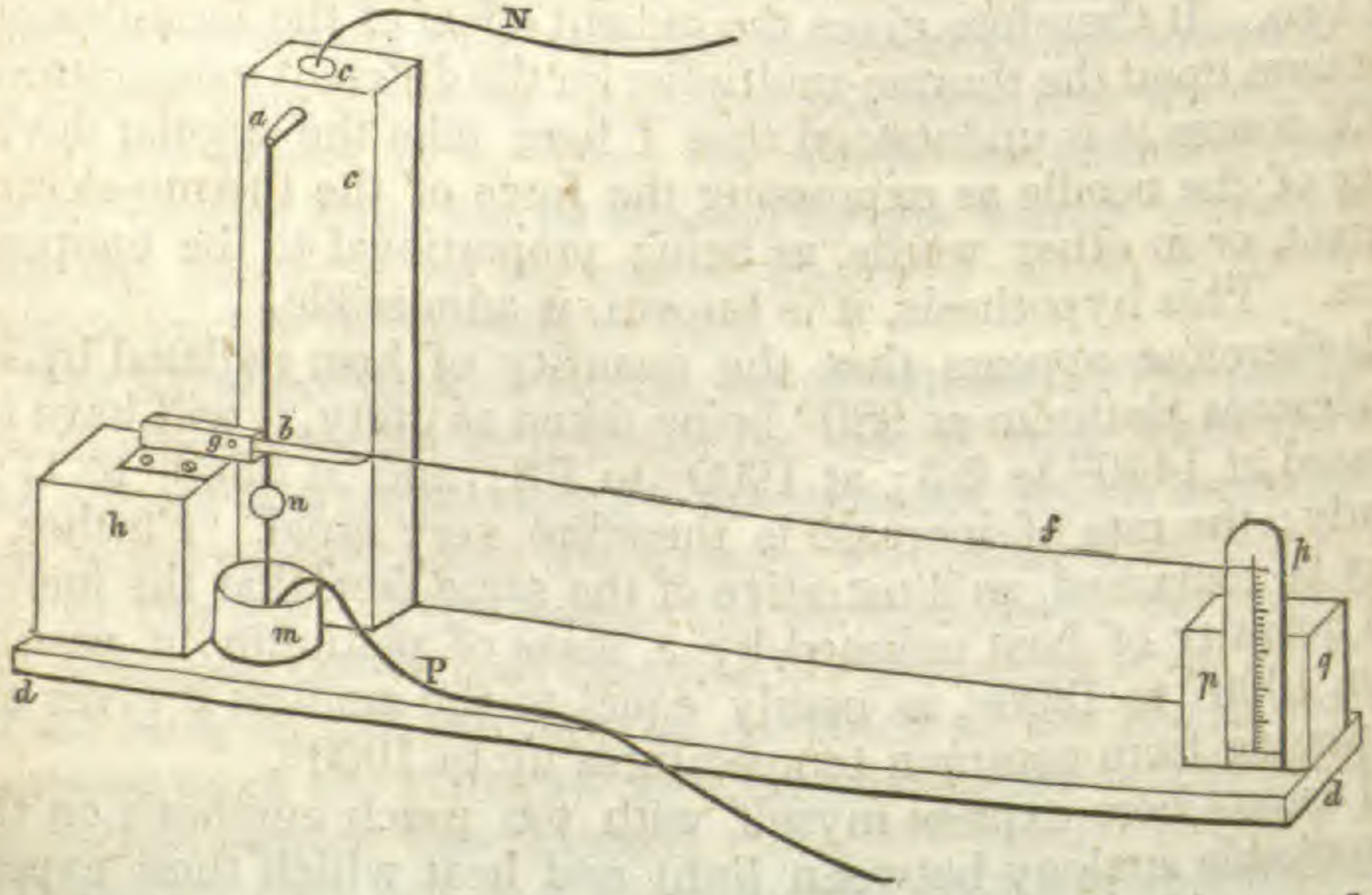
It is not to be forgotten, however, that in the case of light we necessarily measure its effects by an apparatus which possesses special peculiarities. The eye is insensible to rays which are not comprehended within certain limits of refrangibility. In these experiments, it is requisite to raise the temperature of the platinum almost to 1000° before we can discover the first traces of light. Measures obtained under such circumstances are dependent on the physiological action of the visual organ itself, and hence their analogy with those obtained by the thermometer becomes more striking, because we should scarcely have anticipated that it could be so complete.

Description of the apparatus employed in the foregoing experiments.

The source of light is in all instances a slip of platinum foil 1·35 inch long, and $\frac{1}{20}$th of an inch broad, ignited by the passage of a voltaic current, and placed in such a position that its dilatation could be measured by the movements of an index over a graduated scale.

In fig. 7, *a b* represents the slip of platinum, the upper end of which is soldered to a stout and short copper pin *a*, firmly sunk in a block of wood *c*, which is immovably fastened on the basis *d d* of the instrument. A cavity *e*, half an inch in diameter, is sunk in the block *c*, and into this cavity the pin *a* projects; so that when the cavity is filled with mercury, a voltaic current may be passed through the pin and down the platinum.

Fig. 7.



The other extremity of the platinum *b* is fastened to a delicate lever *b f*, which plays on an axis at *g*, the axis working in brass holes supported on a block *h*. Immediately beneath the platinum strip, and in metallic communication with it, a straight copper wire dips down into the mercury cup *m*; on this wire there is a metal ball *n*, weighing about 100 grains. The further end of the index plays over a graduated ivory scale *p p*, which is supported on a block *q*, and can be moved a little up and down, so as to bring its zero to coincide with the index at common temperatures.

The action of the instrument is readily understood. In the mercury cup *e* dip one of the wires N of a Grove's battery of three or four pairs, the other wire P being dipped into the cup *m*. The current passes through the platinum, which immediately expands, the weight *n* lightly stretching it. The index *f* moves promptly over the scale, indicating the amount of expansion, and therefore the degree of heat. Remove the wire N out of its mercury cup *e*, the platinum instantly becomes cold, and pulls the lever to the zero point.

When the platinum is thin, so as to be quite flexible at the point *b*, where it is fastened to the index, the movements take place with such promptitude and precision as to leave nothing to be desired. When the heat has been very high and long continued, the limit of elasticity of the platinum is somewhat overpassed, and it suffers a slight permanent extension. But as the ivory scale *p p* can slide up and down a little, the index is readily re-adjusted to the zero point.

The temperature of the platinum depends entirely on the force of the current passed through it. By intervening coils of brass wire of lengths adjusted beforehand, so as to resist the current to a given extent, any desired temperature may be reached. I found it convenient to intervene in the course of the current one of Prof. Wheatstone's rheostats, so as to be able to bring the index with precision to any degree, notwithstanding slight changes in the force of the voltaic battery.

The following are the dimensions and measures of the instrument I have used:—Length of the platinum strip, 1·35 inch; length of the part actually ignited, 1·14 inch; width of ditto, $\frac{1}{20}$th of an inch; length of the index from its centre of motion to the scale, 7·19 inches; distance of the centre of motion of index from the insertion of the platinum at the point *b*, ·22 inch; multiplying effect of the index, 32·68 times; length of each division on the ivory scale, ·021 inch. From this it would appear, by a simple calculation, using the coefficient of dilatation of platinum given by Dulong and Petit, that each of the divisions here used is equal to 114·5 Fahrenheit degrees. For the sake of perspicuity I have generally taken them at 115°.

The Grove's battery I have employed has platinum plates three inches long and three-quarters wide; the zinc cylinders are two inches and a half in diameter, three high, and one-third thick. As used in these experiments, it could maintain a current nearly uniform for an hour. I commonly employ four pairs.

Among writers on optics, it has been a desideratum to obtain an artificial light of standard brilliancy. The preceding experiments furnish an easy means of supplying that want, and give us what might be termed a "unit-lamp." A surface of platinum of standard dimensions, raised to a standard temperature by a voltaic current, will always emit a constant light. A strip of that metal, one inch long and $\frac{1}{20}$th of an inch wide, connected with a lever by which its expansion might be measured, would yield at 2000° a light suitable for most purposes. Moreover, it would be very easy to form it an available photometer, by screening portions of the shining surface. An ingenious artist would have very little difficulty, by taking advantage of the movements of the lever, in making a self-acting apparatus, in which the platinum should be maintained at a uniform temperature, notwithstanding any change taking place in the voltaic current.

University, New York, Feb. 27, 1847.

Art. XXXVI.—*On the Changes which the Albuminous Substances undergo in the Stomach, during the process of Digestion;* by Prof. Mulder, of Utrecht. (Translated from the Dutch, by Dr. Aug. Völcker.)

I last year demonstrated,* that the fibrin of blood undergoes no change in composition by solution in muriatic acid and precipitation by carbonate of ammonia.

The results of my analysis, employing in the present instance my last experiments on the amount of sulphur in these substances, were as follows:—

	Undissolved fibrin.	Dissolved and thrown down with carbonate of ammonia.
C, . .	52·7 . . .	52·7
H, . .	6·9 . . .	6·9
N, . .	15·4 . . .	15·8
O, . .	23·5 . . .	23·5
S, . .	1·2 . . .	1·1
Ph, . .	0·3 . . .	

The phosphorus has not been determined in the dissolved portion; but as vitellin loses phosphamid under the influence of acetic acid and ammonia,† it is probable that fibrin will have been deprived of the phosphamid under the influence of muriatic acid and carbonate of ammonia.

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* Scheik. Onderz., Deel iii, p. 470.

† Von Baumhauer in Scheik. Onderz., Deel iii, p. 284.

The same experiments were repeated on casein and albumin, and the following results obtained.

A small quantity of muriatic acid was added to milk; a precipitate fell, which was washed for a long time with water. At last the mass began to be gelatinous; in this state it was mixed with water and set aside at a temperature of about 40° C. After some hours the whole was dissolved, and the butter rose to the top. The watery solution was decanted, thrown down by carbonate of ammonia, and the precipitate washed with water, alcohol and ether, and dried at a temperature of 130° C.

0·5568 grms. produced 0·0033 ash.

I. 1·586 " gave after being burned with caustic soda and nitre, 0·07, $Ba O, SO^3$.

II. 1·914 grms. gave 0·101, $Ba O, SO^3$.

I. 0·6512 " without ash, gave 83 cub. cent. of moist N at 16°·5 and 766 m. m.

II. 0·6542 " without ash, " 85 cub. cent. of moist N at 16°·5 and 766 m. m.

I. 0·5652 " free of ash, " 1·1065 CO^2 and 0·3569 H^2O.

II. 0·6113 " " " " 1·1885 " " 0·3816 "

	Undissolved casein.*	Dissolved and thrown down.	
C,	53·8	53·44	53·08
H,	7·1	7·01	6·93
N,	15·6	15·01	15·30
O,	22·6	23·93	23·96
S,	0·9	0·61	0·73

Casein as I have shown as well as Schlossberger,† is a complex body; it consists of different protein compounds, of which the body that I have now studied constitutes the chief element. It is characterized by a somewhat smaller amount of sulphur, and is distinguished besides from the mixture hitherto called casein, by the circumstance that it contains more oxygen. It shows the reaction of sulphamid-protein.

			Without SN^2H^4.
C,	53·5	53·4	54·1
H,	7·0	6·9	7·0
N,	15·0	14·5	14·7
O,	23·9	23·9	24·2
S,	0·6	....	....
	100·0	98·7	100·0

Albumin of eggs, coagulated by heat, was mixed with diluted muriatic acid, and after the addition of a small piece of rennet, set aside at a temperature of 40° C. After some days the albumin was completely dissolved. To the filtered liquid carbonate

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[*] Scheik. Onderz., Deel iv, p. 278.

[†] Ibid, Deel iii, p. 453, and Annalen der Chemie und Pharmac., April, 1846, p. 92.

of ammonia was added, and the precipitate washed with water, alcohol and ether, and dried at 130° C.

0·745 gave 0·004 ash.

I. 0·645, free of ash, 87 of moist N at 17°·5 C. and 766 m. m.
II. 0·640, " " 85 " " " " " " " "
I. 0·573, " " 1·107 CO^2 and 0·358 H^2O.
II. 0·513, " " 0·998 " " 0·319 "

I. 1·103 gave 0·1465 of sulphate of barytes, by means of caustic soda and nitre.

II. 0·938 gave 0·118 of sulphate of barytes.

	Undissolved albumin.[*]	Dissolved and precipitated. I.	II.	Mean.
C,	53·5	52·74	53·11	53·0
H,	7·0	6·93	6·93	6·9
N,	15·5	15·97	15·60	15·8
O,	22·0	22·53	22·63	22·5
S,	1·6	1·83	1·73	1·8
Ph,	0·4	. . .	. . .	. .

The phosphorus, probably not contained in the precipitated albumin, was not determined. The quantity of the sulphur exceeds that in albumin by 0·2; however, I do not doubt that this increase must only be ascribed to an error of experiment. It showed at any rate the reaction of sulphamid.

			Without SN^2H^4.
C,	53·0	53·0	54·9
H,	6·9	6·8	7·0
N,	15·8	14·2	14·7
O,	22·5	22·5	23·4
S,	1·8	. . .	. . .
	100·0	96·5	100·0

Thus albumin has not been changed in composition, as regards the C, N, H, O and SN^2H_4, and it appears that no new combination of albumin is produced during the digestion in the stomach. Is this the case also with casein? No other conclusions can be drawn from the above analysis than that, either casein contains already a substance richer in oxygen, or that the production of such a combination is caused during the solution in the stomach.

Let us now compare the organic group which remains, after deducting the elements of sulphamid from fibrin, hair and this dissolved casein:—

	Fibrin.	Hair.	Dissolved casein.
C,	54·4	53·6	54·1
H,	7·0	7·1	7·0
N,	14·4	14·6	14·7
O,	24·2	24·7	24·2

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[*] Scheik. Onderz., Deel iv, p. 223.

and let us place next to it the group, occurring originally in casein and albumin:

	Casein.	Albumin from eggs.	Albumin from blood.
C,	54·8	55·6	55·0
H,	7·1	7·1	7·2
N,	15·1	14·4	14·5
O,	23·0	22·9	23·3

it will now easily be seen, that there exists a considerable difference. In the first three groups is contained evidently less C and more O.

They are expressed by

	Atoms.	Calculated.
C,	36	53·6
H,	54	6·7
N,	8	13·9
O,	13	25·8

The first change of the albumin in the stomach is therefore only solution; that of casein may also be oxydation. I say it may be, for it is possible that this group already preëxists in casein. This can only be determined with certainty when the other constituents of casein shall have been farther examined.

At all events, in casein, after its solution in the stomach, the same organic group exists as in fibrin, and there is so far an intimate relation between fibrin and casein. Casein must easily produce fibrin, while albumin remains still albumin in the stomach and probably undergoes no other change, except in the proportion of sulphamid it contains.

The question now is, how far the use of milk will be advisable in inflammatory diseases. I address this question to medical experience, but I am far from establishing any opinion, upon the numerical results of experiments. Medical experience has its own rights, as well as chemistry. The one must not dictate to the other, but to propose such questions is both the right and the duty of chemistry.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Atomic Volume of some Isomorphous Oxyds of the regular system;* by Chas. Gerhardt.—It is known that analogous isomorphous compounds possess the same atomic volume. This volume however, is not rigorously the same, on account of the differences which naturally exist between the angles of isomorphous substances, or the variations of temperature and density under which they have been taken, which last alone modifies the angles of the crystals by an unequal dilatation of their axes. As this influence of heat upon the angles is in effect noth-

ing for those crystals which possess a simple refraction, and as the angles of these last are not subject to the slight variations which affect the results in other isomorphous groups, it appeared to me of interest to verify the principle of M. H. Kopp,[*] upon some oxyds crystallizing in the regular system.

Mineralogy presents us many compounds crystallizing in the regular system to which chemistry applies the most diverse formulas. I here cite them with the notation of Berzelius.

		Specific weight.
Magnetic iron, ...	(FeO, Fe_2O_3) . . .	5·094
Octahedral oligist iron (martite),	(Fe_2O_3) . .	4·76 to 4·65
Spinelle, ...	(MgO, Al_2O_3) . .	3·48 to 3·62
Gahnite, ...	(ZnO, Al_2O_3) .	4·23
Ceylanite, of the Ural, (Abich)	$(FeO, Al_2O_3)+2(MgQ, Al_2O_3)$	3·6 to 3·8
" of Vesuvius, (Abich)	$(FeO, Al_2O_3)+9(MgO, Al_2O_3)$	
Chlorospinelle of Slatoust, (G. Rose,)	$(MgO, Fe_2O_3)+11(MgO, Al_2O_3)$	3·59
" " " (G. Rose)	$(MgO, Fe_2O_3)+6(MgO, Al_2O_3$	
Chromic iron (crystallized), Baltimore, (Abich,)	$5(MgO, Cr_2O_3)+(FeO, Cr_2O_3)+3(FeO, Al_2O_3)$	4·3 to 4·5
do. do. (compact), Baltimore, (Abich,)	$6(MgO, Cr_2O_3)+(FeO, Cr_2O_3)+2(MgO, Al_2O_3)+(FeO, Al_2O_3)$	
do. do. St. Domingo, (Berthier,)	$(Cr_2O_3, Fe_2O_3)+(Al_2O_3)$	
Titanic iron, Mount Ilmen, (Mosander,)	$(8(FeO, TiO_2)+Fe_2O_3$	4·745 to 4·78
" " Egersund, (H. Rose,)	$(6FeO, TiO_2)+Fe_2O_3$	
" " Egersund, (Mosander,)	$(3FeO, TiO_2)+Fe_2O_3$	
" " Arendal, (Mosander,)	$(FeO, TiO_2)+Fe_2O_3$	
" " Uddevalla, (Plantamour,)	$(2(FeO, TiO_2)+5Fe_2O_3$	
Franklinite, (Abich,)	$(FeO, Mn_2O_3)+(ZnO, Fe_2O_3)$	5·19
Periclase, (Damour,)	$(18MgO, Fe_2O_3)$	3·75
Perowskite, (H. Rose,)	(CaO, TiO_2)	4·017
Braunite,[†]	(Mn_2O_3)	4·75 to 4·818

It is difficult to unite formulas so complicated and so diverse as those which represent these oxyds, and it often happens that the same mineral species will be expressed by very different formulas although the crystalline form remains exactly the same. If we search for a relation between the specific gravities of these minerals and their atomic weights

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[*] Annal. de Chim. et de Phys., 2d series, t. lxxv, p. 406.

[†] The octahedrons of braunite do not belong to the regular system; the angle of two adjacent faces upon the pyramid is 109°·53′; (over the basal edge 108°·39′,) for the crystals of Agersburg: and 109°·46′ (over the basal edge 108°·33′) for those of St. Marcel, while it is 109°·28′ 16″ in the regular octahedron. But this difference is not so great as that which exists between the angles of substances regarded as isomorphous, as for example, those of the different carbonates, of the rhombohedral system.

We may perhaps add to the preceding list the *Hausmannite*, or manganoso-manganic oxyd, which crystallizes in octahedrons with a square base. The difference between the angles is however, much greater, (105°·25′ and 117°·54′.) We may here inquire to what limit the angles may differ in substances considered as isomorphous. See on this subject the views of Mr. Laurent, (Compt. Rend. der Trav. de Chimie, 1845, p. 97.)

according to the preceding formulas, we fail to find it, and often are surprised to see that the specific weight of a mineral presents but slight oscillations which scarcely accord with the widely varying composition attributed to its different varieties. For example, it is not easy to understand why titaniferous iron has always a specific weight, varying only from 4·745 to 4·78, while it is composed sometimes of equal equivalents of ferric oxyd and ferrous titanate, and sometimes of one equivalent of ferric oxyd and six equivalents of ferrous titanate.

