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MISCELLANIES.—DOMESTIC AND FOREIGN.

ERRATA.

P. 21, l. 3 fr. bot. for *June* 11, 1811, read *June* 18, 1811.—P. 23, l. 2 fr. top, for *those* read *these*.—P. 27, l. 4 fr. top, for *successively*, read *successfully*.—P. 29, l. 18 fr. bot. for *Humphrey*, read *Humphry*.—P. 305, l. 2 fr. top, for *the American elk*, read *Cervus Alces*, L.

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P. 305, l. 4 fr. top, for *bevel* read *level*; l. 3 fr. bot. after *wire*, add—"The number of divisions was then taken where the arms met."—P. 346, l. 21 fr. top, for *Collitelus*, read *Callitelus*.

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JOURNAL OF SCIENCE, &c.

ART. I.—*Examination of the Theory of a Resisting Medium, in which it is assumed that the Planets and Comets of our System are moved;* by R. W. HASKINS, of Buffalo, N. Y.

IN all ages, when astronomy has been cultivated, the opinion seems to have been entertained, in some one or more of its numerous forms and modifications, that the regions around us, beyond our atmosphere, and to an indefinite extent, are supplied with a rare, invisible medium, of unknown composition and character, in which all the bodies of our solar system, and perhaps the bodies of all other systems also, in executing the several motions assigned them, are necessitated to move. To this substance the name of *ether* has usually been applied; and by this name we propose to designate it, while we examine into its history, the evidences of its existence, and its effects. The period at which this celestial ether was introduced into the science of astronomy, no less than the race of people by whom it was effected, is probably beyond the reach of inquiry: we know only that in the most remote periods of the history of that science, we find it constituting a prominent part of the celestial mechanism. The Bramins, of India, whose astronomical tables, constructed more than three thousand years before the Christian era, are still preserved to us,(1) assumed its existence, and figuratively supposed the stars to move themselves therein, in a manner

(1) Bailly, Traite de l'Astronomie Indienne et Orientale: Prof. Playfair's works, articles Astronomy of the Bramins, and Trigonometry of do.; Hutton's History of Algebra, and Rev. S. Vince's complete System of Astronomy, Vol. 2, p. 252.

similar to the movement of fish in water.(2) The name by which it was known to them is *akash;* and Mr. Dow, in his dissertation upon the religion of the Bramins, defines it to be "a celestial element, pure and impalpable, in which the planets move." "This element," he continues, "according to Bedang, offers no resistance; so that the planets have moved uninterruptedly therein, from their first impulsion which they received from the hand of Brama; and they will not be arrested until the moment when he shall seize them in the midst of their course."(3) The Chaldeans, also, held this opinion, and in the figurative language of the East were wont to represent the planets, including the sun, the earth and the moon, as vessels moving therein, and suited to such navigation.(4) Alhazen, an Arabian optician of the eleventh century, taught the existence of ether, which he designated "the substance of heaven," and he supposed it situated beyond, and differing in character from, our atmosphere.(5) Tycho Brahe reinstated the ether of the ancients in all its rights. But though he regarded it as existent, he denied to it the power of causing refraction, which he attributed solely to the grosser vapours of our atmosphere. Whatever may be the difference in the natures of these two fluids, says he, the atmosphere so diminishes in density upward, that at the point where it touches the ether it differs little from it.(6) Kepler, in following the crowd who had gone before him, revived this theory, in his day, and turned the substance in question to good account in framing some of the absurd theories which he put forth, along with his immortal discoveries. In seeking the origin of comets, he supposed them native inhabitants of this ether, as fishes are of the waters of the earth; and that God created them to inhabit the immense spaces of the universe, as he did whales and other monsters to people the vast solitudes of the ocean. The sombre and bloody appearance which the sun sometimes exhibits he attributed to a coagulation of the ether; and when these appearances ceased, that result was produced by a collection of the grosser portions, which had disturbed its transparency, and their conversion into comets.(7)

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(2) Bailly, Histoire de l'Astronomie Ancienne, p. 115.

(3) Bailly, Traite de l'Astronomie Indienne et Orientale, p. 206. The work of Mr. Dow we have not seen.

(4) Bailly, Histoire de l'Astronomie Ancienne, p. 139.

(5) Bailly, Histoire de l'Astronomie Moderne, tome 1, p. 238.

(6) Ibid. tome 1, p. 404. (7) Ibid. tome 2, p. 124.

Through the long period of time embraced by these references, we see the existence of this fluid matter every where accredited; yet so vague and indefinite do all ideas respecting it appear to have been, that rigid investigation of its character or necessity seems to have been quite neglected; and even its practical utility, so far as we know, was but very limitedly considered. But we are now to enter upon a new era, and that a very important one, in the history of this fluid; for we are to see it elevated from the subordinate station hitherto assigned it, to that of a primary agent in carrying out the great motions of the universe. This application was the offspring of the genius of DESCARTES. The conception was a sublime one which dared to identify the law of the general movement of the universe, with that of the movement of terrestrial bodies: and this is due to Descartes. His vortices are a bad explanation of gravity and of the system of the world, but they are mechanical. He discovered that the same mechanism moved bodies in the celestial spaces and at the surface of the earth; and if he was not able to seize this mechanism, we should not forget that this new and sublime thought was of his conception.(8) According to this philosopher "matter, possessed only of the properties of extension, impenetrability and inertia, was supposed to fill all space, and its parts, both great and small, to be endued with motion in an infinite variety of directions. From the combination of these, the rectilineal motion of the parts became impossible; the atoms or particles of matter were continually diverted from the lines in which they had begun to move; so that circular motion and centrifugal force originated from their action on one another. Thus matter came to be formed into a multitude of vortices, differing in extent, in velocity and density; the more subtile parts constituting the real vortex, in which the denser bodies float, and by which they are pressed, though not equally, on all sides. Thus the universe consists of a multitude of vortices, which limit and circumscribe one another. The earth and the planets are bodies carried round in the great vortex of the solar system; and by the pressure of the subtile matter, which circulates with great rapidity, and great centrifugal force, the denser bodies, which have less rapidity, and less centrifugal force, are forced down toward the sun, the centre of the vortex. In like

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(8) Bailly, Histoire de l'Astronomie Ancienne, Discours Preliminaire; and Playfair on Mathematical and Physical Science.

manner, each planet is itself the centre of a smaller vortex, by the subtile matter of which the phenomena of gravity are produced, just as with us at the surface of the earth."(9) In this system of philosophy, if such it may be called, the agency of the ether, in causing and sustaining the planetary motions, is indispensable; and when we consider how universal was the belief, by all learned and scientifick men, in this doctrine, for more than half a century, we find a ready excuse for the opinion of the less informed upon the subject. For more than thirty years after the publication of Newton's discoveries, this absurd doctrine of vortices kept its ground in France, Germany, and in the universities of England and Scotland. It was finally driven out of the Cambridge University, in England, by a friend of Newton's publishing, in 1718, an edition of their Cartesian text book, *with notes*, embracing the truths which Newton had disclosed. These gradually undermined the doctrine of Descartes, and finally caused its expulsion.(10) This, however, was a work of time; and the absurdities in question were not generally, or even in any considerable degree, driven from the colleges and learned societies of Europe, before about the year 1720.(11)

When the errours of Descartes were finally removed from the schools, and from the minds of philosophers, they gave place to the Copernican system of the universe, as rigidly demonstrated by Newton, upon the basis of the laws of Kepler. By this system, and these demonstrations, the celestial revolutions are shown to be carried on independently of all assistance from the ether; and the agency of that fluid was consequently no longer demanded. But, though thus discarded from all participation in planetary motion, a belief in

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(9) Playfair on Mathematical and Physical Science, part 1, Sec. 4, Art. 4.

(10) Ibid. part 2, Sec. 4.

(11) It is, then, no more than about one hundred and seventeen years since even the learned world became sane upon the grand outline, alone, of the celestial mechanism. Three of the colleges of our own country were founded prior to that date, namely, Harvard, in 1638; William and Mary, in 1693; and Yale, in 1700. At that early period of our history, and with the professors' chairs, in these institutions, generally occupied by European scholars, we can hardly suppose wide deviations, in the doctrines taught, from the received opinions in Europe; and consequently, without any direct proof at hand, upon this point, we from necessity infer that the New World has just claims to a portion of whatever of renown or reproach may rightfully attach to the inculcation of the Cartesian doctrine of the universe, at so late a day; and that, for a period of eighty years, this was gravely taught and believed at one, and for shorter periods at two other of the colleges of our infant country.

the existence of this fluid was still retained by Newton, who sought to employ it in a new capacity. "And now we might add something concerning a certain most subtile spirit, which pervades and lies hid in all gross bodies; by the force and action of which spirit, the particles of bodies mutually attract one another at near distances, and cohere if contiguous; and electrick bodies operate to greater distances, as well repelling as attracting the neighbouring corpuscles; and light is emitted, reflected, refracted, inflected, and heats bodies."(12) He furthermore supposed that this substance is spread through all the heavens; and when for lack of demonstration, uncertainty arose in his mind, he thus queried: "Is not this medium much rarer within the dense bodies of the sun, stars, planets and comets, than in the empty celestial spaces between them? And in passing from them to great distances, doth it not grow denser and denser perpetually, and thereby cause the gravity of those great bodies towards one another, and of their parts towards the bodies; every body endeavouring to go from the denser parts of the medium towards the rarer?"(13)

In 1762 the Academy of Sciences, of Paris, proposed, for a prize, the question, "*Do the planets revolve in a medium of which the resistance produces a sensible effect upon their movements?*" For this prize *M. l'abbé Bossut* was the successful competitor. His calculations showed him that the effect of resistance, offered to the planets, would be to diminish the axis of their orbits, and consequently to shorten their periods of revolution. An acceleration in the movements of the moon had been observed, which was without explanation, and on applying his reasonings to the motions of this planet he satisfied himself that the observed acceleration was due to the resistance of ether, encountered by the moon, in traversing her orbit. The sum of that resistance he measured; and this theory being equally applicable to all the planets, he extended it to them all, and subjected each to the resisting influence of the ether.(14)

The tails of comets were objects of early attention; and it was remarked, both by *Fracastor* and *Apian*, that the tail of the comet

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(12) Newton's Mathematical Principles of Natural Philosophy, vol. 2, p. 393. The copy of Newton to which all references in this article are made is the English translation, by Andrew Motte, 12 mo. edition, in two vols. London, 1729.

(13) Newton's Opticks, third edition, London, 1721, p. 325.

(14) Bailly, Histoire de l'Astronomie Moderne, tome 3, p. 237; and Bossut, Histoire des Mathématiques, tome 2, p. 409.

of 1531, and those of two subsequent ones, *were all directed opposite to the sun.*(15) Pingré subsequently supposed that these tails are formed of the most subtile portions of the comet's atmosphere, greatly rarefied by the sun, and driven to the side *opposite the sun*, by the resistance of the ether; aided, perhaps, by the solar rays.(16) This direction of comets' tails, as laid down by Fracastor and Apian, seems to have been very universally adopted. *Newton* says the tails of comets arise from their heads, and tend towards the parts opposite to the sun.(17) *Bailly* adopts the same opinion, in strong language, namely, that the tails are always opposite the sun.(18) *Delambre* is equally unreserved. He says the tail of a comet is always opposite the sun, or in prolongation of the radius vector of the sun and the comet.(19) *Laplace* calls them trains of vapour, always situated on the other side of the heads of comets, relatively to the sun.(20) *Vince* says comets are surrounded by a dense atmosphere, and from the side opposite the sun they send forth a tail.(21) *Bonnycastle* denominates them fiery tails, which continually issue from that side of the comets which is farthest from the sun.(22) *Brewster* states that when a comet is near its perihelion, it is accompanied with a tail or train of light, directly opposite the sun.(23) *Morse* avows that comets are usually attended with a long train of light, always opposite to the sun.(24) *Prof. Farrar*, of Harvard, describes the trains, and adds, their direction is always opposite to the sun.(25) The younger *Herschel* describes the nucleus, and adds that from the head, and in a direction *opposite to that in which the sun is situated* from the comet, appear to diverge two streams of light, constituting the tail.(26) Sustained by the high standing and great numerical force of these authorities, the position here assumed has quite regularly found credence and a place

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(15) Delambre, Histoire de l'Astronomie du Moyen Age, p. 390 et 393.

(16) Delambre, Histoire de l'Astronomie du Dix Huitième Siècle, p. 680. The work of Pingré, namely, *Comètographie*, we have not seen.

(17) Math. Prin. of Nat. Phil. (vide note 12,) vol. 2, p. 364.

(18) Histoire de l'Astronomie Moderne, tome 2, p. 549.

(19) Astronomie Theorique et Practique, tome 3, p. 401.

(20) Systéme du Monde, p. 128.

(21) Complete System of Astronomy, vol. 1, p. 444.

(22) An Introduction to Astronomy, p. 44.

(23) Edinburgh Encyclopedia.

(24) American Universal Geography, vol. 1, p. 32.

(25) Cambridge course of Natural Philosophy, fourth part, p. 306.

(26) A treatise on Astronomy, first published in 1833; American edition, p. 284.

in the numerous works of subordinate authors; insomuch that we have pretty uniformly recognized it in the elementary works upon astronomy that we have examined in the English language.(27)

The cause assigned for this direction of comets' trains, by Pingré, namely, the resistance of the ether, appears not to have found much favour in the minds of his successors; consequently we find, in general, the expression employed, namely, "*impulsion of the sun's rays*," to denote both the agent and the manner of that agent's action, in producing this result.

Great additional impulse has, within a few years, been given to the theory of a resisting medium by the detailed and able paper of Prof. Encke, upon the observed decrease of the times of revolution of the comet which bears the name of that astronomer. This paper has been translated into English, and is more or less extensively quoted by almost every writer who has employed his pen upon celestial motions, since the date of its appearance. The author says: "If I may be permitted to express my opinion on a subject which, for twelve years, has incessantly occupied me, in treating which I have avoided no method, however circuitous, no kind of verification, in order to reach the truth, as far as it lay in my power; I cannot consider it otherwise than completely established, that an extraordinary correction is necessary for Pons' [Encke's] comet, and equally certain that the principal part of it consists in an increase of the mean motion proportionate to the time."(28) Dr. Bowditch, by reference to the memoir of Encke, supposes the existence of a resisting medium highly probable, as there disclosed, in the motions of Encke's comet, in its successive appearances between the years 1786, and 1829.(29) Arago, of the Royal Observatory, at Paris, in an essay, in 1832, fully recognizes this resisting medium, on the authority of Encke, and dwells at considerable length upon its effects.(30) M. Gautier assumes that, results obtained in 1828, from the movement of Encke's comet, accord with those which Encke had previously procured, and which induced him, (Encke,) in 1823 to suppose the existence of a medium or ethereal fluid, in space, of which the resistance, acting as a tangential force against the motion of the comet, would augment the power of the sun, and shorten the period

(27) Some of the recent French works, of a similar character, constitute exceptions to this rule.

(28) Prof. Encke's Memoir, as quoted in the American Almanack, 1834.

(29) Mécanique Céleste, (Bowditch,) translator's note, vol. 3, p. 678.

(30) Tract on Comets, by Arago, translated into English, by Prof. Farrar, Boston, 1832.

of revolution.(31) The younger Herschel refers to Encke's memoir; admits its conclusions, if the premises shall be found valid, and adds: "accordingly, (no other mode of accounting for the phenomenon appearing,) this is the solution proposed by Encke, and generally received."(32) Mrs. Somerville, adverting, also, to Encke's memoir, deems the existence of resisting ether rendered "all but certain, within a few years, by the motion of comets;" and this insinuated negation she quite recalls some eight pages afterwards, by substituting the emphatick words, "which puts the existence of ether beyond a doubt." The same pen not only prophesies that by this resistance, comets will be finally precipitated upon the sun, but also that "the same cause may affect the motions of the planets, and be ultimately the means of destroying the solar system."(33) Upon this memoir of Encke, theological arguments have been founded, having for their object to prove the destruction of the solar system, through the agency of this ether; and so certain has that result been considered, upon this authority, that the most positive forms of expression have been employed in pointing to such a consummation.(34)

It is believed that we have assembled, above, the leading facts and arguments upon the *affirmative* of the position of a resisting medium to the planets, so far as to embrace all that is requisite and necessary for a clear understanding and subsequent impartial investigation of the question. The method of division incident to this arrangement has been adopted in the belief that such arrangement would afford a view, more distinct than any other, of the entire question. We proceed, then, to subject the several positions and arguments to examination, in the order of their occurrence.

The evidences, if any, upon which the Bramins and the Chaldeans founded their belief in the existence of this ether, not having come down to us, the reasons for their faith are placed beyond investigation: nor are we better circumstanced in relation to the opinions of Alhazen, Tycho Brahe, and some others who, while they supposed such ether to occupy the celestial regions, gave no demonstration of the fact, nor made application of it to any of the

(31) Silliman's Journal of Science, vol. 17, p. 389.

(32) A Treatise on Astronomy, American ed. p. 291.

(33) Mrs. Somerville on the connection of the Physical Sciences.

(34) Astronomy and General Physicks, considered with reference to Natural Theology (one of the Bridgewater treatises) by the Rev. W. Whewell, of Trinity College, Cambridge.

known purposes of the universe. The opinions of Kepler, upon this subject, may not have received less credence, in the day they were uttered, than did his discovery of the fundamental laws of the celestial movements; but they were promptly consigned to oblivion by the subsequent revelation that comets, no less than planets, belong to our solar system, and move in ellipses more or less elongated, about the sun, obeying the same laws as the grosser planets. Of Descartes' system, and of its fate, we have spoken. That system was undermined by the discovery and application of the law of universal gravitation; and as this ether constituted all that was most essential to the Cartesian doctrine, the celestial motions were no sooner found to be carried on independently of its aid, than the whole theory was abandoned. Newton, himself, as we have seen, applied this substance, under the name of "a most subtile spirit," to the production of certain results, in his Principles of Natural Philosophy, and again in his Opticks. The passages we have quoted. These positions appear to have had their origin in a desire so to explain the doctrine of gravitation as to free it from the implied assertion that bodies act in places where they are not—a form of attack which the metaphysicians chose to employ against it. Yet this was but subjecting the question to new difficulties; as there is nothing like a satisfactory explanation of gravity in the existence of this elastick ether. True, a fluid disposed as Newton has assumed, would urge bodies in the direction he supposed; but what could maintain this fluid in the condition of its density varying according to the assumed law, is as inexplicable as the gravity it was meant to explain. The nature of such a fluid, if unrestrained, must be to equalize the density of all its parts, to the destruction of this hypothesis.(35) That Newton did not consider gravity inherent in matter is manifest from the passages under consideration; and he most fully states this, in words, in one of his letters to Dr. Bentley, as quoted by Prof. Playfair. Yet how he should have supposed he had escaped its necessity by his resort to the agency of this ether—since it is clearly for this purpose that he sought its aid—may well be deemed inexplicable. "If two particles of matter, at opposite extremities of the diameter of the earth, attract one another, this effect is just as little intelligible, and the *modus agendi* is just as mysterious, on the supposition that the whole globe of the earth is interposed, as on that of nothing, whatever, being interposed, or of a complete vacuum

(35) Playfair on Math. and Phys. Science, pt. 2, sec. 4.

existing between them. It is not enough that each particle attracts that in contact with it; it must attract the particles that are distant, and the intervention of particles between them does not render this at all more intelligible."(36) We may close this point of investigation, by arraying Newton against himself. Notwithstanding the force with which Newton supposed bodies to be urged by the unequal density of the ether, in certain directions, yet, when treating of the tails of comets, his language is, "from whence, again, we have another argument proving the celestial spaces to be free and without resistance, since in them not only the solid bodies of the planets and comets, but also the extremely rare vapours of comets' tails maintain their rapid motions with great freedom, and for an exceeding long time,"(37) To such and kindred anomalies have the greatest minds been occasionally subject, in all ages.

We have seen that, in 1762, this theory of resistance had so far commanded attention that the French Academy offered, in that year, a prize for the best examination of it; and we have also seen upon what evidences this prize was awarded. The results of the most careful modern observation, compared with those of a very ancient date, including some eclipses observed at Babylon, as early as 719, 720, and 721 years before the Christian era, show very clearly that the period of the moon's revolution is shorter in modern than in those remote ages.(38) This acceleration, Dr. Halley, the English astronomer, in 1695, believed to exist, and declared his conviction that he could demonstrate the fact.(39) A more detailed and extensive labour of comparison was subsequently performed by the ***Rev. Richard Dunthorne***, who, in 1749, published its results, and verified the truth of the suspicions of his predecessor.(40) It was the cause of this acceleration which the French Academy demanded, in 1762. ***M. l'abbé Bossut*** sought that cause in the resistance of ether; and believing he had discovered it there, he made such returns of his labours to the Academy, that the proffered prize was awarded him: nor was the errour into which he had fallen, discov-

(36) Playfair on Math. and Phys. Science, pt. 2, Sec. 4. See, also, preface to Newton, by Roger Cotes.

(37) Math. Prin. of Nat. Phil. (vide note 12,) vol. 2, p. 369.

(38) Delambre, l'Astronomie au Dix-Huitième Siècle, p. 597, *note de l'editeur.*

(39) Philosophical Transactions of the Royal Society of London, abridgment by Hutton, Shaw and Pearson, vol. 4, p. 65. All references to the transactions of this Society, made in the course of this article, will be to the same edition here designated.

(40) Ibid. vol. 9, p. 669, and onward.

ered for almost a quarter of a century afterwards. In 1786, however, the true cause was revealed. In that year *M. le Marquis de Laplace* discovered both the cause and the law of this acceleration. He demonstrated that it is produced by the action of the sun upon the moon; that it varies with the eccentricity of the terrestrial orbit, and consequently that such acceleration is a necessary result of the law of universal gravitation.(41) In a chapter founded upon the assumed possibility of a resisting ethereal fluid, Laplace says: "Hence it follows, that the resistance of the ether can become sensible, in the moon's mean motion only. Ancient and modern observations evidently prove that the mean motions of the moon's perigee and nodes are subject to very sensible secular inequalities. The secular motion of the perigee, deduced from the comparison of ancient and modern observations, is less by eight or nine sexagesimal minutes, than that which results from the comparison of the observations made in the last century. This phenomenon, of which no doubt can remain, must, therefore, depend upon some other cause than the resistance of ether. We have seen that it depends on the variation of the eccentricity of the earth's orbit; and, as the secular equations resulting from that variation satisfy, completely, all the ancient and modern observations, we may conclude that the acceleration, produced by the resistance of an ethereal fluid, on the moon's mean motion, is yet insensible."(42) Again: "the accordance of theory with observation proves to us that if the mean movements of the moon are varied by causes foreign to the law of universal gravity, their influence is so small as not yet to have become sensible."(43)

The errour of *Fracastor* and *Apian*, in regard to the uniform direction of the tails of comets, has enjoyed an extent of credence not often secured to a false position. Although a direction nearly in prolongation of the radius vector of the sun and the comet is not unusual for these tails, yet observations very early furnished exceptions enough to destroy the rule which has been so long adhered to in this particular. If, as Pingré supposed, the resistance of ether has any agency in producing these tails, we should always expect them to be situated *behind* the nucleus, relatively to the comet's actual motion, without relation to the position of the sun: but this

(41) Delambre, l'Astronomie au Dix-Huitième Siècle, p. 598.
(42) Mécanique Céleste, (Bowditch,) vol. 3, p. 694.
(43) Système du Monde, p. 229.

is not so. Indeed they form so many different angles, both in regard to the comet's line of motion, and to the relative position of the sun, that no settled fact seems deducible from the circumstance of their direction. Flamsted, in his account of a comet which he observed at Greenwich, in May, 1677, is at the pains to state that its tail was not directed in a line opposite the sun, but deviated therefrom at an angle of ten degrees.(44) Hevelius, of a comet he observed, in 1682, says, "sometimes its tail was directed pretty exactly in opposition to the sun, as August 30, in the morning; but often with a considerable deviation, as is usual in most comets."(45) The great comet of 1744 had, at one time, no less than *six* distinct tails, spread out like a fan. They were each about 4° broad; and the space between these several tails was as dark as the rest of the heavens. There exist other examples of the tails of comets which have separated into several branches.(46) Newton cites two comets, the tails of which deviated from a right line joining the sun and comet, one ten, and the other no less than twenty one degrees.(47) The comet which appeared in January, 1824, besides the usual tail, opposite the sun, had another directed from the nucleus of the comet *towards* the sun. "The singular form of this comet," says the narrator, "adds new difficulties to the problem by which it has been explained, in a manner quite satisfactory, that the impulsion of the sun's rays is the principal cause of comets' tails always taking a direction opposite to the sun."(48) Much that has been written upon the cause, nature and character of these peculiar appendages of comets, appears to have been based entirely upon assumed data. Such authority is alike unsafe and detrimental. The views of Arago are more sane, and therefore more valuable. "Kepler supposed the formation of the tails of comets was the result of the impulsion of the solar rays, which detached from the head of the comet the lighter portions of that body, and removed them to a distance beyond it. To render this explanation admissible it is necessary to prove that the solar rays are endowed with an impulsive force; for the most

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(44) Philos. Trans. of the Royal Society, (vide note 39;) vol. 2, p. 394.

(45) Ibid. p. 559.

(46) Delambre, l'Astronomie au dix-Huitième Siècle, p. 680; et Delambre, Astronomie Théorique et Practique, tome 3, planche. Also, Arago, tract on Comets, Farrar's translation.

(47) Math. Prin. (vide note 12,) vol. 2, pp. 360 and 364.

(48) Jambon, Nouveau cours démonstratif et élémentaire d'Astronomie, p. 330, et 331.

delicate experiments have hitherto failed to render such force perceptible. This force shown and admitted, it will still remain to be demonstrated why the tail is not always situated opposite to the sun; why there are sometimes several tails, making, one with another, so great angles; why they form and again vanish, in so short periods of time; why some of them have a rapid rotary motion; and finally, why some comets, of which the envelope seems very light and delicate, exhibit no trace of this appendage. A crowd of other theories, more or less ingenious, have been proposed; but they all equally fail to explain the phenomena."(49)

The enormous length to which these tails have sometimes attained, has given rise to theories no less fanciful, nor yet more philosophical, respecting the consequences of such elongation. Newton supposed that the extremely distant portions of these tails could never be recalled, by attraction, to the nucleus of the comet, but must be scattered through the heavens, to be subsequently gathered to the different planets by attraction, and mingled with their atmospheres, to be there appropriated to supply the waste of matter spent upon vegetation, &c.(50) Laplace, the younger Herschel, and some others among the moderns, have assumed that portions of comets' tails are, at each revolution, "*scattered in space,*" and that, consequently, these bodies are continually wasting away. So indefinite a phrase seems not well calculated to convey any idea of facts; for we must suppose the matter of these tails, however elongated from the nucleus of the comets, will still obey the laws of gravitation to those bodies, unless brought within the *stronger* attraction of some other body: and in either case no dissemination of matter would take place. But the diminution of comets from loss of matter, by any cause, seems not well sustained. It is true that Arago, in 1832, fully concurred in this view; and hence advised us that in the then approaching return of Halley's comet we must not expect to behold so brilliant a body as the same had been at former periods of its return to the sun.(51) But this opinion of that astronomer he did not find supported by the actual appearance of Halley's comet, in 1835; and this fact he has promptly announced. He has, also, collectively presented what has come down to us of the apparent size, length of tail, &c. of Halley's comet at its various

(49) Arago, Leçons d'Astronomie Professées á l'Observatoire Royal, p. 207—8.
(50) Math. Prin. (vide note 12,) vol. 2, p. 371.
(51) Tract on Comets.

former apparitions; and contrasted this with the results of the careful and accurate observations upon the same body, made at various points, during its last appearance. At the close of these he adds: "If the reader will take the trouble to compare what I record of the comet of 1835 with the circumstances of its former apparitions, he certainly will not find in this collection of phenomena, *the proof* that Halley's comet is gradually diminishing. I will even say that if, in a matter so delicate, observations made at very different periods of the year, will authorize any positive deduction, that which would most distinctly result from the two passages of 1759 and 1835, would be that the comet had increased in size during that interval. I ought to seize, with the more eagerness, this occasion to combat an errour extensively accredited, (a belief in the constant wasting away of comets,) because I believe I have somewhat contributed to its dissemination."(52) This review of the theory of the diminution of comets, otherwise foreign to our subject, seemed demanded by the assumption of some that matter thus lost from these bodies will remain diffused through the celestial regions, of course offering constant obstruction to the progressive motion of the planets and comets. How such matter is to be maintained in this state of diffusion, has not, so far as we know, been explained; nor is it easy for us to conceive how the body resisted or encountered by it shall be prevented from appropriating it to itself, by adding it to its own mass.(53)

Comets, from their great volumes, as compared with their masses, have justly been considered, of all celestial bodies, the most necessarily subject to the action of any resisting medium there may be in the regions in which they are moved. They are known to be subject to great disturbances, in their orbits, by the attraction of the

(52) Arago, Sur la dernière apparition de la comète de Halley; Annuaire, pour l'an 1836.

(53) The following "poetical license" occurs in the younger Herschel's Treatise on Astronomy, a late work, now used in some of the schools of this country. It contrasts very strangely with the really sane and valuable portions of that work, and it would hardly be supposed possible that it is from the same pen with these. The author is treating of Zodiacal light, upon which he thus fancifully expresses himself. "It is manifestly in the nature of a thin, lenticularly-formed atmosphere, surrounding the sun, and extending at least beyond the orbit of Mercury and even Venus, and may be conjectured to be no other than the denser parts of that medium, which, as we have reason to believe, resists the motion of comets; loaded, perhaps, with the actual materials of the tails of millions of those bodies, of which they have been stripped, in their successive perihelion passages, and which may be slowly subsiding into the sun"!

planets of the solar system; and revolving as they do in ellipses of great eccentricity, many of these bodies having their aphelions at such immense distances as are not readily appreciable, by any of our methods of computation, their motions are much less subject to rigorous demonstration than those of the planets.(54) Still so much confidence had Prof. Encke in the conclusions he had been able to draw, in the paper we have mentioned, that the movements of all these bodies which have been visible since its publication have been observed with increased care and assiduity; while the most rigid investigations of their former movements have not been overlooked.