These anomalies disappear entirely if we write all these oxyds after one formula, OM_2 similar to that of water OH_2, and in which M can be replaced by different metals in indefinite proportions, provided that the sum of the equivalents of these metals are equal to 2.[*]

See the oxyds thus represented with their atomic volume, which equals the product of the atomic weight divided by the density.

		Mean.
Type oxyd,	OM_2	11·0
Oligist iron,	$OFe\beta_2$	11·4
Braunite,[†]	$OMn\beta_2$	11·2
Magnetic iron,	$O(Fe\beta\tfrac{1}{2}Fe\tfrac{1}{2})_2$	11·4
Gahnite,	$O(Al\beta\tfrac{1}{2}Zn\tfrac{1}{2})_2$	10·9
Spinelle,	$O(Al\beta\tfrac{1}{2}Mn\tfrac{1}{2})_2$	10·6
Ceylanite,	$O(Al\beta^{x}Fe^{y}Mg^{z})_2$	10·6
Chlorospinelle,	$O(Al\beta^{x}Fe\beta^{y}Mg^{z})_2$	10·6
Chromic iron,	$O(Al\beta^{u}Fe\beta^{v}Cr\beta^{x}Mg^{y}Fe^{z})_2$	11·2
Titaniferous iron,	$O(Ti\alpha^{x}Fe\beta^{y}Fe^{z})_2$	10·9
Franklinite,	$O(Fe\beta^{v}Mn\beta^{x}Zn^{y}Fe^{z})_2$	11·1
Perowskite,	$O(Ti\alpha\tfrac{1}{3}Ca\tfrac{2}{3})_2$	11·2
Periclase,	$O(Fe\beta^{y}Mg^{z})_2$	10·9

I am obliged to indicate by letters the most of those fractional numbers, of which the sum is equal to two equivalents. It is easy to replace these letters by their numerical values, which are derived from the formulas we have previously given. In the same manner I suppress the details of the calculations relative to the atomic volume.

This volume, it is to be remarked, is essentially the same for all the oxyds mentioned; there are but slight differences apparent, which are due to the fact that in calculating these formulas, we have not always taken into account those oxyds which are contained in small quantities in the minerals. It is very rare that a mineral is chemically pure, and as the presence of a very small quantity of any foreign substance always modifies the specific weight, it is evident that we cannot obtain a number rigorously exact in dividing the specific weight by the atomic weight of the substance supposed to be chemically pure.

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[*] It is necessary to recollect that $Fe\tfrac{2}{3}$, $Al\tfrac{2}{3}$, $Cr\tfrac{2}{3}$, $Mn\tfrac{2}{3} = Fe\beta$ (ferricum), $Al\beta$ (aluminicum), $Cr\beta$ (chromicum), $Mn\beta$ (manganicum), are the equivalent of H, Fe (ferrosum), Mn (Manganosum), Mg (magnesium), etc., because an oxyd M_4O_3 reacts with six equivalents of hydrogen to form $3H_2O$, M_4 resting in the place of H_6. If we represent the oxyd of titanium by Ti_2O_2(TiO_2, Berzelius), Ti_2 becomes equal to H_4: then $Ti\tfrac{1}{2} = Ti\alpha$ equals H.

[It will be remembered that M. Gerhardt divides the ordinarily received equivalents of hydrogen and the metals. The protoxyds MO then become M_2O, and the sesquioxyds M_2O_3, M_4O_3. See this Journal, p. 171, this volume.]

[†] The Hausmannite D=4·22 gives an atomic volume of 12·2.

It is not, however, necessary to suppose that all the oxyds crystallizing in the regular system, have the same atomic volume. We know by the study of polymeric bodies, that the same elements may be differently condensed: thus a volume of elaldehyde in vapor contains three times as much carbon, hydrogen and oxygen, as the same volume of aldehyde in the same state. A similar relation may exist for solids and liquids. A volume of an oxyd may contain OM_2, O_2M_4 or O_3M_6, or in general OnM_2n, but if the atomic volume of an oxyd OM_2 is V, the volume of its polymere will be V^n. There may then be oxyds crystallizing in regular octahedrons, having an atomic volume different from that of the preceding oxyds.

The protoxyd of copper Cu_4O, and the arsenious anhydride As_2O_3, are illustrations in point; if we calculate the atomic volume of these oxyds, reducing their formulas to the expression OM_2, we obtain 23·6 for one and 18·0 for the other; these numbers are approximate multiples of the atomic volume of the preceding minerals by 2 and 1½. It is as if the molecule of protoxyd of copper* was $O_2Cu\alpha_4$, and that of arsenious anhydride $O1\frac{1}{2}As\alpha_3$ in relation to the molecule OM_2 of those minerals. Beside this we do not indicate whether the type in which we have placed these last, be OM_2 more than O_2M_4, (OM_2, OM_2) or $O_3M_6=(OM_2, OM_2, OM_2)$; we shall be able to establish our considerations upon all other formulas, provided that it is *the same* for all the oxyds. It is nothing in effect but a question of ratios.

2. *On the Acid contained in the North American Columbite;* by Henry Rose, (L., E. and D. Phil. Mag., xxx, 360, from Poggend. Annal.)—The columbite of North America has the same crystalline form as that from Bodenmais and Bavaria, but is distinguished from it in general by a lower specific gravity; however, we find the same difference in the specific gravity of the American mineral as occurs in the different crystals of the Bodenmais columbite. The lightest crystals from the last locality have the same specific gravity (5·704) as the heaviest crystals from North America (5.708).

I have already communicated two analyses of North American columbites, one of which however it was doubtful whether it came from America. The following analysis of American columbite was made by M. Grewink in my laboratory; it yielded,—

Acid, ...	80·06
Protoxyd of iron, ...	12·59
Protoxyd of manganese, . . .	5·97
Oxyd of tin, ...	0·96
Oxyd of copper and lead, . . .	0·44
	100·02

The specific gravity in fragments was 5·323; in powder, 5·3202.

This columbite comes nearest in composition and also in specific gravity to that examined by M. Schlieper.

I have on a former occasion shown that the different specific gravity of the crystals of the Bavarian columbite was owing to the different proportions of niobic and pelopic acids which are found in the different

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* $Cu\alpha=Cu_2$, cuprosum; $As\alpha=As\frac{2}{3}$ arseniosum.

crystals. The specific gravity of these two acids is widely different, but unequally so, according to the temperatures to which they have been exposed previous to weighing.

Owing to want of material, I found it impossible to make a thorough examination of the two acids which are contained in the North American columbite: I very soon ascertained, after the discovery of niobic acid, that this was the principal acid constituent in the American columbite, but I could not determine whether it was mixed with pelopic or with tantalic acid; I therefore addressed myself to Mr. B. Silliman, of New Haven, who with the greatest readiness procured me a very considerable quantity (half a pound) of this now very rare mineral.

A large quantity of this columbite was used for the preparation of the acid. When treated in the same manner as that from the Bavarian columbite, it proved to consist principally of niobic acid combined with pelopic acid; but the amount of the latter was far smaller than in the Bodenmais mineral, so that I do not think it would have been possible for me to have examined the properties of pelopic acid so completely as was necessary in order to recognize it as an essentially distinct acid from tantalic acid, if I had had only the American mineral at my disposal. But both the acids were so perfectly identical in all their properties with the two acids prepared from the Bodenmais mineral, that I did not find the least difference, even as regards the specific gravity.

As the specific gravity of pelopic acid is considerably higher than that of niobic acid, when the two are heated in the same manner, the higher specific gravity of the Bavarian columbite is thus satisfactorily explained.

I have moreover found small quantities of tungstic acid in the acids from the American columbite, as well as in those from the Bodenmais mineral.

3. *Diamond converted to Coke*, (Proc. Brit Assoc., 1847, Athen., No. 1028.)—Dr. Faraday exhibited some diamonds, which he had received from M. Dumas, which had, by the action of intense heat, been converted into coke. In one case, the heat of the flame of oxyd of carbon and oxygen had been used—in another the oxyhydrogen flame—and in the third the galvanic arc of flame from a Bunsen battery of 100 pairs. In the last case, the diamond was perfectly converted into a piece of coke,—and in the others the fusion and carbonaceous formation were evident. Specimens, in which the character of graphite was taken by the diamond, were also shown. The electrical characters of these diamonds were stated also to have been changed,—the diamond being an insulator, while coke is a conductor.

4. *On Different Properties of the Various Rays of the Solar Radiation on the Daguerreotype Plate prepared with Iodine, Chlorine and Bromine, in producing and preventing the Fixation of Mercurial Vapor*; by A. Claudet, (Proc. Brit. Assoc., 1847, Athen., No. 1027.)—M. Claudet has made a series of observations upon light transmitted through certain coloring media, through the vapors of the atmosphere, and through red, orange and yellow glasses. Having directed a camera obscura upon the sun when its disc appeared quite red, he obtained after ten seconds a black image of the sun. The red sun had produced no photogenic effect, although the surrounding spaces had been

sufficiently affected by the photogenic rays proceeding from the zenith to attract the white vapors of mercury. This proved that the red rays had no photogenic power. He then operated in a different manner; not content with the slow motion of the sun, he moved the camera obscura from right to left and *vice versâ*. In this manner the sun had passed rapidly over five or six zones of the plate. Its passage was marked by long black bands, whilst the intervening spaces were white; showing again that it was sufficient in order to destroy the action of the photogenic rays to let red rays pass rapidly over the spaces previously affected by them. He operated afterwards with colored glasses; after having obtained upon a Daguerreotype plate the impression of a black lace by white light, he covered one half of the plate and exposed the other half to the radiation of a red glass. The mercury developed an image of the lace on the part which had been acted on only by the white light, and the other part which had afterwards received the action of the red rays remained black. The red glass had destroyed the photogenic effect, as had taken place with the red light of the sun. He made the same experiments with orange and yellow glasses, and obtained the same results but in different periods of time. The photogenic action of the red rays is 5,000 times longer than the white light, that of the orange is 500 times longer and that of the yellow 100 times. The destructive action of the red rays is 100 times longer than that of white light; the orange 50 times, and yellow only 10 times. When a plate has been exposed to the destructive action of any particular ray, it cannot be affected photogenically by the radiation which has destroyed the first effect; it is only sensitive to the other radiations.

Mr. R. Hunt remarked that his own observations had led him to the conclusion, that instead of having to deal with three differently colored rays, we had to deal with three distinct principles,—these three colors being a property of only one of them. Light, heat, and actinism he regarded as antagonistic forces; and it was only because they were found in different proportions in the three classes of colored rays that the results of M. Claudet could be in any way associated with the colors of light.—Mr. Maskelyne objected to some of these conclusions.

5. *Report on the Influence of Light on the Growth of Plants;* by R. Hunt, (Proc. Brit. Assoc., 1847, Athen., No. 1027.)—The author confirms the conclusions that seeds will not germinate under the influence of light separated from the chemical principle with which it is associated in the sunbeam; that germination being effected and the first leaves formed, light—the luminous rays—become essential to the plant to enable it to secrete the carbon obtained from the carbonic acid of the atmosphere; and that the increased action of the heat rays is essential to insure the production of the reproductive elements of vegetable life. It is found that the chemical principle of the solar rays is more active, relatively to heat and light, during the spring than at any other period of the year; that as summer advances this power diminishes and luminous force increases, whilst with the autumn both light and actinism are subdued, but the calorific radiations increased. Thus we find the conditions of the light of the seasons varying to suit the necessities of vegetable life. The production of chlorophyl, or the coloring matter of the leaves, was shown to be due to the joint

action of light and actinism—the first being necessary to effect the secretion of the carbon and the latter for the oxydation of this deposited carbon.

6. *On the Application of Photography to copying Microscopic Objects;* by Dr. Carpenter, (Rep. Brit. Assoc. for 1847, Athen., No. 1028.)—Numerous specimens of Daguerreotype and other photographic copies of very delicate microscopic objects were exhibited. These were peculiarly beautiful, and were obtained by the use of the solar microscope, the object being thrown upon the paper or plate instead of upon the ordinary screen. The minute fidelity of these copies was far beyond anything which could be obtained by the artist; and the ease with which they were produced, particularly on photographic paper, recommended this application of the art to the attention of naturalists.

7. *On the Quantity of Electrolysis as affected by the Extent of the Sectional Area of the Electrolyte;* by W. R. Grove, Esq., (Proc. Brit. Assoc. for 1847, Athen., No. 1028.)—The experiments here described were made two years ago, and were intended as the commencement of a series of researches on the influence of quantity in voltaic arrangements, both as regarded the *generating* and also the *conducting* portions of the circuit. A single cell of a zinc and platina diaphragm battery charged on the negative side with peroxyd of manganese and hydrochloric acid, has a more intense action and will decompose more water in a given time than a similar battery charged with nitric acid; but two or more cells of the former, arranged in series, are far inferior to a similar number of the latter, particularly if large electrodes be employed. This inferiority in the chlorine battery arises, I believe, from want of quantity in the electro-negative element: the chlorine is slowly liberated and much diluted by the liquid hydrochloric acid, while the nitric acid supplies an indefinite quantity of what we may term liquid oxygen. Thus the cathode is in the one case bathed by hydrochloric acid, and in contact with a comparatively small portion of chlorine, while in the other case it is covered to nearly its whole extent by oxygen; in other words, the sectional area of the efficient electrolyte is smaller in the first case than in the second. It is admitted that in metallic conductors the facility of conduction is directly as the sectional area of the conducting substance; but the problem is rendered more complex in electrolytes by the polarization or reaction occasioned by the liberated ions, and also by the quantity of the efficient chemical ingredients contained in the electrolyte, whether they act directly as ions or secondarily by absorbing or preventing the liberation of the cathions at the cathode. Dr. Faraday, in his 'Researches,' has shown that separate pairs of electrodes interposed in the same circuit, yield the same amount of gas whatever be their size; and this result has been misinterpreted by many, and regarded as establishing that the size of electrodes with regard to that of the battery plates makes no practical difference in the amount of gas liberated. From the great practical experience which the application of voltaic electricity to the electrotype and its kindred arts has promoted, this error has now for some years been removed. I believe I was the first to point out the necessity of electrodes equal in area to the battery plates in order to yield the full

amount of gas which a battery is capable of yielding; and at the Royal Institution in the year 1840, I showed a voltameter constructed on this principle, which yielded mixed gas from a battery of four square feet surface, at the rate of 110 c. i. per minute. The voltameter used in these experiments was one which M. Gassiot caused to be constructed upon a suggestion of mine, and which consisted of five pairs of plates, each exposing to the other eight square inches of surface. Any number of these plates could be thrown into action at a time, so that excluding the outward sides of the exterior electrodes, the sectional area of the electrolyte would be 8..8+8..16+8, and so on up to 72 square inches. The diminution of the sectional area of the electrolyte in the battery occasioned by the porous cells, was ascertained by first charging a given battery with sulphate of copper without any porous cell, ascertaining the amount of decomposition per minute, and then placing in the battery the porous cells, which had been previously soaked in the same solution of copper,—again decomposing, and calculating from the difference the diminution of area. The following is the table of experiments made with that view—and which will in great part explain itself:—

Experiments on Relative Sizes of Electrodes.—September 24th, 25th, 26th, 1845.

No. of Cells of N. A. Battery in series.	No. united in quantity.	Surface exposed of Battery each plate.	Surface exposed of Electrodes in sq. inches.	Quantity of Gas in c. i. per minute.
1	1	8	8	A trace
1	id.	8	72	id.
2		8	72	6·7
			32	6
			8	5·2
			1	2·8
			Wire	0·9
2	4	32	72	20·5
			64	20·5
			56	20·3
			48	20
			40	20
			32	19·4
			24	18·8
			16	16
			8	12
			1	3·5
			Wire	1

Remarks.—Battery in these experiments charged with nitric acid, sp. gr. 139, sulphuric acid, 1·22, or 1+4 water.

Dr. Faraday remarked on the importance of this investigation, and its application to the principles of electro-telegraphic communications, now that the discharging current was to be made through the earth.

8. *On a new theory of the Polarization of Light;* by Prof. Challis, (Proc. Brit. Assoc., Athen., No. 1028.)—In this theory *ether* is regarded as a continuous fluid substance, and is treated mathematically on hydrodynamical principles. By means of a new general equation in hydrodynamics, which the author has discovered, he shows that a filament of the fluid may continue in agitation without lateral spreading, and that motion may be propagated along it uniformly, provided the motion consist of vibrations partly longitudinal and partly transversal,

following the law of sines. Such a filament of motion is supposed to correspond to a ray of light. The sensation of light is due to the *transverse* vibrations. In a ray of common light the transverse motion is in planes passing through the axis of the ray, and is alike in all directions from the axis; in a plane-polarized ray, the transverse motion is in planes not passing through the axis; and in an elliptically polarized ray, the transverse vibrations are elliptical. Prof. Challis has extended his theory to the phenomena of double refraction, by a method which involves a new theory of the *dispersion* of light. He finds the surface of elasticity to be that of an ellipsoid; which is not in accordance with Fresnel's theory of double refraction. The equation of the wave-surface is, however, the same as in Fresnel's theory.