According to Prof. Encke, the comet which bears his name, in its several revolutions, between 1786 and 1819, exhibited a mean decrease in the times of those revolutions. Now, as resistance, from an ethereal medium, would have the effect, by diminishing the velocity of the comet, to lessen its centrifugal force, and thus force it down nearer the sun, it follows that precisely the result which Encke observed, would be the effect of such resistance. To the agency of ether, therefore, was this diminution ascribed, though not until after all other circumstances which were supposed to have had any agency in the result had been carefully considered. Biela's comet, or the comet of six years and three quarters, was also observed with reference to this action of resisting ether; as was, finally, the comet of Halley, whose last disappearance was in 1836. These three are the only ones, of all that have been seen, whose regular, periodical return is known, at the present day. The acceleration in the mean motion of Encke's comet if not due to the resistance of ether, is still unexplained. Biela's comet, in its return, in 1832, was also retarded, "but it throws new perplexity upon the question of a resisting medium. Encke and Gauss find a diminution of nine tenths of a day

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(54) Too many authors of just renown, have overlooked perspicuity, and written vaguely, upon this point. Brewster, (Encyclopedia,) has not wholly escaped the charge of sacrificing philosophical accuracy to euphony, in the following: "Traversing unseen the remote portion of its orbit, the comet wheels its ethereal course far beyond the limits of our system. What regions it there visits, or upon what destination it is sent, the limited powers of man are unable to discover. After the lapse of years, we perceive it again returning to our system, and tracing a portion of the same orbit round the sun, which it had formerly described." If it leave the sphere of our sun's attraction must it not of necessity, gravitate to some other body, and be thus prevented from ever returning? Laplace, (Système du Monde,) has been more careful. "Innumerable comets, after having approached the sun, are elongated from it to such distances as to prove that its empire extends much beyond the known limits of our planetary system."

in the observed duration of its period, due to this resistance. Valz, from the computations of Damoiseau, finds this diminution to be eight tenths. Prof. Santini, from his own elements finds four tenths, while Encke's formula and constant, for computing this acceleration, only accounts for a diminution of three hundredths of a day. The mean of the three results would show that Biela's comet experiences the resistance of a medium twenty-five times as powerful as that which is encountered by Encke's comet."(55) Halley's comet remains to be noticed. We have seen that the two above were accelerated, though very unequally, the cause of which was supposed to be the resisting ether. But Halley's comet, in its return to its perihelion, in 1835, was, from some cause, detained beyond its time for arriving at that point—a result directly opposite to that in the case of the other two bodies. "In traversing a resisting ether the comet of Halley would have arrived at its perihelion, in 1835, sooner than if moving in a void; now on the contrary, according to the calculations of M. Rosenberg, that body, by observation, was *six days* behind its time, according to the results of calculations disconnected from any allowance for the action of resisting ether. The difference, though much less, found by M. Pontecoulant, is of the same kind! Hitherto, then, the last appearance of Halley's comet has added nothing to our knowlege of the phyical constitution of the celestial spaces."(56)

We have said the acceleration of these bodies is unaccounted for: so is the retardation; but we shall presently see whether other agents than ether may, within the bounds of probability, be supposed to give rise to these. Clairaut, in announcing to the French Academy, in 1758, that the then expected return of Halley's comet would be retarded six hundred and eighteen days beyond its previous period, by the combined action of Jupiter and Saturn, adds that, "a body which traverses regions so elongated from the sun, and which escapes, for so long periods, from our view, may be subject to forces totally unknown; such as the action of other comets, or even of planets, so distant from the sun as to have remained hitherto undiscovered."(57) Uranus was unknown until 1781, twenty three years after this announcement; and four other planets, belonging to our system, have been discovered within the present century—in all

(55) S. C. Walker, Preface to Herschel's Astron.
(56) Arago, Annuaire, pour l'an 1836.
(57) Laplace, Systême du Monde, p. 214.

five since Clairaut penned his suggestion. The masses of the several planets, upon which so much depends in these investigations, appear more or less imperfectly known. Laplace gives the following table of them, that of the sun being taken for unity.(58)

Mercury, ...	$\frac{1}{2025810}$
Venus, ...	$\frac{1}{405871}$
The Earth, ...	$\frac{1}{354936}$
Mars, ...	$\frac{1}{2546320}$
Jupiter, ...	$\frac{1}{1070,5}$
Saturn, ...	$\frac{1}{3512}$
Uranus, ...	$\frac{1}{17918}$

Pontecoulant, from the same unit, gives the several masses of the same planets thus:

Mercury, ...	$\frac{1}{1909706}$
Venus, ...	$\frac{1}{401839}$
The Earth, ...	$\frac{1}{356354}$
Mars, ...	$\frac{1}{2680337}$
Jupiter, ...	$\frac{1}{1053,924}$
Saturn, ...	$\frac{1}{3512}$
Uranus, ...	$\frac{1}{17918}$

These values, says our author, appear to us the most exact which have hitherto been obtained of the planetary masses. It will be observed that these two tables agree only in the masses of Saturn and Uranus; and of these Pontecoulant says it is very probable they need correcting, and that observations to determine that fact are in progress.(59) This was in 1834. Since that period this great geometrician has had cause to change his views in relation to some of these values. In calculating the perturbations of Halley's comet, he has made use of the following values, namely:(60)

Jupiter, ...	$\frac{1}{1048,69}$
Saturn, ...	$\frac{1}{3500,2}$
The Earth, ...	$\frac{1}{357500}$

These values, it will be seen, do not accord with those in either of the above tables. In the calculations here referred to, the action of Venus, Mercury and Mars was neglected as insensible. But a German geometrician, Rosenberg, on the contrary, has announced

(58) Laplace, Système du Monde, p. 210.

(59) Théorie Analytique du Système du Monde, tome 3, p. 341, et suiv.

(60) Connaissance des Tems, pour l'an 1838.

that the action of these three bodies, neglected as insensible by Pontecoulant, was sufficient to produce an acceleration of six days and one third in the return of Halley's comet.(61) With all these uncertainties respecting the larger known planets of our system, we must not forget that the masses of the four new planets are in no degree known, beyond the fact that, compared with some of the older ones, they are very small. But still, small as they are, they are probably capable of exercising an influence, according to relative position, distance, &c. upon bodies as easily disturbed as comets; and yet no sane attempt at a demonstration of the amount of such influence can be made, in the present state of our knowlege, for want of the necessary data. Brewster, in endeavoring to account for the lost comet of 1770, supposed, what indeed the subsequent investigations of Laplace have rendered wholly improbable, namely, that one of these new planets had arrested that body in its course, and added it to its own mass.(62) We have seen that the mass of Uranus, as well as of other planets, is unsettled: the number of its satellites is equally so. Herschel enumerates six. Laplace says powerful telescopes are necessary to perceive the second and the fourth, and that the published observations of Herschel upon the other four are too few to determine the elements of their orbits, or even incontestibly to assure us of their existence.(63) The younger Herschel says, of these satellites, "two undoubtedly exist, and four more have been suspected."(64)

The immense periods of time consumed by some comets in performing their stated revolutions, are sufficient to convince us that the space beyond the orbit of the most distant planet now known to us, and within which moving bodies gravitate to our sun, is such that its extent could not easily be computed by any of our habitual methods. Whether planets still undiscovered by us are revolving there, in orbits beyond that of Uranus, is wholly unknown to us, and this ignorance of ours, while it continues, must involve in uncertainty the movements of all such comets as have their aphelions within the regions in question. The changes in the form and bulk of these bodies, in calculations so minute as have been attempted, to establish this theory of resistance, deserve attention. If, as appearances in-

(61) Arago, Annuaire pour l'an 1836.
(62) Edinburgh Encyclopedia, article Comets.
(63) Système du Monde, p. 46.
(64) Astronomy, p. 282.

dicate, portions of the small masses of these bodies are occasionally removed from the nucleus or its vicinity to form the tails, which are sometimes extended to enormous lengths, while at others these portions of matter are reassembled around the nucleus, in whole or in part, these changes, by shifting the centre of gravity of the cometary body, must effect the action of foreign bodies thereon, and consequently influence the comet's motions. One other source of uncertainty, and one too which it would seem must forever remain such, in the movements of comets, is their action upon each other. To remove this source of errour no less would seem to be required than to identify every comet belonging to our solar system; to know the mass of each, the elements of the orbit it describes, as well as the elements of all those which perturbations may cause it hereafter to assume; and to weigh all its disturbing forces with such accuracy as to be able to determine its place, relatively to the sun and to every other body, at any given point of time. May not these numerous and active causes very well account, not only for the inequalities we have observed in the motions of comets, but even for much greater and more numerous ones, without the aid of a resisting medium? Some of these taken singly would, indeed, produce only slight results; but when it is considered that "in the immense ellipse described by a comet, the imperfection of analysis obliges the geometrician to follow that body step by step, as it were, without once losing sight of it for a single moment" throughout its revolutions, they may readily enough be supposed to cause greater deviations from calculated periods than "three one hundredths of a day," or less than forty-four minutes in a term of six years and three quarters. Pontecoulant deems it impossible, in the present state of science, to determine within one or two days, the instant of the passage of a comet through its perihelion; so very uncertain are the elements which astronomy furnishes for calculating their perturbations.(65)

Having thus submitted the leading positions and arguments favourable to the theory of a resisting medium in the celestial regions, to detailed examination, the whole, according to the views we have taken, may be resolved into the following heads:

1st. That in periods of the most remote antiquity there prevailed a belief in the presence of ether in the celestial regions; but the proof, if any, upon which this belief was founded has not been pre-

(65) Connaissance des Tems, pour l'an 1838, p. 119.

served to us; nor are we better circumstanced, in reality, with regard to the basis of the faith of Alhazen, Tycho Brahe, Kepler, &c., in regard to this subject: but this belief we must not forget, was not coupled, so far as we have seen, with the theory of resistance.

2d. That when the Cartesian theory arose, this ether, being an indispensable agent thereof, was every where believed in; not, indeed, as a resisting medium, but as a propelling one, which carried the planets forward in their orbits: this faith came to the ground with the doctrine of which it formed a part.

3d. When the laws of universal gravitation had exposed the errours of the Cartesian system, we find Newton still vaguely imagining of and concerning this substance, but in language so indistinct as not always to be definable; at one time supposing it to be the cause of gravity, and at other times, by its unequal density, mechanically giving direction to the motions of the heavenly bodies: the errour of these views is apparent.

4th. The ingenious arguments of Bossut, which took the prize of the French Academy, in 1762, were supposed to have well shown the resisting agency of this ether, in the acceleration of the moon's mean motion; and no doubts of the truth of this arose, until Laplace demonstrated that such acceleration is wholly due to the law of universal gravitation.

5th. That this ether has offered to the movements of comets a resistance which has rendered its agency appreciable. If the objections that have been offered against this are valid, they are much more than sufficient to destroy even its plausibility.

If the conclusions at which we have arrived, then, be correct, we have shown that the existence of this ethereal medium was for a long series of years believed in, without evidence known to us; that it has been, during another long series of years, even to the present day, accredited, also, upon different points of evidence, at different periods of time, but all which evidence has failed to sustain the fact of its existence; and that, therefore, to be hereafter adhered to, fresh evidences of its truth will be requisite to render it more than a mere hypothesis, or gratuitous assumption: not that its existence has been disproved; but only that confirmatory evidence of that existence no longer remains.

The predictions, therefore, that have pointed at the destruction of the solar system, through the agency of a resisting ether, may very well be discarded. Inequalities there certainly are, in the motions of the heavenly bodies; but all these are confined within narrow limits, and they constantly oscillate around a mean position. This ensures the stability and duration of the system. Many of them, indeed, extend through vast periods of time, for their accomplishment; but they are all the necessary consequences of the ascertained laws of gravity, and can never exceed their known limits. They constitute, in the sublime language of Pontécoulant, "immense pendulums of eternity, which beat the ages as ours do the seconds!"

Art. II.—*Sketch of the Early History of Count Rumford, in which some of the mistakes of Cuvier, and others of his biographers, are corrected;* by John Johnston.

Read before the Natural History Society of the Wesleyan University, June 30th, 1837.

The name of Count Rumford is familiar with every one who is at all acquainted with the progress of science and the arts, during the last half century. It is not however generally known, that Cuvier's Historic Eulogy* of this distinguished individual, and the short memoirs of him in our Encyclopedias and other standard works, so far at least as "they relate to that part of his life which was spent in America, are *very defective*, and in many respects *materially erroneous*."†

My attention was first drawn to this subject by observing the discrepancies in these memoirs with regard to the time and place of his

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* Eloge Historique de Comte de Rumford lu dans le séance publique de L'Institute de France, le 9 Janvier, 1815.

† Hon. Josiah Pierce, of Gorham, Me., who is a nephew of Count Rumford, and to whom I am indebted for most of the information contained in this paper.

The entire confidence which is to be reposed in the statements of Mr. Pierce, will be seen from the following extract from a private letter of his, which he will pardon me for introducing.

"My father says he was half brother to Benjamin Thompson,—afterwards Count Rumford,—having had the same mother, and was but three and a half years the Count's junior. They lived together in childhood, and my father was in constant correspondence with him up to the time of Rumford's death, in August, 1814. My grandmother lived in my father's house for seven years previous to her death, which occurred June 11th, 1811. The Countess Rumford was often a member of my father's family, and from the lips of the mother, brother, and daughter, I have the facts I am possessed of with regard to Rumford's early life."

birth, and the circumstances attending his departure from this country for Europe at the commencement of the American revolution.

Cuvier, in the paper referred to, says, "Benjamin Thompson, more commonly known by his German title of Count Rumford, was born in 1753, in the English colonies of North America, at a place then called Rumford, and at present Concord, in the state of New Hampshire." Again he says, "in the night of the 18th of April, 1775, the royal troops marched from Boston, and after having fought a first battle at Lexington, proceeded towards Concord; but, being presently assailed by a furious multitude, were obliged to betake themselves to their garrison. Mrs. Thompson's family was attached to the government by several important offices. Her husband, young as he was, had himself received from it some marks of confidence. His personal opinions, besides, led him to support the government. Thus it was natural that he should join the ministerial party with all the fervor of his age, and freely participate in its chances. He therefore returned to Boston with the army, and in such haste, that he was obliged to leave his wife at Concord. Having afterwards to move from place to place he never saw her again, nor was it until after a period of twenty years, that he met [in Europe] the daughter to whom she gave birth a few days after his departure."*

It is not at all surprising that Cuvier, who never was on this side of the Atlantic, should confound Concord, Massachusetts, with Concord, New Hampshire; but it will perhaps be a little difficult to imagine how he could mistake, as we shall presently see he did, on other points, concerning which he seems to express himself with such perfect confidence.

In the Edinburgh Encyclopedia likewise, we are told his birth-place was at Concord, New Hampshire; but in Rees' Cyclopedia it is said, "he was born at the village of Rumford in New England, in the year 1752."

The Encyclopedia Americana, correctly as to place, but erroneously as to time, says, he was born at Woburn, Mass., in the year 1752.

In a short biographical notice of Count Rumford in the Philosophical Magazine, for 1801, his birth-place is said to have been Rumford, Mass.†

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* American Journal of Science, &c. Vol. XIX, p. 28.

† Philosophical Magazine, Vol. IX, p. 135.

It has been my chief object in preparing this paper to correct some of those errors to which I have alluded, and in doing it, I will give a brief sketch of the early history of this distinguished personage. His later history will be found in the works to which reference has already been made.

Benjamin Thompson, better known by his German title of Count Rumford, was born at Woburn, Mass., sixteen miles from Boston, March 26th, 1753. His father and grandfather were farmers in moderate circumstances, and had long resided in Woburn. When he was about eight months old his father died, and in 1755, his mother married Mr. Josiah Pierce, grandfather of the gentleman whose name has already been introduced. A maternal uncle by the name of Joshua Simonds, who also resided in Woburn, was appointed young Thompson's guardian. He continued to live with his mother and father-in-law, from whom he appears to have received every necessary attention, and at the proper age was sent to the grammar school of his native town, then kept by Mr. John Fowle, a gentleman of a liberal education and esteemed an excellent teacher. Here he acquired considerable knowledge of reading, writing, arithmetic, and the Latin language. Subsequently he attended school in Byfield, Mass., and in March, 1764, he removed to Medford to attend the school of a Mr. Hill, then a celebrated teacher. In this place he remained nearly two years, and it was while attending school here that he one day surprised his instructor,* by bringing him the calculations of an eclipse, which he had made without assistance, and which proved to be singularly accurate.

Early in the year 1766, he left the school at Medford and went to live with a respectable druggist and apothecary of Salem, Mass., by the name of John Appleton, being then about thirteen years old. Here he was when the news of the repeal of the stamp act by the British parliament was received in this country, and produced such a sensation of joy throughout the colonies. Partaking largely of the same feeling himself, he undertook to prepare fireworks to be exhibited on the occasion; but in making a preparation of fulminating powder the composition accidentally took fire, and he was so badly burned and otherwise injured by the explosion, that his life was for

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* By some it is said his instructor in mathematics, to whom he brought his calculations of the eclipse, was the Rev. Mr. Bernard. I have no other information with reference to it than that found in the books referred to.

some time despaired of. Having at length partially recovered, he was removed to his step-father's in Woburn; but before he was able to return again to Salem, the non-importation agreement entered into by the Americans had destroyed Mr. Appleton's business, and he was thus thrown out of employment. About this time, that is, when he was about fourteen years of age, he astonished his friends by producing a small piece of engraving which he had executed upon the brass cover of a pocket compass, with no other instrument than one of his own construction. The engraving, it is said, would not do discredit to a professed engraver at the present day, and is now in the possession of his relative in Maine.

The next winter,—the winter of 1768-69,—we find young Thompson teaching school in Wilmington, Mass., it being, I think, his first attempt of the kind; and the following summer he spent in Woburn, attending to the study of anatomy and physiology. In the winter of 1769, he was employed as a clerk in Boston, in the store of Mr. Hopestill Capen, who kept in Union street; but the business not suiting his inclination, he remained there but a few months. Mr. Capen once told his mother, that "he oftener found her son *under* the counter, with gimblets, knife, and saw, constructing some little machine, or looking over some book of science, than *behind* it, arranging the cloths or waiting upon customers." Here he was on the 5th of March, 1770, rendered memorable by the British massacre, as it has been called, and subsequently by the stirring eloquence of Dr. Warren in commemoration of the event. With other young men, whose feelings were powerfully excited by the atrocities of the British soldiery, he was with difficulty restrained from attacking them on the spot.

I may remark here, that Thompson's conduct on this occasion would not seem to favor the assertions of Cuvier and others, who affirm that, in the difficulties that led to the American Revolution, he was from the first, in principle and feeling, attached to the government party. But I shall have occasion to refer to this again.

In the spring of 1770, he returned again to Woburn, and during the summer, in company with his early and constant friend, the late Col. L. Baldwin, of Maine, he walked daily to Cambridge, a distance of nine miles, and back at night, to attend *as a charity scholar* the regular course of philosophical lectures in Harvard University. Speaking of these lectures at a late period of his life, he said he looked upon the few weeks he attended them, as the most delightful of his youthful life; they very much increased his stock of information and confirmed his taste for natural science.

In the autumn of this year (1770) he was invited to instruct a school in Concord, New Hampshire, then called Rumford; and here he closed his career as a schoolmaster in a manner not a little interesting, as in this place the train of circumstances seems to have originated, that eventually tore him from America and gave him to Europe. I allude to his marriage, an event always so productive of happiness or misery, and sometimes of both, as appears to have been the case in the present instance.

Mr. Thompson, soon after taking up his residence in Concord, became acquainted with Mrs. Sarah Rolfe, widow of Col. Rolfe, a lady of wealth and respectability; and their acquaintance resulted in their marriage when he was but nineteen years of age. Mrs. Rolfe was some ten or twelve years older than himself, and for the honor of her hand, Cuvier says he was indebted to his "belle figure, et des manières nobles et douces."

By the relatives of his wife, Thompson was introduced to Mr. Wentworth, then provincial governor of New Hampshire, who was much pleased with him, and bestowed upon him an unusual share of his attention. He soon gave him a major's commission in the militia of the province, and thus placed him at once over many older officers. This appointment must be admitted to have been exceedingly injudicious, but, as it was legal, it afforded no excuse for the feeling of envy and jealousy which was excited against Thompson, and from which all his subsequent difficulties appear to have originated previous to his leaving the country. It was whispered that Major Thompson was a tory; and such were the circumstances of the times, it is not surprising that many should give full credit to the rumor. We have the most satisfactory evidence, however, that up to this time at least, he was firmly attached to the cause of American liberty. As this is a point of some importance, I may be permitted to give my reasons a little in detail.

In the first place, Thompson had always professed strong attachment in principle and feeling to the popular cause, and his friends,*

* In Capt. Parker's company, which was paraded on the green in Lexington upon the approach of the British troops on the morning of the 19th of April, 1775, there were four of the name of Simonds, the maiden name of Thompson's mother.

In the afternoon of the same day, among the killed was *Daniel Thompson* of Woburn.—*Everett's Orations*, pp. 523 and 524.

who espoused the same cause, ever had the utmost confidence in him.

II. His conduct had uniformly been in accordance with his professions. His conduct in Boston on the 5th of March, 1770, has already been referred to,—he was there found sword in hand, among the most eager to attack those whom he considered the enemies of his country. Also, when he learned that his intimacy with Gov. Wentworth was made the occasion of suspicions with regard to the character of his political principles, he at once broke off the intercourse, and even resigned his commission in the militia and retired to his relatives in Woburn. He was present at the battle of Lexington; but whether he participated in the events of the day is to me unknown.

When, after the battle of Lexington, the American forces began to collect about Boston, we find him among them earnestly seeking employment, and on the best terms with the Massachusetts whig officers. When the battle of Bunker Hill occurred, he was with the American army at Cambridge; and on the arrival of Washington the 3d of the next month, to take charge as commander in chief, Thompson was favorably introduced to him by the officers, and would probably have obtained command of the American artillery had it not been for the opposition of some of the New Hampshire officers, who could not forget his former appointment over them by Gov. Wentworth. Jeremiah Gridley was finally appointed to the place.

III. He was formally tried before a committee of investigation, upon the general charge of being inimical to the cause of his country, and acquitted. Failing to obtain a place in the army he returned to Woburn, and such was the feeling of the populace at this time excited against him, that a mob once actually collected around the house in which he was and demanded him. The mob appear to have failed in their immediate object; but the insult his high spirit could not endure, and he at once applied to the committee of vigilance for the appointment of a court of inquiry to investigate his case. He was therefore arrested at his own request, and notice extensively given in the public papers of Massachusetts and New Hampshire, of the time and place appointed for his trial, and all who knew any thing against him were invited to be present and testify. The charge was the general one of being "unfriendly to American liberty." When the day of trial arrived, the committee assembled at the place appointed,—the meeting-house of the first parish in Woburn,—and took their seats before an overflowing house. Thompson managed his own defense; and though he could of course know but little previously of the *specific charges* that would be brought against him, he successively repelled them all, showing that they were based upon vague rumor, or had their origin in envy and jealousy. The committee gave this decision, but they still refused to give him a public acquittal which he demanded. The reason given was that it would give offense to his opponents, as it would be in a sense condemning them. They even refused to give him a copy of their proceedings for publication. This, Thompson very properly thought to be exceedingly illiberal and unjust treatment, and it is not surprising that his feelings were highly exasperated.*

If further proof of Thompson's political feelings previous to this time be wanting, we have the testimony of Col. Baldwin, at whose head quarters he remained while the American army was before Boston, who repeatedly said he knew his political views well, and that he was certain of his sincere attachment to the cause of his country. Another revolutionary officer of unimpeachable integrity, said to Thompson's brother,—or rather half brother,—the late Hon. Josiah Pierce, of Baldwin, Me., some years after the close of the war, that he knew Major Thompson well while he was with the American army at Cambridge in 1775, and that "he was certain his feelings were any thing but hostile to the cause of American liberty." He added further, that while the army was at Cambridge, on more

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* The following is an extract from the original report of the committee of vigilance and correspondence of the town of Woburn, before whom Thompson was tried in 1775, drawn up by one of their number, but which was not permitted to go before the public as Thompson demanded. After a statement of their authority and the prominent circumstances of the case, the committee say, "After a strict and impartial inquiry into Major Thompson's character and behavior, we do not find that *in any instance* he has shown a disposition unfriendly to American liberty, but that, on the contrary, his general conduct has evinced a contrary disposition, and we think he justly deserves the confidence, friendship, and protection of the public."

In a postscript it is added, "This may certify that when Major Thompson was examined before the committee of correspondence for the town of Woburn, (being brought before them on suspicion of being inimical to American liberties,) the affair of the return of four deserters from Concord in New Hampshire, to Boston, in which said Thompson was supposed to be instrumental, and also his conduct relative to the Concord donation,—sending a load of peas to Boston,—and an undue connection or correspondence with Gov. Wentworth, were matters *which were laid* to his charge against him, *which were thoroughly examined into,* and in every particular the committee received full satisfaction from said Thompson."

than one occasion, Washington conferred with him upon important military affairs.

After his acquittal by the committee at Woburn, Thompson notwithstanding was still accused of "toryism" by the populace, and the mob again threatened him, till he at length formed the desperate resolution to quit forever his native country, and espouse the cause of her enemies! He had first, through the envy and jealousy of others, failed of promotion in the army, which appears to have been the highest object of his ambition, and to this had been added gross insult from the populace and injustice from public officers; and he unquestionably considered his personal safety in danger; but, trying as were the circumstances, his decision can hardly be justified. This act, in the eyes of his countrymen at least, must ever remain as a blemish upon his otherwise illustrious character. As remarked by Cuvier, it was unquestionably an evil to fight against his countrymen, but we should perhaps rather lament it as an evil, than impute to him blame.

Having determined to leave the country, Thompson communicated his design to no one but his brother before mentioned, who, taking him in a common horse-cart, started from Woburn in the night, and proceeded with him directly to Rhode Island, where he left him. Thompson soon made his appearance at Newport, and was taken on board the British ship of war Scarborough, in which he sailed for England; and even his mother for months did not know where he was.

The precise time of his departure from the country, I am not able to determine, but his biographers say he was sent to England immediately after the evacuation of Boston by the English troops, which occurred March 24th, 1776, to convey intelligence of that event.

In 1781, he sailed again for New York, where he raised a regiment of dragoons, and was in consequence promoted to the rank of Colonel, and remained connected with the British army till the close of the war, when he again went to Europe never to return. His subsequent brilliant course in the scientific world is well known. Though he had been persecuted from his native country, and been associated with those who for a time at least, were her enemies, yet he ever cherished an ardent affection for the land of his birth. In a letter to a relative written December, 1808, he says, "I never can forget the place of my birth, nor the companions of my early years." In another letter he remarks, "you cannot conceive how much I have the happiness of my native country at heart."

Nor did the American government on its part show an entire disregard for him, when in the year 1800, an important place was offered him, which however his engagements in Europe would not permit him to accept.

He ever took a lively interest in the American Academy of Arts and Sciences at Boston, "and in 1796 he established two biennial prizes of the value of about sixty guineas each, for the most important discoveries in light and heat; the one to be adjudged by the Royal Society of London,* and the other by the American Academy of Arts and Sciences."

Thompson was knighted by George III, immediately after his second arrival in Europe, in 1784, and for several years was known by the title of Sir Benjamin Thompson. Ten or twelve years afterwards, being then resident in Munich, he was created Count of Rumford, in reference to the place of his marriage, by the Elector of Bavaria, and various honors bestowed upon him, and a life pension of £1200.

After his return to Europe in 1784, most of his time was spent in the promotion of science and its application to the useful arts of life, in which, as is well known, he was eminently successful.

Count Rumford was not a learned man but a very close observer, and possessed great mechanical skill, and all his investigations appear to have been directed with a view to the discovery of *practical truths*, and directly benefitting mankind.

Among the imperishable honors that will ever attach to his name, is that of having been the first to suggest the plan of the Royal Institution of London, and of having selected young Humphrey Davy, then only twenty two years of age, to fill the chair of chemistry. This institution was founded in the year 1800, and in establishing it Count Rumford, in connection with other noble spirits in the scientific world, spent nearly a year and a half. Through it has been introduced to the world in the department of chemistry, in the short space of thirty five years, a Davy, a Brande, and a Faraday.

But it would not be in accordance with my design to pursue the history of this distinguished individual further. The last ten years of his life were spent at Auteuil, a small village near Paris. Though he had received many flattering marks of public favor, he had also

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* This medal was awarded by the Royal Society to

Prof. Leslie,	in	1804.	Dr. Wells,	in	1816.
M. Malus,	"	1812.	Dr. Brewster,	"	1818.
Sir H. Davy,	"	1814.	M. Fresnel,	"	1826.

Edinburgh Encyclopedia, Art. SOCIETY.

Whether the American Academy has ever made any award or not I am not informed.

learned something of its fickleness, which appears to have produced some effect upon his mind in souring it against human nature. In 1802, he married the widow of the celebrated Lavoisier, but the union proved unhappy and they soon separated. After this event the most of his time was spent in retirement, till his death which occurred August 21st, 1814.

Count Rumford left an only daughter, who was born, not as Cuvier affirms, at Concord, Mass., shortly after the battle of Lexington, from which her father had retired with the British troops to Boston, but at Concord, New Hampshire, Oct. 10th, 1774. She is still living, and possesses the title of Countess of Rumford, and a liberal pension. Much of her life has been spent in Europe, but she came to this country the last season on a visit to her friends, and I believe is now with them.

Art. III.—*On the Drawing of Figures of Crystals*; by James D. Dana, A. M., Assistant in the department of Chemistry, Geology and Mineralogy in Yale College.

1. The modern and improved methods of projecting the crystalline solids, have not, hitherto, been explained in any American publication; it is therefore presumed that the following exposition of this subject will not be unacceptable to the scientific public. The "Introduction to Crystallography" of H. J. Brooke,* is the only work in our language, which treats of crystallographic projection; and this work though valuable at the time of its publication, and highly reputable to its accomplished author, is necessarily behind a science, which, since its publication, has been so rapid in its advances. The principles embraced in the following pages, have been mostly drawn from the very complete and philosophical German treatise on crystallography by C. F. Naumann.†

2. The importance of accuracy in the delineations of crystals, is obvious. The edges of a crystal, as exhibited in a correct figure, constitute a language readily interpreted by the crystallographer. He reads, in them, the relations of each plane to the axes of the solid and with the preliminary knowledge of a few interfacial angles, (fre-

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* A familiar Introduction to Crystallography, by Henry James Brooke, 508 pp. 8vo, London, 1823.

† Lehrbuch der reinen und angewandten Krystrallographie, von Dr. Carl Friederich Naumann. Two vols. 8vo. Leipzig, 1832.

quently one is sufficient,) ascertains with perfect confidence, every other angle in the crystal. Consequently if these edges were incorrectly represented, the figure would be comparatively useless and unintelligible, and often would prove worse than useless, by leading to incorrect deductions.

Since these deductions depend on the parallelisms of edges, the following principle is of fundamental importance in the drawing of crystals; *edges which are parallel in the crystal should be represented in the figure as parallel.* Figures projected with this principle in view, though with no attempt to attain mathematical accuracy, will be valuable to the science. Yet a knowledge of mathematical crystallography, greatly facilitates the application of this principle. Crystals are often imperfect and the intersections of planes are indistinct, and consequently the exact limits of the planes and the direction of their mutual intersections cannot be observed. They are also frequently so much distorted that some planes are obliterated by the extension of others, and generally it is desirable to introduce in the figure, the plane or planes which may have been thus obliterated. These and other difficulties can only be surmounted by applying the principles of mathematical crystallography, which afford expressions for the planes indicating their exact situation.*

3. In the projection of crystals, the eye is supposed to be at an infinite distance, so that the rays of light fall from it on the crystal in parallel lines; otherwise the more distant parts of parallel edges should *converge,* as in the ordinary sketches of scenery. If parallel lines were drawn from the vertices of the solid angles of a crystal, to a board placed behind it, and the points thus formed on the board, were connected by straight lines, as in the crystal, a representation of the crystal would be formed, constructed according to the mode of projection employed in crystallography. The plane on which the crystal is projected, is termed the *plane of projection.* This plane may be at *right angles* with the vertical axis, may pass *through* the vertical axis, or may intersect it at an *oblique angle.* These different positions give rise, respectively, to the *horizontal, vertical* and

* With but an *imperfect* knowledge of these principles, it becomes a simple process to project the axes of their relative dimensions and exact obliquity, and after this preparation, to lay off with accuracy, the situation and intersections of the various secondary planes. Indeed, the *projection of the axes* in each of the systems of classification excepting perhaps the clinate, may be easily understood without any acquaintance with mathematical crystallography, and the subsequent construction of the secondary forms requires only a familiarity with the system of crystallographic notation.

oblique projections. The rays of light may fall *perpendicularly* on the plane of projection, or may be *obliquely* inclined to it; in the former case the projection is termed *orthographic,* in the second *clinographic.* In the horizontal position of the plane of projection, the projection is always orthographic. In the other positions, it may be either orthographic or clinographic. It has been usual to give the plane of projection an oblique position, and to use the orthographic mode of projection. It is however preferable to employ the vertical position and clinographic projection, and this method will be elucidated in the following remarks.

PROJECTION OF THE PRIMARY FORMS.

4. The projection of the axes of a crystal, is the first step preliminary to the projection of the crystal itself. It will be more convenient, to illustrate first the projection of the axes in the monometric primaries, which are equal and intersect at right angles. The projection of the axes in the other classes, may be obtained by varying the lengths of the projected monometric axes, and also, when oblique, their inclinations.

5. 1. *Monometric system.**—When the eye is directly in front of a face of the cube, neither the sides nor top of the crystal are visible, nor the secondary planes that may be situated on the intermediate edges. On turning the crystal a few degrees from right to left, a side lateral plane is brought in view, and by elevating the eye slightly, the terminal plane becomes apparent. Half the planes on the crystal are now visible, and consequently this is a convenient

* The systems of crystallization at present recognized, are seven in number.

The *Monometric* includes the cube, regular octahedron and dodecahedron, the three crystallographic axes of which are of *one* kind, and intersect at right angles.

The *Dimetric* system includes the right square prism and square octahedron, the axes of which are rectangular and of *two* kinds, the vertical being unequal to the lateral.

The *Trimetric* system includes the right rectangular and rhombic prisms, and the rectangular and rhombic octahedrons, the axes of which primaries are rectangular, and *unequal,* or of *three* kinds.

The *Monoclinate* system includes the right rhomboidal prism and the oblique rhombic prism, in which, two of the intersections of the axes are rectangular and *one oblique.*

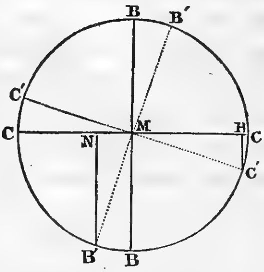
The *Diclinate* system includes the oblique rectangular prism, in which one of the intersections of the axes is rectangular and *two oblique.*

The *Triclinate* system includes the oblique rhomboidal prism, in which the *three* intersections of the axes are *oblique.*

The *Tetraxonal* system includes the rhombohedron and hexagonal prism, which contain four axes, viz. three horizontal and one vertical.

position for projecting it. In the following demonstration the angle of revolution is designated δ, and the angle of the elevation of the eye, ε. Fig. 1. represents the normal position of the horizontal axes, supposing the eye to be in the direction of the axis BB; BB is seen as a mere point, while CC appears of its actual length. On revolving the whole through a number of degrees equal to BMB' (δ) the axes have the position exhibited in the dotted lines. The projection of the semiaxis MB is now lengthened to MN, and that of the semiaxis MC is shortened to MH. Since the angle $HMC'=MB'N=\delta$, $MH=\cos\delta$ and $MN=\sin\delta$; and if the ratio of the projected axes be as

Fig. 1.



$$r:1,\ MH:MN::\cos\delta:\sin\delta::r:1;$$

$$\therefore \cos\delta = r\sin\delta,$$

and consequently, $\cot\delta = r.$

If the eye be elevated, the lines $B'N$, BM and $C'H$ will be projected respectively below N, M and H, and the lengths of these projections (which we may designate $b'N$, bM and $c'H$) will be directly proportional to the lengths of the lines $B'N$, BM and $C'H$. Now $B'N=\cos\delta$, and bM, the projection of BM, $=\tan\varepsilon$; consequently,

$$BM(=1) : \tan\varepsilon :: \cos\delta\,(B'N) : b'N \text{(the projection of } B'N).$$

Hence, $b'N = \tan\varepsilon\cos\delta.$

In the same manner we find $c'H = \tan\varepsilon\sin\delta.$

If the relation of $b'N$ to MN ($=$the first projection$=\sin\delta$) equals $\frac{1}{s}$

$$\tan\varepsilon\cos\delta\,(b'N) = \frac{1}{s}\sin\delta;$$

consequently, $\tan\varepsilon\cot\delta = \frac{1}{s}:$

and finally, since $\cot\delta = r,$

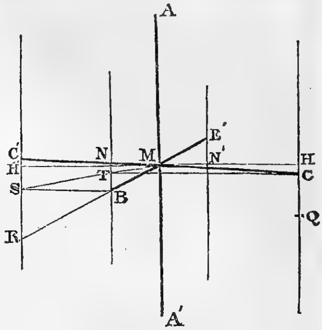
$$\cot\varepsilon = rs.$$

6. The preceding demonstration affords the following simple method of projecting the monometric axes; r is supposed to be given equal to 3, and s equal to 2.

1. Draw two lines AA', $H'H$ (fig. 2.) intersecting one another at right angles. Make $MH=MH'=b$. Divide HH' into r parts, and through the points, N, N', thus determined, draw perpendicu-

lars to HH'. On the left hand vertical, set off, below H', a part $H'R$, equal to $\frac{1}{s}b=\frac{1}{s}H'M$; and from R draw RM, and extend the same to the vertical N'. $B'B$ is the projection of the front horizontal axis.

Fig. 2.



2. Draw BS parallel with MH', and connect S, M. From the point T in which SM intersects BN, draw TC parallel with MH. A line (CC') drawn from C through M, and extended to the left vertical, is the projection of the side horizontal axis.

3. Lay off on the right vertical, a part HQ equal to $\frac{1}{r}$ MH, and make $MA=MA'=MQ$; AA' is the vertical axis.

Proof. 1. By construction, MN (the first projection of the semi-axis BM, N being in the line HH') : MH(the first projection of MC) :: $1 : r$, which is the ratio required in the preceding demonstration. Again, by construction, $BN : NM :: RH' : H'M :: 1 : s$, therefore BN (the second projection of BM)$=\frac{1}{s}$ MN, which is also the ratio required above. BB' is therefore correctly the front horizontal axis.

2. From the method of construction,

$$H'S(=BN) : TN(=HC) :: H'M : NM :: \cos\delta : \sin\delta.$$

Therefore HC is the true depression of the axis CC'; for in the preceding demonstration, the depressions were proved to equal respectively $\tan\varepsilon\cos\delta$ and $\tan\varepsilon\sin\delta$, and consequently to have the ratio of $\cos\delta : \sin\delta$.

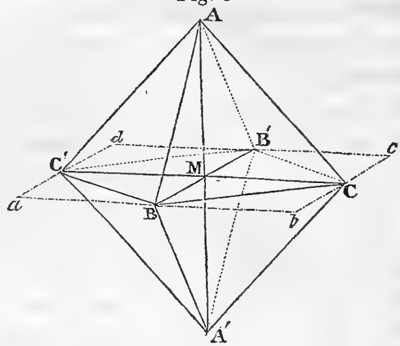
3. $MH=\cos\delta$ and HQ is the sine of the same angle. MQ is therefore the radius in the same circle (fig. 1.) and equals the vertical semiaxis; for the position of the eye does not change the apparent length of this axis, since it is situated in the plane of projection.

AA', $C'C$, BB', are therefore the projected monometric axes.

The values of r and s, commonly taken are, $r=3$, $s=2$, in which case, δ : 18° 26′ and $\varepsilon=9°$ 28′. It is not unusual to give s the value 3, in which case $\varepsilon=6°$ 20′. This affords a narrower terminal plane.

7. The regular octahedron may now be drawn, by connecting the extremities of the horizontal axes, and then uniting them by right lines with the points A, A', as in fig. 3. If lines be drawn

Fig. 3.



through the points B and B', parallel with CC', and through C, C', parallel with the axis BB', a plane figure *abcd* is formed, which is a horizontal section of the cube. Through the points a, b, c, d, draw lines parallel with the vertical axis AA', and extend them each side of these points, to a distance equal to the vertical semi-axis MA. By connecting the upper and also the lower extremities of these perpendiculars by lines parallel with the lines *ab*, *bc*, *cd*, *da*, the figure will represent a cube.

The cube may also be projected by drawing lines from M to the center of each edge of the octahedron, and then extending these lines to double their length. Their extremities are the vertices of the angles of the cube; and by connecting them a representation of the cube is formed.

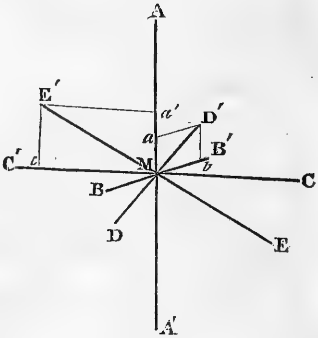
8. *Dimetric System.*—In the dimetric system of crystallization, the vertical axis is of varying dimensions, while the horizontal axes are equal as in the monometric system. The vertical axis may be made to correspond to the dimensions in a dimetric crystal, by laying off on MA and MA', (taken as units,) extended if necessary, a line equal to $\frac{a}{b}$; or if b, the horizontal axis of the prism, $=1$, the line should equal a (the vertical axis) merely. After determining thus the points A'', A''', the dimetric octahedron may be formed in the same manner as the regular octahedron above described, except that the points A'', A''' should be substituted for A, A'. The method of describing the cube, already explained, may be employed also for the right square prism. Another right square prism may be represented by drawing lines parallel with the vertical axis, through the extremities of the horizontal axes, making them equal to the vertical axis, and uniting their extremities. Also another square octahedron may be constructed by connecting the points a, b, c, d, with the extremities of the vertical axis.

9. *Trimetric System.*—The monometric axes may be adapted to trimetric forms as follows: if the axis $b=1$, lay off MA'' and

MA''' equal to a, and MC'', MC''' equal to c: if $c=1$, make MB'', MB''', equal to b. By connecting the extremities of the axes, as already explained, the rhombic octahedron may be constructed. The rectangular prism may be projected, in the same manner as the cube; the rhombic prism in the same manner as the second square prism just described; and the rectangular octahedron, in the same manner as the second dimetric octahedron explained in the last section.

10. *Monoclinate System.*—The axes a and b in the monoclinate system are inclined to one another at an oblique angle$=\gamma$. To project this inclination, and thus adapt the monometric axes to a monoclinate form, lay off on the axis MA, $Ma=MA \cos\gamma$, and on the axis BB' (before or behind M according as the inclination of b on a, in front, is acute or obtuse) $Mb=MB\times\sin\gamma$. From the points b and a, draw lines parallel respectively with the axes AA' and BB' and from their intersection D', draw through M, $D'D$, making $MD=MD'$. The line DD' is the front lateral axis, and the lines AA, $C'C$, DD' represent the axes in a monoclinate solid in which $a=b=c=1$. The points a and b and the position of the axis DD' will vary with the angle γ. The relative values of the axes may be given them as above explained; that is, if $b=1$, lay off in the direction of MA and MA' a line equal to a, and in the direction of MC and MC' a line equal to c, &c.

Fig. 4.



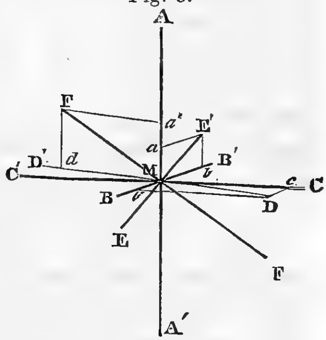
The right rhomboidal prism may be projected in the same manner as the cube or right rectangular prism, and the oblique rhombic prism, in the same manner as the right rhombic prism.

11. *Diclinate System.*—In the diclinate system, the vertical sections through the horizontal axes intersect one another at right angles, as in the preceding system, but the inclination of a to b (γ) and a to c (β) are each oblique. This obliquity may be given the monometric axes as follows: Lay off on MA, (fig. 4,) $Ma=MA\times\cos\gamma$, and on the axis BB' (brachydiagonal), $Mb=MB'\times\sin\gamma$. By completing the parallelogram $MaD'b$, the point D' is determined. Make $MD=MD'$; DD' is the projected brachydiagonal. Again lay off on MA, $Ma'=MA\times\cos\beta$, and on MC', to the left, $Mc=MC'\times\sin\beta$. Draw lines from a' and c parallel to MC' and MA; E', the

intersection of these lines, is one extremity of the macrodiagonal; and the line $E'E$, in which $ME=ME'$, is the macrodiagonal. AA' DD', EE' are the axes in a diclinate form in which the axes are equal. From the observations on the preceding systems of crystallization, the method to be employed in giving the axes their relative values in a particular diclinate form, is sufficiently obvious. The construction of the oblique rectangular prism is analogous to that of the cube.

12. *Triclinate system.*—The vertical sections through the horizontal axes, in the triclinate system, are obliquely inclined; also the inclination of the axis a to each axis b and c, is oblique. In the adaptation of the monometric axes to the triclinate forms, it is therefore necessary, in the first place, to give the requisite obliquity to the mutual inclination of the vertical sections, and afterwards, to adapt the horizontal axes, as in the diclinate system. The inclination of these sections we may designate A, and as heretofore, the angle between a and b, γ, and a and c, β. BB' is the analogue of the brachydiagonal and CC' of the macrodiagonal. An oblique inclination may be given the vertical sections, by varying the position of either of these sections. Permitting the brachydiagonal section $ABA'B'$ to remain unaltered, we may vary the other section as follows:

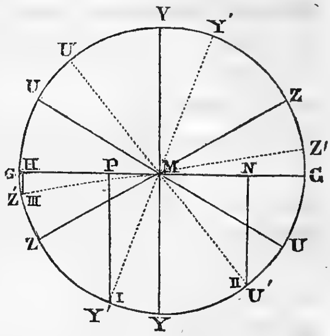
Fig. 5.



Lay off on MB, $Mb'=MB\times\cos A$, and on the axis $C'C$, (to the right or left of M, according as the acute angle A is to the right or left) $Mc=MC\times\sin A$; completing the parallelogram $Mb'Dc$, and drawing the diagonal MD, extending the same to D' so as to make $MD'=MD$, we obtain the line DD'; the vertical section passing through this line is the correct macrodiagonal section. The inclination of a to the new macrodiagonal DD', is still a right angle; as also the inclination of a to b, their oblique inclinations may be given them by means of the same formulas employed in the diclinate system, except that the axis $D'D$ is to be substituted for $C'C$. The vertical axis AA' and the horizontal axes EE' (brachydiagonal) and FF' (macrodiagonal) thus obtained, are the axes in a triclinate form in which $a=b=c=1$. Different values may be given these axes according to the method heretofore illustrated.

13. *Tetraxonal system.*—This system of crystallization includes those forms which contain three equal horizontal axes, at right angles with the vertical. The normal position of the horizontal axes is represented in fig. 6. The eye, placed in the line of the axis YY, observes two of the semiaxes, MZ and MU, projected in the same straight line, while the third MY appears a mere point. To give the axes a more eligible position for a representation of the various planes on a tetraxonal solid, we revolve them from right to left through a certain number of degrees, δ, and elevate the eye at an angle ε. The dotted lines in the figure represent the axes in their new situation, resulting from a revolution through a number of degrees equal to $\delta = YMY'$. In this position the axis MY' is projected upon MP, MU' upon MN and MZ' on MH. Designating the intermediate axis I, that to the right II, that to the left III, if the revolution is such as to give the projections of I and II, the ratio of 1 : 2, the relations of the three projections will be as follows: I : II : III $=1:2:3$.

Fig. 6.



The projection of

$\text{I} = \sin \delta.$

$\text{II} = \sin(60^\circ - \delta)$, for $MU'N = U'MY = YMU - UMU' = 60^\circ - \delta.$

$\text{III} = \sin(60^\circ + \delta).$

From these equations and the above ratios, it follows that,

$$\sin(60^\circ + \delta) = \sin(60^\circ - \delta) + \sin \delta;$$
$$\sin(60^\circ - \delta) = 2 \sin \delta;$$
$$\sin(60^\circ + \delta) = 3 \sin \delta.$$

Consequently since (Trig. Anal.)

$$\sin(60^\circ + \delta) = \sin 60^\circ \cos \delta + \sin \delta \cos 60^\circ = 2 \sin \delta;$$
$$\sin(60^\circ - \delta) = \sin 60^\circ \cos \delta - \sin \delta \cos 60^\circ = 3 \sin \delta.$$

Adding the equations we obtain

$$2 \sin 60^\circ \cos \delta = 5 \sin \delta;$$

Whence $\tan \delta = \dfrac{2 \sin 60^\circ}{5} = \dfrac{2\sqrt{\frac{3}{4}}}{5} = \dfrac{\sqrt{3}}{5};$

$$\therefore \cot \delta = 5\sqrt{\tfrac{1}{3}}.$$

From this equation we may deduce

$$\sin \delta = \sqrt{\tfrac{3}{28}};$$
$$\therefore \delta = 19^\circ\ 6'\ 24''.$$

If the eye be elevated above the horizontal plane, the lines PY', NU', HZ' will be projected below GG. The lengths of these projections are in direct ratio to the lines projected.

To obtain the values of PY', NU', HZ', we observe that

$$PY'=\cos\delta;\ NU'=\cos(60^\circ-\delta);\ HZ'=\cos(60^\circ+\delta).$$

Whence, since $\cos=\sqrt{(R^2-\sin^2)}$,

$$\cos\delta=\sqrt{(1-\sin^2\delta)}=5\sqrt{\tfrac{1}{28}};$$
$$\cos(60^\circ-\delta)=\sqrt{(1-4\sin^2\delta)}=4\sqrt{\tfrac{1}{28}};$$
$$\cos(60^\circ+\delta)=\sqrt{(1-9\sin^2\delta)}=\sqrt{\tfrac{1}{28}}.$$

From these equations, the following relations result:

$$PY' : NU' : HZ' :: 5 : 4 : 1,$$

which, therefore, is also the ratio of the projections of these lines below GG consequent on an elevation of the eye at any angle ε.

If the second projection of the semiaxis I $(y'P)$, $=\frac{1}{s}$ part of PM (the first projection),

$$\cot\varepsilon=s\cot\delta=5\,s\sqrt{\tfrac{1}{3}}.$$

For if PY' be made radius in the two triangles $PY'y'$ and PYM, we shall have $Py'=\tan\varepsilon$, and $PM=\tan\delta$. But $Py' : PM : 1 : s$; consequently $\tan\varepsilon : \tan\delta :: 1 : s$;

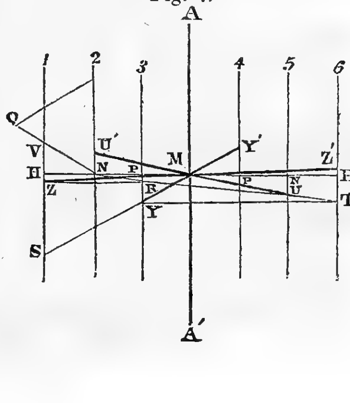
$$\tan\varepsilon=\frac{\tan\delta}{s};$$

$$\therefore\ \cot\varepsilon=s\cot\delta.$$

In general it is most convenient to assume 2 as the value of s; then $\varepsilon=9^\circ\ 50'$. If $s=\sqrt{3}$, $\varepsilon=11^\circ\ 18{\cdot}5'$.

14. *Projection of the axes.*—The above demonstration affords a method of projecting the tetraxonal axes, which is similar to the method in the monometric system. We may assume $r=3$, $s=2$.

Fig. 7.



1. Draw the lines AA, HH at right angles with, and bisecting each other. Let $HM=b$, or $HH=2\,b$. Divide HH into six parts by vertical lines. These lines including the left and right hand verticals may be numbered from one to six as in the figure. In the first vertical, below H, lay off $HS=\frac{1}{s}\,b$, and from S

draw a line through M to the fourth vertical. YY' is the projection of the axis I.

2. From Y draw a line to the sixth vertical and parallel with HH. From T the extremity of this line, draw a line to N in the second vertical. Then from the point U in which TN intersects the fifth vertical, draw a line through M to the second vertical; UU' is the projection of the axis II.

3. From R, where TN intersects the third vertical, draw RZ to the first vertical parallel with HH. Then from Z draw a line through M to the sixth vertical: this line ZZ' is the projection of the axis III.

4. For the vertical axis, we observe in fig. 6. that $Z'H = \sin (30° - \delta) = \cos (60° + \delta)$; also $MH = \cos (30° - \delta) = \sin (60° + \delta)$. But $\sin (60° + \delta) : \cos (60° + \delta) = 3\sqrt{3} : 1 = 3 : \tan 30°$.

Consequently $\frac{1}{3} MH : Z'H :: 1 : \tan 30°$, or $Z'H$ equals tan 30°, in a triangle whose base is $\frac{1}{3} MH$. If therefore we lay off from N on the second vertical (fig. 7.) a line of any length and construct upon this line an equilateral triangle, one side NQ of this triangle will intersect the first vertical at a distance, HV, from H, corresponding to $Z'H$ in fig. 6.; for in the triangle NHV, the angle HNV is an angle of 30° and $HN = \frac{1}{3} MH$. MV is therefore the radius of the circle (fig. 6.) Make therefore $MA = MA' = MV$; AA' is the vertical axis, and YY', UU', ZZ' are the projected horizontal axes.

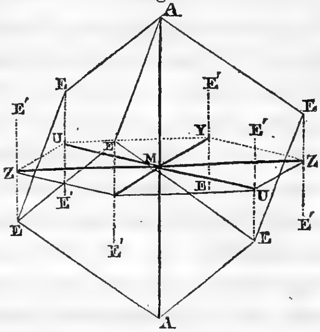
The explanation of this construction, is obvious from the preceding demonstration, and from the remarks under the monometric system.

15. The vertical axis has been constructed equal to the horizontal axes. Its length in the several tetraxonal primaries may be laid off according to the method sufficiently explained. If lines be drawn through the extremities of the horizontal axes, parallel with the vertical axis, and the parts above and below be made equal to the vertical semiaxis, their extremities will be the vertices of the angles of a *hexagonal prism*, and by connecting them, we obtain the projection of this solid. A double hexagonal pyramid, the isosceles dodecahedron, may be projected by connecting the extremities of the horizontal axes with each other and also uniting them with the extremities of the vertical axis. By drawing lines through the extremities of each horizontal axis, parallel to a line connecting the extremities of the other two axes, a plane hexagonal figure will be obtained which is the section of a hexagonal prism diagonal with the one above referred to; and by connecting the angles of this

hexagonal plane with the extremities of the vertical axis, a *second* isosceles dodecahedron is projected.

16. To construct a rhombohedron, lay off verticals through the extremities of the horizontal axes, and make the parts, both above and below these extremities, equal to the third of the vertical semiaxis, (fig. 8.) The points E, E, E′ E′ &c. are thus determined; and if the extremities of the vertical axis be connected with the points E or E′, rhombohedrons, in different positions, m R or $-m$ R, will be constructed.

Fig. 8.



Delineation of Secondary Planes on the Primary Forms.

17. Previous to drawing the secondary planes on a primary, it becomes necessary to determine the direction of the intersections of these planes with the primary faces, and also in most cases, with other secondary planes. The principles of analytical geometry have afforded Naumann formulas for these intersections; but it would be giving this article too great an extension to enter into a full discussion of this method of determining intersections. It is in general sufficient to employ the method of construction. This method has been fully explained by Brooke, but in connection with the Abbé Haüy's system of crystallographic notation.

In the employment of the plan of construction, the projection of the prism $0P . \infty P\infty$, is the most convenient preliminary step; that is, the cube in the monometric system, right square prism in the dimetric system, the rectangular prism in the trimetric, the right rhomboidal in the monoclinate, and the prism $0P . \infty\bar{P}\infty . \infty\breve{P}\infty$, in the diclinate and triclinate systems.* This is advisable because in these forms the lateral edges are equal and parallel to the vertical axis, and the basal edges, to the horizontal axes; and consequently in laying off the different planes, these edges may be substituted for the axes.

* The system of notation here adopted, is that employed by Naumann. It will be found explained and illustrated in my system of Mineralogy.

18. Suppose for example the right rectangular prism has been projected, (fig 9.) and it is required to place on its angles the plane 2P, whose parametric ratio is 2 : 1 : 1. Since 2 refers to the vertical axis, we lay off on the lateral edge (*e*) twice as many parts of this edge as of each of the terminal edges (ē and ĕ.) Consequently, by taking a point in the edge *e* distant from *a*, $\frac{1}{4}$ the length of *e*, and a point in each ē and ĕ, $\frac{1}{8}$ their respective lengths, and then joining these points, the conditions will be complied with, and the plane 2P will be constructed. If the plane to be introduced were $4\bar{P}2$ the parametric ratio of which is 4 : 2 : 1, (in which 4 refers to the vertical axis and 2 to the longer horizontal,) we should in the same manner mark off 4 parts of *e*, 2 of ē and 1 of ĕ; if the plane were $4\breve{P}2$, (in which 2 refers to the shorter horizontal axis,) 2 parts of ĕ should be laid off, and 1 of ē. By connecting the points thus determined, the plane $4\bar{P}2$ or $4\breve{P}2$ would be delineated. If the plane were $2\bar{P}\infty$ (2 : ∞ : 1), which represents a plane on the longer terminal edge, 2 parts of *e* should be laid off, and 1 of ĕ; from the determined points in e and ĕ, lines should be drawn to the opposite edges parallel with the edge ē, and by connecting the extremities of the lines thus drawn, the desired representation of a plane $2\bar{P}\infty$ would be completed. The same should be repeated on all the similar edges. This will suffice to illustrate the manner of substituting the edges for the axes, and also the method of delineating single planes.

19. The manner of determining the intersections of planes, we may illustrate by an example. Suppose it were required to place the planes P, 2P, $4\breve{P}2$ and $2\bar{P}2$ on a right rectangular prism. Two rectangular prisms should first be accurately projected by the method which has been explained. One, of a size which may be considered convenient for a representation of the crystal, drawn with light pencil marks; the other of larger dimensions, for the purpose of determining the direction of the intersections; these intersections when determined are to be transferred to the smaller figure. On fig 9, we may first lay down the plane P, by drawing lines connecting the centers of the three edges about the angle. These lines are necessarily parallel to the diagonals of the three faces; the triangle *mno* is therefore the plane P. By connecting the points *m*, *b*, *n*, the plane 2P is constructed; for the plane *mbn* cuts off 2 parts of *e* to 1 of each ē and ĕ, as the expression 2P requires. To lay off $4\breve{P}2$ (4 : 1 : 2.) Let the whole edge *ab* represent 4; then *an* ($\frac{1}{2}$ of ĕ) will equal 2

parts on the edge ĕ, and *ap* ($\frac{1}{4}$ of ē) will equal 1 part on ē, agreeably to the expression $4\breve{P}2$; *npb* is therefore the plane $4\breve{P}2$. The

Fig. 9.

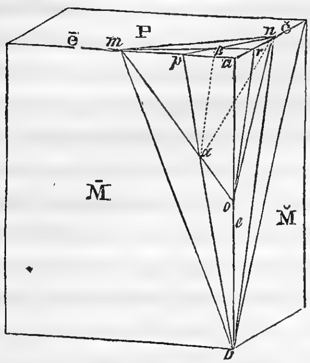
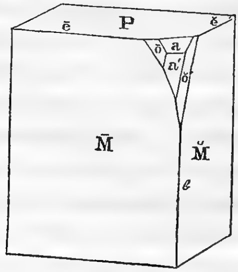


Fig. 10.



perimeters of the planes *npb* ($4\breve{P}2$) and *nmo* (P) intersect one another in the points *n* and α; consequently the line of intersection, between these two planes must be situated between these points, and therefore the direction of the intersection of P and $4\breve{P}2$ is $n\,\alpha$.

The planes *nmb* (2P) and *npb* ($4\breve{P}2$) intersect in the line *nb*, and therefore the intersection of 2P and $4\breve{P}2$ is in the direction of *nb*.

Again, the intersection of P and 2P has the direction *mn*.

We may next lay off the plane $2\bar{P}2$, (2 : 2 : 1,) which may be constructed by marking off 2 parts on each *e* and ē and 1 part on ĕ. Such a plane is *mro*, since $ao=\frac{2}{4}\,e$, $am=\frac{2}{4}$ ē, and $ar=\frac{1}{4}$ ĕ. Therefore the intersection of *mro* ($2\bar{P}2$) with *mno* (P) has the direction of the common line *mo*.

The perimeters of the planes *mro* ($2\bar{P}2$) and *npb* ($4\breve{P}2$) intersect in the points α and β. If therefore these planes formed an edge of intersection it would have the direction of the line $\alpha\beta$ or *ro*.

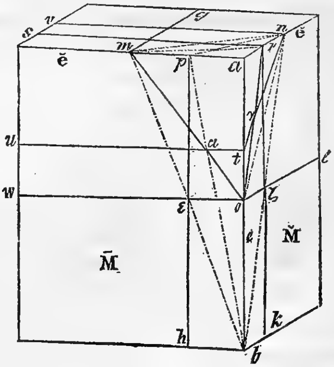
The line *ro* of the plane *mro* ($2\bar{P}2$) is parallel to *nb*, of the plane *mnb* (2P); the intersections of $2\bar{P}2$ and 2P would therefore be parallel with these lines. In this manner all the mutual intersections of these and other planes may be obtained.

Fig 10 exhibits these planes in their respective positions as above determined. The planes may be lettered as in the figure; *mno*=a, *mnb*=a′, *mro*=ō, *npb*=ŏ′. The edges a : P and a : a′ were made parallel with *mn* (fig. 9.) The intersection of P with ō has the direction *mr*, that of P with ŏ′, the direction of *np*. The intersections of a, ō, M̄ are parallel with *mo*; those of a′, ŏ′, M̆, have the direction *bn*, as determined above. The edge a : ŏ′ is drawn in the direction *nα*, explained above as the intersection of *npb* and *nmo*. Finally the edge M̄ : a′ is drawn parallel with *mb*, and the edge M̄ : ŏ′, parallel with *pb*, which in fig. 9, is obviously the intersection of *pbn* with M̆. The planes ō and ŏ′ do not meet; were the plane a′ wanting, their intersection would have been drawn parallel with *αβ* or parallel with the edge a′ : ŏ′.

20. In this manner a sketch of a crystal may be made or rectified, or a figure may be drawn, whose prototype has not been observed. The crystallographic expressions however, do not indicate the size of the planes. The edge M̆ : ŏ′ might have been so drawn as not to have formed an intersection with the plane P. Again, these secondary planes might have been so extended, that in connection with the corresponding planes on the other angles, they should obliterate mostly or entirely the primary faces. The intersections of the planes would not however be changed in direction. There would be new intersections of planes on opposite parts of the same primary face, which it would be necessary to determine in the above manner.

21. We may now add the planes $\frac{2}{3}\bar{P}\infty$, $2\bar{P}\infty$, $\breve{P}\infty$, and ∞P; the two former are replacements of the longer terminal edge ē, the third is situated on the shorter edge ĕ, and the last is a replacement of a lateral edge. We may also suppose that $\frac{2}{3}\bar{P}\infty$ meets the planes a and ō; $2\bar{P}\infty$, the plane ō; $\breve{P}\infty$ the planes a and ŏ′, and ∞P, the planes a′ and ŏ′. It is therefore necessary to determine the direction of these intersections. For this purpose fig. 9 is redrawn (fig. 11) to avoid confusion from the multiplicity of similar lines, (this would not be required in practice,) and the lines in the preceding figure, not including the new planes, are here dotted.

Fig. 11.



The plane *ntuv* is so drawn that *an* equals ½ĕ and *at*=⅔ of ½*e*, which fulfills the conditions for the plane $\frac{2}{3}\bar{P}\infty$ ($\frac{2}{3}$: ∞ : 1). Again *srow* is the plane $2\bar{P}\infty$ $(2 : \infty : 1)$; for it cuts off $\frac{2}{4}$ of e and $\frac{1}{4}$ of $\breve{e}$, or 2 parts of e to 1 of $\breve{e}$.

The perimeters of the planes *vntu* ($\frac{2}{3}\bar{P}\infty$) and *mno* (P) intersect in the points n and α; the intersections of $\frac{2}{3}\bar{P}\infty$ with P has therefore the direction αn, and is parallel with the edge a : $\breve{o}'$ in figure 10.

The perimeters of the planes *vntu* ($\frac{2}{3}\bar{P}\infty$) and *mro* ($2\bar{P}2$), intersect in the points α and γ; and a line from α to γ marks the direction of the edge between the planes $\frac{2}{3}\bar{P}\infty$ and $2\bar{P}2$.

The perimeters of the planes *srow* ($2\bar{P}\infty$) and *mro* ($2\bar{P}2$), coincide in the line *ro*. The intersection of $2\bar{P}\infty$ and $2\bar{P}2$ has therefore the direction *ro* and is parallel with the edge $\bar{o}$: a$'$ in fig. 10.

Again, the plane *gmol* represents $\breve{P}\infty$, $(1 : 1 : \infty)$ for it cuts off equal parts of the edges e and $\bar{e}$. The perimeters of the planes *gmol* and *nmo* (P) coincide in the line *mo*; their intersection is therefore parallel to this line, or to the edges a : $\bar{o}$ and $\bar{o}$: $\bar{M}$, fig. 10.

The perimeters *gmol* and *npb* ($4\breve{P}2$) intersect in the points α and ζ; a line from α to ζ therefore marks the direction of the edge between $\breve{P}\infty$ and $4\breve{P}2$ ($\breve{o}'$).

Again, the plane *prkh* is the projection of ∞P $(\infty : 1 : 1)$, for it cuts off equal portions of $\bar{e}$ and $\breve{e}$, and is parallel with the lateral edge. The perimeters *prkh* (∞P) and *mbn* (2P) intersect in the points ε and ζ; a line between these points is parallel with *mn*. The intersection of these planes will therefore be parallel with *mn*, or the edge a : a$'$ (fig. 10.)

The perimeters *prkh* (∞P), and *pnb* ($4\breve{P}2$) intersect in the points p and ζ. A line drawn from p to ζ determines therefore the intersection of ∞P and $4\breve{P}2$ ($\breve{o}'$).

Fig. 12.

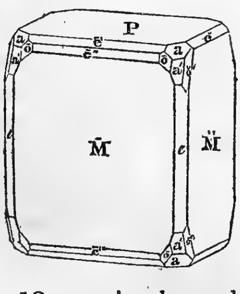


Fig. 13.

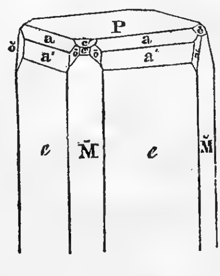


Fig. 12, contains these additional planes laid down according to the above deductions. The edge a : $\bar{e}'$ ($\frac{2}{3}\bar{P}\infty$) is parallel with the edge a : $\breve{o}'$; the edge $\bar{e}'$: $\bar{o}$ has the direction $\alpha\gamma$; the edge $\bar{e}''$($2\bar{P}\infty$) : $\bar{o}$

is parallel with the edge ō : a′; the edge a : ĕ($\breve{P}\infty$) is parallel with the edge a : ō or $\overline{M}$: ō; the edge ŏ′ : ĕ has the direction of a line from α to ζ; the edge a′ : *e*(∞P) is parallel with the edge P : a; and finally the edge *e* : ŏ′ has the direction of a line drawn from *p* to ζ.

In this manner the intersections of all possible planes may be determined and transferred. It should be observed that similar parts of a crystal are similarly modified. Figure 12 is a completed representation of a crystal which presents the planes above designated, viz.

$$0P \,.\, \infty\bar{P}\infty \,.\, \infty\breve{P}\infty \,.\, P \,.\, 2P \,.\, 2\bar{P}2 \,.\, 4\breve{P}2 \,.\, \breve{P}\infty \,.\, \tfrac{2}{3}\bar{P}\infty \,.\, 2\bar{P}\infty \,.\, \infty P$$

$$P \quad \overline{M} \quad \breve{M} \quad a \quad a' \quad \bar{o} \quad \breve{o}' \quad \breve{e} \quad \bar{e}' \quad \bar{e}'' \quad e$$

This same descriptive expression applies equally to fig. 13, which contains the same planes as fig. 12, but differently proportioned in size. The planes M have been diminished by the enlargement of *e*, thus producing a modified rhombic prism. The directions of the intersections are identical with those in fig. 12. This figure illustrates a preceding remark (§ 19), that the descriptive expressions of planes indicate merely their situation and not their size.