9. *Observations on the general Nature and Laws of Electrical Attraction;* by Sir W. S. Harris, (Proc. Brit. Assoc., 1847, Athen., No. 1029.)—The author commenced by a brief account of the theory of electricity resorted to by the French philosophers, and then proceeded to notice some physical facts which appeared to invalidate this theory;—amongst others, the electrical condition of a well-insulated body in a space nearly void of resistance, and which if preserved at a considerable distance from conducting matter maintained a charge, as well as under ordinary circumstances. The author, by a careful process, had been enabled to preserve the electricity of a small sphere in an exhausted medium for a very considerable time—many days. In conveying a charge to a common electrical jar it might be proved that equal quantities were received into it, in equal times, until there was a sort of overflow; being more analogous to the filling a vessel with an unelastic fluid such as water, than the condensation of an elastic fluid such as air. The action of the proof plane and the balance of torsion, as employed by the celebrated philosopher, Coulomb, was next adverted to. Here the author endeavored to show that great difficulties arose in deducing accurate results, inasmuch as the proof plane could not be considered as an element of the surface, and any electrometer acting on the principle of repulsion was liable to great uncertainty, and that hence deductions as to the particular distribution of electricity on the surfaces of bodies were inconclusive. It might so happen that the distribution may be uniform, and yet a proof plane come away more highly charged from one point than from another. The author called attention to an experiment of the celebrated Volta, who found that an electrical charge reposed more quietly on a long rectangular parallelogram than on a square, although the areas of the surface were the same. It was to be regretted, on account of the received mathematical theory of electricity, that all our experimental evidence relative to the distribution of a charge on the surface of conductors rests upon experiments with the proof plane, or some other body brought into contact with the given conductor and subsequently removed from it. The author, by a new method of experiment, had shown that the intensity of a charged surface of any rectangle was the same as when rolled up into the form of a cylinder, the quantity of electricity being the same—and that the intensity of a circular area was the same as that of the sphere into which we might conceive it to be transformed. An electrometer, depending on the attractive forces exerted between a

charged and neutral plane, was here exhibited to the Section, and was said to be susceptible of great accuracy in measurements of this kind. The author supposes every case of electrical attraction to resolve itself into the conditions of the Leyden experiment, and to be a simple case of electrical charge obtained by the opposition of two conducting surfaces with an intervening nonconducting medium; and it is well known that in the electrical jar the charge is not dependent on the thickness of the coatings but on their extension. If we could suppose a single body only in the universe—and to be charged with electricity—there appears no reason from experiment to suppose *à priori*, an unequal distribution upon it, be the form what it may; but if we conceive a second body to be called into existence, then the action termed electrical induction arises between the two, which is again reflected back by the second body upon the first; and on a space void of resistance this induction, however small, would cause an electrical current to flow through a space however great; but if a resisting nonconducting medium be interposed between these bodies, then we have to consider the action upon the interposed particles, and we have immediately a case of charge between the opposed surfaces of the two bodies,—and which will be greater in proportion to the amount of induction or electrical disturbance of which the previously neutral body is susceptible. In this way we may consider any two conducting bodies when opposed to each other as forming the coatings to an intermediate mass of air, and these are all the conditions we have to consider. In the case of two spheres opposed to each other, one insulated and charged with a given quantity of electricity, the other uninsulated and free, the determination of the laws of the attractive force was simple and the problem easy of solution, without any complicated consideration of an hypothetical distribution of the electricity upon the spheres and conductors connected with them;—we had, in fact, a chargeable system, with convex coatings. We have only to consider the opposed areas. Here, in whatever way the primary forces between the surfaces may be conceived to exist, they are finally reduced to an action between opposite and similar points, depending on the engagement of opposed positive and negative forces, by which an exclusive action between certain points is established. The attractive force between the spheres or rather opposed hemispheres, is as the number of attracting points, and inversely, and as the squares of the distances inversely; we can hence determine the position of two points q q' within the surface of each opposed hemisphere in which we may conceive the whole force to be collected, and to be the same as if derived from every point on the surface. The whole force will vary as the squares of the distances between these points inversely; so that a unit of force at a unit of distance between the nearest points of the spheres being given, it is easy to assign or predict the force at any other distance at which the intermediate air can become charged. The following formula was given by the author for determining the distance of the points q q' within the hemisphere: $z=\frac{(a^2+2ar)^{\frac{1}{2}}-a}{2}$. In which z is the distance of the point q, a the distance between the nearest points of the spheres, and r the radius. When both hemispheres are equal, the whole force will vary as $\frac{1}{a\,(a+2r)}$. As the distance between the spheres increases, the points $q\ q'$ recede from the surface, and would finally coincide with the centres of the spheres; which would limit the distance at which a charge could possibly occur. The author exhibited to the Section the striking agreement of the calculation with experiment by means of this electrical balance: consisting of a delicate scale-beam, with a duly poised suspended sphere. The weights requisite to balance the force between this sphere and a second sphere placed beneath it, and charged with a given quantity of electricity, were predicted with great precision. In the course of this paper some magnetic experiments were exhibited, illustrative of the action of the forces between similarly placed and opposite points. The author observed that every kind of case in ordinary electricity could be easily and simply investigated upon these principles; and that without the air between conductors could become charged, no attractive force would be apparent, and this would of course limit the distance at which such force could exist. It has been shown by Faraday, that with the same constraining power, induction takes place more readily, or with more difficulty, as the extent of the intervening dialectric particles is diminished or increased. We might have electrical currents in a space devoid of resistance; but without an interposed dialectric medium it is doubtful whether those phenomena indicative of attraction between the bodies would exist.

II. MINERALOGY AND GEOLOGY.

1. *On an Amorphous Boracite;* by Dr. M. KARSTEN, (Rep. Brit. Assoc., for 1847, Athen., No. 1028.)—When boring for rock salt at Neusalzwerk, in the neighborhood of Minden, in Prussia, at the depth of about 1,400 feet, a bed of amorphous boracite was found, of which specimens were brought out by the boring apparatus. The chemical analysis, which proves that the composition of the amorphous mineral is exactly the same as that of the well-known crystallized body, was made by Dr. Karsten in Berlin, particulars of which may be seen in the monthly reports of the Berlin Academy. It seemed to him interesting to examine if that uncrystallized species would show the pyroelectric quality which in so high degree is to be seen in boracite crystals. Sir D. Brewster has pointed out a way by which the pyroelectric quality of pulverized tourmaline may be shown. By heating that substance the fine particles cohere together, and show that a polarization has taken place in them. The same phenomenon is to be seen in the particles of the amorphous boracite by pulverizing and heating it on a metallic plate. These boracite particles show by their pyroelectric properties that they must be crystallized, although by microscopic examination the crystallization cannot be discovered. The conclusion must be, that the difference between the crystallized and the amorphous states cannot be exactly determined, since the microscope shows in this case no crystallization where the pyroelectricity is a proof that we must suppose a crystalline structure.

2. *On Sulphato-Chlorid of Copper, a new Mineral;* by Prof. CONNELL, (Proc. Brit. Assoc., 1847, Athen., No. 1027.)—Amongst some

minerals which were lately put into my hands by Mr. Brooke for chemical examination, there was one which I found to consist of sulphuric acid, chlorine, copper, and a little water. Although I had not enough material to determine the proportions of the constituents, there can be no doubt that it consists of sulphate and chlorid of copper, with a little water. It occurs in small but beautiful fibrous crystals; which, according to Mr. Brooke, are hexagonal prisms, having the angles replaced,—and thus belong to the rhombohedral system. Their color is a fine blue,—pale when the fibres are delicate, but much deeper where they become thicker. Lustre, vitreous. Translucency considerable. Locality, Cornwall. The mineral is associated with arseniate of copper. Ten specimens are at present known; one is in the British Museum.

3. *On the Geological Structure of Barbadoes, and on the Fossil Infusoria, described by Prof. Ehrenberg, from the Tertiary Marls of that Island;* by Sir R. H. SCHOMBURGK, (Proc. Brit. Assoc, 1847, Athen., No. 1028.)—Barbadoes is about twelve miles in length from north to south; about one-seventh part, forming the district of Scotland, consists of tertiary sandstones and limestones, rising to the height of nearly 1,200 feet above the sea. Over the rest of the island raised coral reefs cover the entire surface, which is divided by vertical walls of coral rock, some of them nearly 200 feet high, into six terraces, indicating as many different periods of upheaval. In the lowest of these terraces, fifteen or twenty feet above high water, Indian hatchets have been found in the reef, showing that the last movement had taken place within the human period. The shells found at the height of 150 and 300 feet above the sea still live upon the adjacent coast. In the southern part a well had been dug to the depth of 240 feet through compact coral rock. The highest part seems to have been the centre of the elevating force: from this point ravines, some of them 250 feet in depth, radiate in all directions towards the sea. The tertiary rocks of the Scotland district are more or less inclined, and sometimes vertical, or contorted. The marl beds, which form the greater part of the series, are several hundred feet thick. Bitumen, bituminous coal and sandstone, clays and ferruginous sands, are also found at Mount Hillaby and Springfield. Burnt Hill, near Conset's Bay, is reported to have been set on fire accidentally, and to have continued burning for five years. Slags are found on the surface bearing distinct marks of fire; and sandstone, containing bitumen and mineral oil, abound in the neighborhood. The summit of Bissey Hill, 986 feet above the sea, consists of silicious limestone, containing teeth of two species of shark (Lamna and Odontaspis), spines of Echini, and shells, one of which (*Scalaria Ehrenbergii*) is considered by Prof. Forbes to belong to the miocene period. In the white marls of the Scotland district, M. Ehrenberg has discovered the silicious skeletons of nearly 300 species of microscopic infusoria. These belong to a group called Polycistina by M. Ehrenberg, and to fifteen genera found hitherto in the marls of Sicily, at Oran in Africa, in Greece, in the tripoli of Richmond in Virginia, and in Bermuda; some of them are forms now living in the North Sea, and at the bottom of the sea near the South Pole. Prof. Ehrenberg remarks, that whilst phosphate of lime is the most important

element of the bones of the vertebrate animals, and carbonate of lime the chief material is the skeletons of the molluscous animals and zoophytes, silica is almost peculiar to these minute races of infusoria. Some of the marls in which these silicious animalcules are found contain a large admixture of pumice, giving it the character of volcanic tufa.

4. *Exploration of the Volcano Rucu-Pichincha*, (*Quito*;) by MM. Seb. Wisse et Garcia Moreno, during August, 1845, (abridged from the Comptes Rendus, 1846; Quart. Jour. Geol. Soc., No. 10.)—Pichincha is situated eleven miles in a straight line W.N.W. from Quito: its sides, which are covered with vegetation to the height of 12,116 feet, are furrowed by deep ravines. All the part above, called the 'Arenal,' is covered with sand and pumice, and is inclined at an angle of 25° to 35°.

The authors having ascended the Arenal to the height of 1542 feet, reached the edge of the crater, which is broken down on the south and on the west, and found the cavity of the volcano to consist of two funnel-shaped craters, apparently resulting from two sets of eruptions. They descended into the eastern crater, a depth of 1050 feet, and found it to consist simply of a vast ravine, at the bottom of which was the bed of a torrent, always dry except during rains.

The western crater is nearly circular, and regularly funnel-shaped: at the bottom is a small plain, through which flow two torrents, which unite near the western opening of the crater. On the western side of this plain rises a hill or cone of eruption, whose height is about 260 feet above the mean level of the bottom of the crater, and its diameter about 1476 feet. This hill is embraced by the two torrents, so as to form a kind of peninsula during heavy rains. It is far from perfectly conical at present, being covered with irregular heaps of stones, and fissured in all directions, proving the violence of the convulsions it has been subjected to in recent times. The volcanic vents, whether active or extinct, are all situated in this cone of eruption; not the slightest trace of one being found elsewhere. They are arranged in nearly circular groups of different dimensions, some of them attaining a diameter of 82 feet. There are in all nine of these groups, six in activity and three extinct, all situated in those parts of the cone which appear to have been most recently convulsed. The cavity at the eastern foot of the cone is 150 feet in diameter and 65 feet in depth, and contains three groups, two at the sides in activity, and one extinct in the centre. These are the first that are met by a person descending from the east, and are the only ones seen in fine weather from the summit of the eastern crater. At a short distance to the right of this cavity is a fissure about four inches in breadth, from which issue vapors; and on the left a single vent occurs in the midst of vegetation, which grows luxuriantly within a yard of the orifice.

In mounting the cone two more groups of active vents are reached; and finally at the summit, the most considerable and imposing group of all. It contains nearly forty active vents within a cavity 260 feet in diameter and 65 feet in depth, and exhibits proof of tremendous exertions of force. Cubical masses of rock, upwards of 12 feet in the side, are thrown about in the utmost confusion; while between their interstices the most suffocating vapors arise.

Lastly, at the foot of the cone are found two more groups of extinct vents. The total number of active vents is about seventy.

Vapors also find their way through the loose soil, which consists of ashes, sand, and sulphur: their odor was that of burnt sulphur and of rotten eggs; from which it is to be presumed that they consist of a mixture of the sulphurous and hydrosulphuric acids. The authors next mounted with incredible labor to the summit of the volcano, whose crest is serrated with sharp pyramidal rocks, resembling the teeth of a saw. The inner walls near the top consist of detached blocks and rocks of all sizes; and lower down, of sand and soil with occasional patches of vegetation. The rocks blackened by time, the profound obscurity, and the vast columns of smoke issuing from an abyss 2460 feet in depth, are described as forming a majestic and terrible scene.

The authors give the following reasons for believing the eastern crater to be the more ancient. It contains no traces of volcanic fumeroles, and its cone of eruption has entirely disappeared; its interior walls are but slightly inclined; and the ridge which separates the two craters, though gently inclined towards the eastern crater, is cut off almost perpendicularly towards the western. The trachytic rocks of the eastern crater are covered over with sand and pumice, which have evidently been ejected from the western. The eastern crater burst forth near the summit of the ancient Pichincha, and the western on its side.

The later eruptions of Pichincha have produced nothing but pumice, that being the only rock visible at the surface. Below the Arenal, the sides of the mountain are covered with vegetation, the surface being composed of soil, sand, and pumice, without any débris which can be attributed to recent convulsions. The few masses of rock which pierce the vegetable crust are probably part of the interior stony structure. Yet the eruptions which caused the present craters must have been tremendous: solid rock which once formed the summit of Pichincha and the matter thrown from the interior must have reached immense distances, while violent earthquakes must have desolated the neighboring country. Had these been witnessed by man, tradition ought to have preserved the memory of them. But according to the historian of Quito, previous to the eruption of 1539, Pichincha was not known to be volcanic; the traditions of the Indians being absolutely silent on the point. The authors think it therefore probable that the eruptions which caused the present craters took place before man inhabited this part of the Cordilleras. The fumeroles of the present cone must also have been obstructed during a great lapse of time; otherwise the Indians must have noticed great columns of smoke, such as now rise from it. The only known eruptions in 1539, 1577, 1587 and 1660, have all issued from the existing cone; and to this epoch must be referred the blowing away of the matter which choked the old vent, and the formation of the present cavities.

But in spite of history and tradition, it is impossible to believe that the vast blocks, more than 12 feet in diameter, which cover part of the plain of Iña Quito, distant 3½ leagues, can have been thrown out by the eruption of 1539. There are no traces of such recent eruptions on the sides of Pichincha, and the present cone is far from being considerable enough to have furnished such a vast quantity of projectiles. Those which were thrown at angles less than 45° would strike against the inner walls of the crater, and roll back again into it; those only which were thrown at greater angles, and with force enough to rise 16,000 feet above the plain of Quito, could reach their present positions; and although this is not physically impossible, yet it is contradicted by the appearances of the later eruptions, which have clearly been of a very tranquil description.

The authors consider as equally fabulous, a tradition that the eruption of 1660 was accompanied by showers of incandescent rocks, which are said to have fallen on all sides, but of which not a vestige is now to be seen. J. C. M.

5. *Count Keyserling's Geology of the Northeastern Extremity of Russia in Europe;* by Sir R. I. MURCHISON, (Proc. Brit. Assoc., 1847, Athen., No. 1028.)—Sir R. I. Murchison exhibited the new work, entitled, "*Wissenschaftliche Beobachtungen auf einen Reise in das Petschora-land*,"* and explained its value in completing the acquaintance of geologists with the great northeastern angle of Russia in Europe, which is watered by the river Petschora. The geographical and astronomical observations in this expedition (to a region previously known only imperfectly to the Russians through the traders in fur) are by M. P. von Krusenstern, of the Imperial Navy. The geological outline of the present work (executed in 1843) was communicated to Sir R. I. Murchison previous to the publication of the volumes on the "Geology of Russia and the Ural Mountains," and constitutes one of the chapters of that work; but the object of this communication was to call attention to the additions which had appeared: first, in regard to the physical and geological delineation of this wild country in two maps; and, secondly, to the numerous plates (twenty-three in number) of the organic remains of the Silurian, Devonian, Carboniferous, Permian, and Jurassic systems, occurring in a hitherto unexplored region which extends over near 11 degrees of latitude; viz. from 60° to 71° N. lat., and 25° long., including the northernmost range of the Ural Mountains. Sir R. I. Murchison stated that although the eastern flank of that chain had been touched upon at one or two points by the authors, and notably in N. lat. 65°, enough had only just been done by them in this respect to connect, in an approximate manner, the structure of the northern end of the chain with that previously described: all this rocky territory, extending 3° and 4° of latitude beyond the limits of arboreal vegetation, is now under the survey of a distinct expedition, commanded by Col. Hoffman, and sent out under the auspices of the Geographical Society of St. Petersburg. The chief geological interest attached to the work of Count Keyserling, (in addition to the points alluded to,) is the determination of an axis of palæozoic rocks constituting the Timan Ridge, which, branching off from near the Ural Mountains in lat. N. 62°, trends in a N.N.W. direction to the left bank of the Petschora to the bay of Techeskaya, and is prolonged into the promontory of Kanin-

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* This work consists of a 4to volume of text, published in German at St Petersburg in 1846, with 23 elegant 4to plates of fossils, and two maps.—J. D. D.

Nos in lat. 68° 45′. This ridge, divergent from the meridian direction of the Ural Mountains, but parallel to their northern extremity, seems to form a part of the great girdle of palæozoic deposits which wrap round the crystalline nucleus of Lapland and Scandinavia, of which the Baron Leopold von Buch, by his description of the fossils collected there, has recently determined an important fragment of carboniferous age in Bear Island near Spitzbergen, on the north-western flank of Scandinavia.

6. *On the Fossil Vegetation of Anthracite Coal.*—Mr. J. E. TESCHEMACHER, at the recent meeting of the American Association of Geologists and Naturalists, read a paper on this subject, confining his observations to the remains of vegetation found in the *body* of the coal, apart from that in the accompanying shales. The principal points of the memoir were that, the remains of the larger forms of the coal epoch, as well as of the smaller plants, were abundant in the coal, contrary to the usual opinion. Specimens were exhibited from the interior of the coal, showing the external and internal parts of plants—the vessels—the leaves—the seeds, &c.

Since the meeting, Mr. Teschemacher has continued his investigations, and has communicated in a letter to one of the editors the following results.

1st. What I considered as vessels were said to be mere marks of sliding of the coal. Prof. Bailey prepared a specimen of this, by his method, and told me that if I found vessels there, my proposition was correct. Examined by Agassiz and myself, with his large Oberhauser, it turns out to be *nothing* but a *mass* of perforated vessels, as clear and distinct as if they were recent. Mr. Agassiz observed, "one moment suffices to remove every doubt on the subject."

2nd. What I considered as fossil seeds, were said to be mere peacock-eye coal; the dark carbonaceous centres of these seeds which I held to be carbonized cellular matter, was thought to be a mere mistake and the seeds imaginary. I have since discovered them with distinct and clear apparently spinous appendages. Mr. Agassiz thinks the seed a Samara, and I have found sufficient quantity to pick out the carbonaceous matter from the interior with a fine needle—decarbonize it in a clean platina crucible over a spirit lamp, with every possible precaution to prevent any foreign substance mixing therewith; on examining this with the Oberhauser, 700 diameters, Mr. Agassiz shewed to Dr. Gould and myself the cells as clear and plain as possible; it is a mass of cellular matter as I stated. You may of course imagine the extreme tenuity of the parietes of cells of seeds when decarbonized, and the difficulty of those less experienced than Agassiz in the microscope in managing the subject—he feels quite convinced of their being fossil seeds. The nature of the genus of plants must require further examination.

3rd. The smooth glossy surfaces which I considered the external parts of large plants rendered smooth by intense pressure, were said to be nothing more than slickenslides. My position here is proved much more easily than in the other cases, by specimens passing gradually from the smoother through different degrees of protuberance, (all still smooth and polished,) until we arrive at the full form of the Lepidodendron. Nay more, I have found the parallel lines (channels) which are on the slickenslides, also on the perfectly formed Lepidodendra. The correctness of my views here I could prove to the most skeptical.

The discoveries still to be made on this subject are numerous and important, and I doubt not that the investigation of the coal itself will soon solve the doubts hitherto existing in the comparison of the coal fossils with recent plants.

I will merely add, that I have found quite distinctly the impression of the cellular cuticle of some of these plants, which of course cannot be seen in an impression on shale, the grains of the sedimentary matter being as large as the surface of the cells; but on the pasty mass of coal the impression is perfect.

III. BOTANY AND ZOOLOGY.

1. *Description of a supposed new species of Columba, inhabiting Mexico;* by GEORGE A. M'CALL, (Proceed. Acad. Nat. Sci. Philad., July, 1847.)—*Columba solitaria.*—Length 13 inches 9 lines. Alar extent 23 inches. Wing, from the flexure, 7 inches, 5 lines. Tarsus 1 inch; middle toe 1 inch, 2 lines; first toe 9 lines, and longer than the third; nails light flesh color; feet and legs deep red. Iris dark orange. Bill above, 1 inch, 1 line, but feathered to within 5 lines of the tip; reddish near the base, whitish near the tip. Head chocolate-blue. Throat chocolate-white. Neck and breast blueish-chocolate with brilliant reflections. Back, belly, flanks, underwing-coverts and greater exterior wing-coverts light red color, the last faintly bordered with white. Lesser wing-coverts chocolate red, forming a bright shoulder spot of elliptical shape. Quill feathers dusky, tinged with lead color on the outer vanes. 3rd primary longest. Upper and under tail-coverts blueish-lead color. Tail 5 inches; slightly rounded; of twelve feathers; dusky.