According to the same method, crystals may be projected in each of the crystallographic classes, after their axes have been accurately laid down. It was remarked that the figure employed for determining the intersections should be large: in a large figure slight variations from the true direction or position of lines produces errors of less magnitude. Also the lines should be carefully and delicately drawn. With the point of a needle on glazed cards, a very great degree of accuracy may be attained.

PROJECTION OF SIMPLE SECONDARY FORMS.

21. *Monometric system.*—The projection of many of the simple secondary forms,—for example the trisoctahedrons, the hexoctahedrons, &c.—by the method of construction which has been explained, would be a long and tedious process; at least when compared with the more simple method, depending on the relative lengths of the axes and the rhombic and trigonal interaxes in these forms. The right lines passing through the centre of the octahedron to the centres of its edges, are called *rhombic interaxes;* and those which pass to the centres of the faces, are the *trigonal interaxes.* In the several monometric forms, the extremities of one or more of these interaxes extended or diminished in their lengths, occupy the ver-

tices of the solid angles. If therefore these points (the extremities of the interaxes,) can be determined in the several crystalline forms, it will only remain to connect them, in order to form a projection of these solids. The principles of analytical geometry afford the means of determining how much the interaxes of the octahedron must be increased or diminished to equal the interaxes in these different forms. It is thus found that each half of a trigonal interaxis must be increased by that portion expressed in the fraction

$$\frac{2\,mn-(m+n)}{mn+(m+n)};$$

and for each half of a rhombic interaxis, we have the corresponding fraction

$$\frac{n-1}{n+1}.$$

By giving m and n different values from 0 to ∞, the values of these interaxes for any monometric form may be obtained. The following values are thus deduced for several occurring forms;

		Trig. interaxes.	Rhombic interax.
Trigonal trisoctahedron (fig. 20.)*	2O	$\frac{1}{5}$	0
Dodecahedron (fig. 7.)	∞O	$\frac{1}{2}$	0
Hexoctahedron (fig. 25.)	3O$\frac{3}{2}$	$\frac{1}{2}$	$\frac{1}{5}$
"	4O2	$\frac{5}{7}$	$\frac{1}{3}$
"	5O$\frac{5}{3}$	$\frac{2}{3}$	$\frac{1}{4}$
Tetrahexahedron (fig. 11.)	∞O2	1	$\frac{1}{3}$
"	∞O3	$\frac{5}{4}$	$\frac{1}{2}$
Tetragonal trisoctahedron (fig. 16.)	2O2	$\frac{1}{2}$	$\frac{1}{3}$
"	3O3	$\frac{4}{5}$	$\frac{1}{2}$
Cube,	∞O∞	2	1

To construct the form 4O2, the octahedron is first to be projected, and its axes and interaxes drawn. Then add to each half of each trigonal interaxis, five sevenths of its length; and to each half of each rhombic interaxis, one third of its length. The extremities of the lines thus constructed, are situated in the vertices of the solid angles of the hexoctahedron 4O2, and by connecting them, the projection of this form is completed.

22. In the *inclined hemihedral* monometric forms—that is, those hemihedral forms whose opposite faces are inclined to one another and not parallel, as the tetrahedron, &c.—the rhombic interaxes do

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* For these and the following references to figures, the reader is referred to the copperplates in my system of Mineralogy.

not terminate in the vertices of the solid angles, and may therefore be thrown out of view in the projection of these solids. The two halves of each trigonal interaxis, terminate in the vertices of dissimilar angles, and are of unequal lengths. One is identical with the corresponding in the holohedral forms, and is called the holohedral portion of the interaxis; the other is the hemihedral portion. The length of the latter may be determined by adding to the half of the octahedral interaxis, that portion of the same indicated in the formula,

$$\frac{2\,mn-(m-n)}{mn+(m-n)}$$

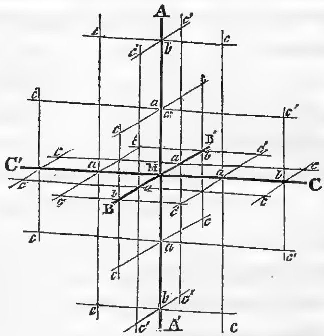
If the different halves of the trigonal interaxes, be assumed at one time as the holohedral and again as the hemihedral portion, the reverse forms $\frac{mOn}{2}$ and $-\frac{mOn}{2}$ may be projected. The following table contains the values of the above fraction for several of the inclined hemihedral forms and also the corresponding values for the holohedral portion of the interaxis.

		Holohed. interax.	Hemihed. interax.
Tetrahedron (fig. 30.)	$\frac{O}{2}$	0	2
Trigonal hemitrisoctahedron (fig. 34.)	$\frac{2O2}{2}$	$\frac{1}{2}$	2
"	$\frac{3O3}{2}$	$\frac{4}{5}$	2
Tetragonal hemitrisoctahedron (fig. 40.)	$\frac{\frac{3}{2}O}{2}$	$\frac{1}{8}$	$\frac{5}{4}$
"	$\frac{2O}{2}$	$\frac{1}{5}$	1
Inclined hemihexoctahedron (fig. 41)	$\frac{3O\frac{3}{2}}{2}$	$\frac{1}{2}$	$\frac{5}{4}$
"	$\frac{4O2}{2}$	$\frac{5}{7}$	$\frac{7}{5}$
"	$\frac{5O\frac{5}{3}}{2}$	$\frac{2}{3}$	$\frac{8}{7}$

23. The *parallel hemihedrons,* (for example, the Pentagonal Dodecahedron, or Hemi-tetrahexahedron) contain a solid angle, situated in a line between the extremities of each pair of semiaxes, which is called an unsymmetrical solid angle. The vertices of these angles are at unequal distances from the two adjacent axes,

and therefore are not in the line of the rhombic interaxes. The coordinates of this solid angle for any form, as $\frac{[mOn]}{2}$, may be found by the formulas $\frac{m(n-1)}{mn-1}$ and $\frac{n(m-1)}{mn-1}$. By means of these formulas, the situation of two points, a and b, (fig. 14.) in each of the axes may be determined: and if lines are drawn through a and b in each semiaxis parallel to the other axes, the intersections c, c' of these lines will be the vertices of the unsymmetrical solid angles, those marked c of the form $\frac{[mOn]}{2}$ and those marked c', of the form $-\frac{[mOn]}{2}$.

Fig. 14.



The trigonal interaxes are of the same length as in the holohedral forms. The values of these interaxes, and of the coordinates of the unsymmetrical solid angle for different parallel hemihedrons, are contained in the following table.

		Trigonal interaxis.	Coord. of the unsym. solid angle.	
Parallel hemihexoctahedron (fig. 49.)	$\frac{[3O\frac{3}{2}]}{2}$	$\frac{1}{2}$	$\frac{3}{7}$	$\frac{6}{7}$
"	$\frac{[4O2]}{2}$	$\frac{5}{7}$	$\frac{4}{7}$	$\frac{6}{7}$
"	$\frac{[5O\frac{5}{3}]}{2}$	$\frac{2}{3}$	$\frac{5}{11}$	$\frac{10}{11}$
Hemitetrahexahedron (fig. 44.)	$\frac{[\infty O\frac{3}{2}]}{2}$	$\frac{4}{5}$	$\frac{1}{3}$	1
"	$\frac{[\infty O2]}{2}$	1	$\frac{1}{2}$	1
"	$\frac{[\infty O3]}{2}$	$\frac{5}{4}$	$\frac{2}{3}$	1

24. *Dimetric system.*—In an octagonal pyramid, mPn (fig. 59.) the interaxes, or diagonals symmetrically intermediate between the horizontal axes, terminate in the interaxal basal angles. Their length exceeds the length of the interaxes of the octahedron, by a portion equal

to $\frac{n-1}{n+1}$. If therefore the octahedron mP and its interaxes be projected, and these interaxès be increased by a portion of their length expressed in the fraction, $\frac{n-1}{n+1}$, they will equal the interaxes of the octagonal pyramid mPn. This solid may then be projected by connecting the extremities of these interaxes, with the extremities of the horizontal axes, and joining all the angles of the octagonal base thus formed, with the extremities of the vertical axis.

25. *Tetraxonal system.*—The dihexagonal pyramid (fig. 126.) may be projected in the same manner as the octagonal pyramid just described; that is, by increasing the interaxes by a portion equal to $\frac{n-1}{n+1}$, uniting the points thus determined with the horizontal axes, and connecting the angular points of the base thus projected, with the extremities of the vertical axis.

The scalenohedron (fig. 116.) mR^n admits of a similar construction with the rhombohedron mR. The only variation required, is to multiply the vertical axis, by the number of units in n, after the points E and E′ in the rhombohedron mR have been determined; then connect the points E, or the points E′, with one another and with the extremities of the vertical axis.

Art. IV.—*Meteorological Sketches;* by an Observer.

[Prepared for the 13th edition of the American Coast Pilot.]

The science of Meteorology is not only interesting to the philosophic observer, but the natural phenomena of which it takes cognizance, are such as daily affect the interest and comfort of every member of the human family. But to no class of persons are these phenomena, as exhibited in various parts of the world, of so much practical importance as to the members of the nautical profession. A competent knowledge of these exhibitions, or of geographical meteorology, is therefore an important element of that varied knowledge which is acquired by the skillful navigator.

General View of the Atmosphere.

The transparent aerial fluid which surrounds our globe, and which we denominate *the atmosphere,* forms a comparatively thin stratum or envelope, which in the immediate vicinity of the earth, is greatly compressed by its own weight, and which in its most expanded and tenuous state is supposed to extend itself to the height of only forty-five or fifty miles from the earth's surface. Its superincumbent pressure or weight is ascertained by means of the barometer, and is equal to a column of mercury about thirty inches in height. By means of this instrument we learn that one half its weight or actual quantity is within three miles and a half of the surface of the ocean; and it is within this limit that nearly all the visible or important phenomena of the atmosphere are apparently developed. The superficial area of the lower surface of the atmosphere is equal to about 200,000,000 square miles; and as a compression of the whole mass to the common density which it exhibits at the sea level, would reduce its entire height to about five miles, it follows that by this standard of comparison the height or thickness of the atmosphere is to its superficial extent in the proportion of only 1 to 40,000,000.

These several facts are too important to be lost sight of, in our general reasonings upon the phenomena of the atmosphere; and the more so, as we are prone to give too much *altitude* to our conceptions on these subjects. If we even consider the proper height or thickness of the atmosphere as equal to fifty miles, still, as compared with its entire surface, this is only equal to one five hundredth of the proportion which the thickness of a common sheet of paper, of the foolscap size, bears to its surface dimensions; and if we view the atmosphere either as condensed to the mean of the surface pressure, or in relation to the actual limit of all its tangible phenomena, it will only be equal to one five thousandth part of the proportional thickness here mentioned. We may hence perceive the inapplicability of analogical reasonings that are founded on the movements which occur in a chimney, or in an inclosed apartment, as attempted to be applied in explanation of the general movements of the atmosphere.

Two instruments of modern invention, the *barometer* and *thermometer*, are truly invaluable as testing the condition of the atmosphere, and their use should be familiar to every navigator. By the first, as we have seen, the amount or weight of the superincumbent atmosphere, at any place, may always be accurately known, and by the indications of the other the temperature of the air as well as of the ocean, may be ascertained with equal precision.

Among the most striking peculiarities of the atmosphere, are its rapid and almost constant movements of progression or circulation, which, with some unimportant exceptions, appear to prevail throughout the globe. These movements evidently show the continued operation of some powerful impulse, which, to the writer at least, does not appear to have been satisfactorily explained. It is estimated from the average rate of sailing of ships during long voyages through different seas, and from other data, that the average velocity of the wind near the surface of the ocean is equal to eighteen miles an hour throughout the year, and in the common region of the clouds the velocity must be much greater.

Temperature of Elevation.

Elevation above the level of the sea, or the general level of a country, causes a regular variation in temperature. The first 300 feet usually cause a difference of about 1 degree of Fahrenheit's thermometer. After ascending 300 feet, it is estimated that the thermometer falls a degree in 295 feet, then at 277, 252, 223, and 192 feet; but 300 feet to a degree is a common rule. On these principles the limit of perpetual frost has been calculated. It is made a little more than 15,000 feet at the equator, and from that to 13,000 between the tropics, and from 9,000 to 4,000 feet between latitudes 40° and 59°.

It has been found, however, that the above rule is subject to great variations, owing, probably, to the course, temperature, and superposition of the atmospheric currents which prevail in different regions, and at different altitudes. Colder currents are often found resting upon, or interposed between, those of a higher temperature, and *vice versa.* On the Himalaya Mountains, in Asia, between the latitudes of 28° and 34° north, the region of vegetation has been found to extend several thousand feet above the supposed line of congelation in those latitudes. It is also remarkable that the line of perpetual snow is found at a much greater altitude on the *northern* side of these mountains than on the southern side in a lower latitude. From this it may be inferred that the temperature in high regions, as well as in lower situations, is greatly affected by the geographical course and physical condition of the currents of atmosphere which prevail in those regions.

Stratification and Elevation of the Currents of the Atmosphere.

It is obvious, from the courses of the clouds and other light bodies which sometimes float in the atmosphere, that the movements of the latter are mainly horizontal, or parallel to the earth's surface. Notwithstanding this, the common theory of winds supposes a constant rising of the atmosphere in the equatorial regions, connected with a flow in the higher atmosphere towards the polar regions, and a counter flow at the surface towards the equator, to supply the ascending current. This ascending movement, however, has never yet been discovered, and it is easy to perceive that if it existed in the manner supposed, its magnitude and velocity must be altogether too great to have eluded observation.

It is apparent, however, that different currents often prevail at different altitudes, superimposed one upon another, and moving at the same time in different directions. These currents are often of different temperatures and hygrometrical condition, and are found moving with different degrees of velocity. It is by the influence of these currents that volcanic ashes, and other light substances, which are elevated by means of volcanic spouts or whirlwinds to the higher regions of the atmosphere, are conveyed to great distances, and in directions which are often contrary to the prevailing wind at the surface. On the eruption in St. Vincent, in 1812, ashes were thus deposited at Barbadoes, which is 60 or 70 miles to the windward, and also on the decks of vessels still farther eastward, while the trade wind was blowing in its usual direction. On the great eruption of the volcano of Cosiguina, on the shores of the Pacific, in Guatemala, in January, 1835, the volcanic ashes fell upon the island of Jamaica, at the distance of 800 miles in a direct line from the volcano. Facts like these ought to put at rest the common theory of the trade winds, according to which these ashes would sooner have fallen upon the northern shores of the Gulf of Mexico, or the peninsula of Florida. On the same occasion the volcanic ashes were also carried westward in the direction contrary to the trade wind on that coast, and fell upon H. M. ship Conway, in the Pacific, in lat. 7° N., long. 105° W., more than 1,200 miles distant from the volcano, in the direction which is nearly opposite from that of Jamaica. These phenomena were doubtless the effect of two different currents prevailing at different elevations; but we shall seek in vain, in these developments, for proof of the commonly received but imaginary system of the trade winds.

The occasional interposition of a warmer current of atmosphere between the lower current and the higher regions, has been proved by the observations of aeronauts. In countries situated like the United States, where the surface is often occupied in winter, for long periods, by an intensely cold stratum of air from the interior elevations, the warm currents from lower latitudes appear to find their way at a superior elevation; and their presence in this position is often demonstrated by the phenomena which they induce.

Clouds, Fogs and Rain.

The atmosphere is always pervaded by water in the form of transparent or invisible vapor, and the process of evaporation is continually carried on, except in cases where the thermometer is below what is called the dew point, or when the vapor is being condensed in the form of clouds, fogs, or rain. "Clouds and fogs are the same thing, being an assemblage of small vesicles of water floating in the atmosphere. At a distance in the atmosphere we see the whole as a cloud, but when the vapor sinks to the earth, or will not rise, and we are immersed in it, we call it a fog. Dew-fogs which hang over fields, are *stratus* clouds; and fogs which involve elevated objects, are *cumulous* clouds." It is to circumstances of distribution, light, shade, distance, and perspective, that the great variety in the *appearance* of the clouds is owing; and on this variety of appearance the following classification has been founded, by which the clouds have been considered as pertaining to seven classes:

1. Like a lock of hair, or a feather, called *cirrus*.
2. A cloud in conical or rounded heaps, called *cumulus*.
3. A horizontal sheet, called *stratus*.
4. A system of small fleecy or rounded clouds, called *cirro-cumulus*.
5. The wavy or undulating stratus, called *cirro-stratus*.
6. The cumulus and cirro-stratus mixed, called *cumulo-stratus*.
7. A cumulus spreading out in cirrus, and raining beneath, called *nimbus*.

The cirrus is usually the most elevated—sometimes as a gauze veil, or parallel threads. Its height is apparently from one to four miles.

Dew is the condensation of aqueous vapor upon the surface of a condensing body or substance. Clouds and fogs are watery particles condensed from aqueous vapor while floating in the atmosphere, where they continue to float till precipitated, or again dissolved. If by the concentration of these particles, or by any additional condensation, their weight be increased beyond that which the extent of their surface can sustain, they then descend in the form of rain; and as the condensation ordinarily increases as the drops increase in magnitude, it is common to have more rain fall on the surface of the ground than on an equal space upon the top of a house or church. Clouds, fogs, and rain are therefore essentially the same, the latter being the continuation or extension of the same process which produced the former.

Owing to the evaporating properties of the atmosphere in the higher regions, as well as the intensity of cold which there uniformly prevails, distinct clouds are seldom, if ever, found at a greater elevation than the summits of the highest mountains, which is about five miles. At an intermediate region, however, the clouds are often at a temperature above freezing, while the air at the surface is much below the freezing point, and the earth covered with snow. This condition of the clouds seems not unfrequently evident by their appearance to the eye of an observer. Snowy or frozen clouds are usually dim and undefined in their aspect or appearance; and a fall of snow may not unaptly be termed the fall of a frozen cloud.

Of Hail.

Hail of small size, as it falls in wintry storms, appears as frozen rain-drops. From the occurrence of this phenomenon in a freezing state of weather, we find evidence that a stratum of air in the region of clouds is at a temperature above the freezing point, or warmer than that which is found at the surface at the same time. A heavy fall of snow when the temperature is much below the freezing point, affords, perhaps, the same indication.

Summer hail of large size, which is deposited in a definite path or vein, or in a locality of limited extent, is usually accompanied by heavy thunder and vivid or continued lightnings, or a heavy rumbling sound or rapid concussions, high winds, &c., and is believed to be the production of a vortex or whirlwind in the atmosphere, or *spout* as it is sometimes called, which is connected at its upper extremity with an overlying stratum of unusually cold air. A portion of this cold stratum probably descends on the exterior of the vortex, and on approaching the earth's surface, is pressed into the vortex and there entwined or laminated with the layer of warm and humid air of the surface, which is drawn in at the same time. A rapid condensation, as is known, thus commences at the lower extremity of the whirling mass or column, and the condensed and frozen drops, passing into layers of air of a temperature alternately above and below the freezing point, are carried upward by the powerful whirling and ascending action of the vortex, till, with the successive coatings of condensation received, they are finally discharged into the cold stratum at the upward extremity of the vortex, owing to the reduced temperature of which, they are prepared to receive a renewed accession during their fall to the earth; or perhaps by their accumulated weight they are sometimes thrown through the sides of the vortex before reaching its higher extremity. By this violent whirling and elevating action, some of the hail-stones are thrown against each other and broken; and each successive layer of congelation may often be seen in the fractured sections of the hail. In all vorticular condensations of this character, when the cold is not sufficiently intense to produce hail, drops of rain are produced of a much greater size than are ever found in a common and direct fall of rain.

Hail storms of this character are less frequent in the tropical regions than in the temperate latitudes, for the reason, probably, that a stratum of sufficient cold to produce the hail, is seldom found so near the lowest stratum that a vorticular communication can be established with the former, by means of an ordinary gust, spout, or whirlwind. Nor does this ordinarily happen in the temperate latitudes; but only when the lower warm stratum becomes overlaid, in close proximity, by a stratum from a colder region; an event which is not unfrequent in most countries within the temperate latitudes. It commonly happens, therefore, that several hail storms of greater or less magnitude and violence, occur on the same day, or about the same period.

Of Thunder Storms and Gusts.

When a cold stratum or current of the higher atmosphere moves or rests upon a warm one which is next the earth, neither stratum, as such, can penetrate or displace the other. Nor can a sudden interchange or commingling take place between the masses or particles of which these strata are composed, except by the slow and tedious process of the successive action and convolution of single particles, or small groups of particles, upon or around each other; but if a communication or interchange between the two strata becomes established by means of the action of a gradually excited whirlwind or water-spout, or if, owing to any inequality of surface or other accident, a depression is made upon the lower stratum, so as to enable the colder air to descend at this point, then an immediate gyration or convolution will take place in the two masses at this point, the warm air rising as it becomes displaced, and a copious condensation will immediately follow. It is movements of this character which produce the dense and convoluted appearance known as a thunder-cloud, and the thunder and lightning, rain, and perhaps hail, follow as necessary results.

The precipitation of the colder stratum thus commenced, is regularly continued and enlarged till an equilibrium is produced, and the thunder storm thus engendered, assumes, of course, the direction of the upper current to which it is appended, and which, in the temperate latitudes, is commonly from the western quarter. The warm surface air which is thus displaced at the commencement of the process, rises immediately in front of the colder intruding mass, and by the gyratory action thus commenced, becomes convolved in detached masses or layers with the colder surrounding air, and by the reduction of temperature thus produced, furnishes the large supply of aqueous vapor which is first condensed in the thunder cloud, and then precipitated in a heavy fall of rain; and the electric phenomena which are induced by this sudden contact or intermingling of masses of air of different temperatures and hygrometric conditions, become highly vivid, and too often destructive. The active gyration which is commonly produced within the body of the thunder storm or gust, is in the direction of the advance of the storm and of the rising warm air which is forced upward, or in the direction of forward and upward at the lower front of the storm.*

In consequence of this gyratory action, a storm which advances at the rate of fifteen or twenty miles an hour, is often known to exhibit a velocity of wind during the period of its greatest violence, of sixty or eighty miles an hour. If the axis of this gyration in a thunder storm assumes, from any cause, a vertical position, we then have a perfect whirlwind or tornado, which, if it be so situated as not to reach the earth by its direct action, will exhibit to us the phenomena of a heavy thunder storm accompanied by rumbling sounds and concussions, and a fall of hail in or near some portion of its path. But if the regular action of the whirlwind should reach the earth,

* See also Prof. Mitchell on thunder storms: Am. Jour. of Science, Vol. XIX. p. 278—282.

and continue for some time, great destruction may be expected to follow. The path of these destructive whirlwinds is generally narrow, and often but a few hundred yards in width.

From the nature of the causes which we have before mentioned as being favorable to the occurrence of a thunder storm, it follows that many of these storms will be likely to occur on the same day, in different parts of the same country, as has been already remarked in the case of hail storms, with which they are often identical; and the writer has often found this to be true to a remarkable extent. The fatal accidents by lightning, in different parts of the country have often happened on the same days, and we have reason to believe that scores of tornadoes, hail storms, and thunder storms, have sometimes occurred on the same afternoon. It usually happens that the precipitations of colder atmosphere at these numerous points of disturbance, are sufficient to produce a marked change in the temperature of the surface stratum within a period of twelve hours thereafter.

Atmospheric disturbances of this kind, which do not produce violent thunder or hail, are usually denominated *squalls;* and it appears highly probable that the presence of air of a temperature considerably above the freezing point, is necessary to the production of thunder and lightning. In the Strait of Magalhaens, in Patagonia, where the air at the surface is neither warm nor very cold, the squalls, called by the sailors williwaws, are very frequent, and tremendously severe; but, according to the observations of Capt. P. P. King, lightning and thunder are seldom known.

The heavy condensation presented in a thunder cloud, is often spoken of in a manner which implies that the cloud possesses some mechanical or other energy, by means of which the violent wind is sent forth; but nothing can be more unreal than such a supposition. The cloud may indeed be the means of electric development, and furnishes also the watery deposition for the hail or rain, but all the particles of the cloud are passively inert, like those of a common fog or mist, and the violent winds and disturbing forces which may be present, operate to produce the cloud, but do not, in any important sense, result from its action.

Water-spouts and Whirlwinds.

The character of these meteors has already been described, in a measure, in our account of hail and thunder storms. The identity of whirlwinds and water-spouts, was maintained by Franklin, and although at a later period this has been called in question, it appears to have been done without sufficient reason.

From the equal distribution of the atmosphere as the oceanic envelop of our earth, it results, that no movement of great violence can take place in any of its parts, except by means of a direct circuit of rotation in the form of a vortex or active whirlwind.

A vortex will not be regularly formed, nor continue itself in action, without the aid of an external propelling force and a constant spiral discharge from that extremity of its axis towards which is the tendency of motion. Both these conditions, it is believed, are fulfilled to the letter in the case of a common whirlwind or water-spout. The air at the upper extremity of the whirling column, owing to its elevation, is rarer than at the base, and the column itself, particularly in its central portions, is mechanically rarefied by the centrifugal effect of its own whirling motion. We have thus a sort of rarefied chimney into which the denser air at the base of the column is continually forced, by the pressure of the surrounding atmosphere; not to ascend in a separate current as in the common chimney, but entering into the organization of the whirling vortex, to supply the place of the preceding portions of air which are winding inwards and upwards to be again discharged at the upper extremity. The condition of force by which the propulsion is maintained, is found in the pressure of the surrounding atmosphere upon all sides of the whirling and therefore mechanically rarefied column, and if the expansive whirling motion be sufficiently active to produce nearly a vacuum at the center, the external propelling force will be nearly fifteen pounds to the square inch. As the whirling column turns within its own compass like a top or any other rotative body, this force is quite sufficient to account for all the violence that is ever produced.

Were there no vorticular or whirling action already excited, and no discharge from the upper extremity of the vortex, there could then be no inequality of pressure to produce rotation; but this movement and upward discharge having once commenced, from any cause, the particles near the exterior of the column, like those of water in a funnel, yield at a little more than a right angle, to the external pressure, in their spirally approximating course towards the rarefied center. By the slowness of this central approximation as compared with the whirling action, the intensity or magnitude of the external pressure becomes gradually merged in the velocity of the rotative action. As the area of the spiral circuit decreases rapidly as we approach the center, it follows that the velocity of the whirling movement must be proportionally increased, as we perceive it to be in the funnel and in all regular formed vortices. Thus, if the rotative velocity near the exterior of the whirling column be at the rate of but ten miles an hour, at one third nearer the center the velocity must be more than doubled, and at two thirds of the distance from the first named point to the center, the absolute whirling velocity must be increased nine fold, which in this case is equal to ninety miles an hour; and in consequence of the reduced diameter of the circuit of gyration at the last point, the number of revolutions must here be as four hundred, to one at the point first mentioned. The increased ascending velocity, however, is not here taken into account, which may perhaps reduce the number of comparative revolutions in the central portions of the column. The extraordinary condensing and electric effects which often attend or follow these active whirlwinds, have been cursorily noticed under the head of thunder storms and hail.

It is not intended to dwell here upon the causes by which whirlwinds and spouts are excited or first set in motion, but local disturbances in a heated stratum, at points where the same is beginning to be penetrated by the colder air of a higher stratum, are probably the chief exciting cause as in thunder storms. The agency of heat may also be effective in continuing the upward discharge and vorticular organization, in cases where there is great disparity in the temperature of the air at the upper and lower extremities of the whirling mass or column, but it is to the mechanical expansion caused by the centrifugal action and the powerful impulse of the external atmospheric pressure, that the increased and powerful activity of the whirlwind is chiefly to be referred.

The term *water-spout* is undoubtedly a misnomer, as there is no effect produced of which this term is properly descriptive, although the term air-spout would not be greatly inappropriate. The visible column of condensed vapor which often appears in the rarefied center of the vortex when the latter is not enveloped in cloud, has probably given name to this meteor. But the water of the sea is not taken up by the spout or whirlwind, except in a slight degree and in the form of fine spray, like other light matter which is swept from the surface. This cloudy stem or column frequently appears and disappears, while the action of the whirlwind continues without any important change. Owing to this fact, observers sometimes believe that they witness the commencement of a water-spout, or tornado, when the same has previously been in action for one or more hours, and when the cloudy pipe or pillar happens to disappear, the spout is supposed to have 'burst,' while, often, it has undergone no important change, except, perhaps, a slight decrease in its activity. The active and violent portion of the whirlwind surrounds the spout invisibly, and is probably of much greater diameter at a distance from the surface of the earth than at the base of the spout. Thus, when a spout or whirlwind has passed near a ship, the upper spars have been converted into wreck while no violence of wind was felt on the deck.

Water-spouts follow the course either of the surface wind or of the higher current with which they may communicate, or their course may be modified by both these influences without being absolutely determined by either. They abound most, however, in those calm regions which are found at the external limits of the trade winds, and in the regions near the equator.

It has been common to ascribe whirlwinds and water-spouts, as well as larger whirlwind storms, to an impulse produced by the meeting of contrary currents, but the laws of distribution and of motion in an oceanic body, are such as do not permit the movements of its different currents and gyrations to meet in conflict with each other; besides, any conflicting movement in the air would necessarily produce a rise in the barometer, whereas it is generally known to fall at the commencement of a storm or whirlwind, either of large or small extent. We may observe, also, that whirlwinds and spouts appear to commence gradually, and to acquire their full activity without the aid of foreign causes; and it is well known that they are most frequent in those calm regions where, apparently, there are no active currents to meet each other, and they are least frequent where currents are in full activity.

Of Trade Winds and the circuitous Character of the Atmospheric Currents.

It is found that in almost every country, and in every sea, the wind is more or less predominant in a particular direction. In open sea, between the equator and the 30th parallel of north and south latitudes, the wind, for the most part, blows from the eastward; but near the eastern borders of any ocean, below these latitudes, the wind blows in a direction more towards the equator than in its central or western portions.

In the higher latitudes north of 30°, the westerly winds are found greatly to predominate, although the eddying or rotative action which is acquired by large portions of the lower stratum of air in these latitudes, causes much diversity and frequent changes in the specific direction of the local winds. But in the common region of clouds, where this eddying movement is less frequent, the main atmospheric current, at least in the United States, is fully as constant from the westward, as is the trade wind from the eastward in any tropical region.

At New York, in four successive years the westerly winds have been found to be to the easterly, as nearly as two to one. Observations on the courses of the clouds for the same period, show the prevalence of an atmospheric current from the westward at that elevation to be, as compared with those from the eastward, nearly as fourteen to one; the prevailing wind being southwesterly. At Montreal, in Lower Canada, as appears by the observations of J. M'Cord, Esq. the westerly surface winds also appear to exceed the easterly, in the proportion of more than four to one. In consequence of the general prevalence of westerly winds and currents in these latitudes, the passages of the fastest ships, from Europe to America, are found to occupy a much longer period than from America to Europe.

The first movement of the trade winds towards the equator and westward, necessarily occasions an equal movement from the higher latitude to supply their place; and as the trade winds in their progress westward are opposed by the American and Asiatic continents, across which these winds do not pass, it follows that these winds become deflected or thrown off towards the poles in order to support an equal distribution of the atmosphere in the higher latitudes; but the air thus transferred to these latitudes carries with it the rotative impulse which it acquired in the tropical latitudes, and by reason of the slower rotative motion which here prevails, is thrown to the eastward in the form of westerly winds.

An entire circuit of atmospheric currents is thus maintained on both sides of the equator, the most equable and determinate portion of which is to be found in the region of the trade winds; and this appears to be the general outline of the great system of circulation in our atmosphere, as well as in the ocean itself. It is to the geographical course pursued by the winds in different portions of these great circuits that the peculiarities of temperature and climate pertaining to different countries lying in the same latitudes, are chiefly to be referred, as also the remarkable absence or predominance of *rain* which is peculiar to certain regions.

The Monsoons of the Indian Seas are but a modification of the same system of circulation; the regular trade wind instead of turning towards the higher latitudes, being here deflected across the equator, where it returns to the eastward in the form of the *westerly* monsoons; the *easterly* monsoons being the regular trade wind. The monsoons have, indeed, been ascribed to local rarefaction in Asia and New Holland, but the northwesterly monsoon, regardless of this hypothesis, sometimes sweeps over half the breadth of the great Pacific Ocean in its eastwardly progress.

The above generalization may also be expressed in the following form:

I. Between the two parallels of 30° N. and S. the atmosphere at the earth's surface, for the most part revolves around the axis of the earth with a slower motion than the earth's crust, or is constantly being left behind in the movement of rotation.

II. The space previously occupied by the atmosphere so left behind, is by the centrifugal action of the earth's rotation, constantly supplied from the higher latitudes.

III. That portion of the atmosphere which is left behind in the tropical latitudes, and passes westward by the earth's rotation, as above described, is, by the force of direct gravitation, constantly transferred to the higher latitudes; thus preserving the equilibrium of distribution, so far as the same is ever maintained in these latitudes.

IV. That portion of the atmosphere which is so transferred to the higher latitudes after having acquired the high rotative velocity of the equatorial regions, is by this previously acquired impulse, thrown rapidly eastward in the form of westerly winds, thus completing the great circuit of perpetual gravitation, which is developed in each of the oceanic basins on both sides of the equator.

It is by the currents of these natural circuits of gravitation, that hurricanes and storms are found to be transported from one region or locality to another; and the track of these storms affords demonstrative evidence of the predominating course which these currents pursue. Different sections of these currents often become locally modified in their apparent courses from various causes, and being often stratified, or as it were *shingled* upon each other, they exhibit in their crossings, specific movements in different directions, and consequently frequent changes at the surface, while still performing with no little regularity the systematic courses which have been summarily pointed out. One obvious cause of the local irregularity and superposition of these currents is found in the retardation to which the lowest portions of the air are subject, owing to the resistance of the earth's surface.*

The rotative motion of the atmosphere and the earth's surface in the latitudes which form the boundary between the trade winds and the returning westerly winds being nearly equal, this region is necessarily subject to calms, and to those sudden gusts and squalls which are usually excited in warm regions in the absence of a prevailing wind. This region, in the North Atlantic, is known to navigators as the *horse latitudes*, because the traders between New England and the West Indies, in consequence of the lack of sustenance occasioned by these calms, were sometimes under the necessity of throwing overboard the whole or a part of their deck loads of horses. The great circuits of winds intersect and cross these latitudes in both directions on almost every meridian, but with little sensible effect at the surface, except towards the eastern margin of the Atlantic, where the northerly winds decidedly prevail; and towards the western margin of the Atlantic and in the Gulf of Mexico, where the southerly winds are usually prevalent.

Similar results are found in nearly all the regions which separate the great natural circuits of winds from each other, and these tracts of ocean are known by the designation of *the calms*, and sometimes are called the *rains* or the *variables*. Such is the region about the equator, which separates the northern from the southern trade winds, and the easterly from the westerly monsoons. The easterly monsoons, in approaching the equator, where they run into the westerly monsoons, necessarily acquire the same velocity of rotation as the earth's crust, which of course produces calms; the northerly or southerly tendency of the monsoons being here too small to produce a leading breeze at the surface.

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* There is one point of some interest which it has not been found convenient to introduce into these sketches, viz. an explanation of the causes which tend to produce extensive and successive gyrations in the lower strata or currents of air which pass from the tropical to the higher latitudes; and which tend also to obliterate these gyrations in the strata which are leaving the higher latitudes and approaching the tropical regions.

Land and Sea Breezes.

Near the shores of an island or country it is often found that the wind, during different hours of the day and night, blows alternately to and from the land. Or in the case of a general or trade wind which is parallel to the coast, its course becomes alternately modified by an approximation to the above result. This effect has been justly ascribed to the influence of diurnal heat and cold. Not that any vacuum is created by the heat into which the surrounding air rushes, as has sometimes been supposed, nor that a warmed stratum of air necessarily rises from the surface and ascends to the higher regions; for, aside from the general error of these notions, a flat, low, and strongly heated island or coast, is found to have less effect in producing these breezes than a high and sloping country of more even temperature.

The truth appears to be, that when the stratum which lies upon the inclined surface of a coast becomes warmed and rarefied by the daily heat, it is forced by the increment of pressure at its lowest margin to move along the inclined surface of the country in the direction of the greatest elevation, or as near that direction as the prevailing tendency of the lower current will allow. Owing to the cooling process which goes on during the night, the specific gravity of this inclined stratum becomes predominant, and the reverse movement then commences and continues into the following morning. We find, too, that on the slopes of certain coasts and islands where there is sufficient elevation, the higher margin of this stratum, at certain seasons, will daily reach an altitude at which it is brought in contact with a higher stratum sufficiently cold to set in operation a squall or thunder storm, at a certain hour; after which the equilibrium is restored, and the usual counter movement again follows in its turn.

Some diurnal effect of this kind upon the wind may be observed at times in almost every region; and, taken altogether, it is probably the most extensive agency which is exercised by heat in the production of winds. R.

Art. V.—*Description of an Alembic for distilling Amalgam of Gold,* contrived by M. F. Maury, U. S. N.

The common process of treating amalgam, at the gold mines in Virginia, consists in getting rid of the excess of quicksilver, either by straining, or simply by pouring it off, after it has been allowed to stand long enough in a crucible or other vessel, for the gold to settle at the bottom. The latter is the method more generally practiced, though at the *surface* or *deposit* mines, where the gold is found in larger particles, the amalgam is freed from the excess of quicksilver, by holding it between the palm of the left hand and the thumb of the right, and forcing the excess of quicksilver off by pressure. The residuum, a friable mass of quicksilver and grains of gold, contains from twenty to fifty, or even a larger per centum (in weight) of the latter metal; the per centum being largest when the grains of gold are coarse, and least when they are fine. Thus reduced, the amalgam is put into a sheet iron *still,* holding about a pint, or laid in a common shovel, when it is put on the fire, and the quicksilver is "blown off." When the still is used, about twenty five per centum of quicksilver, and some of the gold, are lost; but when the shovel is used, some of the gold, and all of the quicksilver, is lost.

The loss of gold is greatest, when it consists of grains or points impalpably small; for it appears, that that degree of heat, attainable in the operation of "blowing off" the quicksilver, is not sufficient entirely to neutralize the affinity between the two metals. When the gold is *fine,* and the heat quick, much of the former passes off with the mercurial vapor: this is proved by condensing the vapor, and allowing the quicksilver thus obtained to stand for three or four days, when by carefully pouring off the top of it, an amalgam, having the consistency of oil in incipient congelation, is found at the bottom of the vessel. By subjecting this again to the operation of the still, pure gold is obtained. The residuum in this case is about ten per centum of the gross weight of the amalgam.

The metallurgical process of obtaining gold in Virginia is by no means perfect; in every stage through which it passes, from the stamps to the "blowing off" of the quicksilver, there is a wasteful loss of both metals.

All the gold mines yield more in the small than they do in the large way. This difference is the greatest, when the ores are *lean;*

these sometimes give twenty five or fifty and in some instances even seventy five per cent. more of gold by assays made in the closet, than they will yield in the practical way of extracting the metal on a large scale.

Either Chilian mills or *stamps,* commonly the latter, are used for reducing the gangue (slate or quartz) to the state of fine sand; by this operation the larger particles of gold are detached from its matrix, and remain mixed with the sand. The *stamps* are large cast iron pounders, weighing four or five cwt. They tend, by repeated blows, and by keeping up a constant trituration among the grains of pounded quartz, to render the particles of gold, how minute soever these in the first instance may be, still more impalpable.

The gold and sand thus pounded and mixed together, are washed out through a copper sieve, by a constant stream of water from under the stamps, and by it carried thence over several feet of bullocks' hides, resting on an inclined plane, having their hair upwards and the *grain* of the hair turned down stream. The heavier particles of gold, and other weighty minerals, such as the sulphate of baryta, the sulphurets of lead, zinc, iron, copper, and the like, lodge in the hair of the roughly tanned skins, while the sand, and much of the gold in attenuated particles, are carried off together into the waste by the force of the water. At some of the mines the gold is disseminated through the quartz, in particles so minute, that they are seldom visible to the naked eye. When this is the case, much of the precious metal is floated off by reason of its buoyancy. The phenomenon of solid particles of gold being floated on water may be readily understood; for if we imagine a solid cube to be cut from a flake of gold leaf, and this cube to be further diminished by truncation and bevelment, it is very evident, that the specific gravity of this crystal, will not be less than that of the ingot from which the gold beater obtained it; but if it be placed in a vessel of water, in order to sink, it must, in consequence of it and the water not actually touching each other, displace a quantity of that fluid many times greater in volume than the crystal; therefore the latter, whatever its size might be, would not sink, so long as the volume of water to be displaced by sinking, should exceed the crystal in weight. Upon the same principle, a cambric needle will float on water, while the bar of steel from which it was manufactured, will displace several times its own volume of the same fluid, and carry with it to the bottom large pieces of cork and the like.

The gold with the crust and other minerals that do lodge on the skins, is washed off in a tub, whence it is put into a trough, that conducts a stream of water to one or more amalgamators (Tyrolese or Hungarian bowls,) from which is constantly presented another phenomenon in hydrostatics, viz: that of quicksilver rising from the bottom and floating on the surface of water.

Owing to the rotary motion of the amalgamators, the friction of the sand and water against the quicksilver, it tends to separate into minute globes, which rise to the surface, and are floated off; this tendency increases as the quicksilver loses its fluidity and becomes less yielding, which it does by being more and more heavily charged with gold; a considerable portion of which is thus carried off, atom by atom, from the amalgamators.

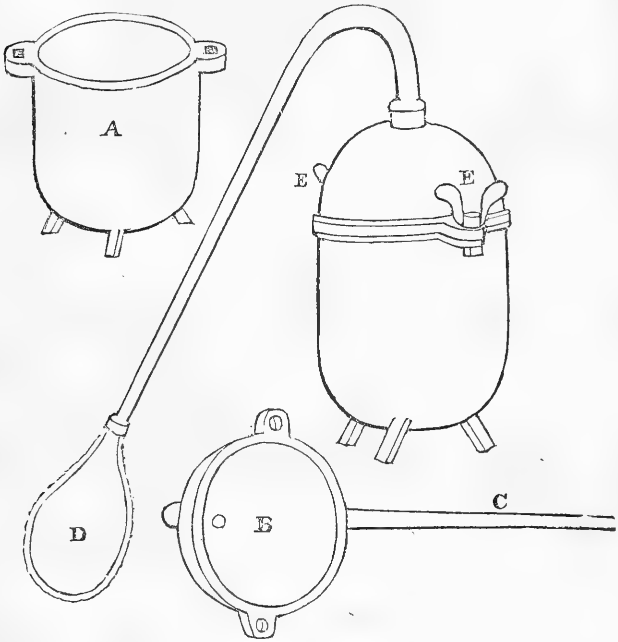
In the course of twenty four hours, two or three per centum of the quicksilver in each amalgamator is lost. About twenty five per centum of that put in the still, and all that put in the shovel, is lost in the operation of "blowing off." There is a loss of gold in the same operation; besides the gold which swims off in the state of amalgam, that which is carried off by adhering to the sand, and that which is floated off into the waste from the skins, and from the amalgamators.

What would be the effect in the amalgamating process, if opposite states of electricity could be induced and kept up between the quicksilver and the gold, until the two metals unite? Would not the tendency to amalgamation be promoted, and in such a case, would not the loss by the floating off the quicksilver and gold be prevented? These questions are proposed, because it is believed that ingenuity is able to supply a practical answer to them. If the metallurgy of gold were better understood, many mines that are now profitless might be advantageously worked.

To save the loss of quicksilver involved in the ordinary process of "blowing off," and to save the gold which escapes with the mercurial vapor, the alembic here described, was invented.

A, is the cucurbit, made of cast iron; it holds half a gallon. B, is the capital, also of cast iron. C, is the beak, made of a gun barrel, bent as in Fig. 2. D, is the condenser, made of India rubber cloth; it was a water bag from the caoutchouc manufactory at Roxbury. The edges of the cucurbit and the capital are ground smooth, so that the escape of vapor may be more easily prevented by luting. The inside of A, is also made smooth, so that the gold may not adhere to the bottom of the alembic. The beak is screwed and rusted into the top of the capital so that the joint may be steam tight. In the other end of the beak is a female screw to receive the screw which is in the mouth of the condenser.

Fig. 1. Fig. 2.



After the inside of the cucurbit has been rubbed with chalk, to prevent the gold from adhering to the iron, in case the former should melt, the amalgam is weighed and put in, and the capital put on and screwed down to the cucurbit, by means of the thumb screws E, E. The condenser *uninflated* is then screwed on to the tips of the beak, the joint luted, and the condenser placed in a bucket of cold water. The joint between the head and the body of the alembic is also coated with a luting of horse dung and pipe clay or fuller's earth.

As soon as the amalgam begins to boil, the condenser becomes inflated with the air, which was in the alembic, and when evaporation ceases, the cold air from the condenser now returns into the alembic, and becoming heated, expands and fills the space formerly occupied by itself and the quicksilver. If while the operation is going on, the heat be suffered not to fall below the boiling point of quicksilver, and the condenser be observed to contract, it is a sure sign that evaporation is no longer going on and that distillation is perfect.

But if the condenser be unscrewed, and the tips of the beak be supposed to remain immersed in water, as soon as the pressure from within (whether by cooling, or from the absence of a fluid to supply vapor,) becomes less than that of the atmosphere without, the water is forced from the bucket through the tube into the alembic, and if the quicksilver be not all evaporated it is wasted, and the alembic is endangered by the concussion and sudden cooling produced within, by the cold water and steam. Therefore as soon at the condenser contracts, the alembic should be removed from the fire, the condenser taken out of the bucket and unscrewed, and the alembic be suffered to cool in the air.

This alembic has been in use at one of the Virginia mines for the last ten or twelve months, and when properly luted, the weight of the gold and quicksilver after distillation has invariably equalled that of the amalgam which they formed previous to the operation. It does away with the necessity of settling and pouring off, or straining, and saves all the gold and quicksilver lost in the common way of "blowing off."

Art. VI.—*Crystallographic Examination of Eremite;* by James D. Dana, A. M., Assistant in the Department of Chemistry, Mineralogy, &c. in Yale College.

[Read before the Yale Nat. Hist. Society, June 19th, 1837.]

At our last meeting we were informed by Mr. Thos. R. Dutton, that he had discovered in a bowlder at Watertown in this State, a few crystals of a mineral, which Prof. C. U. Shepard on examination had announced to be an undescribed species; and that Prof. S. had consequently described it as new under the name of Eremite. Through the kindness of Mr. Dutton, I have examined other crystals in addition to the one investigated by Prof. S. and thus am enabled to add farther confirmation of the conclusion that the specimens belong to a species hitherto unknown.

The crystals are all of them small. The largest is but one fifth of an inch long; the others vary in length from one sixteenth to one twentieth of an inch. The smaller crystals seldom present brilliant faces, and for this reason, as also on account of their minuteness, they scarcely admit of the use of the reflective goniometer. The larger crystal, on the contrary, possesses highly polished surfaces, admitting of easy and accurate measurement. The data for the following calculations have therefore been obtained from the latter alone. Owing to the completeness of the different series of parallel intersections, the crystallographic expressions for the planes of each of the crystals may be deduced with perfect facility and certainty, independently of measurement; and hence, although the planes in some instances are microscopic, their interfacial angles may be accurately determined by calculation. The following are representations of three of these crystals.

Fig. 1, a.

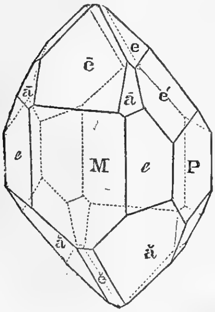


Fig. 2, a.

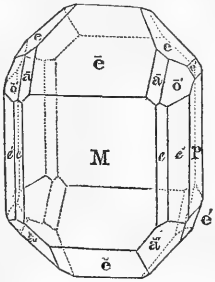
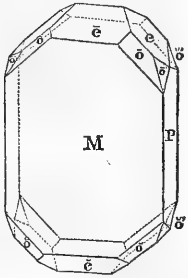
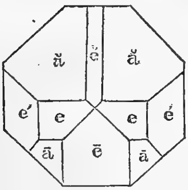


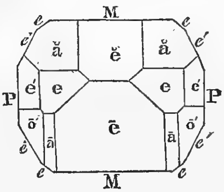
Fig. 3, a.



b



b



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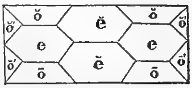

The character of the crystals is obviously monoclinate. There are no traces of cleavage to indicate whether the primary is the oblique rhombic or right rhomboidal prism; but the size and brilliancy of M and P, two faces of the rhomboidal prism, and the occasional absence of the planes *e*, *e′* which belong to rhombic prisms, favor the conclusion that the latter is the primary. The third plane T, of the rhomboidal prism, has been obliterated by the extension of ē and ĕ.* The crystals have been lettered in accordance with this view; the

* The figures represent the crystals as standing on one of their rectangular primary faces (T) as a base. The obtuse edge between M and T, is replaced by the plane ē, and the acute edge by ĕ.

planes ē and ĕ replacing respectively the obtuse and acute terminal edges; e and e′ each rectangular terminal edge; a and o the obtuse or acute solid angles, according as the mark – or ⌣ is placed over the letter; and *e*, *e′* replacing the lateral edges.

For the determination of the descriptive expressions of the crystal, (in which I employ Naumann's system of notation,) the planes ā may be assumed as faces of the positive fundamental hemipyramid. The following descriptions are thence deduced for the crystals:

Fig. 1. ∞P∞ . ∞P′∞ . ∞P . P∞ . P . P′∞ . 2P′∞ . –P . –P∞ .
M P *e* ē ā e e′ ă ĕ

Fig. 2. ∞P∞ . ∞P′∞ . ∞P. ∞P2 . P∞ . P . 2P′2 . P′∞ . 2P′∞ .
M P *e* *e′* ē ā ō′ e e′

–P . –P∞ .
ă ĕ

Fig. 3. ∞P∞ . ∞P′∞ . P∞ . 2P2 . 2P′2 . P′∞ . – 2P′2 . –2P2 .
M P ē ō ō′ e′ ŏ′ ŏ

–P∞ .
ĕ

The angles assumed as the basis of the calculations are as follow:

M : ē=140° 40′, M : ĕ=126° 8′, M : *e*=136° 35′

The following are the results obtained by calculation. In some instances the angles coincide exactly, in others very nearly, with those which I have obtained with the reflective goniometer.

$a : b : c = \cdot 9471 : 1 : 1 \cdot 0265$

$\gamma = 76° \, 14' \therefore M : T = 103° \, 46$

ā : ā=119° 22′	ō′ : ŏ′(over e′)=130°39′	e′ : ō′=157° 43′
ā : T=133° 39′	ō : ō=138° 8′	ē : T=143° 6′
ā : M=131° 53′	ō : M=148° 12′	ĕ : T=130° 6′
ă : ă=106° 36′	ŏ : ŏ=129° 58′	ē : ĕ(adjacent)=93°12′
ă : T=121° 6′	ŏ : M=141° 25′	ē : ā=149° 41′
ă : M=118° 13′	ō : ŏ(over e)=70°24′	ē : ō′=130° 32′
ā : ă(over e)=109°54′	e : P=131° 52′	ĕ : ă=143° 18′
ō′ : ō′=81° 4′	e′ : P=150° 50′	*e* : *e*= { 93° 10′ / 86° 50′ }
ō′ : T=121° 18′	e : M= { 100° 13′ / 79° 47′ }	*e′* : M=117° 51′
ō′ : M=120° 10′	e′ : M= { 93° 6′ / 86° 54′ }	*e* : *e′*=161° 16′
ŏ′ : ŏ′=67° 44′	e : ā=148° 20′	*e* : ā=146° 17′
ŏ′ : T=111° 2′	e : ă=141° 34′	*e* : ă=138° 58′
ŏ′ : M=109° 11′	e′ : ō′=152° 56′	*e′* : ō′=155° 28′

As these crystals (especially fig. 2.) afford a fine example of the method of crystallographic calculation in the monoclinate system, I here subjoin, for the assistance of such as may be interested in the study of Mathematical Crystallography, the several steps by which the above results have been obtained. In these explanations, I must necessarily make frequent references, for principles, to my System of Mineralogy.

We may select for this examination, figure 2. Assuming ā as a face of the fundamental form, $M=\infty P\infty$, $P=\infty P'\infty$. The general descriptive expressions for the remaining planes are as follow:

$\bar{e}=mP\infty$	$e'=m'P'\infty$
$\breve{e}=-mP\infty$	$\bar{o}'=m'P'n$
$e=mP'\infty$	$e=\infty Pn$
$\breve{a}=-mP$	$e'=\infty Pn'$

The plane e ($mP'\infty$) forms parallel intersections, with ā and ă, which intersections, since they are parallel with the edge ā : M ($\infty P\infty$) are also parallel with the orthodiagonal edge of ā (P.)

Hence

$$\breve{a}=-P \text{ (§ 84, 2,) and } e=P'\infty \text{ (§ 84, 2.)}$$

and also since *e* forms parallel intersections with a and −a,

$$e=\infty P \text{ (§ 84, 1.)}$$

ē truncates the edge between ā and ā, which is the clinodiagonal edge of P, and therefore,

$$\bar{e}=P\infty \text{ (§ 84, 4.)}$$

ĕ in the same manner truncates the clinodiagonal edge of −P. Consequently,

$$\bar{e}=-P\infty. \text{ (§ 84, 4.)}$$

The intersection of ō′ ($mP'n$) with ā (P) is parallel to the clinodiagonal edge of P, (fig. 2.) consequently $n=m$ (§ 84, 8) and $\bar{o}'=mP'm$. Again ō′ forms parallel intersections with e ($P'\infty$) and *e* (∞P,) and therefore its sign is of the general form $mP'\frac{m}{m-1}$, (§ 84, 9.) But from the above, $n=m$, and consequently $m=\frac{m}{m-1}$; from which we find $m=2$ and,

$$\bar{o}'=2P'2.$$

The edge ō′ : e′ ($mP'\infty$) is parallel to the orthodiagonal edge of ō′ ($2P'2$, fig. 2. b) consequently $m=2$ (§ 84, 2,) and

$$e'=2P'\infty.$$

The intersection of $\bar{o}'$ (2P′2) with e' (∞P′n′) is parallel to the basal section of 2P′2 (apparent in the crystal, though not in the figure, a perspective representation of it;) hence n′=2 (§ 84, 1) and $e' = \infty P'2$.

Thus all the expressions for the planes of this crystal have been determined without a measurement. If the intersection of $\bar{o}'$ with e were not apparent in the crystal, it would be necessary first to determine e' by measuring the interfacial angles M : e and M : e'; these angles 136° 35′ and 117° 51′, diminished by 90° give the angles X in the two forms e (P∞) and e' (∞P′n′;) and then since, tan 46° 35′=2 tan 27° 51′, it follows that n′=2 and $e' = \infty P'2$. Thence since the intersection of $\bar{o}$ with e' is parallel to the basal section of $\bar{o}$ (mP′m), $\bar{o}$=2P′2 (§ 84, 1) as before found. The same might have been similarly determined by measuring the inclination of P on e and e′.

For the determination of $\bar{o}$ and $\breve{o}$ of fig. 3. we observe that $\bar{o}$, e, M, and $\breve{o}$ form parallel intersections with one another, which intersections are parallel to the orthodiagonal edge of $\bar{o}$ and $\breve{o}$; therefore $\bar{o}$=mPm and $\breve{o}$= −m′Pm′. Again, $\bar{o}'$, $\bar{e}$ and the opposite e, form parallel intersections. Introducing therefore in the general equation for the parameters of planes forming parallel intersections, (§ 28.)

1, ∞, −1 for m, n, r
m, 1, n for m′, n′, r′,
1, 1, ∞ for m″, n″, r″

we obtain $n=\frac{m}{m-1}$. But we have already determined that n=m, hence $m=\frac{m}{m-1}$ and m=2; accordingly $\bar{o}$ =2P2. In the same manner it is found that $\breve{o}$= −2P2.

For the calculation of the dimensions and angles of the crystal we have as data, ∞P∞ : P∞ =140° 40′, ∞P∞ : −P∞ =126° 8′, ∞P∞ : ∞P=136° 35′.

$$180° - 140° 40' = 39° 20' = \mu' \text{ (Min. App. pp. 67. 68.)}$$
$$180° - 126° 8' = 53° 52' = \mu$$
$$136° 35' - 90° = 46° 35' = X \text{ in } \infty P.$$

Since P∞ and −P∞ are coordinate forms, we may determine γ by the equation, $\tan\gamma = \frac{2 \sin\mu \sin\mu'}{\sin(\mu - \mu')}$ whence we obtain

$$\gamma = 76° 14' = C.$$

To determine the axes there are given the angles γ, μ, and X in ∞P. If $b=1$, $\tan X \sin\gamma = c$ (§ 82;) consequently

$$c=1.0265.$$

Again $a=\dfrac{\sin(\gamma+\mu)}{\sin\mu}=\dfrac{\sin 49^\circ\ 54'}{\sin 53^\circ\ 52'}$

therefore $a=\cdot 9471$

Hence $a : b : c = \cdot 9471 : 1 : 1\cdot 0265.$

After thus determining the axes, the angles X, Y, Z, in the various forms are readily obtained by the equations p. 68 or 69. For example, with regard to the form $\pm$P. X and X′ may be determined by the equations $\tan X=\dfrac{\tan\pi}{\sin\mu'}$, $\tan X'=\dfrac{\tan\pi}{\sin\mu}$, $\tan\pi$ having first been found by the equation, $\tan\pi=\dfrac{c}{a}$. This gives $X=59^\circ\ 41'$ which is half the interfacial angle ā : ā. By means of the equations $\tan Y=\dfrac{\tan\mu'}{\sin\pi}$, $\tan Y'=\dfrac{\tan\mu}{\sin\pi}$, we obtain Y and Y′ which are respectively the supplemental angles of M on ā and M on ă. Again, by the equations, $\tan Z=\dfrac{\tan(\gamma-\mu')}{\sin\sigma}$, $\tan Z'=\dfrac{\tan(\gamma-\mu)}{\sin\sigma}$, ($\sigma$ being found by the equation $\sin\sigma=\dfrac{c}{b}$,) we find the angles Z, Z′ which are the supplements of T on ā and T on ă. $Y+Y'$= the inclination of ā on ă over an orthodiagonal terminal edge, and $Z+Z'$= the inclination of ā on ă over a basal edge of the form $\pm$P.

In the form 2P′2 whose axes have the ratio, $2a$, $2b$, c, the angle μ is identical with the corresponding angle in P. π is found by the equation $\tan\pi=\dfrac{c}{2a}$, and σ by the equation $\tan\sigma=\dfrac{c}{2b}=\dfrac{c}{2}$. After the determination of these angles, X, Y, Z, in this form, may be found by the same equations as above. The inclination of T on e may be determined by the equation for tan Z, in the form ∞P, $\tan\left\{\begin{matrix}Z\\Z'\end{matrix}\right.=\mp\dfrac{\tan\gamma\sqrt{(b^2+c^2)}}{c}$, which affords the supplement of the desired inclination; or by the equation, $\sin\Pi$ (the sought angle)$=\dfrac{\cos X}{\cos\sigma}$, or $\cos\Pi=\sin X\cos\gamma$, in which X, is the angle X in the form e (∞P.) The interfacial angle e : M is determined by the equation for tan Y in P′ ∞.

In a similar manner the angles of the other forms may be obtained.

Art. VII.—*Address delivered at the Anniversary Meeting of the Geological Society of London, on the 17th of February*, 1837; by Charles Lyell, Jun., Esq., M.A., F.R.S., President of the Society.

Gentlemen,—You will have learnt from the Treasurer's Report that the finances of the Society are flourishing, and they would have appeared in a still more prosperous condition, had we not expended above 500*l.* within the year on our Transactions. Part of this sum has already been repaid by the sale of the volume just published, of which I may safely say that it yields to no preceding number in the value of its contents or the extent and beauty of its illustrations.

The total number of Fellows of the Society, exclusive of Honorary and Foreign Members, at the close of the year 1835, was 670; at the close of 1836, 709; being an actual increase, after deducting 14 for deaths, removals, and resignations, of 39 Fellows.*

We have to lament the loss of Dr. Henry, of Manchester, so highly distinguished as a chemist and philosopher, and who took a warm interest in the progress of our science. Our list of Foreign Members has been diminished by two deaths, those of Professor Hoffman of Berlin, and Baron Férussac of Paris.

Professor Frederick Hoffman was suddenly cut off in his 39th year, at the moment when the scientific world were impatiently expecting his account of the Geology of Sicily. You are probably best acquainted with him as the author of the great Geological Map of Western Germany, in which he made known the results of many years of patient and accurate research. This Map, published in 1829, was divided into twenty-four sheets, and was followed in 1830 by an Atlas containing sections, and a more general map on a smaller scale of the same country. In the same year the author's Geography and Geology of North-western Germany appeared,† which may be regarded as a commentary on the great map, comprising a description of the physical outline of the country, its mountains, valleys, plains, and river-courses, and a sketch of a portion of its geo-

* The return of the number of Fellows, and the deaths alluded to in this Address, refer exclusively to the year 1836, and not to the period intervening between the last and present Anniversary.

† Orograph. und Geognost. Verhältnisse vom Nordwestlichen Deutschland, 2 vols. Leipzig, 1830.

logical structure, embracing the transition and secondary rocks of the Hartz, Thuringerwald, and Lower Rhine. In the larger map all the tertiary and alluvial deposits are represented by one color, the author having never entered upon the subdivision and classification of these formations. He had studied, however, the newer secondary formations, which were depicted by several distinct colors, and their history would have been included in the work above alluded to, had he not been interrupted by his tour in Italy and Sicily in 1830.

Among his other writings, I may enumerate an Account of Magdeburg, Halberstadt, and the adjoining territory, and various papers which will be found scattered through the journals of Poggendorff and Karsten, the Hertha, and other German periodicals. The only fruits which we as yet possess of the scientific expedition sent by the Prussian Government under Hoffmann's direction to Italy and Sicily, are some letters written by him during the journey, and an excellent Memoir on the Lipari Islands; and a valuable work by one of his companions, Dr. Philippi of Berlin, who published in Latin a detailed account of the recent testacea of Sicily, and the tertiary fossil shells collected in the course of the expedition.*

From Hoffmann's letters it clearly appears that the novelty of the volcanic and tertiary phenomena of Southern Italy and Sicily had made a deep impression on his mind. He had been astonished, on recognising the identity of the modern trap rocks of the Val di Noto with those of ancient date in Germany, and the no less striking similarity of the Sicilian tertiary limestones, containing recent shells, to many calcareous secondary formations of northern Europe. The Lipari Islands afforded him a field for the examination of modern igneous rocks, and the slow effects of volcanic heat in modifying aqueous deposits. The picture which he has given of the fumeroles of the western coast of Lipari, the principal island of the group, is graphic and highly instructive. At St. Calogero numerous fissures are seen permeated by heated vapors which are charged with sulphur, oxide of iron, and other minerals, in a gaseous state. Here the tufaceous and other rocks are variously discolored wherever the steam has penetrated, and are sometimes crossed with ferruginous red stripes, so as to assume a chequered and brecciated appearance. In one place a feldspathic lava has been turned by the vapors into stone as white

* Phillippi, "Enumeratio Molluscorum Siciliæ tum viventium tum in tellure tertiaria fossilium, quæ in Itinere suo observavit Auctor." 280 pages 4to, and 12 lithographic plates, Berlin, 1836.

as chalk marl; in another, a dark clay has become yellow or snow-white, and these effects are not limited to a small space, but are seen extending for four miles through horizontal strata of tuff, which rise occasionally to the height of more than two hundred feet. The greater part however of the alterations are referred to what are properly called extinct fumeroles, or the action of volcanic emanations which have now ceased, but which must at one period have resembled those of St. Calogero. Some of these have produced veins of fibrous gypsum, calcedony, and opal, minerals which must have been introduced into the rents in a state of sublimation.

In some places there are tufaceous marls, regularly alternating in thin beds, with still thinner and countless layers of granular gypsum, the whole mass being again run through every where by irregular branching veins of silky fibrous gypsum. These strata, thus insersected, present a perfect counterpart to some of the secondary gypseous marls, both of the keuper and variegated sandstone formations in Germany.*

When reading the Professor's description of these phenomena, we share in the pleasure and surprise which he felt on comparing strata of high antiquity with others of so recent a date, and which, moreover, owe a portion of that resemblance to changes now daily in progress.