Individuals of this fine species, which in general contour, resembles *Columba Œnas*, were found on the Rio Grande, from Matamoras to Camargo; these were shy, and only met with at intervals. They were again observed on one or two of the smaller water courses between the former place and Victoria, but never in flocks; nor were more than half-a-dozen seen anywhere in a single day while hunting over large extents. Their haunts were in the neighborhood of running streams or very large ponds of clear water: here four or five might be found scattered over some 20 or 50 acres; thus showing little sociability even on their feeding grounds. But most frequently he is found alone, perched near the water, or with rapid wing shaping his solitary course across the extensive waste. His flight is extremely bold, as he pitches in wide irregular *zig zags* through the air, with a velocity scarcely to be surpassed. The meat for delicacy of flavor is not excelled by any of the family.

2. *Basilosaurus*, (communicated by Prof. Agassiz, from a letter recently received from M. A. Retzius.)—The following is an extract from a letter from Prof. J. Müller to Mr. A. Retzius, dated Berlin, March 24, 1847.

"The *Hydrarchus*, *Koch*, found in the tertiary formation in Alabama, is identical with Harlan's *Basilosaurus* and Owen's *Zeuglodon cetoides.**

*** Phocodon, Agassiz. Squalodon, Grateloup, in Leonhard and Bronn's Jahrbuch für Mineralogie, 1841, p. 830.**

The crowns of the teeth, with which Owen was not acquainted, have a great resemblance to those of the seal; in the maxillary teeth they are cutting and many pointed; most of the maxillary teeth have double roots, but the anterior has, as in the seals, only a single root. In the anterior part of the jaw are found conical curved teeth, viz. an incisive and a canine, at least this is the case with the under jaw.

"As such teeth as those which are found in the Hydrarchus, occur in the tertiary formation in Malta, we may conclude that this animal belongs likewise to the tertiary formation of that island.

"I think I can positively show that the Hydrarchus is not a reptile, but a mammal belonging to a peculiar extinct family. It has the ear formed as in the mammals, viz. a helix, and a tympanic bone as in the whales. It has moreover two occipital condyles, and in the whole formation of the cranium no trace of reptile structure occurs, but on the contrary every thing is as in mammals.

"The vertebral column is very peculiar in its structure. The cervical vertebræ, probably more numerous than in any other mammal, are without perforations in their transverse processes; the ribs are only attached to the transverse processes of the vertebræ; at the central and posterior part of the column, the bodies of the vertebræ are unusually long, and must both at the anterior and posterior part of the extremities have been cartilaginous, inasmuch as we find here beneath the bony shell a mass of pure stone, while the central part of these vertebræ consists wholly of bone."

3. *On the History of the Dodo and other allied species of Birds;* by H. E. STRICKLAND, (Athen., No. 1029.)—He showed from historical data that each of the three islands of the Indo-African Ocean—Mauritius, Rodriguez and Bourbon—was originally inhabited by peculiar species of brevipennate birds, all of which were speedily destroyed by the early colonists. Mauritius was the birthplace of the Dodo:—the first notice of which was not, as erroneously stated, by Vasco de Gama, (who never visited Mauritius,) but by Van Neck, a Dutchman, in 1598. Several successive voyagers mention the bird, down to Cauche in 1638; and in the latter year a live specimen was brought to London, and was described by Sir Hamon Lestrange. The *pictorial evidence* respecting the dodo consists of four oil paintings:—one in the British Museum, without the artist's name; one at the Hague, and another at Berlin, by Roland Savery; and one at Oxford, by John Savery, his nephew. All these are evidently from one design,—and may have been drawn from a specimen which Van Neck brought to Holland. The *osteological evidences* of the Dodo consist of the foot in the British Museum, the head and foot at Oxford, and a head lately discovered at Copenhagen. The three former specimens were exhibited; and a cast of the latter had also been sent for the meeting; but was detained by the vexatious formalities of the London Custom House. The Oxford head and foot have been recently dissected; and from the characters thus exposed it is certain that the Dodo was not related either to the gallinaceous birds, the ostriches, or the vultures, as others have conjectured—but is closely allied to the pigeons. With the exception of its short wings, it approaches greatly to the *Trerons*, or fruit-pigeons; and still more to the *Didunculus*, a kind of pigeon from the Samoan

Islands, of which the only specimen in Europe was exhibited at the meeting. The author supposes that the Dodo fed upon the cocoa-nuts, mangos, and other fruits which in tropical forests fall from the trees at all seasons of the year. The lecturer then drew attention to the island of Rodriguez, visited in 1691 by Leguat; who has given a description and figure of a brevipennate bird which he calls the *Solitaire.* Several bones of this bird from the Museums of Paris and of Glasgow, were on the table; and a comparison of them with those of the Dodo clearly proved that the "Solitaire" was an allied, but distinct species,—longer legged than the Dodo, and related, like it, to the pigeons. It was next shown, from the narratives of several voyagers, that the island of Bourbon was also formerly inhabited by two species of short-winged birds of the same abnormal group as the Dodo and the Solitaire. Unfortunately, we have as yet no osseous remains of these birds from Bourbon:—but they might doubtless be procured from the caves and alluvial deposits of that island; and by similar researches in Mauritius and Rodriguez, the entire skeletons of this remarkable family of extinct birds might be reconstructed.

4. *Ehrenberg on the Sirocco-dust that fell at Genoa on the* 16*th May*, 1846, (Quart. Jour. Geol. Soc., No. 10, from the 'Berlin Monats-Bericht,' for 1846, p. 202–207.)—The microscopic analysis of this dust produced 22 polygastrica, 21 phytolitharia, together with the pollen of plants and the spores of Puccinium. The varieties of dust which since 1830 have fallen in the Atlantic Ocean, as far as 800 sea miles west from Africa, on the Cape Verd islands, even in Malta and Genoa, which the author has had an opportunity of examining, all agreed in the following particulars:—1st, they are all ochre yellow, never grey, like the dust of the Khamseen in the north of Africa; 2nd, the color is produced by iron oxyd; 3rd, from one-sixth to one-third of their mass consists of recognizable organic parts; 4th, these are either siliceous polygastrica and phytolitharia, or carbonaceous but uncarbonized portions of plants, or calcareous polythalamia; 5th, the greater number of the ninety species already found equally occur in the most widely separated of the places just named; 6th, the most numerous forms are every where land and freshwater productions; yet some marine animalcules are constantly mixed with them; 7th, in no case were dried up, living species (except the pollen and spores), nowhere melted, calcined, or carbonized forms among them; 8th, even the dust of Genoa, although brought there by the Sirocco, exhibited as little as any of the former, characteristic African forms, which yet are found in every small portion of mud from Africa; on the contrary, one of them, *Synedra entomon*, is a decidedly characteristic South American form. It is remarkable that the few (2?) European observations hitherto made have always fallen on the 15th and 16th of May. The author concludes with the question, whether there is not a current of air uniting Africa and America in the region of the trade-winds, which is occasionally, and especially on these days, turned towards Europe, and brings that dust along with it? J. N.

5. *A Fact respecting the Habits of Notonecta glauca;* by Prof. Forrest Shepherd, (communicated for this Journal.)—In the evening twilight of a pleasant day in September, 1846, Sir George Simpson en-

camped for the night, on his route from Red River to the head waters of the Mississippi, in the vicinity of latitude 48 degrees North and longitude 95 or 96 degrees West from Greenwich. While supper was preparing, he perceived something falling on his hat like drops of rain; but as there were no clouds to be seen, presumed it could not be rain. On looking on the ground near the fire, he saw distinctly that the falling substance instead of being rain was a small winged insect, which, although unable to fly had yet life and motion. The number rapidly increased so as to give great annoyance by falling into the frying-pan and supper vessels; and continued until the ground was covered by the shower. On the following morning, Sir George ascertained that this extraordinary shower extended at least from twenty-five to thirty miles in the direction he was travelling. No information has been received as to its extent in other directions. It was observed that soon after the shower, the weather changed suddenly from warm to cold. It is therefore probable that the whole of this immense swarm of insects encountered the cold current, and were paralyzed and precipitated thereby. They all died soon after falling. Specimens of these insects were collected by the attendants of Sir George, from whom I received them. In no instance, however, were they seen to revive after coming into a warmer atmosphere. Not being able to recognize this species, I took the specimens to Professor Bachhofner, of the Royal Polytechnic Institution of London, who at once declared them to be the "*Notonecta glauca*," a species of aquatic diptera, well known in Europe.

Other specimens were given to Dr. Le Conte, of New York, from whom the scientific community will probably hereafter receive a more particular description through the columns of the American Journal.

Western Reserve College, Hudson, Ohio, July 27, 1847.

6. *On the Diatomaceous Vegetation of the Antarctic Ocean;* by Dr. J. HOOKER, (Proc. Brit. Assoc., 1847, Athen., No. 1028.)—The author found the Diatomaceæ in countless numbers between the parallels 60° and 80° south, where they gave a color to the sea, and also to the icebergs floating on it. The death of these bodies in the south Arctic Ocean is producing a sub-marine deposit, consisting entirely of the siliceous particles of which the skeletons of these vegetables are composed. This deposit exists on the shores of the Victoria Land, and at the base of the volcanic mountain Erebus. Dr. Hooker accounted for the fact that the skeletons of Diatomaceæ had been found in the lava of volcanic mountains, by referring to the position of the Diatomaceæ deposits in relation to Mount Erebus,—which lie in such a position as to render it quite possible that the skeletons of these vegetables should pass into the lower fissures of the mountain, and then passing into the stream of lava, be thrown out unacted upon by the heat to which they have been exposed.

7. *Analogy between the Fossil Flora of the European Miocene and the living Flora of America;* by Prof. AGASSIZ, in a letter to R. I. Murchison, (Athenæum, No. 1023.)—"I think I made a lucky and quite an unexpected hit, by tracing the close analogy between the fossil Flora of the European miocene deposits (*molasse*) and the living Flora of the temperate parts of the United States of North America. The correspondence extends to all the types of organized beings. After

having seen the Chelydra alive in the swamps here, under the shade of trees analogous to those which cover the ancient soil of Oeningen, (so celebrated for its profusion of terrestrial and freshwater fossil remains,) I cannot help thinking that the climate could not have been tropical in Europe at the time when the strata of Oeningen were deposited. Again, I may observe that there is the closest affinity between the Flora of the Atlantic shores of North America and that of Japan; where we have the Megalobatrachus, the corresponding living type of the Andrias, or great fossil salamander of Oeningen. As I am unable to write a paper now, I would thank you to make these remarks known before I can publish them *in extenso*."

IV. ASTRONOMY.

1. *The New Planet* Iris.—The discovery by Mr. J. R. Hind of London, of another planet between Mars and Jupiter, is thus announced in his letter to *The Times*, published Aug. 18, 1847.

"*Sir*—In addition to the Berlin Maps, which we have revised, and in some instances corrected, Ecliptical charts of stars down to the tenth magnitude, have been formed for some of the hours of Right Ascension, which it is Mr. Bishop's intention to publish as soon as they are completed. On the 13th of August, I compared Wolfers's Map [Hora xix] with the heavens, and was surprised to find an unmarked star of 8·9 magnitude in a position which was examined June 22 and July 31, without any note being made. The mere existence of a star in a position where before there was none visible, would not have been sufficient to satisfy me as to its nature; because during an eight months' search I have met with very many variable stars,—a class which I believe to be far more numerous than is generally supposed. But on employing the wire micrometer we were enabled in less than half an hour to establish its motion, and thus to convince ourselves that I had been fortunate enough to discover a new member of the planetary system. It may appear to many of your readers rather bold to announce the existence of a new planet, from the detection of so small an amount of motion as $2^{s}{\cdot}5$ in R.A.; but such is the firm mounting of the large refracting telescope, and the perfection of the micrometers, (for which we have to thank Mr. Dollond,) that a far smaller change would have been sufficient to convince us as to the nature of the object in question. Mr. Bishop has fixed upon *Iris* as an appropriate name for the new planet; and we hope that astronomers generally will join with us in its adoption. The following are all the observations we have yet made.

	Gr. m. t.	R.A. of Iris.	S. decl.
	h. m. s.	h. m. s.	° ′ ″
1847. Aug. 13,	9 39 46	19 57 30·38	13 27 21·5
13,	10 37 24	19 57 28·41	13 27 27·6
14,	9 23 58	19 56 38·30	13 29 14·0
15,	9 0 39	19 55 47·64	13 31 4·3

Mr. Bishop's Observatory, Regent's Park, Aug. 17."

Mr. Hind subsequently communicated to the *Times* his first approximation to the elements of this planet, from an observation of Aug. 20, by Prof. Challis, and two taken by himself, Aug. 13 and 26, neglecting parallax and aberration.

Mean long. 1847, Sept. 0, Gr. m. t.,	356° 9′ 13″·3	
Long. of perihelion,	26 9 48 ·5	m. eqx. 1847·0
" " ascending node,	251 41 14 ·5	
Inclination,	4 37 22 ·1	
Angle of excentricity,	25 35 22 ·1	
or *e*,	0·43192	
Log. semi-axis major,	0·4598916	
Period in sidereal years,	4·896	

This orbit, as Mr. Hind observes, is remarkable for its great excentricity; and the period of revolution is longer than that of any of the other asteroids.

Hebe is the name given to the planet discovered by Mr. Hencke, July 1, 1847. (See p. 286 of this volume.)

2. *Comet of May* 7, 1847, (Astr. Nach., No. 603.)—Prof. Colla, at Parma in Italy, discovered, May 7, 1847, a faint telescopic comet in the constellation *Leo Minor*. D'Arrest of Berlin has given the following elements.

Perihelion passage, 1847, June	12^{d}·41336 m. t. Berl.	
Long. of Perihelion,	137° 41′ 33″·7	m. eqx. 1847·0
" " Asc. Node,	173 25 50 ·3	
Inclination,	80 16 56 ·5	
Log. Perih. dist.,	0·3257617	
Motion,	Retrograde.	

3. *Comet of July* 4, 1847.—In the *Comptes Rendus*, July 26, 1847, Mauvais gave the following elements (second approximation) of the orbit of the comet discovered by him July 4, 1847, (see p. 287, this volume,) viz.

Perihelion passage, 1847, Aug.	8^{d}·451318	
Long. of Perihelion,	247° 9′ 46″·7	m. eqx. July 0, 1847.
" " Asc. Node,	338 8 45 ·4	
Inclination,	83 27 25 ·9	
Perihelion dist.,	1·767552	
Motion,	Retrograde.	

4. *New Comet*, (Lond. Athen., Sept. 11, 1847.)—*M. Schweizer*, at Moscow, discovered a telescopic comet Aug. 11, 1847, between *β* and *θ Aurigæ*. It was round and without tail. In 24 hours its R.A. diminished about 13 minutes of time, and its declination lessened about 10 minutes of space.

5. *New Comet*, (Boston Evening Transcript, Oct. 9.)—A telescopic comet was discovered by a lady of Nantucket, on the morning of Oct. 1, 1847, in the constellation *Cepheus*. It is now visible to the naked eye. Its position determined at the Cambridge Observatory, from comparisons with *zeta Draconis*, was

Oct. 7, 7^{h} 56^{m} 31^{s}, R.A. 17^{h} 10^{m} 56^{s}·2, and
N. Dec. 70° 1′ 18″; referred to M. Eqx. Jan 1.

6. *The New Telescope at Cambridge.*—The following letter from Mr. Bond, the Director of the Observatory at Cambridge, Mass., respecting the performance of the Grand Refractor recently mounted there, will be read with much interest.

Cambridge Observatory, Sept. 22d, 1847.

Dear Sir—You will rejoice with me that the great nebula in Orion has yielded to the power of our incomparable telescope.

This morning the atmosphere being in a favorable condition, at about 3 o'clock the telescope was set upon the Trapezium in the great nebula of Orion.—Under a power of 200, the 5th star was immediately conspicuous; but our attention was directly absorbed with the splendid revelations made in its immediate neighborhood. This part of the nebula was resolved into bright points of light. The number of stars was too great to attempt counting them; many were however readily located and mapped. The double character of the brightest star of the Trapezium was readily recognized with a power of 600.—This is "Struve's 6th star;" and certain of the stars composing the nebula were seen as double stars under this power.

It should be borne in mind that this nebula and that of Andromeda have been the last strong-hold of the nebular theory; that is, the idea, first thrown out by the elder Herschel, of masses of nebulous matter in process of condensation into systems. The nebula in Orion yielded not to the unrivaled skill of both the Herschels, armed with their excellent Reflectors.

It even defied the power of Lord Rosse's three-foot mirrors, giving "not the slightest trace of resolvability," or separation into a number of *single* sparkling points.

And even when, for the first time, Lord Rosse's grand Reflector of six-feet speculum was directed to this object, "not the veriest trace of a star was to be seen." Subsequently his Lordship communicated the result of his farther examination of Orion, as follows:—

"I think I may safely say, that there can be little if any doubt as to the resolvability of the nebula.—We could plainly see that all about the Trapezium is a mass of stars; the rest of the nebula also abounding in stars, and exhibiting the characteristics of resolvability strongly marked."

This has hitherto been considered as the greatest effort of the largest reflecting telescope in the world;—and this our own telescope has accomplished.

I feel deeply sensible of the odiousness of comparisons;—but innumerable applications have been made to me for evidence of the excellence of the instrument, and I can see no other way in which the public are to be made acquainted with its merits.

With sincere respect and esteem, I remain, Sir, your obedient servant, (Signed) W. C. Bond.

Pres't Everett.

V. Miscellaneous Intelligence.

1. *Eighth Annual Meeting of the Association of American Geologists and Naturalists.*—This meeting was convened according to adjournment, at Boston, on the 20th Sept., and continued to the 25th. It was numerously attended by gentlemen of science from all parts of the country, and the presence of several Europeans of eminence added interest and value to the sessions. No official account of the proceedings has appeared, but from the daily journals we are able to give a

tolerably complete list of the papers read during the meeting. The most important step taken at this meeting was the enlargement of the sphere of operations in this association and a corresponding change of name—THE AMERICAN ASSOCIATION FOR THE PROMOTION OF SCIENCE is hereafter to be its designation, and it is designed to embrace all laborers in Physical Science and Natural History. Hitherto but few papers have been read on chemistry, natural philosophy, and general zoology, the title of the Association appearing to many to exclude these topics. A corresponding increase of valuable papers and collaborators it is anticipated will follow this desirable change.

The vacancy in the office of chairman, occasioned by the lamented death of Dr. Binney, was filled by the appointment of Prof. Wm. B. Rogers of Virginia.

Papers read September 21st.

On the Mississippi Bluff formation, near Natchez; by Col. B. L. C. Wailes, of Washington, Miss.

On animal torpidity; by Peter A. Browne, Esq. of Philadelphia.

On the fossil vegetation of Anthracite coal; by Joseph E. Teschemacher, of Boston.

On the structure of the Echinodermata; by Prof. Agassiz.

On certain new species of Fossil Mammalia from Illinois; by John L. LeConte, of New York.

September 22d.

On the remains of existing Marine Shells found in the hills of Drift and Boulders, in Brooklyn, N. Y.; by W. C. Redfield.

On the Structure of Anthracite Coal; by Prof. J. W. Bailey.

On the Animals which formed the Fossil Footmarks in New England; by President Hitchcock.

On certain relations of the Alkaline Earths; by Prof. E. N. Horsford.

On the Antiquity of the Indian Mounds; by E. G. Squier.

On the structure of Polyps; by Prof. Agassiz.

September 23d.

On the Mastodon; by Dr. J. C. Warren.

On certain Laws of Cohesive Attraction; by J. D. Dana.