The writings of Baron Daudebard de Férussac were not devoted principally to Geology, but we are indebted to him for several memoirs, and among others for an Essay, published in 1814, on freshwater formations, with a catalogue of the species of land and freshwater shells which were then known to enter into their composition. Monsieur de Férussac contributed largely to the Geological section of the Bulletin Universel des Sciences Naturelles, a journal, of which he was the chief editor and original projector. This Bulletin had, for its object, to give a monthly analysis or brief abstract, usually unmixed with criticism, of the contents of all new publications in every department of science. The work was first carried on for a year on a smaller plan, and then assumed in 1824 its enlarged and permanent form, being divided into eight sections, one of which was devoted to Geology, Palæontology, and Natural History. A monthly number appeared regularly, on this and each of the other seven sections, the whole forming together a large octavo volume. In the or-

* Liparischen Inseln, p. 41. Leipzig, 1832.

ganization and direction of this scheme, the Editor was indefatigable, and he succeeded in obtaining the co-operation of a great number of the most able and eminent writers. In announcing the original aim and scope of the undertaking, he laid stress on the difficulties under which men of science labor in procuring intelligence of new works, written in a great variety of languages in different parts of the world, and frequently buried in the voluminous and costly transactions of learned societies. He therefore expressed a hope that his Bulletin would serve as "a kind of telegraph" for the rapid conveyance of the earliest intelligence of inventions and discoveries, so as to prevent philosophers from wasting their time and money in slowly feeling their way to results already found out by others, and attaining with great labor the very points from which they might have started. The Geological section of the Bulletin was ably supported by MM. Boué, Brongniart, and other writers, and survived the other sections for some time, maintaining itself for seven years, till at length it was given up in 1831 for want of sufficient encouragement.

The works of Baron Férussac on Natural History, and especially Conchology, would deserve from me a fuller notice, if they were not irrelevant to the subject of this address.

HOME GEOLOGY.

I shall now commence my retrospect of the proceedings of the Society, during the last year, by considering those papers which have been devoted to the Geology of the British Isles. There is probably no space on the globe, of equal area, which has been so accurately surveyed as this kingdom; yet the most experienced geologists are now exploring several parts of it with the feeling that they are entering upon terra incognita. Not only do they find it necessary to trace out more correctly the limits of formations previously known, but also to introduce new groups of fossiliferous strata and new divisions, in districts before supposed to have been well investigated.

The carboniferous deposits which are alike interesting, in a scientific and economical view, have deservedly occupied of late the particular attention of many able geologists, and we have received communications on the subject from Mr. Murchison, Mr. Prestwich, Professor Sedgwick, and Mr. Peile. The observations of Mr. Prestwich relate to the coal-measures of Coalbrook Dale, and the formations immediately above and below them, together with the accompanying trap-rocks.

There is perhaps no coal-field in the whole country of equal size in which the strata have been so much dislocated and shattered. Mr. Prestwich gives a detailed description both of the principal and minor faults, their direction, extent, inclination, breadth, and fall, and the difference of level produced by them in their opposite sides, which is sometimes slight, but sometimes amounts to six hundred or seven hundred feet. In some instances the change of level is by steps or hitches, which, it is truly said, may be owing either to unequal resistance, or to a series of small dislocations. The walls of the fissures in the disjointed strata are sometimes several yards apart, the interval being filled with the debris of the strata. In other places they are in contact. In this last case it is particularly remarked that the surface of the ends of the fractured beds of coal and shale is shining and striated. You are aware that this appearance has usually been attributed, and I believe rightly, to the rubbing of the walls of the rent one against the other, the lines of the polished and striated surfaces indicating the direction of the motion, but I have lately seen it objected to this theory, that the striæ are not always parallel, but often curved and irregular, and that the earthy contents of veins and faults often present the same glittering and striated faces, or slickensides as they have been called. I am familiar with the fact, and have always inferred that the movements were irregular and complicated, occasionally changing their direction, and that even when uniform, they may have acted unequally on materials varying in hardness and pliability. It is much to be desired that scientific travelers who visit countries shaken by earthquakes would observe with minute care all the phenomena attending the fissuring of rocks and buildings. I have been informed by an eye-witness of one of the late minor earthquakes in Chili, that the walls of his house were rent vertically, and made to vibrate for several minutes during each shock, after which they remained uninjured and without any opening, although the line of the crack was still visible. On the floor, at the bottom of each rent, was a small heap of fine brickdust, evidently produced by trituration. In such instances it would be desirable to obtain fragments of the rent building, and compare them with the walls of natural fissures.

In his examination of the fossils of the coal-measures, Mr. Prestwich has shown that beds containing marine remains alternate with others in which fresh-water shells and land plants occur, appearances which he attributes to the flowing of a river, subject to occasional freshes, into the sea, rather than to repeated changes in the relative level of land and sea.

It is certainly the safer course to incline to this hypothesis whenever there are no unequivocal signs, as in the Purbeck strata in Portland, of land plants having become fossil on the very spots where they grew. For although there may be many river deltas like that of the Indus, where the land is subject to be alternately upheaved above, and then let down below the waters of the sea, yet such oscillations of level must be considered as exceptions to the general condition of the earth's surface near the mouths of rivers at any given period. Even in a case like the delta of the Indus, both the causes above alluded to may be expected to co-operate in producing alternate fluviatile and marine strata; for in the long intervals between great movements of the land, the river will annually advance upon the sea with its turbid waters, and then retreat again as the periodical flood subsides, and the salt waters, after being driven back for a time, will re-occupy the area from which they have suffered a temporary expulsion.

In the conclusion of his valuable paper, Mr. Prestwich observes that the carboniferous strata of Coalbrook Dale must once have been entirely concealed under a covering of new red sandstone, and they owe their present exposure partly to those movements which have shattered and elevated the coal measures, and partly to extensive denudation. It is natural therefore to inquire how many other coal-fields may still lie buried beneath the new red sandstone of the adjoining district.

In relation to this point of great practical importance, Mr. Murchison formerly offered some conjectures, when speaking of the probable passage of the ten-yard coal of the Dudley field beneath the new red sandstone, which there flanks it on the east and west. That geologist now informs us that his conjectures have been verified, and that at Christchurch, one mile beyond the superficial boundary of the coal-field, the ten-yard and other seams have been reached by borings carried down to the depth of nearly three hundred yards. Adverting to this discovery, he directs attention to the possible extension of other carboniferous tracts beneath the surrounding new red sandstone of Shropshire, Worcestershire, Staffordshire, and other central counties.

It is clear that these geological considerations must be duly weighed by those who speculate on the probable future duration of British coal, according to the actual or any assumed rate of consumption.

Mr. Murchison, in describing the Dudley and Wolverhampton coal-fields, informs us that he has not yet found any fossil remains of decidedly marine origin, like those observed by Mr. Prestwich in Coalbrook Dale. The shells seem to be all of fresh water genera, and the *Megalichthys Hibberti*, and other fish occuring at Dudley, of species identical with those of the coal measures of Edinburgh, may have inhabited fresh water.

The same author has colored on an Ordnance map the superficial area of the Silurian rocks connected with the coal-fields above mentioned, and has shown that the Lickey quartz rock between Bromsgrove and Birmingham, of which the geological position has remained hitherto uncertain, is in fact nothing more than altered Caradoc sandstone, a member of the lower Silurian group. The same appears as a fossiliferous sandstone in one district, while in another, it passes into a pure quartz rock, a modification attributed to the proximity of underlying trap, for analogous changes have been seen at neighboring points where the absolute contact of the sandstone with the trap is visible.

We are also indebted to Mr. Murchison for some interesting remarks on the dislocations of the strata in the neighborhood of Dudley, and particularly for a description of some dome-shaped masses, from the center of which the beds have a quâquâversal dip. He speculates on the probable dependence of these phenomena upon the protrusion of volcanic matter from below, at points where it has been unable to find issue. It would, I think, have been more satisfactory, if, in confirmation of his theory, some natural section of one of these dome-shaped masses could be pointed out, where not only a nucleus of trap was apparent, but could be shown to have taken up its actual position in a soft or fluid state. Even if we should find in some instances a subjacent central mass of trap, porphyry or granite, not sending out veins or altering the strata, the folding of the beds round such a protuberance might admit of an explanation like that suggested by Dr. Fitton. He has supposed a set of yielding horizontal strata to be pressed upon by a subjacent hill or boss of hard rock, in which case the effect of upward pressure might resemble that seen, on a small scale, in the paper of a bound book, where a minute knob in one leaf has imparted its shape to a great number of other leaves without piercing through them.* Whatever hypothesis we favor, it is essential to observe that such hills as the Wren's nest near Dudley, and others of similar ellipsoidal forms and internal structure, do not correspond to the type of volcanic hills, such as Etna, Mount Dor, or the Cantal. In both cases there may be an approach to a cone, and the beds may dip every where outwards from a common centre; but, in the volcanic mountain, the beds having an outward dip, thin off as they approach the base or circumference of the cone, which is not the case in inclined beds composing the hills alluded to in the neighborhood of Dudley; nor in the last mentioned instances do the lowest or subjacent rocks crop out round the circumference of the cone, as happens in the instances of the volcanic eminences before alluded to, where the granite of the country round Mount Dor, the fresh-water beds and mica schist in the Cantal, the marine deposits around Mount Etna in Sicily,—each appear at the surface as soon as we have left the slope of the cone, and advance upon the surrounding low country.

In attempting to explain the principal transverse faults of the Dudley coal-field, Mr. Murchison refers frequently to the theoretical principles expounded by Mr. Hopkins in his Researches in Physical Geology, a paper printed in the sixth volume of the Transactions of the Cambridge Philosophical Society. Mr. Hopkins has there endeavored to develop, by reasoning founded on mechanical principles, and by mathematical methods, the effects of an elevatory force acting simultaneously at every point, beneath extensive portions of the crust of the earth. He is aware that in nature such a force must usually act under complicated conditions, so as to produce irregular phenomena; but he observes that in order to have a clear conception of the manner in which it would operate in producing movements and dislocations, it is useful to assume certain simple conditions to which mathematical investigations may be applied. When we have deduced in this manner some results free from all uncertainty, these may serve as standard cases to which the geologist may refer more complex problems. Thus for example, a portion of the earth's crust may be assumed to be of indefinite length, of uniform depth, and bounded laterally by two vertical parallel planes, beyond which the disturbing force does not extend. It is then supposed that a quantity of subterranean vapor or melted rock, existing at a

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* Dr. Fitton, Geol. Trans. 2nd Series, vol. iv. p. 244.

certain depth, is expanded by heat so as to elevate the superincumbent mass, the resulting fissures in this mass may then become matters of calculation. According to Mr. Hopkins, rectilinear lines of dislocation will give rise to a set of longitudinal parallel fissures, and simultaneously to others precisely at right angles to them; whereas in conical elevations, the fissures will diverge from a centre. If the general axis of elevation be curvilinear, the longitudinal fissures preserving their parallelism with it will be also curvilinear, while the transverse fissures being perpendicular to the former at their points of intersection will no longer be parallel.

To return from this digression, I must now recall your attention to other papers relating to the carboniferous deposits of England. The coal-measures of the northwestern coast of Cumberland have been examined by Prof. Sedgwick and Mr. Williamson Peile, who have described the Whitehaven and other fields in great detail, illustrating their account with a map and sections. The recorded observations in numerous sinkings and borings, both in relation to the succession of the strata and to the complicated faults which intersect them, would have been involved in hopeless confusion, if they had simply consisted of a statistical collection of facts attested by miners; but in this paper, Prof. Sedgwick, aided by Mr. Peile's practical and scientific knowledge, has compared the different sections and generalized the phenomena, giving unity and consistency to the whole, throwing the strata into distinct groups, and referring the several faults to different movements, to which successive periods of time may be assigned.

In connection with these recent contributions to the history of our carboniferous strata, I am happy to mention the excellent volume lately published by Prof. Phillips, forming the second part of his Illustrations of the Geology of Yorkshire. It is almost entirely devoted to a description of the carboniferous or mountain limestone of Yorkshire and the north of England, a subject already admirably treated in some papers read before this Society by Prof. Sedgwick, particularly in his account of the carboniferous chain from Penigent to Kirkby Stephen.* As these geologists had separately explored the same ground, it is satisfactory to perceive that the leading divisions which they have proposed for the classification of the mountain limestone and associated strata, agree in every essential point. Mr.

* Trans. Geol. Soc. 2nd Series, vol. iv. part 1. p. 69.—1835.

Phillips has described the physical geography of the district occupied by these rocks, their lithological character, stratification, jointed structure, and the most remarkable faults which affect them, especially those which have been called the great Penine and Craven faults. He also treats of the trap dykes which cut through the limestone, and discusses the probable epochs of the displacement of the strata, judiciously pointing out the difficulties unavoidably opposed to the rigorous determination of the date of such dislocations. A large and very valuable portion of the work is filled with descriptions and plates of organic remains, especially of the brachiopodous and cephalopodous mollusca. Most of the species of these classes were probably inhabitants of the deeper parts of the sea, but there are fossil shells in the mountain limestone, which the author supposes to have lived near the shore, and belonging to genera formerly regarded as foreign to the carboniferous limestone, such as Isocardia, Nucula, Pecten, Patella, Turritella, and Buccinum. Many species of Zoophytes and Crinoidea are also described and figured in this excellent monograph.

We are indebted to Mr. Austen for a description of the South of Devonshire between the river Ex and Berry Head, and between the coast and Dartmoor, a district consisting of transition rocks, new red sandstone, greenstone, and trap. His speculations on the origin of the different formations and the causes which gave rise to the existing features in the physical geography of the country, display much talent and are full of instruction.

The structure of Devonshire has also furnished a fertile field of inquiry to Messrs. Sedgwick and Murchison since our last anniversary. They have attempted the difficult task of establishing a classification of the older rocks so largely developed in that county. In every geological map hitherto published of Devonshire, all the stratified deposits of higher antiquity than the new red sandstone had been represented by one common color, the limestones being all included as integral parts of one great formation called greywacke.* But these gentlemen, after examining this region, announced at Bristol to the geologists assembled at the meeting of the British Association, that the great mass termed greywacke, and previously undi-

* The abstract of the Report of Messrs. Sedgwick and Murchison, published with a section in the Athenæum, August, 1836, and in other scientific journals, is the same as that written for insertion in the Proceedings of the Association. From that document, and from a written explanation of their views, which I obtained from the authors, the present observations are deduced.

vided, comprised in it several formations of great thickness, ranging in age from the Cambrian system of Prof. Sedgwick up to the true carboniferous series inclusive. The first groups mentioned by them in ascending order are the Cambrian and Lower Silurian, which great mass contains many distinct courses of limestone; and is separable into several formations, distinguishable from each other by stratigraphical position and by lithological and zoological characters.

There appears, however, to be a great hiatus in the succession of rocks in Devonshire, as compared to South Wales, there being no traces of the upper Silurian strata, nor of the old red sandstone, nor even of the mountain limestone in its ordinary aspect. On the contrary, the next group met with in ascending order, is a culmiferous series, the base of which distinctly reposes upon the above mentioned ancient rocks. This culmiferous deposit, far from appearing as a mere band, or at detached points, occupies about one third of the large county of Devon, and a considerable adjacent part of Cornwall; its southern boundary ranging from Exeter on the east, by Launceston, to St. Gennis in Cornwall on the west; its northern frontier running by Barnstable and and South Moulton to near Wellington in Somersetshire. These culmiferous beds are shown to contain thick beds of limestone; entirely dissimilar in structure and fossil contents from any limestones of the underlying "grauwacke," in which they had previously been merged. The culm measures consist of grit, sandstone, shale and limestone; and these rocks, it is said, are never affected by a slaty cleavage like the lower Silurian and Cambrian rocks on which they rest. From this character, as well as from their prevailing mineralogical structure and imbedded fossil plants, the authors regard the culmiferous formation of Devon as perfectly identical in age with other coal-fields, and as more particularly analogous to the culm-bearing strata of Pembrokeshire; a part of which also once passed for "grauwacke," but Mr. Murchison has recently shown that it belongs to the South Welsh coal-field, which is known by all geologists to rest upon mountain limestone.

Thus referred to the age of our ordinary coal, these strata of North Devon are further proved to lie in a great trough, their southern edges being turned up against the granite of Dartmoor, where they acquire, in contact with the granite, when traversed by elvan dykes, many characters of the metamorphic rocks, or those commonly termed primary. The phenomena of interference and alteration at the junction are such as to give a comparatively modern date for the eruption of the Dartmoor granite, and to explain why so much difficulty and ambiguity has prevailed in determining the age of some of the altered culm beds.

Among other points which this survey of Prof. Sedgwick and Mr. Murchison has settled, so far as Devon is concerned, is one of the highest theoretical interest, and on which for more than two years the Society has been anxiously desiring more accurate information; I allude to the true stratigraphical position of certain shales near Bideford in North Devon, containing fossil plants of the same species as those which are found abundantly in the coal. I may first remind you that a discussion had previously arisen respecting the alledged discovery by Mr. Weaver of anthracite, with the usual carboniferous plants, in the greywacke or transition rocks of Ireland.* Notwithstanding the value justly attached to the opinion of so experienced and long-practiced an observer, your Council hesitated to print his statement, and requested him to reexamine the ground. At the same time Mr. Griffiths, to whom we are looking for the publication of a Geological Map of Ireland, had come to a different conclusion, and Mr. Weaver having been induced to repeat his observations, became convinced that he was in error, and has since studiously availed himself of every opportunity of announcing this change in his views.

You are aware that as yet in the British islands, scarcely any vegetable impressions have been met with in rocks more ancient than the carboniferous strata above the old red sandstone, so that we know not what species of plants belong to the greywacke or transition group. We can only presume from analogy that since the shells, corals, and other organic remains of that ancient group differ from those found above the old red sandstone, the plants also, if ever discovered, will differ as greatly. Considerable surprise was therefore excited when, during the Presidentship of my predecessor in this chair, a letter was read, addressed to him from Mr. De la Beche, stating that he had found near Bideford in North Devon, many well known coal plants in the lower greywacke, or far down in the transition series.† Such of the plants as were determinable had been identified by Prof. Lindley with species characteristic of the true coal measures, and which had never been found elsewhere

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* Proceedings Geol. Soc., vol. i. p. 231.

† Proceedings Geol. Soc., vol. ii. p. 106.

below the coal. The anomaly, therefore, in the supposed position of these fossils was so great, that between the ordinary geological site of such remains, and that in which they were here inferred to present themselves, there would be interposed, if the series were complete, the whole of the old red sandstone, and at least the two upper formations of the Silurian system. When this point was considered, I expressed to the Society my opinion in common with Mr. Murchison, as to the insufficiency of the proofs relied on by our Foreign Secretary, and we feel that we had a right to call for more conclusive evidence. The simple fact of shales having been found charged with true coal plants, raised so strong a presumption in favor of their belonging to the regular carboniferous series, that the burthen of proof rested with him who wished to assign to them either a higher or lower position. Our scepticism was regarded by Mr. Greenough as implying too marked a bias for a preconceived theory, and this he afterwards hinted in his anniversary address.* I may affirm, however, that in the first place it implied on my part no distrust of Mr. De la Beche's skill or experience in geological surveying, and that had Prof. Sedgwick and Mr. Murchison advanced a similar opinion on analogous proofs, I should equally have withheld my assent. Suppose, for example, they had announced to us that they had found fossil fruits and leaves identical with those of Sheppey in strata of the age of the white chalk with flints. I should have demanded from them, in corroboration, the most clear, unequivocal, and overwhelming evidence. If it were a region of disturbed and vertical strata, I should expect them first to have resorted in vain to every hypothesis of inverted stratification with a view of explaining away such an exception to the general rule.

I might perhaps be told that we are unacquainted with the flora of the upper cretaceous period, and I admit that we are as ignorant of it as of that which belonged to the transition period, but when we consider the contrast of the shells and other fossils of the chalk and London clay, we naturally anticipate that if plants are ever found of the precise age of our chalk with flints, they will not prove to be of the same species as those of the Sheppey clay. There is a like presumption from analogy against the conclusion that the same vegetation continued to flourish on the earth from the period of the lower greywacke to that of the coal, because we know that in the course

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* Proceedings Geol. Soc., vol. ii. p. 164.

of the intervening epochs the testacea, zoophytes, fish and other classes of organic beings were several times changed.

In regard to the proofs relied on by Mr. De la Beche, I should observe that he never attempted to show that the plant-bearing shales at Bideford were interstratified with rocks charged with shells or other fossils known to belong to rocks older than the old red sandstone.

Since writing the above sketch of the different views recently published of the structure of Devonshire, I have received a letter from Mr. De la Beche, from which I am happy to learn that it is his intention before concluding his report on the Ordnance Map of Devon, to re-examine Devonshire. He is far, he says, from pretending that his first views were perfect, and if he finds reason to modify any of them, he shall not hesitate to announce the change of opinion. In the mean time he no longer contends that the culmiferous strata are referable to the lower greywacke, and considers the point of difference to lie within a narrower compass, namely, whether the culm beds are to be considered as upper greywacke or coal. This question, on which he is not yet satisfied, evidently appears to him of much less theoretical importance than, I confess, it does to me. It is fair, however, that I should state the arguments which influence his mind. If the plants, he says, found at Bideford in the culmiferous series should belong to strata more ancient than the old red sandstone, the fact would not stand alone, for he has lately received a letter from M. Elie de Beaumont, detailing analogous phenomena in Britanny. It is stated that the greywacke there closely corresponds in general character with that of Devon, the upper part like the Devonian series containing anthracite. With this anthracite or culm are found at Montrelais, Chatelaison, and other places, fossil plants, the greater part of which are identical with those in the coal measures; but there are others which have not hitherto been detected in the latter rock. Patches of true coal measures rest in unconformable position upon these upper greywacke beds of Britanny. Now I regret that I have not seen any printed account of the geology of this part of France; for until we learn whether the plants in question are associated with true Silurian fossils, the testimony is quite incomplete. We know not, for instance, whether the plant-bearing series in question, is old red sandstone or a Silurian formation, or whether it is a lower part of the true carboniferous system of which the strata had been disturbed before a higher portion was superimposed.

Similar remarks hold in regard to the observations made by M. Virlet in the Dictionnaire d'Hist. Naturelle, where in his late article "De l'Origine des Combustibles Minéraux," he speaks of certain carboniferous deposits of Ireland, (those alluded to by Mr. Weaver before mentioned,) as well as others examined by M. Voltz in the Black Forest, also the culm beds of Britanny, and those of the department of La Sarthe, as all belonging in age to the newest transition formations, "*terrains de transition les plus récens.*"

Mr. De la Beche alludes to another discovery of coal plants implying as great an anomaly as that which he had imagined to occur in Devonshire, and by which he was himself once led into error during an Alpine excursion, about eighteen years since, when he met with coal plants in the schists of the Col de Balme, in Switzerland. He then inferred that the beds belonged to the true coal measures, but M. Elie de Beaumont afterwards proved them to be lias; that is to say, he identified them with other rocks not far distant in the Alps, which were shown to be lias by containing Belemnites and other fossils. Mr. De la Beche was at first sceptical on the point, but after revisiting the Alps, he came round to the same opinion. Having therefore been in one instance misled by relying on the fossil vegetables of the coal as affording a good chronological test, he naturally attached but small value to the same testimony as a criterion of the age of another set of rocks in Devonshire. Now you will easily understand that a geologist, who is once persuaded that the same plants flourished in European latitudes from the period of the true coal to that of the lias, will be ready to concede without difficulty the probable existence of the same plants at an era long antecedent to the coal. We know that between the deposition of the coal and the lias there were successive revolutions in the races of animals which inhabited the waters; the zoophytes, mollusca, fish, and, as far as we know them, the reptiles having been changed again and again; so that the fossils of the mountain limestone differ from those of the magnesian limestone or zechstein, these again from the organic remains of the muschelkalk, and these last from those of the lias. If we are to believe that the same plants survived on the land, while such fluctuations in animal life occurred in the waters, why should we not imagine the longevity of the same species to have been still greater, so that they began to exist even before the deposition of the old red sandstone? But let me remind you that botanists have been led to very different conclusions respecting the laws governing the distribution of fossil vegetables from the study of undisturbed districts. You are not ignorant that the strata of the Alps are involved in extreme confusion and complexity, mountain masses having been completely overturned and twisted, so that the same set of strata have been found at the top and bottom of the same section separated by several thousand feet of beds belonging to an older formation. So obscure is the order of position in Alpine geology, that the cretaceous and greensand series have been classed by experienced geologists as more ancient than the oolite, under which, in point of fact, they occasionally lie.

Prof. Studer, in his work on the Bernese Highlands, after years of personal investigation, has published a map in which he has given a colored ground plan without venturing to commit himself by sections, or a table of the regular order of superposition.

After devoting a summer to the investigation of the same portion of Switzerland, with the advantage of Mr. Studer's map and work, I was unable to satisfy myself that I had found a key to the classification or superposition of the formations, so enormous is the scale on which they have been deranged. I collected fossil plants on the Col de Balme, but I have not examined the precise localities further to the west appealed to by M. de Beaumont. I am far, therefore, from denying his facts or inferences, hoping at some future period more carefully to inquire into the evidence on the spot. No one, I am aware, is more desirous that others should visit the southern Alps and verify or criticise his facts than M. de Beaumont. Meanwhile I am reminded of an expression of our mutual friend M. Von Buch. When I related to him some geological phenomena which surprised him; "I believe it," he said, "because you have seen it, but had I only seen it myself, I should not have believed it."

But to conclude, and to recall your attention to the structure of Devonshire, you will perceive that Mr. Murchison and Prof. Sedgwick have endeavored, and I think successfully, to work a great reform in the classification of the ancient rocks of that country, by applying to them the arrangement which they had previously made for the deposits termed by them Cambrian and Lower Silurian in Wales and the adjoining parts of England. According to their survey and sections, the coal plants of Bideford, so far from constituting any anomaly, so far from affording any objection to the doctrine that particular species of fossil plants are good tests of the relative age of rocks, do in reality from the place which they occupy, confirm that doctrine, culmiferous rocks distinctly overlying the so-called grauwacke, and not being referable to any of the well defined and normal types, which compose the old red sandstone and Silurian system.

I shall now pass on to the consideration of other memoirs on English Geology. The limestone which the Germans call muschelkalk, and the numerous fossils which are peculiar to it, have not yet been detected in England in any part of that great series of beds which intervene between the lias and the coal. In those parts of Germany where it occurs, it divides the beds of red marl and sandstone, which occupy that great interval into two divisions, the upper of which is called keuper, and the lower bunter sandstein. In the absence of the muschelkalk in this country, it has been impossible for us to separate our new red sandstone into two well defined masses; but Dr. Buckland considers that certain portions of the upper beds in Warwickshire and elsewhere may be identified with the keuper by their mineral character, and near Warwick by the remains of a Saurian, which he believes to be of the genus Phytosaurus, a genus characteristic of the keuper of Wirtemberg.

An examination in the South-east of England of the strata usually termed plastic clay, has led Mr. John Morris to offer several new, and as they appear to me, judicious suggestions in regard to the classification of these beds. It is well known that wherever the tertiary strata are seen in immediate contact with the chalk, they consist of alternations of sand, clay, and pebbles, and in some few places a calcareous rock,—all these varying greatly in their thickness and in their order of succession in different places. Mr. Morris divides those of Woolwich into two parts, and states that the upper is characterized by a mixture of marine and fresh-water shells, the fresh-water genera being Cyrena, Neritina, Melanopsis, and Planorbis. The lower division contains exclusively marine shells. The author refers this intermixture to the influx of a river into the sea, in which the London clay was formed. Mr. Morris considers the Bognor strata, which rest immediately upon chalk, as the equivalents of the lower Woolwich deposit, observing that the shells agree with those of the London clay. These remarks seem to confirm the conclusion to which he had been previously led by the grand section at Alum Bay in the Isle of Wight, namely that the beds usually styled plastic and London clays belong to one zoological period.

MINERAL VEINS.

Your attention has been called to the origin of mineral veins by Mr. Fox, who has endeavored to explain why so large a proportion of the metalliferous veins in England and other parts of the world should have an east and west direction. He supposes fissures filled with water, containing sulphurets and muriates of copper, tin, iron, and zinc in solution, through which currents of voltaic electricity are transmitted. The metals separated from their solvents by this action are deposited in the veins, and most abundantly in veins running at right angles to the direction of the earth's magnetism; for as the magnetic currents of the earth pass from north to south, they cause those of electricity to move east and west, although considerable deviations from this direction must be occasioned in the course of geological epochs by variations in the magnetic meridian.

Since Mr. Fox first ascertained the existence of electric currents in some of the metalliferous veins in Cornwall,* Mr. Henwood has made many experiments on the same subject, together with observations on the distribution of metallic and earthy minerals in veins. He considers the results obtained by him to be in a great degree opposed to the theory of Mr. Fox.†

Mr. Fox conceives the fissures in which metalliferous substances occur, to have been at first small and narrow, and to have increased gradually in their dimensions. This doctrine has also been propounded in a work with which you are probably familiar, and from which I have derived much instruction, I mean M. Fournet's Essay on Metalliferous Deposits. This Essay was originally included in the third volume of M. Burat's continuation of D'Aubuisson's Treatise on Geology, (1835,) but it is now published separately, and gives the clearest general view which I have seen of the application of geological theories to phenomena observed in mining. It is written by one who has acquired much practical knowledge as a miner, and who is well versed in chemistry and mineralogy.‡

Werner, when he published his justly celebrated Essay on Mineral Veins, had come to the conclusion that the same rent, after being

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* Phil. Trans. 1830, p. 399.

† See Mining Journal, Supplement 9. p. 34, December, 1836, and Annals of Electricity, No. 2. vol. i. on Electric Currents, &c. by W. T. Henwood, Esq.

‡ Etudes sur les Dépots Métallifères, par M. I. Fournet.

wholly or partially filled, has sometimes been reopened; and M. Fournet has endeavored more fully to explain the successive dilatation of the same veins at distinct periods. He has given examples in mines worked under his direction at Auvergne, in which the sulphurets of iron, copper, lead, and zinc, besides quartz, barytes, and other minerals, seem evidently to have been introduced at different periods by chemical action accompanied by new fractures and dislocations of the rocks, and the widening of preexisting fissures.*

You will find in M. Fournet's treatise a copious analysis of a great variety of books on mining, besides a detail of facts which have fallen under his own observation. He has described first those veins which are decidedly connected with rents produced in rocks by mechanical movements, and which are supposed to have been chiefly filled from below by sublimation, more or less obviously connected with volcanic action. He afterwards passes on to the consideration of those masses which have been called stockwerks by the Germans, which are imagined by some to have their origin in the contraction of granite, porphyry, and other rocks as they cooled, numerous rents being then formed, in which metallic particles were concentrated. In treating the subject in this order the author appears to me to have followed the most philosophical course, beginning with cases of undoubted rents of mechanical origin filled with minerals and metals introduced by sublimation, and then carrying with him as far as possible the light derived from these sources to dissipate a part of the obscurity in which all theories respecting the nature of Plutonic rocks and their minerals must, I fear, be forever involved. Much will still remain unexplained; but those who proceed in an opposite direction often throw doubt and confusion upon the simplest phenomena, as has sometimes happened in an analogous case, when geologists have begun with the examination of granite and granite veins, and have then endeavored to apply the ideas derived from this study to the trap rocks and volcanic dykes.

Among the most interesting conclusions deduced by M. Fournet from his examination of the mining districts of Europe, I may mention the modern periods at which the precious metals appear to have entered into some veins: thus, to select a single example, some veins of silver of Joachimsthal in Bohemia are proved to have originated in the tertiary period.†

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* See "Etudes," &c. Section 3.

† See "Etudes," &c. Section 2.

FOREIGN GEOLOGY.

Among the researches into the geology of foreign countries in which our members have been recently engaged, I have great pleasure in alluding to the labors of Mr. H. E. Strickland and Mr. Hamilton in Asia Minor. These gentlemen first examined the neighborhood of Constantinople, and found on both sides of the Thracian Bosphorus an ancient group of fossiliferous strata, consisting of schist, sandstone, and limestone. From the character of the fossils it is inferred that these rocks may probably be the equivalents of the upper transition or Silurian strata of England. The shells belong to the brachiopodous genera Spirifer, Producta, and Terebratula, with which the remains of corals and Crinoidea were associated, and fragments of a Trilobite.

The rarity of any fossiliferous deposits of higher antiquity than the old red randstone in any of the countries bordering the Mediterranean, or indeed to the south of the Alps and Pyrenees, lends considerable interest to this observation. In their way through France, our travelers examined the well known region of extinct volcanos in Auvergne, and afterwards found a counterpart to it in the Catacecaumene, a district in Asia known by that name in the time of Strabo, from its burnt and arid appearance. Some of the volcanos in Asia are of very modern appearance, although no notice of their eruptions falls within the limits of history or tradition. The volcanic hills rise partly through lacustrine limestone in the valley of the Hermus, and partly cover the slope of the schistose hills which bound it to the south. There are about thirty older cones, worn by time, and of which the craters are effaced or only marked by a slight depression; and three newer cones, which preserve their characters unaltered, the craters being perfectly defined and the streams of lava still black, rugged, and barren. Here, as in the country of corresponding structure in France, we find streams of lava following the course of existing valleys, and yet frequently cut through by rivers. We find also a tertiary fresh-water formation, sometimes resembling chalk with flints, like that of Aurillac in France, and forming detached hills capped with basalt, while more modern lavas have flowed at the base of the same hills. The extent of this analogy will be best appreciated by those who compare Mr. Strickland's drawings with Mr. Poulett Scrope's masterly illustrations of the French volcanic region.

The countries watered by the rivers Meander and Cayster are described as having a simple geological structure. There are granitic rocks, with saccharine marble; there are also hippurite limestone and schist, and tertiary deposits unconformable to these, besides igneous rocks of various ages. The tertiary formations are chiefly lacustrine, and occur in nearly every large valley. They are composed of horizontal beds of calcareous marl and white limestone, in which are layers, and nodules of flint; they also consist of sandstone, sand, and gravel.

The only representative of the secondary rocks of Europe is termed by Mr. Strickland "hippurite limestone," which appears to be very sterile in fossils. In this respect and in its other characters it agrees with that great calcareous formation described by MM. Boblaye and Virlet in their splendid work on the Geology of the Morea.* According to these French geologists, three quarters of the Peloponnesus are occupied by a compact limestone several thousand feet thick, in which they could discover scarcely any organic remains, except a few hippurites and nummulites, but which is supposed to be the equivalent of our chalk and oolites. Nothing, they say, can be more monotonous in character than this calcareous mass in the South of Europe, which appears to represent the larger part of our upper secondary formations of the North, where the rocks are so varied in lithological aspect and so distinguishable from each other by their well preserved fossils.

Ancient fossiliferous strata resembling those of the neighborhood of Constantinople are said to be largely developed in the Balkan, a mountain chain of which we may soon expect to receive information from the pen of M. Ami Boué. That indefatigable geologist has already explored a large part of Servia, a country of whose physical and moral condition we are perhaps more ignorant than of any other in Europe, and he is rapidly extending his survey over various parts of the Turkish empire, to the examination of which he proposes to devote several years. Meanwhile our late secretary, Mr. Hamilton, is continuing, with great zeal, his investigation of the borders of the Black Sea and other parts of Asiatic Turkey.

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* Paris, 1833, in folio. It is to be regretted that this work cannot be procured separately from other folios containing the scientific information collected during the French expedition to the Morea.

In a paper on the structure of part of the Cotentin, near Cherbourg, the Rev. W. B. Clarke describes that country as consisting of hills or ridges of quartz rock alternating with valleys of slate occasionally associated with syenite and greenstone, which appear to be of posterior origin. A curious fact is mentioned: the quartz rock splits naturally into irregular masses, which have, nevertheless, some angles of fixed dimensions, namely, 103°, 64°, and 83°. Fragments of a green variety of schist exhibit the same angles under the same circumstances of position, proving that similar causes had acted on the two formations *en masse*, the same sets of joints, lines of stratification, and cleavage being found in both. Besides these facts, which are illustrated by diagrams, the author mentions others calculated to throw light on the cleavage and jointed structure of rocks.

PROOFS OF MODERN ELEVATION AND SUBSIDENCE.

Under this head I shall first consider several notices of beds of gravel, sand, clay, and marl, containing recent marine shells, which have been observed in various parts of Great Britain, a subject very frequently brought before our notice of late years. Deposits of this kind have been found by Dr. Scouler in the vicinity of Dublin, where they rise to the height of 80, and in some places of even 200 feet above the level of the sea. Besides marine shells of existing species, he has ascertained that some of the lower beds of this formation contain bones of the extinct Irish elk, by which we learn that this quadruped, although belonging to a comparatively modern period, and found in peat-mosses, had nevertheless begun to inhabit this part of the world at a period anterior to some of the last changes in the position of land and sea, changes which are proved by the upraised shelly beds just alluded to. Now Professor Nilsson of Lund in Sweden, although ignorant of these facts, had remarked to me that some great alteration must have occurred in the shape and extent of dry land and sea in Great Britain and the surrounding parts subsequently to the time when the Irish elk existed, otherwise so many entire skeletons of so large an herbivorous quadruped as the *Cervus megaceros*, would not have been found in so small an island as the Isle of Man. That island may at no remote geological period have been united to the main land, and may have since been separated from it by subsidences, on a scale equal to the elevations of which there is such clear evidence in Ireland and elsewhere.

Changes in the relative level of land and water, in the estuary of the Clyde, are indicated by facts described in another paper by Mr. Smith of Jordan Hill, near Glasgow. Superficial deposits, in which a great number of marine shells of recent species are imbedded, are found on the banks of the Clyde below Glasgow, at the height of thirty or forty feet above the sea. I had myself an opportunity of verifying during the last summer several of these observations of Mr. Smith, and found equally clear proofs that the Island of Arran had participated in the upward movement, so that a circle of inland cliffs may be traced all round that island, between the base of which and the present high-water mark a raised beach occurs, and in some places beds of marine marls, formed of recent shells, as in the bay of Lamlash. Mr. Smith has also traced sea-worn terraces on each side of the Clyde below Dumbarton and between the Cloch Lighthouse and Largs.

We are indebted to Sir Philip Egerton for some new details respecting the shelly gravel of Cheshire, of which he had previously treated; and to Mr. Murchison and Prof. Sedgwick for a joint paper on "a raised beach in Barnstable Bay on the northwest coast of Devonshire." This beach puts on for several miles where it is best exposed, the form of a horizontal under terrace resting upon an indented and irregular surface of the older formations. It presents a cliff towards the sea, in which beds of calcareous grit, sandstone, and shingle are seen perfectly stratified. The bottom of the deposit is chiefly composed of indurated shingles resting on the ledges of the older rocks, and filling up their inequalities. Through the whole cliff, but especially in the indurated grits, shells are abundantly dispersed, identical in species with those now living on the coast, and well preserved, though sometimes water-worn.

The authors point out that these beds cannot have been formed by accumulations of blown sand. They demonstrate an elevation of the coast during the modern period; and there are phenomena both on the north and south coasts of Devonshire and Cornwall, which afford proofs of modern changes in the level of the land, both of upheaval and depression. The raised beach of Hope's Nose, correctly described by Mr. Austen, is the most striking instance in South Devon.

The quantity of rise of land in the modern period is from ten to forty feet in South Devon and Cornwall, nearly seventy feet in North Devon, while in Lancashire, Cheshire, and Shropshire there are marine deposits with recent shells at the height of from three hundred to five hundred feet above the sea.

It is natural to inquire what changes the surface of the dry land in England may have undergone during the occurrence of such upward and downward movements. Perhaps some observations lately made by Mr. Bowerbank in the south of the Isle of Wight may elucidate this point. He has given us an account of a bed of chalky detritus, containing recent land shells, at Gore Cliff. This bed is ten feet thick, and rests immediately upon chalk marl. Many of the shells, which are plentifully scattered through it, retain their color. As the deposit ranges to the foot of St. Catherine's Down, it is possible that the waste and denudation of that chalk hill may have supplied the materials. I have lately seen similar detritus resting on the chalk with flints, and arranged in numerous thin layers in the section exposed in cutting the railroad at Winchester, where a black layer of peaty earth and carbonized wood intersects thin layers of white chalk rubble, from twenty to thirty feet thick. Such appearances are, in fact, very general in chalk districts; a bed of flints not water-worn occurring on the highest downs, while fragmentary chalk, often inclosing land shells, occurs on their slopes and at lower levels. Violent rains have been known even of late years to tear off the turfy covering from certain points near Lewes, and to wash away flints and chalky mud, and leave them in the hollow combs or flanks of the hills. This action of the elements would be most powerful at periods when the chalk first emerged from the sea, or whenever it assumed in the course of subterranean disturbances a new position or physical outline.

We must, I think, infer from the occurrence of certain recent marine shells and shingles in the bottom of what has been termed the elephant-bed at Brighton, that the chalk in the Southeast of England has undergone some movements of a modern date, the land having subsided there to the depth of fifty or sixty feet, and having been subsequently raised up again to a level somewhat higher than its original position.*

If it should appear upon careful research that that the land shells found in terrestrial alluviums covering the chalk are almost universally of recent species, I should not conclude that the emergence of the chalk hills from the sea had generally occurred at a very modern pe-

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* See Principles of Geology, 4th edit., vol. iv. p. 274.

riod, but merely that these hills had been modified in shape in recent times, and that during that modification, alluviums of older date had been washed away, or the land shells which they may once have contained have decomposed and disappeared. In regard to the great numbers of these shells preserved throughout the bed at Gore Cliff, and in many other places even at greater depths, it will not seem surprising to those who have observed the number of dead land shells which are strewed over the surface of the chalk downs, or lie concealed in the green turf in numbers almost as countless as the blades of grass. If the slightest wash of water should pass over such a soil, it must float off myriads of these shells, and they would immediately be involved in that white cream-colored mud which descends from wasting hills of chalk after heavy rains. Land shells so buried may retain their color for indefinite periods, as is shown by the state of species in the loess of the Rhine, and even in tertiary strata of much higher antiquity.

While a variety of geological monuments are annually discovered which attest modern alterations in the level of the land, it is important to remark that new testimony is also daily obtained of the rising and sinking of land in our own times. I discussed at some length, in my last anniversary address, the evidence for and against the upheaval of the coast of Chili during the earthquake of 1822, a controverted point to which our attention has lately been again recalled. I may remark, however, that since we have ascertained the fact of a rise of three, five, and even ten feet in parts of the same country in 1835, so distinctly attested by Captain Fitzroy, all doubts entertained as to the permanent effects of a preceding convulsion are comparatively of small interest. Don Mariano Rivero dissents from the opinion that a change of level occurred at Valparaiso in 1822, and Colonel Walpole, after seeing the ground and conversing with persons who were on the spot in 1822, and who still reside there, also considers the statement of a rise to be inaccurate. On the other hand Mr. Caldcleugh, who was formerly sceptical on the same point, has now come round to the opinion of Mrs. Calcott, (Maria Graham,) and believes that an elevation of land did take place.

Mr. Darwin, whose opportunities of investigation both in Chili and other parts of South America have been so extensive, thinks it quite certain that the land was upheaved two or three feet during the earthquake of 1822, and he met with none of the inhabitants who doubted the change of level. He states that the rise of land, even in the bay of Valparaiso, was far from being uniform, for a part of a fort not formerly visible from a certain spot has, subsequently to the earthquake, fallen within the line of vision. The most unequivocal proof of a recent rise is drawn from the acorn-shells, *Balanidæ*, found adhering to the rock above the reach of the highest tides. These were observed by Mr. Darwin sixty miles south of Valparaiso, and at Quintero, a few miles to the north of it; but his friend Mr. Alison detected them on a projecting point of rock at Valparaiso itself. The attached shells were there seen at the height of fourteen feet above high-water mark, and were only exposed upon the removal of the dung of birds, by which they would have been concealed from ordinary observation. In Mr. Darwin's paper you will find many other facts elucidating the rise of land at Valparaiso, and he has also treated of the general question of the elevation of the whole coast of the Pacific from Peru to Terra del Fuego. Beds of shells were traced by him at various heights above the sea, some a few yards, others five hundred or even thirteen hundred feet high, the shells being in a more advanced state of decomposition in proportion to their elevation. Mr. Darwin also shows that parallel terraces such as those of Coquimbo, described by Captain Basil Hall and others, which rise to the height of three hundred feet and more, are of marine origin, being sometimes covered with sea-shells, and they indicate successive elevations. There are also grounds for believing that the modern upheaval of land has proceeded not only by sudden starts during convulsions of the earth, but also by insensible degrees in the intervals between earthquakes, as is now admitted to be the case in parts of Norway and Sweden.

This gradual and insensible rising is supposed to affect, not only the region of the Andes, but also the opposite or eastern coast of South America, where earthquakes are never experienced: for the Pampas of Buenos Ayres bear marks of having risen to their present height during a comparatively modern period, while the coast line of the Pacific, or the region of earthquakes and volcanic eruptions, has been the theater of more violent movements.

It is curious to reflect that if in one portion of a large area of the earth's surface a rise of land takes place at the rate of a few inches in a century, as around Stockholm, while in another portion of the same area land is uplifted about a yard during an equal period, there will be caused, if sufficient time be allowed, a group or chain of lofty mountains in one place, and in the other a low country like the Pampas of South America.

Evidence of a sinking down of land, whether sudden or gradual, is usually more difficult to obtain than the signs of upheaval. I shall therefore mention some facts which have been lately communicated to me by Professor Nilsson, from which it appears that Scania, or the southernmost part of Sweden, has been slowly subsiding for several centuries, in the same manner as was lately shown to be the case with part of Greenland. In the first place there are no elevated beds of recent marine shells in Scania, like those near Stockholm and further to the north. Linnæus, with a view of ascertaining whether the waters of the Baltic were retiring from the Scanian shore, measured in 1749 the distance between the sea and a large stone near Trelleborg. Now Mr. Nilsson informs me that this same stone is a hundred feet nearer the water's edge than it was in Linnæus's time, or eighty-seven years before. He also states that there is a submerged peat moss, consisting of land and fresh-water plants, beneath the sea at a point to which no peat could have been drifted down by any river. But what is still more conclusive, it is found that in sea-port towns, all along the coast of Scania, there are streets below the high-water level of the Baltic, and in some cases below the level of the lowest tide. Thus when the wind is high at Malmö the water overflows one of the present streets, and some years ago some excavations showed an ancient street in the same place eight feet below, and it was then seen that there had evidently been an artificial raising of the ground, doubtless in consequence of that subsidence. There is also a street at Trelleborg and another at Skanör a few inches below high-water mark, and a street at Ystad is just on a level with the sea, at which it could not have been originally built. I trust that we shall soon receive more circumstantial details of these curious phenomena, which are the more interesting because it has been shown that the elevatory movement in Sweden diminishes in intensity as we proceed southward from the North Cape to Stockholm, from which it seems probable that after passing the line or axis of least movement, where the land is nearly stationary, a movement may be continued in an opposite direction, and thus cause the gradual sinking of Scania.

I cannot take leave of this subject without remarking that the occurrence in various parts of Ireland, Scotland, and England, of recent shells in stratified gravel, sand, and loam, confirms the opinion which I derived from an examination of part of Sweden, namely, that the formations usually called diluvial have not been produced by any violent flood or débacle, or transient passage of the sea over the land, but by a prolonged submersion of the land, the level of which has been greatly altered at periods very modern in our geological chronology. I now believe that by far the greatest part of the dispersion of transported matter has been due to the ordinary moving power of water, often assisted by ice, and cooperating with the alternate upheaval and depression of land. I do not mean wholly to deny that some sudden rushes of water and partial inundations of the sea have occurred, but we are enabled to dispense with their agency more and more in proportion as our knowledge increases.

ORGANIC REMAINS.

Gentlemen, you have been already informed that the Council have this year awarded two Wollaston Medals, one to Captain Proby Cautley of the Bengal Artillery and the other to Dr. Hugh Falconer, Superintendent of the Botanic Garden at Saharunpore, for their researches in the geology of India, and more particularly their discovery of many fossil remains of extinct quadrupeds at the southern foot of the Himalaya mountains. At our last anniversary I took occasion to acknowledge a magnificent present, consisting of duplicates of these fossils, which the Society had received from Captain Cautley, and since that time other donations of great value have been transmitted by him to our museum. These Indian fossil bones belong to extinct species of herbivorous and carnivorous mammalia, and to reptiles of the genera crocodile, gavial, emys, and trionyx, and to several species of fish, with which shells of fresh-water genera are associated, the whole being entombed in a formation of sandstone, conglomerate, marl, and clay, in inclined stratification, composing a range of hills called the Siwâlik, between the rivers Sutledge and Ganges. These hills rise to the height of from five hundred to a thousand feet above the adjacent plains, some of the loftiest peaks being three thousand feet above the level of the sea.

When Captain Cautley and Dr. Falconer first discovered these remarkable remains their curiosity was awakened, and they felt convinced of their great scientific value; but they were not versed in fossil osteology, and being stationed on the remote confines of our Indian possessions, they were far distant from any living authorities or books on comparative anatomy to which they could refer. The manner in which they overcame these disadvantages, and the enthusiasm with which they continued for years to prosecute their researches when thus isolated from the scientific world is truly admirable. Dr. Royle has permitted me to read a part of their correspondence with him when they were exploring the Siwalik mountains, and I can bear witness to their extraordinary energy and perseverance. From time to time they earnestly requested that Cuvier's works on osteology might be sent out to them, and expressed their disappointment when, from various accidents, these volumes failed to arrive. The delay perhaps was fortunate, for being thrown entirely upon their own resources, they soon found a museum of comparative anatomy in the surrounding plains, hills, and jungles, where they slew the wild tigers, buffalos, antelopes, and other Indian quadrupeds, of which they preserved the skeletons, besides obtaining specimens of all the genera of reptiles which inhabited that region. They were compelled to see and to think for themselves while comparing and discriminating the different recent and fossil bones, and reasoning on the laws of comparative osteology, till at length they were fully prepared to appreciate the lessons which they were taught by the works of Cuvier. In the course of their labors they have ascertained the existence of the elephant, mastodon, rhinoceros, hippopotamus, ox, buffalo, elk, antelope, deer, and other herbivorous genera, besides several canine and feline carnivora. On some of these Dr. Falconer and Captain Cautley have each written separate and independent memoirs. Captain Cautley for example, is the author of an article in the Journal of the Asiatic Society, in which he shows that two of the species of mastodon described by Mr. Cliff are, in fact, one; the supposed difference in character having been drawn from the teeth of the young and adult of the same species. I ought, to remind you that this same gentleman was the discoverer in 1833 of the Indian Herculaneum or buried town near Behat, north of Seharunpore, which he found seventeen feet below the surface of the country when directing the excavation of the Doab Canal.*

But I ought more particularly to invite your attention to the joint paper by Dr. Falconer and Captain Cautley on the Sivatherium, a new and extraordinary species of mammalia, which they have minutely described and figured, offering at the same time many profound speculations on its probable anatomical relations. The characters of this genus are drawn from a head almost complete, found at first enveloped in a mass of hard stone, which had lain as a boulder in a

* Journ. of Asiatic Society, Nos. xxv. and xxix. 1834. Principles of Geology, 4th and subsequent editions. See Index, Behat.

water-course, but after much labor, the covering of stone was successfully removed, and the huge head now stands out with its two horns in relief, the nasal bones being projected in a free arch, and the molars on both sides of the jaw being singularly perfect. This individual must have approached the elephant in size. The genus Sivatherium, say the authors, is the more interesting, as helping to fill up the important blank which has always intervened between the ruminant and pachydermatous quadrupeds, for it combines the teeth and horns of a ruminant, with the lip, face, and probably proboscis of a pachyderm. They also observe, that the extinct mammiferous genera of Cuvier were all confined to the Pachydermata, and no remarkable deviation from existing types had been noticed by him among fossil ruminants, whereas the Sivatherium holds a perfectly isolated position, like the giraffe and the camels, being widely remote from any other type.

I have not space to enter upon the warm discussion which has arisen in France between MM. Blainville and Geoffroy St. Hilaire respecting the amount of analogy which exists between the Sivatherium and the Giraffe, but I observe with pleasure that in the course of that controversy those distinguished naturalists do justice to the zeal and talents displayed by our countrymen Captain Cautley and Dr. Falconer, and to the services which they have rendered to science.

While these discoveries were made on the banks of the tributaries of the Indus and the Ganges, Mr. Darwin was employed in collecting the bones of large extinct mammalia, near the banks of the Rio Plata, in the Pampas of Buenos Ayres and in Patagonia. Mr. Owen has enabled me to announce to you in a few words some of the most striking results which he has obtained from his examination of the specimens liberally presented by Mr. Darwin to the College of Surgeons, and of which casts will soon be made for our own and other public museums. In the first place, besides a cranium with teeth of the Megatherium, Mr. Darwin has brought home portions of another animal as large as an ox, and allied to the Megatherium. Fragments of its armor are preserved, as well as its jaws, femur, and other bones. There is also a third creature of the order Edentata, and belonging to this same family of Dasypodidæ, in the shape of a gigantic Armadillo, as large as a Tapir. Of the ruminant order there is also a no less remarkable representative in the remains of a gigantic Llama from the plains of Patagonia, which must have been as large as a camel and with a longer neck: and lastly, of the Rodentia there is the cranium of a huge animal of the size of a rhinoceros, with some modification in the form of the skull resembling that in the Wombat.

These fossils, of which a description will shortly be given to the Society by Messrs. Clift and Owen, establish the fact that the peculiar type of organization which is now characteristic of the South American mammalia has been developed on that continent for a long period, sufficient at least to allow of the extinction of many large species of quadrupeds. The family of the armadillos is now exclusively confined to South America and here we have from the same country the Megatherium, and two other gigantic representatives of the same family. So in the Camelidæ, South America is the sole province where the genus Auchenia or Llama occurs in a living state, and now a much larger extinct species of Llama is discovered. Lastly, among the rodents, the largest in stature now living is the Capybara, which frequents the rivers and swamps of South America and is of the size of a hog. Mr. Darwin now brings home from the same continent the bones of a fossil rodent not inferior in dimensions to the rhinoceros.

These facts elucidate a general law previously deduced from the relations ascertained to exist between the recent and extinct quadrupeds of Australia; for you are aware that to the westward of Sydney on the Macquarie River, the bones of a large fossil kangaroo and other lost marsupial species have been met with in the ossiferous breccias of caves and fissures.

A cavern has lately been examined at Yealm Bridge, six miles south-east from Plymouth, by one of our members, Lieut. Col. Mudge, R. E., from whose account it appears that the bones of hyenas are very numerous there. They are associated with those of the elephant, rhinoceros, horse, and other animals usually found in caves. The number of fossil Carnivora, such as the hyena, wolf, fox, and bear, which have now been met with in districts of cavernous limestone in Great Britain, is so great, that we are the more struck with the rarity and general absence of such remains in surrounding and intervening districts, over which the same beasts of prey must have ranged. The Pachydermata, as the elephant, rhinoceros, and hippopotamus, are often discovered in ancient alluvial or fluviatile deposits; but had there been no caves and fissures we should scarcely have obtained any information respecting the existence of lions, tigers, hyenas, and other beasts of prey which inhabited the country at the same period.

The remains of at least two distinct Saurian animals have been discovered by Dr. Riley and Mr. Samuel Stutchbury, in the dolomitic conglomerate of Durdham Down near Bristol. They are allied to the Iguana and Monitor, but the teeth, vertebræ, and other bones exhibit characters by which they are seen to be generically distinct from all existing reptiles. They are particularly deserving of your attention as occurring in the bottom of the magnesian limestone formation, the oldest strata in which the bones of reptiles have as yet been found in Great Britain. The most ancient examples of fossil reptiles known on the continent of Europe, occur also in the zechstein of Germany, a formation of about the same age.

I alluded last year to a memoir of Sir Philip Egerton's, in which he pointed out some peculiarities in the structure of the cervical vertebræ of the Ichthyosaurus. He has now proved that in all the species of this genus there are three accessory bones, which he proposes to call, from their shape and position, subvertebral wedge bones. They are supplementary to the atlas, axis, and third vertebra of the neck, and seem to have escaped the observation of Cuvier and other osteologists.

Mr. Lewis Hunton has communicated to the Society an elaborate account of a section of the upper lias and marlstone in Yorkshire, showing that different beds in those formations are characterized by particular species of Ammonites and other Testacea, each species having a limited vertical range. His observations are valuable not only as illustrating the distribution of fossils on the coast near Whitby, but also as furnishing a point of comparison between that district and many others in Great Britain. Mr. W. C. Williamson of Manchester has had the same object in view in studying the fossils of the oolitic formations of the coast of Yorkshire, and informs us, as the result of his patient investigation, that although certain assemblages of fossils abound in particular subdivisions of the oolite, many species range from the lowermost to nearly the highest beds. This inference is confirmed when we compare the lists drawn up by Mr. Williamson, and those published by Prof. Phillips and other competent authorities. Thus some of the shells of the inferior oolite, mentioned in Mr. Williamson's list (*Trigonia gibbosa*, for example,) occur also in the Portland stone of Wiltshire; another, as *Ostrea Marshii*, is characteristic of the cornbrash in the same county; others pass downwards to the lias, as *Orbicula reflexa* and *Ammonites striatulus*. If you consult the tables of organic remains which

Dr. Fitton has annexed to his excellent monograph on the strata below the chalk, just published in our Transactions, (2nd Series, vol. iv. part 2.) you will see that a considerable number of shells pass from the upper oolitic groups into the green-sand. We are not to conclude from these facts that certain sets of fossils may not serve as good chronological tests of geological periods, but we must be cautious not to attach too much importance to particular species, some of which may have a wider, others a more limited vertical range. The phenomena alluded to are strictly analogous to those with which we are familiar in the more modern deposits where different tertiary formations contain some peculiar Testacea, together with others common to older or newer groups, or where shells of species now living in the sea are associated with others that are extinct.

An assemblage of fossil shells has been presented to our museum by Mr. J. Leigh and Mr. J. W. Binney, found at Collyhurst near Manchester, in red and variegated marls, which were referred by them at first to the upper division of the new red sandstone group; but Professors Sedgwick and Phillips consider them to be a red and variegated deposit, belonging to the magnesian limestone series. As these fossils are new and characteristic of a particular subdivision of the beds between the lias and coal, it is to be hoped that they will soon be described and figured.

The petrifaction of wood, and more especially its silicification still continues to present obscure problems to the botanist and chemist. The first step towards their solution will probably be made by carefully examining vegetables in different stages of petrifaction, and with this view Mr. Stokes has procured several specimens of wood, partly mineralized and partly not. Among these is a piece found in an ancient Roman aqueduct in Westphalia, in which some portions are converted into spindle-shaped bodies consisting of carbonate of lime: while the rest of the wood remains in a comparatively unchanged state. The same author has pointed out cases both of siliceous and calcareous fossils, where the lapidifying process must have commenced at a number of separate points, so as to produce spherical or fusiform petrifactions, independent of each other, in which the woody structure is apparent, while in the intervening spaces the wood has decayed, having after removal been replaced by mineral matter. In some petrifactions, the most perishable, in others the most durable portions of plants are preserved, variations which doubtless depend on the time when the mineral matter was supplied.

If introduced immediately on the first commencement of decomposition, then the most destructible parts are lapidified, while the more durable do not waste away till afterwards, when the supply has failed, and so never become petrified. The converse of these circumstances gives rise to exactly opposite results. As to the manner in which the minutest pores and fibres discoverable by the microscope, even the spiral vessels themselves, can be turned into stone, or have their forms faithfully represented by inorganic matter, no satisfactory explanation has ever yet been offered. In considering, however, this question, you will do well to consult the important suggestion which a celebrated chemist, our late lamented Secretary, Dr. Turner, has thrown out on the application of chemistry to geology. He reminds us that whenever the decomposition of an organic body has begun, the elements into which it is resolved are set free in a state peculiarly adapting them to enter into new chemical combinations. They are in what is technically termed a nascent state, the constituent molecules being probably of extreme smallness and in a fluid or gaseous form, ready to obey the slightest impulse of chemical affinity, so that if the water percolating a stratum be charged with mineral ingredients, and come in contact with elements thus newly set free, a mutual action takes place, and new combinations result, in the course of which solid particles are precipitated so as to occupy the place left vacant by the decomposed organic matter. In a word, all the phenomena attendant on slow putrefaction must be studied whenever we attempt to reason on the conversion of fossil bodies into stone; and in regard to silicification, Dr. Turner has shown how great a quantity of silex is set free as often as felspar decomposes, and how abundantly siliceous matter may be imparted from this source alone to running water throughout the globe.

As I have mentioned the name of Dr. Turner, I cannot pass on without an expression of sorrow for the untimely death of that amiable and distinguished philosopher. Mr. Whewell in most feeling terms alluded this morning at the general meeting to this melancholy event, which is too recent and too painful to myself and others to allow me now to dwell longer upon it.

Before quitting the subject of vegetable petrifactions, I ought to mention a memoir just published, by Mr. H. R. Göppert, Professor of Botany at Breslau, "On the various Conditions in which Fossil Plants are found, and on the Process of Lapidification."* He has

* Poggendorff, Annalen der Physik und Chemie, vol. xxxviii. part 4. Leipsic, 1836.

instituted a series of most curious experiments, and his success in producing imitations of fossil petrifactions has been very remarkable. I have only space to allude to one or two examples. He placed recent ferns between soft layers of clay, dried these in the shade, and then slowly and gradually heated them, till they were red hot. The result was the production of so perfect a counterpart of fossil plants as might have deceived an experienced geologist. According to the different degrees of heat applied, the plants were obtained in a brown or perfectly carbonized condition, and sometimes, but more rarely, they were in a black shining state, adhering closely to the layer of clay. If the red heat was sustained until all the organic matter was burnt up, only an impression of the plant remained.

The same chemist steeped plants in a moderately strong solution of sulphate of iron, and left them immersed in it for several days until they were thoroughly soaked in the liquid. They were then dried and kept heated until they would no longer shrink in volume, and until every trace of organic matter had disappeared. On cooling them he found that the oxide formed by this process had taken the form of the plants. Prof. Göppert then took fine vertical slices of the Scotch fir, *Pinus sylvestris*, and treated them in the same way; and so well were they preserved, that, after heating, the dotted vessels so peculiar to this family of plants were distinctly visible. A variety of other experiments were made by steeping animal and vegetable substances in siliceous, calcareous, and metallic solutions, and all tended to prove that the mineralization of organic bodies can be carried much farther in a short time than had been previously supposed.

These experiments seem to open a new field of inquiry, and will, I trust, soon be repeated in this country. In endeavoring, however, to verify them, the greatest caution will be required, or we may easily be deceived. We must ascertain, for example, with certainty that every particle of animal or vegetable matter is driven off before we attempt to determine the full extent to which mineralization may have proceeded. Prof. Göppert is doubtless aware that coniferous wood may be burnt and reduced to charcoal, and after having been kept for some time at a red heat, will continue to exhibit, on being cooled, the discs or reticulated structure to which he alludes. If, therefore, some small particles of carbon remain in the midst of the oxide of iron, such portions may retain traces of the vessels peculiar to coniferous wood; and an observer not on his guard, might infer that the same structure was preserved throughout the mass.

In my last address, I alluded to Mr. Lonsdale's detection of vast numbers of microscopic corallines and minute shells in the substance of the white chalk of various counties in England, where this rock had not been suspected of consisting of recognizable organic bodies. I cannot deny myself the pleasure of mentioning the still more singular and unexpected facts brought to light during the last year, by Prof. Ehrenberg of Berlin, respecting the origin of tripoli. I need scarcely remind you, that tripoli is a rock of homogeneous appearance, very fragile and usually fissile, almost entirely formed of flint, and which was called polir-schiefer, or polishing slate, by Werner, being used in the arts for polishing stones or metals. There have been many speculations in regard to its origin, but it was a favorite theory of some geologists that it was a siliceous shale hardened by heat. The celebrated tripoli of Bilin in Bohemia consists of siliceous grains united together without any visible cement, and is so abundant that one stratum is no less than fourteen feet thick. After a minute examination of this as well as of the tripoli from Planitz in Saxony, and another variety from Santa Fiora in Tuscany, and one from the Isle of France, Ehrenberg found that the stone is wholly made up of millions of siliceous cases and skeletons of microscopic animalcules. It is probably known to you, that this distinguished physiologist has devoted many years to the anatomical investigation of the infusoria, and has discovered that their internal structure is often very complicated, that they have a distinct muscular and nervous system, intestines, sexual organs of reproduction, and that some of them are provided with siliceous shells, or cases of pure silex. The forms of these durable shells are very marked and various, but constant in particular genera and species. They are almost inconceivably minute, yet they can be clearly discerned by the aid of a powerful microscope, and the fossil species preserved in tripoli are seen to exhibit in the family Bacillaria and some others the same divisions and transverse lines which characterize the shells of living infusoria.

In the Bohemian schist of Bilin, and in that of Planitz in Saxony, both of them tertiary deposits, the species are fresh-water, and are all extinct. The tripoli of Cassel appears to be more modern, and the infusoria in that place, which are also fresh-water, are some of them distinctly identical with living species, and others not. In the tripoli brought from the Isle of France, the cases or shells all belong to well-known recent marine species.

The flinty shells of which we are speaking although hard are very fragile, breaking like glass, and are therefore admirably adapted when rubbed for wearing down into a fine powder fit for polishing the surface of metals. It is difficult to convey an idea of their extreme minuteness, but I may state that Ehrenberg estimates that in the Bilin tripoli there are 41,000 millions of individuals of the *Gaillonella distans* in every cubic inch of stone. At every stroke therefore of the polishing stone we crush to pieces several thousands if not myriads of perfect fossils.

Gentlemen,—Although I have already extended this address beyond the usual limits, I cannot conclude without congratulating you on the appearance of Dr. Buckland's Bridgewater Treatise, a work in the execution of which the author has most skilfully combined several distinct objects. He has briefly explained the manner in which the materials of the earth's crust are arranged, and the evidence which that arrangement affords of contrivance, wisdom, and foresight. He has also given us a general view of the principal facts brought to light by the study of organic remains; thus contributing towards the filling up one of the greatest blanks which existed in the literature of our science, while at the same time he has pointed out the bearing of these phenomena on natural theology.