[Mr. Dana's paper will be found in full, commencing on page 364 of this number.]

Letter from W. C. Bond, on the Resolvability of the Nebula of Orion.

On the Nebular Hypothesis; Prof. B. Peirce.

On a new species of Orang; by Dr. J. Wyman.

On the Geographical Distribution of Animals along the coast of New England; by Prof. Agassiz.

On the Cypress Swamps of Mississippi and Louisiana; by Dr. Dickerson.

Report on the Currents of the North Atlantic; by Lieut. Maury.

On the Fishes of Lake Winipissiogee; by Dr. Wm. Prescott.

On Claystone concretions; by Prof. C. B. Adams.

September 24th.

On the Natchez Bluff formation; by Dr. L. D. Gale.

On the Absorption of Carbonic acid; by Profs. W. B. and R. E. Rogers.

On the Languages of the Aborigines of the Southwest; by S. S. Haldeman.

On the Mounds of the Southwest; by Dr. M. W. Dickerson.

On the general results of Investigations in the Palæontology of the lower strata of New York; by James Hall.

On the Depth and Saltness of the Ocean; by Com. C. Wilkes, U.S.N.

On Heat; by Prof. Henry.

On the Taconic System; by Prof. Adams.

Report on the Taconic System; by Prof. L. Vanuxem.

On the Phenomena of Drift and Glacial action in New England; by Mr. Desor.

On the Drift of New England and the River St. Lawrence; by Prof. H. D. Rogers.

September 25th, Saturday morning.—Final Session.

On the Incrustations of Steam Boilers; by Prof. W. R. Johnson.

On the Structure of the Holothuridæ; by Count Pourtales.

On the Distribution of organic matter in forest and fruit trees; by Prof. E. Emmons.

Report on Trilobites, Crinoidea, &c., of New York; by J. Hall.

On the Organization and objects of the Smithsonian Institution; by Prof. Jos. Henry.

The Association adjourned to meet in Philadelphia in September, 1848.

Abstracts of the papers read and remarks made at the Association will be hereafter given in this Journal as far as they may be sent in by their authors.

2. *Iowa Meteorite*, (from a letter, from Joshua Barney, U. S. Agent, Dubuque, to J. J. Abert, Col. Topographical Bureau, Washington.) —The accompanying fragment of an aerolite fell at 3 o'clock in the afternoon of the 25th day of February, 1847, within seventy-five yards of the house of Daniel Rogers, nine miles due south of Marion, Linn Co., Iowa. The ground was covered with snow at the time it fell. Mr. Rogers heard a loud explosion in the air, and immediately ran to his door. He heard the stone, of which this is a piece, and several others, whiz through the air, and strike the ground, and saw the snow and dirt fly where this stone struck. The weight of the stone before it was broken, was forty-two pounds.

It is said that three more of the stones have been found, all of which are precisely similar in appearance, and nearly of the same weight of this—as it appeared before broken.

The explosion was heard distinctly by one of the surveyors who was engaged on the survey of the public lands, forty miles distant from Mr. Rogers' house.

Note.—The piece referred to was sent to Col. Abert, Washington. It weighs two lbs. eleven ozs.

3. *Supernumerary Rainbows;* by John Brocklesby, (in a letter to the editors, dated Hartford, Ct., Aug. 20, 1847.)—On the evening of the fifth of August of the present year, I beheld just at sun-down, a beautiful rainbow attended by the usual secondary, and two supplementary arcs. The primary bow formed, of course, a complete semicircle, and its tints were remarkably vivid. Within this appeared two supernumerary arcs, the three spectra being in contact with each other, throughout the whole extent of the primary bow.

Only two of the prismatic colors were visible. The red of the primary was succeeded by the green; then came the faint red of the first supernumerary bow; a dark interval next occurred, which was followed by the still fainter red of the second supplementary arc.

This singular optical phenomenon usually presents a succession of green and violet; or green and red arcs, alternating with each other, like those seen by Brewster in 1828; but that supernumerary bows are sometimes formed of a single hue, is evident from what has just been stated, and from the case detailed by Prof. Twining, who beheld, at Montreal, in September, 1823, three supplementary bows of a violet or dull red tint, unaccompanied by arcs of green.

4. *On some Recent and Remarkable Examples of the Protection afforded by Metallic Conductors against Heavy Strokes of Lightning;* by Sir W. S. Harris, (Proc. Brit. Assoc., 1847, Athenæum, No. 1027, July 3.)—The possibility of guarding buildings and other structures against the destructive effects of lightning, has been made a great question in practical science, from the time of Franklin to the present day; and it is of considerable public importance, seeing the frequent damage which occurs to our beautiful churches and other edifices by strokes of lightning, to bring this question completely under the dominion of induction, observation and experiment. The general principles which Sir W. S. Harris submitted as deducible from the inquiries to which he alluded are these:—If we imagine a ship or building to consist altogether of metallic substances, it would certainly be secure from any damage by lightning and for this simple reason, that what we call lightning is the result of the electrical agency forcing a path through resisting matter such as the air, and extricating, with explosive and expansive force, both light and heat in its course. When, on the contrary, it falls upon comparatively non-resisting bodies, such as the metals, then this form of lightning vanishes, and the discharge assumes, if the metallic body be sufficiently capacious, the form of a comparatively quiescent current. Our object should be, therefore, in defending any building or ship from lightning, to bring the general mass so far as possible into that passive or comparatively non-resisting state it would have supposing it a mass of metal. This is, in fact, the single and simple condition of such an application, without any reference whatever to assumed forces of attraction or peculiar specific powers manifested by certain bodies for the matter of lightning, and which really do not exist. This simple principle, by a careful mechanical arrangement calculated to render it practical and applicable to all the duties which the general structure of a ship together with its masts has to perform, is now universally carried out in the navy, with the most perfect success; so that damage by lightning in the vessels so fitted has, for the last fifteen years, quite ceased. The masts are made completely conducting by capacious plates of copper, reaching from the highest points to the keel; and are tied into one general connexion with all the great metallic masses employed in the construction of the hull, and united by large bolts of copper passing through the keel and sides, with the copper expanded over the bottom and with the sea. It is quite impossible that a discharge of lightning can fall on the vessel in any place, and not be at once transmitted safely by the conductors

without, not under the form of lightning, but under the form of a current explosion. Sir W. S. Harris then referred to some remarkable cases.

5. *On the Colored Glass employed in Glazing the new Palm House in the Royal Botanic Garden at Kew;* by R. Hunt, (Proc. Brit. Assoc., 1847, Athen., No. 1028.)—It has been found that plants growing in stove houses often suffer from the scorching influence of the solar rays, and great expense is frequently incurred in fixing blinds to cut off this destructive calorific influence. From the enormous size of the new Palm House at Kew, it would be almost impracticable to adopt any system of shades which should be effective—this building being 363 feet in length, 100 feet wide and 63 feet high. It was therefore thought desirable to ascertain if it would be possible to cut off these scorching rays by the use of a tinted glass, which should not be objectionable in its appearance, and the question was at the recommendation Sir Wm. Hooker and Dr. Lindley, submitted by the Commissioners of Woods, &c. to Mr. Hunt. The object was, to select a glass which should not permit those heat rays which are the most active in scorching the leaves of plants to permeate it. By a series of experiments made with the colored juices of the palms themselves, it was ascertained that the rays which destroyed their color, belonged to a class situated at the end of the prismatic spectrum which exhibited the utmost calorific power, and just beyond the limits of the visible red ray. A great number of specimens of glass variously manufactured were submitted to examination, and it was at length ascertained that glass tinted green appeared likely to effect the object desired most readily. Some of the green glasses which were examined obstructed nearly all the heat rays—but this was not desired—and from their dark color these were objectionable, as stopping the passage of a considerable quantity of light, which was essential to the healthful growth of the plants. Many specimens were manufactured purposely for the experiments by Messrs. Chance of Birmingham, according to given directions, and it is mainly due to the interest taken by these gentlemen that the desideratum has been arrived at. Every sample of glass was submitted to three distinct sets of experiments—1st. To ascertain, by measuring off the colored rays of the spectrum, its transparency to luminous influence. 2nd. To ascertain the amount of obstruction offered to the passage of the chemical rays. 3rd. To measure the amount of heat radiation which permeated each specimen. The chemical changes were tried upon chlorid of silver, and on papers stained with the green coloring matter of the leaves of the palms themselves. The calorific influence was ascertained by a method employed by Sir John Herschel, in his experiments on solar radiation. Tissue paper stretched on a frame was smoked on one side by holding it over a smoky flame, and then while the spectrum was thrown upon it, the other surface was washed with strong sulphuric ether. By the evaporation of the ether, the points of calorific action were most easily obtained, as these dried off in well defined circles long before the other parts presented any appearance of dryness. By these means it was not difficult, with care, to ascertain exactly the conditions of the glass, as to its transparency to light, heat, and chemical agency, (actinism.) The glass thus chosen is of a very pale yellow-green color, the color being given by oxyd of copper, and is so transparent that

scarcely any light is intercepted. In examining the spectral rays through it, it is found that the yellow is slightly diminished in intensity, and that the extent of the red ray is affected in a small degree, the lower edge of the ordinary red ray being cut off by it. It does not appear to act in any way upon the chemical principle, as spectral impressions obtained upon chlorid of silver are the same in extent and character as those procured by the action of the rays which have passed ordinary white glass. This glass has, however, a very remarkable action upon the non-luminous heat-rays, the least refrangible calorific rays. It prevents the permeation of all that class of heat-rays which exists below and in the point fixed by Sir William Herschel, Sir H. Englefield, and Sir J. Herschel, as the point of maximum calorific action. As it is to this class of rays that the scorching influence is due, there is every reason to conclude that the use of this glass will be effective in protecting the plants, and, at the same time, as it is unobjectionable in point of color, and transparent to that principle which is necessary for the development of those parts of the plant which depend upon external chemical excitation, it is only partially so to the heat-rays, and it is opaque to those only which are the most injurious. The absence of the oxyd of manganese, commonly employed in all sheet glass, is insisted on, it having been found that glass, into the composition of which manganese enters, will, after exposure for some time to intense sunlight, assume a pinky hue, and any tint of this character would completely destroy the peculiar properties for which this glass is chosen. Melloni, in his investigations on radiant heat, discovered that a peculiar green glass, manufactured in Italy, obstructed nearly all the calorific rays; we may, therefore, conclude that the glass chosen is of a similar character to that employed by the Italian philosopher. The tint of color is not very different from that of the old crown glass; and many practical men state that they find their plants flourish much better under this kind of glass than under the white sheet glass, which is now so commonly employed.

6. *On the Application of Gutta Percha for Modeling;* by Mr. Busk, (Proc. Brit. Assoc., Athen., No. 1027.)—After alluding to his experiments, he described the mode he followed in obtaining his moulds:—"It is to be rolled out on a smooth surface in sheets of any convenient size suitable to the object to be taken, and varying in thickness according to the size. For small objects, from the $\frac{1}{12}$ to $\frac{1}{16}$ of an inch is thick enough. The sheet is dipped for a moment or two into *boiling* water, and placed warm upon the object, upon the surface of which it is to be carefully pressed with the finger point, or a convenient elastic pad, so as to insure its close and uniform adaptation. In moulding soft objects it is, of course, necessary that they should possess elasticity or resiliency, as is the case with living or recently dead animal bodies. The gutta percha does not seem to be applicable to taking moulds from very fragile bodies,—such as many fossils, which would not bear the requisite pressure nor admit of the removal of the mould when rigid without risk. The most delicate objects, however, and slender projections, if firm enough in the original, may in the plaster cast be removed from the matrix without any difficulty when the latter is softened by momentary immersion in hot water.

Mr. Jerdan stated that there were two kinds of gutta percha—one white, the other black. The former was the best for modelling. He had written to Mr. Brooke, of Borneo, on the subject, who informed him that an unlimited supply might be obtained from that country.—Mr. Crawfurd said it was not hard till after it was submitted to the heat of boiling water. The proper way of pronouncing the word was gutta pertsha, which was a Malay term, and signified ragged gum.

7. *Report on Atmospheric Waves;* by W. R. Birt, (Proc. Brit. Assoc. for 1847, Athen., No. 1028.)—The author in introducing his fourth Report on this subject observed, that in accordance with the resolution adopted at the last Meeting of the Association, about thirty sets of observations had been obtained from various stations in the British islands; the extremes of the area embraced being the Orkneys and Jersey in one direction, and Galway and Dover in the other. As instances of the increasing interest manifested on this subject, he remarked that he had been furnished with curves from stations in the north, where the barometric movements had been considered to result from the transit of the great November wave. Each of these curves was referred to the same period; namely, from the 2nd to the 17th of November; and the observers invariably regarded the regular rise and fall that occurred between these epochs as indicating a well-marked return of the great symmetrical wave. Mr. Birt, after noticing the remarkable circumstances under which the wave returned last autumn—so remarkable that they had no small tendency to mask the waves in the southeastern part of the island—stated that the projected curve at London strikingly developed its essential features; the *five* subordinate waves were well seen, although the inflexions were not strong, owing to the small altitude of the wave on its last return, scarcely exceeding half an inch—its whole development occurring above thirty inches prevented the boldness of the inflexions particularly noticed on the occasion of its return in 1842. The author then proceeded to notice the essential features of the curves as obtained from observations at Ramsgate, St. Vigean's, near Arbroath, east coast of Scotland, the Orkneys and Western Isles, Applegarth Manse, Dumfries-shire, Largs, Limerick, Galway, Helstone in Cornwall, and St. Helier's Jersey.

Our limits will not permit us to give in detail the resemblances and differences of these curves, exhibiting, as they do, the distribution of pressure around Great Britain and Ireland, which the author traced from the southeastern point towards the northwest: but the report will be printed in the forthcoming volume of the transactions. We may, however, here notice that attention was called to the principle which the author laid down in his report of last year, "that the barometric curve, including a complete rise and fall at any one station, does not represent any reality in nature, but is the effect of two or more systems of waves or currents moving in different directions and crossing each other at various angles." He also pointed out the great extent of oscillation (nearly double) observed in the northwest as compared with the southeasterly observations. The great wave commenced on the 2nd of November; at the northern stations it culminated on the 12th; at the southeastern on the 9th; and it terminated on the 17th. In explaining the differences of epoch as indicating the transit of the crest being much earlier in the southeast than in the north, Mr. Birt remarked that the observations clearly showed that the barometer passed *two* maxima, one on the 9th, the other on the 12th; and that the whole extent of the British isles might be divided into *two* barometric areas, distinguished in one case by the superiority of the maximum of the 9th, and in the other by the superiority of the maximum of the 12th. A line passing between Arbroath and Newcastle, south of Dumfries, and between Ireland and Wales, separates these areas. Northwest of this line we find the maximum of the 12th superior; southeast of it we find the maximum of the 9th superior. The maximum of the 9th Mr. Birt regarded as the central wave forming the crest of the great wave, and the maximum of the 12th he considered as the crest of the first subordinate wave on the posterior slope.

The author next proceeded to examine the distribution of pressure as manifested by these observations; from which, in connexion with the features of the projected curve, he deduced the following results:—1st. The return of the great symmetrical wave. This occurred in the southeastern angle of our island under very peculiar and remarkable circumstances. The area of greatest symmetry is closely in accordance with the results of former discussions, and goes far to confirm the result deduced from the examination of Sir John Herschel's hourly observations, "that Brussels is entitled to be considered as a point of comparatively gentle barometric disturbance, * * * * and may be regarded as in a certain sense a *nodal* point, where irregularities are smoothed down and oscillatory movement in general is more or less checked, and such movements increase as we recede from Brussels as a centre, especially *towards the northwest*." The curve of greatest symmetry was obtained from Ramsgate, the nearest station to Brussels. As we proceed *towards the northwest*, the symmetry is considerably departed from, especially by the greater development of the first subordinate wave on the posterior slope, by which the maximum of the 12th became superior. This portion of the wave formed a striking contrast to the similar portion in 1845, which was characterized by a considerable depression.

It is not a little curious, remarked the author, and goes far to show that we are approaching the true explanation of the *nodal* character of Brussels, to observe that movements so dissimilar in their character, so opposite in their value, and presenting themselves under such a diversity of aspects, should, in a certain locality and on particular lines of country, manifest, by means of the barometer, constant and well defined phenomena, that may be recognized year after year, and which give to the curves of barometric rise and fall during the period of their occurrence a peculiar symmetrical appearance. 2nd. Two systems of waves or currents, one having a *general* direction of progress from the northwest, the other from the southwest, traversed the area during the period of the great wave. This is the same result to which we were conducted by an investigation of the symmetrical wave of 1842. The relative positions of the individual waves were somewhat different from those of the wide bi-dual waves of 1842; but there were some striking points of resemblance. The northwesterly system in each case exhibited the largest wave, both as regards amplitude and altitude. The intervals between similar phases of northwesterly waves were nearly equal in 1842 and 1846. During the interval that elapsed between transits of these similar phases in 1842 and 1846, the same number of southwesterly waves passed overthe area—and from the whole it appears highly probable that we have not only ascertained another return of the great symmetrical wave, (the sixth,) but have also detected the return of at least *three* of the individual waves contributing to its production. 3rd. The very precipitous fall of the barometer characterizing the posterior slopes of the northwesterly systems, as developed by the discussion of the observations of 1842, is fully confirmed: in connexion with this, the decrease of oscillation from the northwest towards the southeast is also strikingly developed, as on former occasions.

The author, in alluding to the area over which these observations extend, remarked that the British Isles present a far too limited area for the purposes of examining thoroughly these atmospheric movements; he observed that in the more extensive examination which the movements of November, 1842, are now undergoing, there are four stations at which the barometric changes are of an opposite character during the first eight days of November,—namely, Christiania and St. Petersburgh in the north, and Paris and Geneva in the south. The curves at St. Petersburgh and Geneva present the most decided opposition; rising at the one while falling at the other. The turning point in each case occurred on the 5th. These opposite movements he conceived to be occasioned by the opposite slopes of two waves passing from the *southwest*, and that the *half* breadth of each wave extended at least from Geneva to St. Petersburgh. Such being the extensive character of the waves in question, in order to judge them in their totality it will be absolutely necessary to enlarge the area of observation. The centre of Europe is well dotted over with barometers, from which accurate results may be obtained; but even the British Isles, in connexion with that portion of Europe now under observation, form but a small part of the vast space over which the waves themselves extend. St. Petersburgh is an important northern station, from which we have most excellent observations; but we require them also from Iceland, the northern parts of Norway, Sweden and Lapland, and also from Archangel in one direction, and from the southern parts of France, from Spain, Portugal and the northern parts of Africa in the other; also from the Mediterranean they would be highly important. Observations stretching from the most western point of Africa to the extreme north of Europe would go far to determine the longitudinal directions of the northwesterly systems of waves. In reporting the general progress of the inquiry, Mr. Birt stated that we are now in possession of the materials for examining the great symmetrical wave, not only in particular years, as 1842, 1845, and 1846, but also over the central parts of Europe and the dominion of the Russian empire, as far as Sitka, on the northwest coast of America. He has combined observations extending from the west coasts of Ireland and the Orkneys on the one hand, to St. Petersburgh and Geneva on the other; and he apprehends that the whole of the barometric movements over this area, which occurred during the first eight days of November, 1842, are fully explained by the transits of two large waves on two sets of parallel beds of oppositely directed winds—one from the southwest, the other from the northwest. The continuation of the investigation will be submitted at future meetings of the Association.

In connexion with this, the author observed that a most important point appeared to be developing itself by means of these observations. Those from the northwest appeared strongly to indicate that somewhere in that direction the origin of the great barometric disturbances (a centre of oscillation) giving rise to the waves that pass onwards towards the southeast is to be sought. We have already obtained the *nodal* point of the two great systems of European barometric undulations—namely, Brussels. Between the Orkneys, which appear to be the nearest station to the northwest centre of oscillation, and Brussels the greatest decrease of oscillation occurs. This line of the greatest diminution of oscillation appears to be well determined.

The author closed his report with an allusion to the American system of atmospheric waves, especially those that accompanied the great Cuba hurricane of October, 1844, which has formed the subject of an elaborate investigation by Mr. W. C. Redfield, of New York; and was of opinion that the revolving storm, so ably brought to light by Mr. Redfield's labors, was produced by the crossing of two large long waves moving in different directions, as suggested by Sir John Herschel in his "Report on Meteorological Reductions," presented to the Association in 1843.

8. *On the height of Auroral Arches;* by Prof. T. CHEVALLIER, (Proc. Brit. Assoc., 1847, Athen., No. 1029.)—Of all the phenomena of the Aurora Borealis, the arches which are occasionally seen nearly at right angles to the magnetic meridian are the most definite and permanent; and seem to offer the most promising means of ascertaining the height of the region in which that modification of the aurora is formed. In the 118th No. of the "Philosophical Transactions," Dr. Dalton has collected several facts on the subject; and arrives at the conclusion that these arches are about 100 miles high. Having computed the height of three such arches, I am desirous of laying the results briefly before the Association. The first was the aurora of March 22, 1841, observed at Dunse, near Berwick, by Mr. Wm. Stevenson; at Durham, by myself; at Belfast, by Prof. Stevelly; and at York, by Mr. Phillips. The observations over more than an hour, from 8^h 56^m Greenwich mean time, to 10^h; and the position of the arch was definitely fixed by its place among the fixed stars. The direction of the arch was magnetically east and west. Its height was computed separately from the observations at York and Durham, York and Belfast, and Belfast and Durham; the resulting altitudes being 156, 157, and 165 miles. The second auroral arch was observed on Sept. 21, 1847, at Esk, near Durham, by myself, and at Norwich by Mr. W. Marshall. It was visible only for about five minutes. The resulting height is 106 miles. This determination depends upon two observations only. The third auroral arch was seen on the 19th of March, 1847. It was observed at Darlington, at Spalding in Lincolnshire, at Cambridge, at Norwich, in London, Oxford and Amsterdam. The observations of Darlington and Cambridge, from a base of 172 miles, give an altitude of 175·9 miles; those of Spalding and Cambridge, from a base of 114 miles, give an altitude of

174·4 miles; and those of Spalding and Darlington, from a base of 58 miles, give an altitude of 174·9 miles;—the mean being 175 miles. The extensive area over which this arch was observed is remarkable. A great magnetic disturbance took place at the same time, extending as far as Toronto. In connexion with the cause of these phenomena, it cannot escape notice that there is great similarity between the two kinds of auroral action and the two modes of magnetic action recently discovered by Prof. Faraday; the ordinary auroral beams being parallel to the direction of the magnetical meridian, and the arches being at right angles to that direction.

9. *On the Resources of Irish Sea Fisheries;* by Mr. R. VALPY, (Proc. Brit. Assoc., 1847, Athen. No. 1027.)—Having dwelt at some length on the great abundance of fish in the Irish seas and the want of food by the Irish people, he stated that so far back as the ninth and tenth centuries the Danes had fisheries on the western coast of Ireland, from whence they sent large exports to the south of Europe. In Queen Mary's reign, Phillip II. paid 1,000*l.* annually to purchase for the Spaniards a right of fishing on the Irish coast. The Dutch purchased a similar right from Charles II. for 30,000*l.*; and in 1650, Sweden was permitted, as a favor, to employ 100 vessels in the Irish fishing. From 1800 to 1830 the immense sum of 276,784*l.* was paid in bounties for the encouragement of Irish fisheries; but the system was found to encourage fraud rather than stimulate industry, and it was abolished. In 1821, the number of boats employed in the Irish fisheries were :—

	First class.	Second class.		Men.
	2,766	4,889	worked by	36,159
In 1829 (the year before the abolition of the bounty) the numbers were	3,599	9,552	"	64,771
In 1836, " "	2,897	7,864	"	54,119
In 1843, " "	2,371	17,512	"	93,073*

Thus the abolition of the bounty, though it threw back the fisheries for a time, did not eventually injure their progress; the increase between the years 1836 and 1843 amounting to 37 per cent. All the inspectors of fisheries agree that within the last few years the character of the persons employed in the fisheries has been greatly improved. The author related minutely the history of several abortive efforts to establish joint-stock companies for conducting the fisheries of Ireland; one of which, that of Dunmow, near Waterford, seemed an one time to have very fair prospects of success. Having dwelt at some length on the white fishery, cod, ling, &c.—but with rather vague data for an estimate of its results—the notorious frauds committed under the bounty system rendering the returns then made to Government utterly unworthy of confidence—Mr. Valpy directed attention to the herring fishery. The Irish herrings are better in quality and bring higher prices than those of Scotland, but they are for the most part fished on the coast, the fishermen being prevented from going in search of the

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* The numbers for 1846 are, boats of the first class 2,424, second class 11,793, men 98,538.

shoals by want of suitable boats and tackle. The coast fishery is very uncertain because the herring shoals do not always take the same course, and the fish caught in the deep sea are more abundant and better in quality than those taken near the shore. The Swedes and Dutch pursue the deep-sea fishery with great advantage. The salmon-fisheries of Ireland were then examined. The chief statistics on the subject were obtained from the extensive and well known firm of Messrs. Keays & Co.; but, as the trade is subject to the most capricious fluctuations, we do not think that any safe deductions could be made from the returns of a single house. There is no doubt that the import of Irish salmon into England has increased and is increasing. Irish turbot, soles, and lobsters might profitably be brought to the same market. A desultory discussion took place, in which several explanations of the neglect of the Irish fisheries were suggested. Ignorance, obstinate prejudices, strange superstitions, want of government encouragement, want of capital, acts of violence by which capitalists are deterred from investing their money, the perilous condition of the Irish coasts, particularly in the west, uncertainty of supply, and distance of market.

10. *Smithsonian Institution*, (from the Literary World, Sept. 18, 1847.)—We are glad to have it in our power to announce the first publication of the Smithsonian Institution.

It will be remembered that Mr. Smithson directed, in his will, that his bequest should be devoted to the *increase* and *dissemination* of knowledge. It is therefore incumbent on the Regents of the Institution, endowed by the liberality of Mr. Smithson, to publish and disseminate useful knowledge, and particularly such as may be an addition to our present stock, or the result of original research. The first work to be issued is one strictly in accordance with the wishes of the testator: inasmuch as it will impart facts relating to the early people of the American continent, which are as new as they are interesting. We consider it a fortunate event, therefore, that the Regents of the Smithsonian Institution have secured the work in question, as none could be more appropriate. It will, without doubt, be well received, and hailed as a good beginning by the numerous readers into whose hands the volume may fall.

This work, containing researches into the origin and purposes of the aboriginal monuments and remains of the Mississippi Valley, will embrace the details and results of extended surveys carried on during several years by Mr. E. G. Squier and Dr. E. H. Davis, of Ohio. The labors of these gentlemen embrace the opening and examination of more than two hundred mounds, of every variety and character, from the greatest to the least. These works were not carelessly overthrown, but laid open to their centre; the relics, if any existed, were removed, and the earth again replaced. In these examinations, the number and variety of aboriginal relics which have been brought to light, must excite astonishment in all. Their collection embraces many thousand objects, exhibiting the state of the arts among the ancient people, of whose existence they are the only memorials. They consist of implements and ornaments in silver, copper, lead, stone, ivory and pottery, fashioned into a variety of forms, and exhibiting a skill which, in some instances, modern art cannot surpass. The sculptures of birds, animals and reptiles, constitute a large class of these ancient relics. They are cut from various kinds of stone, and in many instances from porphyry. Several highly finished sculptures of the human head are deserving of notice, and probably convey an idea of the physical character of the people. A single skull, the only one out of many hundreds discovered in fragments, which has been preserved entire, and which our explorers are satisfied belongs to the primitive people, is all we have, aside from these, to enable us to form an opinion of the race.

In examining the remains, we discover articles which show the extent of their intercourse with other parts of the country. Thus, there are instruments of *obsidian*, a volcanic substance found only in Mexico—native copper and lead from Lake Superior and the Upper Mississippi—marine shells and cetacean teeth from the sea, and numbers of pearls of great beauty.

But the mounds and their contents are but a small portion of interesting facts made known by these gentlemen, for we consider the vast earth-works the most remarkable. Their labors embrace surveys of more than one hundred works of this description, some of them miles in extent. Others are vast enclosures covering a space equal to that occupied by the city of New York. Again, we see fortified places, in the construction of which modern military science might perhaps derive some useful hints.

The work in question will embrace the details of these most curious and interesting explorations, and will be illustrated with several hundred wood engravings in the highest style of the art. These will exhibit representations of the relics discovered—views of the mounds and other ancient remains—sections, plans, &c. It will also contain seventy quarto lithographic plans, being the surveys of the other works alluded to, laid down on an accurate scale. What will be the extent of the letter-press we are unable to say, but it will probably exceed 500 quarto pages.

Such is a very brief account of the discoveries which this work will make known. The facts deduced from them open a new era in our aboriginal history. The question will naturally arise, at what period, and by whom, were these works erected? What has become of the people? Had they any connexion with the nations of the other hemisphere? &c. &c.

The relics and the works themselves aid but little in determining the period when they were made. When the country was settled, they were covered with large trees, exhibiting as great an age as the forest around them. But there are other facts connected with their position, which show that great physical changes have taken place since their creation. These aid us in determining their antiquity, which must be reckoned by thousands of years rather than by centuries.

Many analogies are presented to our explorers, in investigating the antiquities and primitive history of some of the earlier nations of the Old World. The serpent and egg, which has a prominent place in the mythology of Egypt and India, typifying a universal principle, has actually been found in Ohio, in a well defined serpent 1200 feet in length, formed of earth, in the act of swallowing an egg. Some striking analogies with the Druidical rites, are also discovered. The Phallic worship, too, so universal throughout the ancient world, may be traced in the remains of the Mississippi valley, as well as many coincidences, as interesting as they are remarkable. Dissertations on these will accompany the work. We cannot close our remarks without speaking of the gentlemen who are engaged in the work. Dr. Davis has, for fifteen years, been a resident of Chillicothe, during which time he has been a close observer, and has collected many valuable relics from the mounds. Mr. Squier removed to the same place a few years since, when a more thorough system of survey and examination of the earth-works was commenced. A number of laborers were employed, and when the weather permitted, these gentlemen were in the field with their spades, surveying instruments, and sketch-book. For three years they have been incessantly engaged in their work. From a personal acquaintance with Mr. Squier, we do not hesitate to say that the exploration and survey of our ancient remains could not have fallen into better hands. Combined with a perseverance in the undertaking, and enthusiasm for the subject, he is an accomplished draughtsman and surveyor; an evidence of which may be seen in the splendid and numerous surveys and drawings with which his portfolios are filled.

11. *Prospectus of the Publication of a New Series of the Journal of the Academy of Natural Sciences of Philadelphia*, (issued by the Acad.)—The publication of this Journal having been unfavorably suspended for several years, it is now proposed to resume it in a New Series, to commence about the middle of the present year.

The first part containing about eighty pages in *quarto form*, will be issued in September, and the work will be continued thereafter semiannually, so that two parts will appear each year, or four in two years, which will form a volume.

The work will be printed on fine paper, with ample lithographic and other illustrations, at $5 per volume, or $1 25 for each part.

The printed Proceedings of the Society will be distributed to subscribers to the Journal free of charge, during the period of their subscription.

12. *On the Discovery of Gun-Cotton;* by Professor SCHŒNBEIN, (Archives des Sciences Physiques et Naturelles; L., E. and D. Phil. Mag., vol. xxxi, p. 7.)—The substance to which I have given in German the name of *schiesswolle*, and in English that of gun-cotton, having excited a lively curiosity, it may be interesting to the scientific world to become acquainted with some details of the way in which I was first led to its discovery.

The results of my researches on ozone led me in the course of the last two years to turn my attention particularly to the oxyds of nitrogen, and principally to nitric acid. The numerous experiments I have made on this subject have led me, as I have stated in detail in Poggendorff's *Annalen*, to adopt a peculiar hypothesis on the so-called hydrates of nitric acid, sulphuric acid, &c., as well as on the normal nitrates, sulphates, &c.

For a long time I had entertained doubts as to the existence of compound bodies of this nature, which cannot be isolated, and which are stated to be capable of existing only in combination with certain other substances; for a long time also I had come to the notion that the introduction of these imaginary combinations had only been an apparent progress in theoretical chemistry, and that it had even impeded its development.

It is well known that what has most contributed to the admission of the existence of these compounds, has been the opinion generally received among chemists respecting the nature of nitric acid. Starting from the existence of the compound of nitrogen NO_5, as an undoubted and demonstrated fact, notwithstanding the impossibility of isolating it, they always cite nitric acid to prove the existence of compounds which cannot exist in an isolated state. In my opinion, there is no degree of oxydation which is represented by NO_5, and what these chemists designate by the formula NO_5+HO must be considered as being really NO_4+HO_2; I am even inclined to regard the normal nitrates NO_5+RO, as compounds which must be expressed by NO_4+RO_2. Amongst other motives which induce me to admit this opinion, I will mention the fact that we can obtain hydrated nitric acid or a normal nitrate by the direct mixture of NO_4 with HO_2 or RO_2. Other considerations, which I have had occasion to detail elsewhere, induce me also to consider hydrated sulphuric acid to have the form SO_2+HO_2, and not that of SO_3+HO, and a normal sulphate that of SO_2+RO_2. It is sufficient here to observe that SO_2 placed in presence of HO_2 gives rise to what is called hydrated sulphuric acid, and that SO_2 placed in presence of BaO_2 or PbO_2 gives rise to what is called sulphate of the oxyd of barium or of lead. Rose's compound, to which the formula $2SO_3+NO_2$ has been assigned, should have, in my opinion, $2SO_2+NO_4$. Admitting this, I considered it probable that the mixture of $2(SO_2+HO_2)$ $(=2(SO_3+HO))$ with NO_4+HO_2 $(=NO_5+HO)$ yields $2SO_2+NO_4$, and that at the same time $3HO_2$ is disengaged, or enters into a loose combination with what is called the bisulphate of deutoxyd of nitrogen. In other words, I conjectured that a mixture formed with the hydrates of nitric acid and sulphuric acid would possess a very great power of oxydation, and would form a kind of *aqua regia*, in which the combination HO_2 would act the part of the chlorine. On this hypothesis, and abstracting HO_2 from the acid mixture by means of a proper oxydable body, there ought to remain Rose's compound.

Guided by these suppositions, which, I admit, may be as little founded as they are contrary to the ideas received among chemists, I commenced in December, 1845, a series of experiments with a view to put my hypothesis to the proof: it will be seen in the sequel whether the results at which I arrived tend to confirm it.

I mixed some flowers of sulphur and a certain quantity of the acid mixture of which I have spoken: immediately, even at a temperature of 32° F., a lively disengagement of sulphurous acid gas took place without the production of deutoxyd of nitrogen. After the reaction, which was accompanied by a development of heat, there remained a colorless liquid, which, mixed with water, disengaged a considerable quantity of deutoxyd of nitrogen, and acted generally as a solution of Rose's compound in hydrated sulphuric acid would have done.

I should add here, that a mixture of four ounces of hydrated sulphuric acid with a single drop of nitric acid, on the addition of flowers of sulphur, disengages a sensible quantity of sulphurous acid. To assure himself of the presence of the latter, the operator has only to hold over the liquid a strip of paper which has been covered with iodid of potassium paste, and tinged slightly blue by exposure to chlorine. The liberated sulphurous acid will soon dissipate this blue color.

Selenium and phosphorus are oxydized in the same manner at low temperatures in the acid mixture in question; and this latter is modified to such an extent, that, on the addition of water, an abundant disengagement of deutoxyd of nitrogen gas takes place.

Iodine even, in the state of powder and shaken up with the acid mixture, rapidly absorbs oxygen, when exposed to a low temperature; and there is formed, besides iodic acid, the compounds to which Millon has lately drawn attention. After the reaction, a liquid remains, which, diluted with water, gives an abundant disengagement of deutoxyd of nitrogen and liberates iodine.

My experiments on ozone having shown that this body, which I consider to be a distinct peroxyd of hydrogen, forms, as well as chlorine, at the ordinary temperature, a peculiar compound with olefiant gas, without apparently oxydizing in the least either the hydrogen or the carbon of this gas, I had the idea that it would not be impossible that certain organic matters, exposed to a low temperature, would likewise form compounds, either with the peroxyd of hydrogen alone, which, on my hypothesis, occurs in a state of combination or of mixture in the acid mixture, or with NO_4. It was this conjecture, doubtless very singular in the eyes of chemists, which principally led me to commence experiments with common sugar.

I made a mixture of one part (volume) of nitric acid, of 1·5 spec. grav., and two parts of sulphuric acid of 1·85, at the temperature of 36° F.; I then added some finely powdered sugar, so as to form a very fluid paste. I stirred the whole, and, at the end of a few minutes, the saccharine substance formed itself into a viscous mass entirely separated from the acid liquid, without any disengagement of gas. This pasty mass was washed with boiling water, until this last no longer exercised any acid reaction; after which I deprived it, as much as possible, at a low temperature, of the water it still contained. The substance now possessed the following properties:—Exposed to a low temperature, it is compact and brittle; at a moderate temperature, it may be moulded like jalap resin, which gives it a beautiful silky lustre. It is semi-fluid at the temperature of boiling water; at a higher temperature, it gives off red vapors; heated still more, it suddenly deflagrates with violence, without leaving any perceptible residue. It is almost insipid and colorless, transparent like the resins, almost insoluble in water, but easily soluble in the essential oils, in ether and concentrated nitric acid, and in most cases it acts in general like the resins in a chemical and physical point of view: thus friction renders it very electro-negative. I will add, that the acid mixture, by means of which this resinous body was obtained, has an extremely marked bitter taste.

I wished to make experiments also with other organic substances; and I soon discovered, one after another, all those about which there has been so much said of late, especially in the Academy of Paris. All this passed in December, 1845, and the first few months in 1846.

In March, I sent specimens of my new compounds to some of my friends, in particular to Messrs. Faraday, Herschel and Grove. It is necessary to note expressly that the gun-cotton formed part of these products; but I must add, that hardly was it discovered when I employed it in experiments of shooting, the success of which encouraged me to continue them. Accepting the obliging invitation which I received, I went in the middle of April to Wurtemburg, and made experiments with gun-cotton both in the arsenal of Ludwigsburg, in the presence of artillery officers, and in Stuttgard, before the king himself. In the course of May, June and July, with the kind coöperation of the Commandant de Mechel, of M. Burkhardt, captain of artillery, and other officers, I subsequently made in this city (Bâle) numerous experiments with arms of small calibre, such as pistols, carbines, &c., and afterwards with mortars and cannon,—experiments at which Baron de Krüdener, the Russian ambassador, was several times present. I may be allowed to mention, that I was the person who fired the first cannon loaded with gun-cotton and shot, on the 28th of July, if I remember aright, after we had previously ascertained, by experiments with mortars, that the substance in question was capable of being used with pieces of large calibre.

About the same time, and indeed previously, I employed gun-cotton to blast some rocks at Istein in the Grand Duchy of Baden, and to blow up some old walls at Bâle; and in both cases I had opportunities of convincing myself in the most satisfactory manner, of the superiority of this new explosive substance over common gunpowder.*

Experiments of this kind, which took place frequently and in the presence of a great number of persons, could not long remain unknown; and the public journals soon gave, without participation on my part, descriptions, more or less accurate, of the results which I had obtained. This circumstance, joined to the short notice which I inserted in the May number of Poggendorff's *Annalen*, could not fail to attract the attention of German chemists: in the middle of August I received from M. Bœttger, Professor at Frankfort, the news that he had succeeded in preparing gun-cotton and other substances. Our two names thus became associated in the discovery of the substance in question. To M. Bœttger the gun-cotton must have been particularly interesting, as he had previously discovered an organic acid which deflagrates readily.

In the month of August I went to England, where, assisted by the able engineer, Mr. Richard Taylor of Falmouth, I made numerous experiments in the mines of Cornwall, which were entirely successful, in the opinion of all competent witnesses. Experiments on the action of gun-cotton were also made in several parts of England, under my direction, both with small firearms and with pieces of artillery, and the results obtained were very satisfactory.

Until that time there had been little or nothing said of gun-cotton in France; and it will appear that the short notices which Mr. Grove gave at Southampton at the meeting of the British Association, and the experiments with which he accompanied them, served first to attract the

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* In the month of June I made also the first percussion caps, and employed them with success for muskets, in the presence of the above-named officers.

attention of French chemists to this substance. At Paris, the thing was at first considered hardly credible, and jokes even were passed upon it; but when there could no longer remain any doubt as to the reality of the discovery, and when several chemists in Germany and other countries had published the processes which they employed to prepare the gun-cotton, then a lively interest was manifested in a subject which had just before excited derision, and it was soon pretended that the new explosive substance was an old French discovery. It was declared to be nothing more than the xyloïdine first discovered by M. Braconnot, and afterwards investigated anew by M. Pelouze, and the only merit left me was to have conceived the happy idea of putting this substance into a gun-barrel. The knowledge of the composition of xyloïdine ought to have sufficed to convince those who put forward that opinion, that it is not suited for firearms, on account of its containing too much carbon and too little oxygen for the chief part to be converted into gaseous matters during the combustion. It was moreover very easy to discover the essential differences which exist between the xyloïdine of Braconnot and gun-cotton. Nevertheless the error was kept up for some months.

Matters stood thus, when, on the 4th of last November, a Scotch chemist, Mr. Walter Crum of Glasgow, published a memoir, in which he showed that gun-cotton is not the same product as xyloïdine, but that it presents an essentially different composition; and towards the end of the same month, the French Academy received a communication of the same nature. The gun-cotton was then no longer xyloïdine; it was called pyroxyloïdine, and the first was admitted to be unsuitable for firearms.

If, therefore, it is proved that from the commencement of 1846 I prepared gun-cotton, and applied it to the discharge of fire-arms and that M. Bœttger did the same in the month of August,—if it be admitted that xyloïdine cannot serve the same purposes as this cotton, and if it be notoriously known that what is now called pyroxyloïdine was not brought before the French Academy and the scientific world until towards the middle of last November, the idea of attributing to France the discovery of gun-cotton cannot be seriously entertained, or of assigning to me merely a practical application of that which another would have discovered.

I appeal to the justice of Frenchmen, to decide the point to whom belongs the honor of not only being the first to apply the new substance in question, but also of having first prepared it—to MM. Braconnot and Pelouze, or myself. I must, moreover, add expressly, that it was not xyloïdine even which led to my discovery, however intimate may be its relation with gun-cotton; it was theoretical ideas, possibly very erroneous ones, but which are peculiarly my own, as well as some facts which I was also the first to discover. *Suum cuique* is a principle of morality on which society at large rests; why should it not be strictly respected in the republic of science? M. Pelouze is a distinguished chemist, and already possesses a sufficiently high reputation not to require to elevate his pretensions on the merits of others; and I am fully persuaded that this estimable chemist, of well known truth of character, will, appreciating with impartiality the circumstances which have occurred, freely render me the justice to which I consider myself entitled.

Bâle, Dec. 28, 1846.

13. *Microscopic Examination of Gun-Cotton;* by Dr. BACON, (Proc. Boston Soc. Nat. Hist., Feb., 1847, p. 195.)—Specimens of the cotton, before and after preparation, were put up in Canada balsam on slips of glass, and covered by very thin glass. When viewed by transmitted light, with powers from 150 to 800, many of the fibres of the gun-cotton appear thickened, but no other change can be perceived on comparison with the unprepared article. There is no appreciable difference in the transparency of the two.

They were now examined in polarized light by means of the polarizing attachment to the microscope. When the polarizing and analyzing prisms are so arranged as to afford a dark field, the riband-like fibres of the cotton before preparation are seen as luminous objects upon a black ground, and are tinged with bright and varied colors. They are thus proved to possess a strong polarizing power. The gun-cotton, under the same circumstances, presents an entirely different appearance. Its fibres are much less luminous, and have a nearly uniform dull blue color. It is evident that the process of preparation has so altered the structure of the fibres as to lessen very greatly their action on polarized light.

Gun-cotton prepared by Dr. Jackson by immersion for twelve and for eighteen hours in the strongest acids, has not lost its polarizing power in any appreciably greater degree than after an immersion of three minutes only. This agrees with the results of other modes of trial in indicating that the latter period is sufficient for the complete preparation of the cotton, when the acids are of full strength. In all the specimens there are some filaments so nearly destitute of polarizing power as to be scarcely visible on the black ground, but none have been found entirely without action. When the polarizing and analyzing prisms are in such a position as to give a bright field, a portion of the fibres becomes tinged with a color approaching to orange, while the remainder appear colorless as in ordinary light.

14. *On the Production of Vanilla in Europe*, (Gardner's Travels in the interior of Brazil, p. 296; Jameson's Jour., xlii, 382.)—In marshy bushy places on this journey, I saw many plants of the *Vanilla planifolia*, seldom bearing flowers, and more rarely producing fruit. It has now been satisfactorily determined, that this is the species from which the true vanilla of commerce is procured. In Mexico it is extensively cultivated for the sake of its fruit, which it yields abundantly: while the plants which have been introduced into the East Indies, and the hothouses of Europe, though they have frequently produced flowers, have very seldom perfected their fruit. Dr. Morren of Liége was the first to study attentively the natural history of this plant, and to prove experimentally that the fruit of the vanilla may be as freely produced in our hothouses as it is in Mexico. He has discovered that from some peculiarities in the reproductive organs of this plant, artificial fecundation is required. In the year 1836, a plant in one of the hothouses in the botanic garden at Liége produced fifty-four flowers, which having been artificially fecundated, exhibited the same number of pods, quite equal to those imported from Mexico; and, in 1837, a fresh crop of about a hundred pods was obtained upon another plant by the same method. He attributes the fecundation of the plant in

Mexico to the action of some insect which frequents the flower; and hence accounts for the non-production of fruit in those plants which have been removed to other countries, There can be no doubt that this plant is as perfectly indigenous to Brazil as it is to Mexico: but it is no less certain that its fruit is there seldom matured. Is this also to be attributed to the absence of the means by which nature is supposed to effect fecundation in Mexico? This is a subject which, as Professor Morren justly observes, well deserves attention in a commercial point of view, since his experiments go to prove that in all intertropical countries vanilla might be cultivated, and a great abundance of fruit obtained.

15. *Phosphorescent Fungus*, (Gardner's Travels in the interior of Brazil, p. 346; Jameson's Jour., xlii, p. 382.)—One dark night, about the beginning of December, while passing along the streets of the Villa de Natividade, I observed some boys amusing themselves with some luminous object, which I at first supposed to be a kind of large fire-fly; but on making enquiry, I found it to be a beautiful phosphorescent fungus, belonging to the genus *Agaricus*, and was told that it grew abundantly in the neighborhood, on the decayed leaves of a dwarf palm. Next day I obtained a great many specimens, and found them to vary from 1 to 2½ inches across. The whole plant gives out at night a bright phosphorescent light, of a pale greenish hue, similar to that emitted by the larger fire-flies, or by those curious soft-bodied marine animals, the *Pyrosoma*. From this circumstance, and from growing on a palm, it is called by the inhabitants "Flor de Coco." The light given out by a few of these fungi, in a dark room, was sufficient to read by. It proved to be quite a new species; and since my return from Brazil, has been described by the Rev. Mr. Berkeley, under the name of *Agaricus Gardneri*, from preserved specimens which I have brought home. I had already named it *A. phosphorescens*, not being aware at the time I discovered it that any other species of the same genus exhibited a similar phenomenon: such, however, is the case in the *Agaricus olearius* of De Candolle; and Mr. Drummond, of the Swan River Colony, in Australia, has given an account of a very large phosphorescent species, occasionally found there.

16. *Effects of Datura sanguinea, R. Pav*, (Travels in Peru, by Dr. J. J. Von Tschudi, p. 269; Jameson's Jour., xlii, 384.)—To this plant the natives give the names *Huacacachu*, *Yerba de Huaca*, or *Bobachero*; and they prepare from its fruit a very powerful narcotic drink, called *tonga*. The Indians believe that by drinking the tonga they are brought into communication with the spirits of their forefathers. I once had an opportunity of observing an Indian under the influence of this drink. Shortly after having swallowed the beverage he fell into a heavy stupor; he sat with his eyes vacantly fixed on the ground, his mouth convulsively closed, and his nostrils dilated. In the course of about a quarter of an hour his eyes began to roll, foam issued from his half-opened lips, and his whole body was agitated by frightful convulsions. These violent symptoms having subsided, a profound sleep of several hours succeeded. In the evening I again saw this Indian. He was relating to a circle of attentive listeners the particulars of his vision, during which he alleged he had held communication with the spirits of his forefathers. He appeared very weak and exhausted.

In former times the Indian sorcerers, when they pretended to transport themselves into the presence of their deities, drank the juice of the thorn-apple, in order to work themselves into a state of ecstacy. Though the establishment of Christianity has weaned the Indians from their idolatry, yet it has not banished their old superstitions. They still believe that they can hold communication with the spirits of their ancestors, and that they can obtain from them a clue to the treasures concealed in the *huacas*, or graves; hence the Indian name of the thorn-apple—*Huacacachu*, or grave-plant.

17. *The Condor of the Cordillera*, (Travels in Peru, by J. J. Von Tschudi, p. 300; Jameson's Jour., xlii, 387.)—In these sterile heights nature withholds her fostering influence alike from vegetable and animal life. The scantiest vegetation can scarcely draw nutriment from the ungenial soil, and animals shun the dreary and shelterless wilds. The condor alone finds itself in its native element amidst these mountainous deserts. On the inaccessible summits of the Cordillera that bird builds its nest, and hatches its young in the months of April and May. Few animals have attained so universal a celebrity as the condor. That bird was known in Europe at a period when his native land was numbered among those fabulous regions which are regarded as the scenes of imaginary wonders. The most extravagant accounts of the condor were written and read, and general credence was granted to every story which travellers brought from the fairy land of gold and silver. It was only at the commencement of the present century that Humboldt overthrew the extravagant notions that previously prevailed respecting the size, strength, and habits of that extraordinary bird.

The full-grown condor measures, from the point of the beak to the end of the tail, from four feet ten inches to five feet; and from the tip of one wing to the other, from twelve to thirteen feet. This bird feeds chiefly on carrion; it is only when impelled by hunger that he seizes living animals, and even then only the small and defenseless, such as the young of sheep, vicuñas, and llamas. He cannot raise great weights with his feet, which, however, he uses to aid the power of his beak. The principal strength of the condor lies in his neck and in his feet; yet he cannot, when flying, carry a weight exceeding eight or ten pounds. All accounts of sheep and calves being carried off by condors are mere exaggerations. This bird passes great part of the day in sleep, and hovers in quest of prey chiefly in the morning and evening. Whilst soaring at a height beyond the reach of human eyes, the sharp-sighted condor discerns his prey on the level heights beneath him, and darts down upon it with the swiftness of lightning. When a bait is laid it is curious to observe the numbers of condors which assemble in a quarter of an hour, in a spot near which not one had been previously visible. These birds possess the senses of sight and smell in a singularly powerful degree.

Some old travellers, Ulloa among others, have affirmed that the plumage of the condor is invulnerable to a musket ball. This absurdity is scarcely worthy of contradiction; but it is nevertheless true that the bird has a singular tenacity of life, and that it is seldom killed by fire-arms, unless when shot in some vital part. Its plumage, particularly on the wings, is very strong and thick. The natives, therefore, seldom attempt to shoot the condor; they usually catch him by traps or by the lasso, or kill him by stones flung from slings, or by the *Bolas*. A curious method of capturing the condor alive is practiced in the province of Abancay. A fresh cow-hide, with some fragments of flesh adhering to it, is spread out on one of the level heights, and an Indian provided with ropes creeps beneath it, whilst some others station themselves in ambush near the spot ready to assist him. Presently a condor, attracted by the smell of the flesh, darts down upon the cow-hide, and then the Indian, who is concealed under it, seizes the bird by the legs, and binds them fast in the skin, as if in a bag. The captured condor flaps his wings, and makes ineffectual attempts to fly; but he is speedily secured, and carried in triumph to the nearest village.

The Indians quote numerous instances of young children having been attacked by condors. That these birds are sometimes extremely fierce is very certain. The following occurrence came within my own knowledge whilst I was in Lima. I had a condor, which, when he first came into my possession, was very young. To prevent his escape, as soon as he was able to fly, he was fastened by the leg to a chain, to which was attached a piece of iron, of about six pounds weight. He had a large court to range in, and he dragged the piece of iron about after him all day. When he was a year and a half old he flew away, with the chain and iron attached to his leg, and perched on the spire of Santo Tomas, whence he was scared away by the carrion hawks. On alighting in the street, a negro attempted to catch him for the purpose of bringing him home; upon which he seized the poor creature by the ear, and tore it completely off. He then attacked a child in the street (a negro boy of three years old), threw him on the ground, and knocked him on the head so severely with his beak, that the child died in consequence of the injuries. I hoped to have brought this bird alive to Europe; but after being at sea two months on our homeward voyage, he died on board the ship in the latitude of Monte Video.

18. *Fossil Footprints;* by JAMES DEANE, (from a letter to Prof. Silliman.)—I beg your permission to correct an error which occurred in the March number of your Journal, relative to a communication of mine in a preceding number.

It is there stated, page 276, that "you are informed by Prest. E. Hitchcock, that the quadruped tracks figured by me, p. 79 of this volume, and supposed to be new, are the *Sauroidichnites palmatus* of his Geological Report, or the *Palamopus anomalus* of his new nomenclature, &c. He lately examined the original specimen in the collection of Mr. Marsh, and immediately recognized it as belonging to the species just mentioned."

I saw this statement with surprise and immediately referred to the descriptions of Prest. H., which are as follows.

"*S. palmatus.* Toes 4, all directed forward: the three outer ones resemble very much the three front toes of most of the species already described; the middle one being somewhat, but not very much, the longest; and those on each side nearly equal. The inner or fourth toe is very short. Length of foot 2½ to 3 inches. Shown of the natural size and in relief on Pl. 34, fig. 15, &c."

"It will be seen from the drawing that the animal which made the tracks was a biped. For the short or fourth toe is found upon opposite sides of the foot in the different tracks, which would not be the case if it were made by the hind and forefoot of a quadruped; and the fact that both tracks point in, almost exactly in the same direction, is with difficulty reconciled to the idea that they were made by the hind and fore feet of a quadruped on different sides of the body, &c."

These arguments appear to be very conclusive in proof of the *biped* character of the impressions, which sustain no analogy to mine. Instead of a single, they were arranged in double rows; instead of pointing "directly forward," the divergence of the feet was remarkable; and instead of being 2½ or 3 inches in length, they were not half so large. My belief is, that there were five instead of four toes. In fact, there is no analogy, however faint.

Greenfield, July 15, 1847.

19. *The Geological Society of France* held its extraordinary session this year at Epinal (Vosges), on the 10th of September. The Society was guided in this selection by the facility of examining in this region a great variety of deposits of geological interest; to wit, the grès de Vosges, which surrounds Epinal on all sides; to the southeast, granitic rocks, gneiss, leptynite, serpentine and porphyry; and to the northwest, the plains of Lorraine, the grès bigarré, muschelkalk, lias and oolite. The basalt of the coast of Essey, the thermal sources of Plombières and the baths of Luxeuil, were also objects of interest. The region is besides interesting for its phenomena of erratic blocks, and the terraces of the valley of the Moselle.

20. *American Science in Turkey.*—We ought long since to have mentioned that our excellent chemical correspondent, Dr. J. Lawrence Smith, of Charleston, S. C., had gone to Constantinople, in the employ of the Sultan as chemist and geologist. He has been successful in discovering valuable deposits of coal and other useful minerals in the Turkish possessions, some account of which we hope to receive from Dr. S. He has also exhibited the electric telegraph in the Royal palace, and his Highness the Sultan was pleased to express himself highly delighted with its performances, and a rumor has reached this country that a decoration of diamonds and a complimentary diploma had been ordered to be sent as a mark of the royal esteem, to Prof. Morse.

There are at the present time several scientific men of different nations in the employ of the Sultan in various scientific pursuits.

21. *Prof. Agassiz.*—We are credibly informed that this distinguished naturalist has consented to accept an invitation to remain in this country in connection with the scientific corps of Harvard College. Every scientific man in America will be rejoiced to hear so unexpected a piece of good news.

22. *Large Crystal of Columbite.*—The large crystal of columbite described in vol. xxx, at p. 387 of this Journal, has been recently purchased for the Wesleyan University in Middletown, Conn.; its weight is 6 pounds 12 oz., and the mass of which it is a portion, weighed 14 pounds.

VI. Bibliography.

1. *The London Geological Journal and Record of Discoveries in British and Foreign Palæontology.*—No. 1 of this Journal appeared in September, 1846—one year ago: No. 2 was published in February and No. 3 in May, 1847; it was announced for six Nos. in a year, but has encountered some of the delays incident to new periodical works. The three numbers include 132 pages of letter-press. The editor, Mr. Ed. Charlesworth, F.G.S., &c., long known as a distinguished naturalist, avowedly avoids long memoirs and discussions, and prefers a terse originality, including criticisms upon the works of other naturalists. The work is got up in a beautiful style of paper and print, and the plates are of unrivalled finish and elegance. There are 23 plates in these three Nos., and several of them of large size. Hitherto the articles are chiefly palæontological and possess a high degree of interest. They are as follows—

No. I.—1. An Alligator and several new mammalia in Hordwell Cliff. Searles Wood, F.G.S.

2. Ichthyosaurus—a new species in Chalk. James Carter, M.R.C.S.

3. Chiton in Magnesian Limestone. Wm. King.

4. Prices of some Fossils. G. A. Mantell, LL.D., F.R.S.

5. Coprolites? in the Crag and London Clay. John Brown, F.G.S.

6. A Reptile or Fish in the chalk of Kent. Toulmin Smith.

7. Mosasaurus with flint in the teeth. Ed. Charlesworth, F.G.S.

8. *Miscellanies*—Exposition of the plan of the Geological Journal. Ear bones of Whales in the Red Crag. Fossil reindeer. British Fauna. New genus of Mammals, South Carolina. Fossil foraminifera,—soft parts in Chalk and Flint. Fossil mammalia and aves in Museum of Royal College of Surgeons.

Obituary—Miss Ethelred Bennett. Literary Intelligence.

No. II.—1. Large species of Unio in the Wealden of Isle of Wight. G. A. Mantell.

2. Tellina, Monograph of, in the Eocene, &c. Fr. Edwards.

3. Brachiopoda of Wenlock Limestone. Th. Davidson, M.G.S., of France.

4. Belemnite in Oxford clay. R. Owen, F.R.S. Extracts.

5. Fossil Cephalopoda, genus Belemnoteuthis. J. C. Pearce, F.G.S.

Miscellanies—Criticism by the Editor. Bibliographical Notices. Extinct Irish Deer. Labors of Agassiz on the Ganoidei. Astacus Phillipsii. Azoic sedimentary strata. Fossil Xanthidea. Pentacrinus, new species. Freshwater strata of Hordwell.

No. III.—1. Fossil Cephalopoda of the Oxford clay. Wm. Cunnington.

2. Hypanthocrinites of the Wenlock Shale. W. A. Lewis, B.A.

3. Tellina—Monograph continued. Fr. Edwards.

4. Brachiopoda. Th. Davidson.

5. Hordwell, fossil and geological phenomena. S. V. Wood, F.G.S., &c.

Miscellanies—Criticisms by the Editor. Bibliographical Notice. Clathrariophyllii, in the Kentish Rag. Lepidodendron with Stigmarian roots. Birds versus reptiles. Mammalia, new genera, Hordwell Cliff. Bones of Loch Gur. Pentacrinus gracilis, &c. Literary Intelligence.

From the Quarterly Journal of the Geological Society, we have made frequent citations, and it is replete with valuable matter. The London Geological Journal of Mr. Charlesworth is not a rival, but pursuing an independent course avowedly without submission to the authority of names will, we trust, promote the interests of science;—the editor will avoid, as we hope, all unnecessary personalities, while he pursues fearlessly the course which truth and candor and fidelity ought to prescribe to every editor.

2. *Darlington's Agricultural Botany.*—This work is acknowledged to have been much needed. It brings science into agreeable and intelligible union with that art, in which the great proportion of our people are engaged, and which supplies a large proportion of our wants. The peculiar and important relations of botany to medicine, the vegetable kingdom furnishing perhaps two-thirds or three-fourths of the articles of the *materia medica*, have often been well and fully treated. In agriculture there is a very much closer dependence on botany. It would be a great public benefit if some patron of the useful arts would distribute Dr. Darlington's work, gratuitously, by thousands, to the farmers of the author's native state, as a certain work from over the water was distributed through an adjoining state, for the benefit of agriculture.* It should be made a class book in our schools, and children throughout this Union should be taught to rival their neighbors, in having their own regarded as the *garden* state, rather than to pride themselves on distinctions which are marks of political strife and love of power.

The work is dedicated to the young farmers of the United States, for reasons which the Preface satisfactorily explains; and we find in the same place an important suggestion, that a work expressly devoted to the *Botany* of the *Arts*, is yet to be supplied. The writer's favorite authorities are Torrey, Gray, and De Candolle. A glossary is furnished, rendering into plain English all the botanical terms used; there is also an explanation of the abbreviations and references. We have moreover in a synopsis the Linnæan arrangement of the genera treated of, followed by a summary of the groups and orders noticed in the work, after the plan of Gray: the first series, that of flowering plants, occupies in the text 236 pages, and the second, that of flowerless plants, but 10 pages. Following a scientific description of each plant, its origin, history, &c., are the author's own observations, showing its relation to agriculture.

The plants treated of are classified in tables under the following heads; which give at a glance, an idea of the particular subjects and their importance:

1. Plants yielding esculent *Roots*, *Herbage*, or *Fruits*, for *Man.*
2. Plants yielding *Food* exclusively or chiefly for *Domestic Animals.*
3. Plants yielding *Condiments* or *Drinks.*
4. *Medicinal* plants.

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* Johnson's Agricultural Chemistry, in New York.

5. Plants employed in the *Arts*, in *Commerce*, in *Domestic* or *Rural Economy*.

6. *Pernicious* plants.

7. Plants which are *mere weeds*.

No one has devoted himself more sedulously than our author, to promote the true interests of agriculture, to inculcate a sense of the dignity and elevated character of the pursuit, and the importance of science to those engaged in it. This is proved by numerous addresses, lectures, and publications, a list of which we here annex.

1. *Address*, at the Third Annual Meeting of the Pennsylvania Agricultural Society, held at Prospect Hill, Philadelphia Co., Oct. 21, 1825.

2. *Address* to the Chester County Cabinet of Natural Science, at the organization of the Society, March 18, 1826.

3. *Florula Cestrica:* An Essay towards a Catalogue of the Phænogamous plants, native and naturalized, growing in the vicinity of the Borough of West Chester, Pa. April 28, 1826.

4. *Flora Cestrica:* An attempt to enumerate and describe the Flowering and Filicoid Plants of Chester County, Pa. April, 1837.

5. *An Essay* on the Development and Modifications of the External Organs of Plants. Compiled chiefly from the writings of Goethe. March 1, 1839.

6. *A Discourse* on the Character, Properties, and importance to Man, of the Natural Family of Plants, called Gramineæ, or True Grasses. February 19, 1841.

7. *Address* to the New Castle County Agricultural Society and Institute, at the Eighth Annual Meeting, held at Wilmington, Del., Sept. 13, 1843.

8. *A Lecture* on the Study of Botany; read before the Ladies' Botanical Society, at Wilmington, Del. March 2, 1844.

9. *Address* delivered before the Philadelphia Society for promoting Agriculture, at the Annual Axhibition, October 17, 1844.

10. *Address* before the Chester County Horticultural Society, at their First Annual Exhibition, in Westchester, Pa. Sept. 11, 1846.

11. *Agricultural Botany:* An Enumeration and Description of Useful Plants and Weeds, which merit the notice, or require the attention, of American Agriculturists. June, 1847.

12. *A Discourse upon Agriculture:* at a meeting of citizens of Oxford and vicinity, Chester County, Pa., assembled for the purpose of forming an Agricultural Society, September 4, 1847.

3. *Foraminifères fossiles du bassin tertiaire de Vienne*, *decrits par* Alcide D'Orbigny. 4to, with numerous plates. *Paris*, 1846.—When it was asserted, many years since, by Lamarck, that more had been contributed to the formation of the earth's crust by microscopic shells, than by whales, mammoths and hippopotami, comparatively little was known as to the real extent of the labors of the minute but beautiful beings called Foraminifera by d'Orbigny, and Polythalamia by Ehrenberg. Thanks to the labors of the eminent naturalists just named, the immense importance of these minute creatures as architects of the earth's crust is now generally known. D'Orbigny in particular has devoted almost a lifetime to their study, and until Ehrenberg investigated the still more minute forms of this class, the former naturalist was almost the only worker in this field.

To d'Orbigny we are indebted for the first scientific classification of these bodies;[*] for a beautiful series of plaster models of them[†] which have made their curious forms familiar to naturalists; and for several important memoirs, not only upon the living species,[‡] but upon the peculiar forms belonging to the chalk and other strata.[§]

The work whose title stands at the head of this notice, is the last contribution made by this indefatigable author to his favorite department of science. It is a beautiful quarto volume, with more than 300 pages of text, and 21 elegant and well filled plates. The text is given in both the German and French languages, and the execution of the whole volume is worthy of the imperial auspices under which it was published.

The Chevalier de Hauer having made an immense collection of the Foraminifera from the tertiary deposits of Austria, prevailed upon M. d'Orbigny to undertake their scientific study, and the Emperor of Austria liberally defrayed the expense of the publication of the work, to the preparation of which the author devoted not less than two years.

This work is not one of merely local interest. No one familiar with the subject, who looks upon its plates, can fail to be struck with the resemblance which many of the forms bear to the fossils which are accumulated in such immense quantity in the tertiary beds beneath Charleston, S. C.,[||] and which are scarcely less abundant in the tertiary of Virginia.

This work on the Austrian forms will be indispensable to all who would study the species belonging to deposits of the same age in other localities. A very valuable portion of the work is an introduction giving a complete exposition of the present views of the author concerning the classification of the Foraminifera, to illustrate which, figures of every genus now known are given. Of high interest also are the author's general paleontological remarks. Commencing with the carboniferous epoch in which the first Foraminifers occur under the form of the genus Fusulina,[¶] a detailed statement is given of the successive additions of genera and species during the different epochs, up to the present time. It appears from the data hitherto obtained, that the number of genera and species in the different periods was as follows:

Carboniferous,	1 genus,	1 species,
Jurassic,	5 genera,	20 "
Cretaceous,	34 "	280 "
Tertiary,	56 "	450 "
Recent,	68 "	1000 "

It appears too, that certain genera are peculiar to certain formations, although some of those which accompanied them may also occur in

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[*] Annales des Sciences Naturelles, Janvier, 1826.

[†] Complete sets are for sale at Rue Louis-le-Grand, No. 5, Paris.

[‡] Foraminifères de Cuba et des Antilles, 1839.

[§] Foraminifères de la Craie blanche, Mem. de la Soc. Geol. de France, 1839.

[||] Recent borings made for an Artesian well at Ft. Sumpter, in Charleston harbor, have reached the Polythalamia beds which were first detected in boring an Artesian well in the city of Charleston. An abundant supply of the marls crowded with beautiful microscopic forms in a perfect state of preservation, has been sent to us for examination, by Capt. A. H. Bowman, of the U. S. Engineers.

[¶] For a notice of American Fusulina limestones, see this Journal, vol. ii, ii Ser., p. 293.

more recent deposits. The value, therefore, of these minute medals of creation in the determination of the age of strata is fully established.

Upon this point D'Orbigny remarks, "that after having devoted twenty years to the study of the Foraminifers he has become fully convinced that they can in all cases be used to determine with certainty the age of a geological formation, if in their comparison there is used that precision of observation which is indispensable to every conscientious labor in zoology or comparative anatomy." Even where it may be the easiest method to determine the age of a stratum by means of the mollusks and other large fossils which it may contain, the accompanying microscopic forms, which in general are far more numerous, should not be neglected. The business of the geologist is not merely to identify strata, but to give a comprehensive and philosophical view of all the phenomena of the epoch under examination, and surely none can be more wonderful than those connected with the labors of those Lilliputian chemists, who little by little have separated from the ocean waters, organized masses of carbonate of lime or silica, which play no inconsiderable part in the formation of our present continents.

In our American strata the Foraminifera are very abundant; the borings of every Artesian well made through the cretaceous or tertiary strata of the southern states, afford a rich supply of these elegant forms. Beautiful living species occur along our coast, but are rare along our sandy shores, in comparison with the immense profusion in which they occur near the Gulf Stream. From a recent examination of soundings taken at depths of about 100 fathoms and at various points near the Gulf Stream,* it appears that the Foraminifers form along the course of this ocean current a perfect milky-way of organic life, whose nebulæ however are easily resolved by the microscope.

While we close this article by recommending the various works by M. d'Orbigny as indispensable to all who would pursue this branch of microscopic paleontology, we would also invite attention to an interesting memoir by Dr. Mantell, on the Fossil Remains of the soft parts of Foraminifera in English Chalk and Flint,† and to another by W. C. Williamson, Esq., on some of the Microscopical Objects found in the Mud of the Levant.‡ Both of these memoirs are valuable contributions to our knowledge of the minute workers in lime and silica, and other vast additions may be hoped for in Ehrenberg's long expected volume, which is to give the results of his comparison of the microscopic beings, recent and fossil of all parts of the world. J. W. B.

4. *Lexicon Scientiarum—a Dictionary of Terms used in the various branches of Anatomy, Astronomy, Botany, Geology, Geometry, Hygiene, Mineralogy, Natural Philosophy, Physiology, Zoology, &c.*, for the use of all who read or study in College, School, or Private Life. By HENRY MCMURTRIE, M.D., &c., Prof. of Anatomy, Physiology and

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* For these soundings we are indebted to A. D. Bache, Esq., Superintendant of the U. S. Coast survey. The soundings abound in many new and interesting organic forms, a memoir upon which is now in the course of preparation.

† Phil. Trans., Part IV. 1846.

‡ On some of the Microscopic Objects in the Mud of the Levant, and other deposits, with remarks on the mode of formation of Calcareous and Infusorial Siliceous Rocks, by Wm. C. Williamson, Esq. Manchester, 1847.

Natural History in the Central High School of Philadelphia. E. C. & I. Biddle, 1847: Philadelphia.

The author was induced to compile this work on account of the difficulties which he experienced as a teacher.

His plan is intended to include "the terms usually employed in all the sciences, to the utter exclusion of ordinary words." Thus he has been able to construct a small portable and cheap book, and to avoid the reproach of his own motto—*μεγα βιβλιον μεγα κακον.*

The etymology of the words is given, and essentially aids the memory. The book is handsomely printed, with a good paper and type—the principal words in capitals, and the explantions in a clear readable character—forming a pocket volume of about 250 pages.

As far as we have looked into it, the definitions appear to be correct, concise and perspicuous, and we believe the work will prove a very useful auxiliary to the student of the natural sciences.

5. *Outlines of the Course of Qualitative Analysis followed in the Giessen Laboratory.* By Henry Will, Ph. D., with a preface by Baron Liebig. Boston: James Monroe & Co., Sept. 1847. 12mo, 145.—All who are engaged either in teaching or acquiring the difficult art of chemical analysis, will feel grateful for this brief but important manual. Baron Liebig says, "The want of an introduction to chemical analysis, adapted for the use of a laboratory, has given rise to the present work, which contains an accurate description of the course I have followed in my laboratory with great advantage for twenty-five years. It has been prepared at my request by Prof. Will, who has been my assistant during a great part of this period." This work has been adopted in the analytical laboratories both in Cambridge and New Haven.

C. D. Badham: A Treatise on the Esculent Funguses of England, *London*, 8vo, 1847.

T. & J. Austin: Monograph on Recent and Fossil Crinoidea, No. 6, 4to, *London.* "About 20 numbers (3*s*. 6*d*. each) will complete the work."

P. H. Boutigny: Nouvelle Branche de Physique, ou études sur les corps à l'etat sphéroidal. 8vo, 2d edit., *Paris*, 1847.

James T. Hodge: Report of a Tour of Exploration through the Mineral Locations of Montreal River, Lake Superior. 1847, 19 pp. 8vo, with a map.

J. J. Berzelius: Neues Chemisches Mineralsystem; herausgegeben von C. F. Rammelsberg. 264 pp. 8vo. *Nürnberg*, 1847.

Proceedings of the Amer. Acad. of Arts and Sciences, Boston.—p. 50. *Jan.*, Observations on the planet Neptune; *W. C. Bond.—Feb.*, p. 51. On the Chinese Language; *S. P. Andrews.—March*, p. 57. Correspondence of a star observed by Lalande with the planet Neptune; *J. C. Walker.*—On the comet of March 4, 1847; *W. C. Bond.*—p. 71. Series of moon culminations observed at the Cambridge Observatory; *W. C. Bond.*—p. 104. Series of moon culminations observed at Dorchester; *W. C. Bond.—April*, p. 129. Demonstrations relating to rectilineal triangles; *Prof. T. Strong.—May*, p. 144. On the planet Neptune; *Prof. Peirce.*—p. 149. Conspectus of Crustacea of the Exploring Expedition under C. Wilkes, U.S.N.; *James D. Dana*, (includes species of the genera Cyclops, Harpacticus, and the two new genera Clytemnestra and Setella.)—p. 158. Meteorological register kept at the Bay of Islands, New Zealand; *J. B. Williams.*

Proceedings of the Academy of Natural Sciences of Philadelphia.—*July*, p. 229. Observations on certain coal fossils from Cape Breton, Nova Scotia; *R. Brown, Esq.*—p. 233. Description of a new *Columba* (C. solitaria) from Mexico,* and remarks on the Geococcyx viaticus; *G. A. M'Call.—August*, p. 248.

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* See this volume, page 421.

Description and Anatomy of a new subgenus of Planaria; *J. Leidy.*—p. 251. Descriptions of two new species of Planaria; *J. Leidy.*

Annals and Magazine of Natural History, Vol. xx, No. 131. *August.* On the Ventriculidæ of the Chalk; *J. T. Smith.*—Geographical Distribution and Classification of Zoophytes; *J. D. Dana.*—Circulation in Insects; *E. Blanchard.* —Microscopic silicious Polycistina of Barbadoes; *R. H. Schomburgk.—Lit. and Phil. Soc. of St. Andrews:* Dr. Reid on the development of the Medusa.—*Zoological Society:* J. E. Gray on the genera of the family Chitonidæ.

No. 132. *September.* Fossil Botany and Zoology of the coal formation of Australia; *F. M'Coy.*—Note on the Teredo Norvegica, Xylophaga dorsalis, Limnoria terebrans and Chelura terebrans; *W. Thompson.*—On the pliocene deposits of the valley of the Thames at Ilford; *R. P. Cotton.*—Additions to the Fauna of Ireland; *W. Thompson.*—On the Ventriculidæ of the Chalk; *J. T. Smith.—Zoological Society:* Dr. Davy on the early generative power of the Goat; J. E. Gray on some new genera and species of Asteriadæ; A. Adams on a new species of Fulgora; A. White on some new Crustacea in the British Museum; G. B. Sowerby on several new species of Spondylus.

Bulletin (Monatsbericht) of the Royal Prussian Academy, Berlin. *October*, 1846. On the new planet; *Encke.*—On the anomalous form of the annual temperature curve in North America; *Dove.*—On the larva condition and the metamorphosis of the Ophiura and Echinus; *Muller.—November.* On the Carburets of Iron; *Karsten.*—Microscopic investigation of the Sirocco dust; *Ehrenberg.*—On the decomposition of water by Galvanism, and some allied topics; *Poggendorff.* On heat; *H. Knoblauch.*—On the position of the Cycadeæ in the Natural System; *Link.—December.* On microscopic organisms from the volcanic ejections of Iceland; and also from a new case of Sirocco dust, from Genoa, May 16; *Ehrenberg.* —Microscopic Polycistina from Barbadoes; *Ehrenberg.—January*, 1847. Reaction of metallic zinc with mercurial solutions; *H. Rose.*—On promoting the decomposition of water by galvanism; *Poggendorff.*—On the geographical distribution of the Camel and Date Palm; *Ritter.*—On the deposit of stone salt at Stafsfurth, and on the Boracite in salt beds; *Karsten.*—On the planet Astræa; *Encke.—February.* On the movement of heat in the earth's strata of different geognostic character; *Dove.*—A new insectivorous mammal, genus Rhyncocyon, from Mozambique (R. Cirnei); *Peters.*—Chemical investigation of silicates containing chlorine, sulphuric acid and carbonic acid; *Whitney.*—Microscopic siliceous Polycistina from Barbadoes, &c.; *Ehrenberg.*—Discovery of Creatine in Urine; *Heintz.*—Examination of the ashes of organic substances; *H. Rose.*—On the appearances presented by polarized light, when the plane of polarization is suddenly turned; *Dove.*

Bulletin de la Société Impériale des Naturalistes de Moscou. Année, 1846. 3 pl.—No. I. Observations on Scandinavian Geology; *E. Eichwald.*—Coleoptera Myrmecophila fennica; *F. G. Mæklin.*—Hylæus quadricinctus, Fabr.; *E. Eversmann.*—No. II. A systematic arrangement and economical review of grape vines; *Dr. F. A. Kolenati.*—Remarks on the collection of Russian Coleoptera of Victor de Motschoulsky.—Treatise on the atomic theory; *P. Einbrodt.*—New or little known species of Russian Coleoptera; *Dr. E. Eversmann.*—Geological section of the environs of Moscow; *M. Rouillier.*—Notes upon some passages of the work of Murchison, Verneuil and Keyserling, on the Geology of Russia and the Urals; *J. Auerbach* and *H. Frears.*—On the beetles of the Aleutian Islands and Sitka; *C. G. Mannerheim.*—Supplement to a memoir on the foliaceous Musci of the Russian empire; *A. Weinmann.*—Meteorological observations made at the astronomical observatory of the Imperial University of Moscow; *Spassky.*

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Fig. 72.

CONIUM MACULATUM.
(Hemlock.)

Fig. 46.

DIOSMA CRENATA.
(Rue.)

Fig. 86.

MYRISTICA OFFICINALIS.
(Nutmeg.)

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Fig. 104.

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Fig. 64.

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