He has shown that geology affords one kind of testimony perfectly distinct from natural history, of the adaptation of particular means and forces to the accomplishment of certain ends for which the habitable globe has been framed. These proofs are illustrated in the author's chapters on the origin and mechanism of springs, on the distribution of metallic and other minerals in the earth, and the position of coal in stratified rocks. In reference to these points it is demonstrated that some even of the most irregular forces have produced highly beneficial results, in modifying the subterranean economy of the globe. But I shall not dwell on this part of the Treatise, but pass on at once to that which constitutes the body of the work, and which relates to palæontology.

In considering this department, the number and variety of objects which offer themselves to the naturalist are so great, that the choice was truly embarrassing. Dr. Buckland has judiciously selected a few of the most striking examples from each of the great classes of organic remains, and when speaking of extinct animals, has explained the method by which the anatomist and physiologist have been able to restore the organization of the entire individual, by reasoning from the evidence afforded by a few bones or other relics preserved in a fossil state. He has described the parts of the living animal or plant most nearly analogous to those which are found buried in the earth, usually illustrating by figures the distinctness and at the same time the resemblance of the recent and extinct species, showing that all are parts of one great scheme, and that the lost species even supply links which are wanting in the existing chain of animal and vegetable creation.

It is impossible to read the account given of the Megatherium, and to contrast it with that drawn up by Cuvier of the same species, without being struck with the increased interest and instruction, and the vast accession of power derived from viewing the whole mechanism of the skeleton in constant relation to the final causes for which the different organs were contrived.

The chapter on saurian and other reptiles has afforded the Professor another beautiful field for exemplifying the infinite variety of mechanical contrivances and combinations of form and structure which the fossil representatives of that class exhibit.

The account also of the Cephalopodous Mollusca, so many thousands of which are scattered through the strata, and which until very recently have presented so obscure a problem to the naturalist, is full of original observation. The history of the animals which formed the Belemnites, of which it appears that nearly one hundred species are now known, and the proofs adduced that they were provided with ink-bags like the cuttle-fish, the description also of the fossil pen-and-ink fish, or Loligo, and other sections of this part of the Treatise, carry our information respecting the family of naked Cephalopods much farther than was ever attempted in any previous work. Nor should I omit to mention the exposition of an ingenious theory for the use of the siphuncle and air-chambers of the Ammonite, which, whether confirmed by future examination or not, becomes in the author's hands the means of conveying to the reader a clear and well-defined notion of the varied forms and complicated structure of these shells, and of awakening a lively desire to understand their singular organization.

I may also recall to your notice the just and striking manner in which certain physical inferences are drawn from the conformation of the eyes of extinct Crustacea, such as the Trilobite. The most delicate parts of these organs are sometimes found petrified in rocks of high antiquity, and it is justly observed, that such optical instruments give information regarding the condition of the ancient sea and ancient atmosphere, and the relations of both these media to light. The fluid in which these marine animals lived at remote periods must have been pure and transparent to allow the passage of light to organs of vision resembling those of living Crustaceans; and this train of reasoning naturally leads us still further, and to more important consequences, when we reflect on the general adoption of the undulatory theory of light, and the connexion between light, heat, electricity, and magnetism.

I have heard it objected, that the zoologist and botanist had already advanced such abundant proofs of design in the construction of living animals, and plants, that the auxiliary evidence of palæontology was useless, and that to appeal to fossils in support of the same views was to add weaker to stronger arguments. In the living animal, it is said, we can study its entire organization, observe its habits, see the manner in which it applies each organ, and so verify with certainty the ends for which any particular member was formed and fashioned. But in the case of the fossil, we have first to infer the greater part of the organization from such parts as alone remain, and then further to infer from analogy the habits and functions discharged, and lastly the former conditions of existence of the creatures so restored. If then we occasionally fall into error when speculating on the use of the organs of living species, how much more easily may we be deceived in regard to the fossil!

In answering this objection, it cannot be denied that the data supplied by palæontology are less complete; but they are nevertheless abundantly sufficient to establish a very close analogy between extinct and recent species, so as to leave no doubt on the mind that the same harmony of parts and beauty of contrivance which we admire in the living creature has equally characterized the organic world at remote periods. If this be granted, it is enough; the geologist can then bring new and original arguments from fossil remains to bear on that part of natural theology which seeks to extend and exalt our conceptions of the intelligence, power, wisdom, and unity of design manifested in the creation.

It can now be shown that the configuration of the earth's surface has been remodelled again and again; mountain chains have been raised or sunk, valleys have been formed, again filled up, and then re-excavated, sea and land have changed places, yet throughout all these revolutions, and the consequent alterations of local and general climate, animal and vegetable life has been sustained. This appears to have been accomplished without violation of those laws now governing the organic creation, by which limits are assigned to the variability of species. There are no grounds for assuming that species had greater powers of accommodating themselves to new circumstances in ancient periods than now. The succession of living beings was continued by the introduction into the earth from time to time of new plants and animals. That each assemblage of new species was admirably adapted for successive states of the globe, may be confidently inferred from the fact of the myriads of fossil remains preserved in strata of all ages. Had it been otherwise, had they been less fitted for each new condition of things as it arose, they would not have increased and multiplied and endured for indefinite periods of time.

Astronomy had been unable to establish the plurality of habitable worlds throughout space, however favorite a subject of conjecture and speculation; but geology, although it cannot prove that other planets are peopled with appropriate races of living beings, has demonstrated the truth of conclusions scarcely less wonderful, the existence on our own planet of many habitable surfaces, or worlds as they have been called, each distinct in time, and peopled with its peculiar races of aquatic and terrestrial beings.

Thus as we increase our knowledge of the inexhaustible variety displayed in living nature, and admire the infinite wisdom and power which it displays, our admiration is multiplied by the reflection that it is only the last of a great series of pre-existing creations of which we cannot estimate the number or limit in past time.

All geologists will agree with Dr. Buckland, that the most perfect unity of plan can be traced in the fossil world throughout all the modifications which it has undergone, and that we can carry back our researches distinctly to times antecedent to the existence of man. We can prove that man had a beginning, and that all the species now contemporary with man, and many others which preceded, had also a beginning; consequently the present state of the organic world has not gone on from all eternity as some philosophers had maintained.

But when conceding the truth of these propositions, I am prepared to contest another doctrine which the Professor advocates, namely, that by the aid of geological monuments we can trace back the history of our terraqueous system to times anterior to the first creation of organic beings. If it was reasonable that Hutton should in his time call in question the validity of such a doctrine, whether founded on the absence of organic remains in strata called primary or in granite, still more are we bound, after the numerous facts brought to light by modern geology, to regard the opinion as more than questionable. I observe with pleasure that Dr. Buckland broadly assumes what I have elsewhere termed the metamorphic theory, having stated in his 6th chapter that beds of mud, sand, and gravel, deposited at the bottom of ancient seas, have been converted by heat and other subterranean causes into gneiss, mica slate, hornblende slate, clay slate, and other crystalline schists. But if this transmutation be assumed, it must also be admitted that the obliteration of the organic remains, if present, would naturally have accompanied so entire a change in mineral structure. The absence, then, of organic fossils in crystalline stratified rocks, of whatever age, affords no presumption in favor of the non-existence of animals and plants at remote periods.

The author, however, in another part of his Treatise contends, that even if the strata called primary once contained organic remains, there is still evidence in the fundamental granite of an antecedent universal state of fusion, and consequently a period when the existence of the organic world, such as it is known to us, was impossible. There was, he says, one universal mass of incandescent elements, forming the entire substance of the primeval globe, wholly incompatible with any condition of life which can be shown to have ever existed on the earth.* Believing as I do in the igneous origin of granite, I would still ask, what proof have we in the earth's crust of a state of total and simultaneous liquefaction either of the granitic or other rocks, commonly called plutonic? All our evidence, on the contrary, tends to show that the formation of granite, like the deposition of the stratified rocks, has been successive, and that different portions of granite have been in a melted state at distinct and often distant periods. One mass was solid, and had been fractured before another body of granitic matter was injected into it, or through it in the form of veins. In short, the universal fluidity of the crystalline foundations of the earth's crust can only be understood in the same sense as the universality of the ancient ocean. All the land has been under water, but not all at one time; so all the subterranean unstratified rocks to which man can obtain access have been melted, but not simultaneously.

* Buckland's Bridgewater Treatise, vol. 1. p. 55.

Nor can we affirm that the oldest of the unstratified rocks hitherto discovered is more ancient than the oldest stratified formations known to us; we cannot even decide the relations in point of age of the most ancient granite to the oldest *fossiliferous* beds.

But why, I may ask, should man, to whom the early history of his own species and the rise of nations presents so obscure a problem, feel disappointed if he fail to trace back the animate world to its first origin? Already has the beginning of things receded before our researches to times immeasurably distant. Why then, after wandering back in imagination through a boundless lapse of years, should we expect to find any resting-place for our thoughts, or hope to assign a limit to the periods of past time throughout which it has pleased an omnipotent and eternal Being to manifest his creative power?

But it is not my intention to advert now to these and other points on which I happen to differ from Dr. Buckland. I would rather express the gratification I feel in finding myself in perfect accordance with him on so many subjects. His work is admirably adapted to convey instruction on organic remains, and other departments of geology, both to beginners and to those well versed in the science, and is characterized throughout by a truly philosophical spirit, which betrays no desire to adhere tenaciously to dogmas impugned or refuted by the modern progress of science. On the contrary, the author has abandoned several opinions which he himself had formerly advocated; and although still attached to the theory which teaches the turbulent condition of the planet when the lias and other fossiliferous rocks were formed, and the general insufficiency of existing causes to explain the changes which have occurred on the earth, he yet refers in almost all parts of his book to the ordinary operations of nature to explain a variety of phenomena once supposed to be the result of causes different in kind and degree from those now acting.

I have now, Gentlemen, only to offer you my acknowledgments for the high honor conferred upon me by my election to fill the President's chair for the last two years; and it is a source of great satisfaction to me to feel assured of the continued prosperity and usefulness of the association when I resign my trust into the hands of a successor so distinguished for his zeal, talents, and varied acquirements as Mr. Whewell.

Art. VIII.—*Experiments in Electro-Magnetism*; by Dr. Charles G. Page, of Salem, Mass.

TO PROFESSOR SILLIMAN.

Dear Sir—I notice in the July No. of the Franklin Institute Journal, an announcement of the discovery of the thermo-electric spark by an Italian philosopher, and also the subsequent exhibition of the spark by Prof. Wheatstone to Faraday and others; the date of the discovery is not given. On referring to my notes I find that I obtained the spark in August last, but not the shock. The spark and shock were both obtained Dec. 2d, 1836, and exhibited to a number of friends, and announced in your last No. It appears that the European philosophers have not yet obtained a current of sufficient magnitude to afford a shock by the multiplier, although they use in the experiment a great number of pairs. In my experiment only a single pair is used either of bismuth and iron, bismuth and zinc, or bismuth and antimony, and yet the induced or lateral shock given by the multiplier is very distinct by acupuncture. The particular arrangement of the thermo-electric elements to produce such powerful effects, I do not wish to describe at present, as I hope ere long to announce it as a substitute for galvanic batteries in many experiments.

On the disturbance of Molecular forces by Magnetism.

A short article on this subject appeared in the last No. of this Journal, under the caption *Galvanic Music.* The following experiment, (as witnessed by yourself and others not long since,) affords a striking illustration of the curious fact, that a ringing sound accompanies the disturbance of the magnetic forces of a steel bar, provided that bar is so poised or suspended as to exhibit acoustic vibrations. An electro-magnetic bar four and a half inches in length, making five or six thousand revolutions per minute near the poles of two horse shoe magnets properly suspended, produces such a rapid succession of disturbances, that the sound becomes continuous, and much more audible than in the former experiment, where only a single vibration was produced at a time.

On the application of Electro-Magnetism as a moving power.

Late in the fall of last year, (November,) I commenced the investigation of this subject, not knowing that any thing more had ever been effected than what appeared in an instrument before me at that time, viz. Ritchie's revolving galvanic magnet, which consists of a horizontal bar of soft iron covered with copper wire, the ends of the wire descending into mercury cells. This instrument was the basis of my pursuit. Finding that this bar never attained its maximum velocity, from the occasional union of the battery poles, I soon remedied this defect by a contrivance, wherein the bar moved vertically, and the mercury cells were entirely independent of each other. The instrument thus improved became an interesting and useful piece of apparatus, and is in fact the revolving interruptor described and figured in the last No. of the Journal. The stationary magnets, instead of being single contrary poles, at opposite sides of the circle described by the bar, were multiplied so as to form an entire circle of poles, with the exception of an inch on each side between the opposite poles. The magnets were short bars arranged in the form of a cylinder, somewhat like the staves of a barrel, and the poles not in use were united by armatures of soft iron. The velocity of this model was very great, but I found the scattering and oxidation of the mercury a great inconvenience and soon substituted for it solid conductors. The wires on the bar had their similar ends united by single wires, which were brought down and soldered by cylindrical segments of metal, firmly fixed upon, but insulated from the axis. These segments, representing the ends of the wires covering the revolving bars, were insulated from each other by pieces of horn or ivory. Two wires connected with the poles of the battery pressing against these segments with a spring, furnished sufficient metallic contact to ensure the passage of the galvanic current through the wires from end to end. As the segments revolved, they presented opposite ends of the wires to the fixed battery wires and thus the poles were changed.* But the most important discovery in relation to the application of this power, is the following, viz. the admissibility of oil between the solid conducting surfaces. After the ma-

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* Before the appearance of the April No. of this Journal, in which Davenport's machine was partly described, I addressed a letter to Prof. Silliman, to learn if he was aware of any experiments of the kind hitherto made. His answer was, "the best information you can have on this subject, will be embodied in the coming No. of the Journal." The Journal appeared with a description of Davenport's machine, but the mode of making battery connection and changing poles was reserved, and until within a short time since, I supposed that mercury was the medium. Finding lately that he used dragging wires upon semizones of metal, I have secured the above arrangement to myself by patent.

chine had revolved for a time, I found it necessary to free the revolving segments, (or discs they may be called,) from oxide, even when it was made of silver, gold or platinum. Amalgamating the surfaces, the oxide collected with still greater rapidity. It occurred to me that if the interposition of oil or naphtha would not interrupt the current, the oxidation of the rubbing surfaces might be entirely prevented. On trying oil I was agreeably surprised to find that the current was not only not interrupted when the pressure of the metals was very slight, but that it passed with greater certainty, and enhanced the operation of the machine six fold. It appears that oil more than compensates for its non-conducting property, by keeping the surfaces free from oxide.

This discovery will prove of vast importance in the laboratory, as it will dispense with the use of mercury in many experiments, and prevent the constant necessity of amalgamating and cleaning conductors. Having attained such an advantage in small models, I proceeded to the construction of a large one. The revolving bars are a foot in length and weigh together ten pounds. They are disposed at right angles on the same axis, but revolving in opposite ends of the cylinder of magnets. With steel magnets its power is very great; but with galvanic magnets its power is sufficient to carry a machine for covering copper wire with cotton; and with the addition of more coils of wire, might doubtless be made to turn a large lathe. Now although it is certain that machines of this description may be applied to a considerable extent, yet it is evident that their power is limited. These and all other similar machines must be liable to the objection, that their magnetic forces cannot be made commensurate with their size and weight. This objection I have surmounted, (as far as theory and a small model afford proof,) by the following arrangement. Instead of extending large bar magnets through the whole diameter of the circle, I have horse shoe magnets carried near to the circumference of the circle. They are arranged on arms or radii like the spokes of a wheel, and both poles of each horse shoe are in operation at once. They each change their poles four times in each revolution, and the change is effected as before by revolving segments or discs. From the great success of a small model on this plan, I have commenced and now nearly finished an engine on a grand scale; from which I expect great power. The revolving apparatus weighs nearly a hundred pounds. If its power should be in proportion to that of the small model, it must exceed one horse.

Salem, August 15, 1837.

Art. IX.—*Remarks on the Rocks of New York;* by Prof. C. Dewey.

TO PROFESSOR SILLIMAN.

The opinion seems to be prevailing that the rocks of this section of our country are chiefly *transition.* A great portion had been ranked among the *secondary.* For this there was a natural reason, viz. the horizontal position of the strata, and the general appearance of the rocks so diverse fron those of primitive countries; especially, as the fossils were not understood. As early however as 1829, Prof. Vanuxem stated his conviction that these rocks are transition,* and in Bakewell's Geology, republished in the same year, you remark in the "Outline," p. 55, upon the rocks of Lockport and Niagara, that "there is a strong approximation to the transition character." This is now well ascertained in relation to rocks much below those in their geological relations. Besides the evidence offered in this Journal for last January, by Dr. Hayes, of Buffalo, and in the Geological Report of this State to the Legislature last winter, I propose to present that which has occurred to me. The subject was pressed upon my attention soon after my removal to this city last year, by considering the position of the coal mines in Pennsylvania and Ohio, and the strongly bituminous odor of the rocks in the *calciferous slate* of Eaton, and the appearance of bituminous shale in the strata above this.

The *dip* of the strata towards the south over a great extent of this State and Ohio and the western part of Pennsylvania, would carry the saliferous rock of Eaton and several of his incumbent strata *far beneath* the rocks in Pennsylvania and Ohio, which have the same relative elevation above the sea. As we pass from Lake Ontario, south and west, strata after strata lie upon each other in successive elevations, all having their dip towards the south, and with nearly the same inclination. Along the Genesee river it is one foot in eighty to one hundred feet. If we call it only one in a hundred, in fifty miles, which is less than the distance to the southern boundary of the State, the dip would place the rocks two thousand six hundred and forty feet or half a mile below their relative situation near Lake Ontario.

* See Am. Jour. Vol. xvi. p. 254. See also Bakewell's Geology, 2d Am. Ed. p. 369.

The surveys for canals and railroads, presented in various reports of the engineers, show us the relative situation of the strata at various places.

	Feet.
Lake Erie is above the level of tide water, ...	570
Top of Niagara falls below Lake Erie, ...	66
Water of the canal at Rochester below Lake Erie, . .	64
Bottom of falls at Niagara, (160 feet,) below Lake Erie, .	226
From bottom of falls to Lewiston, ...	104
Lake Ontario is below Lake Erie, ...	330
Top of falls at Rochester below water of the canal, . .	31
do. do. falls of Niagara, . .	33
Canal at Rochester above Lake Ontario, ...	266
Summit level of Genesee and Olean Canal is above the canal at Rochester, ...	950
The hills near it are several hundred feet higher.	
Allegany river at Olean above canal at Rochester, . .	900
Ohio river at Pittsburgh is below Olean, ...	650
do. do. above canal at Rochester, . .	250
do. do. Lake Erie, ...	186
Coal at Pittsburgh above the Ohio, ...	329
do. do. Lake Erie, ...	515
do. do. canal at Rochester, . . .	579
do. do. Lake Ontario, ...	845
Ohio at Little Beaver river, near west line of Pennsylvania, is above Lake Erie, ...	75
Coal near Little Beaver above Lake Erie, ...	412
Elevation of hill above the coal, ...	80
do. this coal bed above canal at Rochester, .	476

Passing from the Catskill range over its graywacke to the *saliferous rock* of Eaton, which shows itself east of Utica and extends westward to Niagara, lying under all the rocks of this extended district, the location requires it to be the *old red sandstone* of European geologists. It contains abundance of *Fucoides Brongniartii*, Harlan, and many other similar vegetable remains. On this sandstone rests a series of slates, limestones, shales, and siliceous strata, which correspond perfectly to the mountain limestone of Europe, as noticed by Dr. Hayes in his communication already referred to. This great stratum of our mountain limestone includes the strata called by Prof. Eaton, ferriferous slate, argillaceous iron ore, ferriferous sandrock, calciferous slate, geodiferous limerock, and cornitiferous limerock.

More than one hundred feet in depth of the old red sandstone, and another hundred feet of the first four strata just mentioned, are seen at one view at the lower falls of the Genesee. In the calciferous slate which forms the precipitous banks of the river at and above the lower falls, and which is strongly bituminous, trilobites are found in abundance. *Asaphus caudatus,* as figured in Buckland's Geology and Mineralogy, abounds, and is associated with the Orthoceratite and Productus, and occasionally Spirifer. Another trilobite is less abundant, and a third species still more rare, *Calymene Blumenbachii?* It has been found in the thick layer of the fragile argillaceous slate which lies *above* the ferriferous sandrock, and is precisely the same rock as the ferriferous slate which lies under the same stratum and which in truth occurs all through the calciferous slate in thin layers. In the rocks still lower in the geological series the species of tribolite abound. The trilobites of Trenton falls and of the neighborhood of Utica, had placed those rocks in the transition series; but it was supposed they were of very limited extent. It needed only the evidence, now arising from the existence of *trilobites alone,* to prove that the rocks immediately above the sandstone belong to the same formation with those at Trenton falls, and that the rocks of this section belong to the transition series. The position and fossils place the rocks far below the secondary, and render utterly improbable the existence of coal in them or under them. They rank with the mountain limestone of Europe and rest on the old red sandstone. Several names of the rocks given by Prof. Eaton to this mountain limestone are very appropriate, and they make an intelligible reference to different portions of the strata very easy and satisfactory. Still, they seem to form only different parts of the great formation of mountain limestone. Its whole thickness here and southward in the state, will be more than a thousand feet.

Rochester, August, 1837.

NOTE.—The remains of the elephant in the museum of Mr. Bishop, noticed in the last number of this Journal, belong to one species of the mastodon. The teeth of the elephant were from some place, it is said, in Ohio. Those of the mastodon were found with the tusk in Perinton, as described. C. D.

Art. X.—*Queries proposed by the Geologists of the new Survey of the State of New York.**

Rocks.

1. Have *ledges* of rock been observed in your vicinity?

2. Are the ledges on the sides, or on the summits of hills; on the shore, or in valleys?

3. Is the direction of the ledges parallel to that of the hills, or what is the direction of each by compass?

4. Are the rocks divided into regular layers?

5. Towards what point of the compass do these layers pitch with the greatest declivity?

6. Are there veins of other rocks traversing those before mentioned?

7. In what direction do these veins cut through the rock, and are they perpendicular or inclined?

8. Have any ores been found, either diffused through the mass of rock, or in separate beds or veins?

9. Have any useful, or curious, or rare minerals been found in the rocks or veins?

10. What names are commonly used to designate the rocks, ores, minerals, &c. referred to?

11. Have they been applied to any useful purposes?

12. Where ledges of rocks have been recently uncovered by excavations, are the surfaces smooth, as if by the action of running water, or with pot-holes, such as are seen at many water falls?

13. Do any of these surfaces shew grooves and scratches, as if hard masses had been dragged over them?

14. Do the rocks recently uncovered shew traces of the shells of barnacles, or other marine remains attached to them in sheltered situations, and much above the level of the sea?

15. Are shells or petrifactions of any kind, or the remains of plants, found in any of the rocks, and in what kinds of rocks do they occur?

16. Are slate, limestone, sandstone, granite, gneiss, &c. found in your vicinity?

17. Where rocks of different kinds come in contact, is there any change in their characters near their junction?

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* Received from W. W. Mather of the survey, and being of general interest we insert them here.—*Editor,*

18. Do the rocks shew distinct lines of demarkation, or do they gradually blend into each other?

19. At the junction of trapean and granitic rocks with others, are there any evidences of former high temperature, such as sublimation of sulphur into cavities, cokeing of coal, apparent fusion of the rock, a vesicular texture, or other appearances which are familiar to the mind, where the bodies have been heated?

20. Where masses of granitic or trapean rocks occur *in situ*, can any connection be traced between these and dykes or veins of similar materials which traverse the adjacent rocks?

Sands.

1. Are there beds of fine white sand, which contain no black, or red, or yellow grains?

2. Has it ever been used for making glass, or for other purposes?

3. Are there beds of red or black sand washed upon the beach?

4. Are these sands abundant enough for purposes of commerce?

5. Have they ever been used as iron ores, or as a substitute for emery, or for blotting sand?

6. Is the general surface of the country sand, clay or loam?

7. Do these substances form alternating regular layers?

8. Does the sand on the surface of the country drift by the wind?

9. Have any farms been thus materially injured?

10. Have buildings, trees, hedges, fences, or walls been covered from this cause; or marshes or ponds made dry land? Do the sands progress in any particular direction, and at what rate per annum?

11. Is the sand in any locality hardened into a sandstone?

12. Is sand washed along shore by currents, and deposited in new situations?

13. Are any islands, sand-bars, spits, shoals, or beaches, known to have been thus formed?

14. Have islands been connected with each other, or with the main land, by bars, spits, or beaches?

15. Have islands or coasts been washed away entirely, or in part, by the action of the sea?

16. Where cliffs have been undermined, and have tumbled down, what kinds of earth, or rock, were exposed?

17. Were they arranged in layers?

18. Were bones, shells, bits of wood, or lignite imbedded in them?

Clays.

1. Are any beds of clay known in the vicinity?
2. Are the beds extensive or of small magnitude?
3. At what depth do they lie below the surface?
4. What is the thickness of the bed or beds?
5. What materials were observed in digging down to them?
6. Are the clays in thin layers which easily separate?
7. Do the beds of clay alternate with beds of sand and gravel?
8. Are the layers of the beds of clay, gravel, or sand, inclined, or are they level or undulating?
9. What is the color of the clay?
10. Is it mixed with sand or is it free of grit?
11. When mixed with water, does it form a tough and plastic mass, or does it crumble to a pap?
12. When heated red hot, does it become red, brown, or white?
13. To what useful purposes has it been applied?
14. What quantities are annually exported, and for what purposes?
15. Has it been tried as a manure on sandy soils?
16. Do balls, or flat rounded masses of a hard earthy mineral, occur in the clay?
17. Are they arranged in layers parallel to the layers of clay?
18. Are they of the same materials as the clay?

Water, Springs, &c.

1. At what depth is water obtained?
2. What strata are passed through before reaching it?
3. Does clay, loam or rock, occur at the level of the springs?
4. Is the water "hard" or "soft," as these terms are usually employed when speaking of water?
5. Did the water percolate gradually into the well when first dug, or did it come in a strong stream?
6. Have shells, bones, pieces of blackened or common wood, beds of marl, or of clay, been observed in digging wells or cellars, or by the caving down of cliffs or banks on the shore, or by the side of streams?
7. Have mineral springs been discovered?
8. What is their taste? sulphurous, inky, pungent, or saline?
9. Is there any sensible odor to the water? What is it like?

10. Is the water sparkling like bottled beer; and does air bubble up from the fountain?

11. Is there a reddish or yellowish deposit where the waters flow off, or in the adjacent meadows, or ponds, or is there a similar oily scum on the water?

12. Do sticks, mosses, leaves, &c. become incrusted with a hard stony coat, or is there a gray or yellowish rock forming near the spring, by a deposit from its water?

13. Has the water been used in the cure of any diseases?

14. Is the spring copious?

15. Do large springs burst from the earth?

16. What is the temperature of springs?

Salt Marshes.

1. Have the salt marshes in your neighborhood remained unchanged during the observation of the old inhabitants?

2. If they have risen in level, to what cause do you attribute it? to animal or vegetable decomposition, or to both, to drift sand, mineral springs, &c., wash of the sea, wash of the adjacent hills, or all these?

3. If they have sunk below their former level, did it happen gradually, or suddenly?

4. If the latter, was it at the time of any extraordinary natural phenomenon?

5. Of what materials are your meadows composed?

6. Are they covered with moss and cranberries?

7. Can they be made to tremble by walking or jumping on them?

8. Have they changed in the amount of surface that can be mowed, within the period of a life?

9. Are there any evidences or traditions that they were once larger or smaller than they are at present?

Submarine Forests.

1. Have trees, stumps, or logs been seen standing in the water on any part of the coast of Long Island, or of the adjacent coasts or islands?

2. Where have they been seen, and in what depth of water?

3. Is the time of the subsidence of this land known?

4. To what cause do you attribute it?

5. Is there any tradition concerning it?

6. Is the wood in its natural state, or is it more like charcoal in its appearance?

Subterranean Forests.

1. In digging wells, or other excavations, or by the caving down of banks and cliffs of earth, have any traces of trees, wood, bark, leaves, nuts or seeds been discovered buried deep in the earth, or at a greater depth than we would expect to find them from the effect of present causes?

2. Were these remains in their natural state, or were they converted to stone, or to a black substance like charcoal?

3. If the latter, has the substance been used as fuel?

4. At what depth does it lie? and in what earth? (sand or clay?)

5. What strata were observed above and below?

6. Do the trees stand erect?

7. Do they lie all in one direction?

8. Do you suppose drifting sands, washing by water, or other causes have buried them?

9. What is the situation of this lignite with regard to the sea, or to water courses, and its relative height or depth above or below them?

10. Have shells or bones been found in the layer containing the lignite, or in the adjacent strata?

11. What is the color of the adjacent clay, sand or gravel?

12. Have masses of a heavy yellow metallic stone (pyrites) been found in the adjacent clay? and has it been applied to use?

Peat Bogs and Shell Marl.

1. Are there inland meadows or swamps in your vicinity that tremble when one walks over them?

2. Are they covered by moss, and cranberry vines?

3. To what depth can a pole be thrust down?

4. How many are there, and of what extent in your vicinity?

5. Does the peat, or black tremulous mud, rest on sand, gravel, rock, or a white clayey marl containing small shells?

6. Has the peat been used for fuel, or for burning lime or bricks?

7. Has the peat, or shell marl, been used as a manure?

Bog Iron Ore.

1. Are there ponds or marshes in the vicinity, in the bottom of which is a soft spongy, yellowish brown stone, or gravel?

2. Does it originate from mineral springs, or from stagnant waters?

3. Has it been used as an iron ore?

Marshes.

1. Have the marshes on the borders of lakes, on the banks of streams, or on the flat table lands, in your vicinity, changed materially within the period of history, or within the remembrance of old inhabitants?

2. Have they become more wet, and risen so as to cover land before dry?

3. Have they sunk in level, and from what cause?

4. Have they become more dry, and from what cause?

5. Have they changed in the natural growth of the soil?

Drainage of Lakes.

1. Are there any evidences of the lakes in your vicinity having once occupied a higher level than they do at present?

2. Does this evidence consist in elevated beaches, or the cutting down of their outlets, or both these combined?

3. Are there valleys which seem to have been once lakes, and what evidence is there on this point?

4. Are there regular stratified deposits of clay, sand, gravel, &c. in the valleys?

5. Are organized remains of plants or animals found in them?

6. In the gorges at the outlets of lakes, or along the courses of the streams which flow from them, are there marks to show the wearing action of water much above its present level.

7. Are there deep defiles through the country through which the water flows or seems to have once flowed?

8. What is the nature of the strata of those defiles, and generally, of the country at any of the particular localities to which you may have referred?

Rivers.

1. Are the rivers and streams in your vicinity, deepening their channels, or raising their beds by the deposit of alluvial matter?

2. Do you know of instances of lateral streams bringing in such quantities of alluvial matter, and of so coarse a texture, that the larger stream is unable to sweep it away, and causes the formation of lakes in the valleys above?

3. Are rivers or smaller streams lost by sinking in the ground?

Rolled Masses, Pebbles, and Erratic Blocks.

1. Are any large rounded or irregular masses of rock found in your neighborhood?

2. Do they occur mingled with gravel and pebbles, or are they isolated on the surface, or imbedded in the earth?

3. Do they crumble away by the effects of the weather?

4. Are they smooth, or nearly so, like pebbles?

5. Are there scratches on them in one or more directions?

6. Are there ridges on them in one direction only from the harder points of the stone, and parallel to the scratches?

7. Are these rounded masses all of one kind of rock?

8. What rock or rocks constitute these masses and pebbles?

9. Are they similar to ledges of rock known to you, either in the vicinity or elsewhere?

10. Are barnacles or other shells, or the remains of marine animals observed on them, where they are at a distance from the sea, or buried in the earth?

11. Has ice been known to move masses of rock in ponds, streams, bays, or inlets?

Elevation of Land.

1. Are there beds of rock containing remains of animals or plants, whose proper habitat is the ocean?

2. Are the rocks horizontal or inclined?

3. Are they bent, contorted, or are they dislocated?

4. What is the direction of the line of bearing of the strata?

5. Is there any evidence that the rocky strata have been elevated at one, or at several epochs? If at one epoch, all the strata are conformable up to the time of its occurrence, unless in the rare case of elevation without derangement of the dip. If at several, the strata, formed subsequent to each of these epochs, are successively unconformable to those below, with the same exception as above.

6. Are the axes of elevation parallel, or do they intersect, and what are their directions?

7. The occurrence of anticlinal and synclinal lines, and their directions, should be particularly noted.

Agriculture, Manures, &c.

1. What manures are employed on the soil?

2. Has a rotation of manures been tried?

3. What rotation of crops is employed on the light, and what on the heavy soils?

4. Have changes of rotations of crops been tried, and with what success?

5. How are your manures prepared?

6. Does lime, or ashes, or marl, or gypsum, or barilla, enter into the composition of the compost heap?

7. Has salt, or nitre, or copperas been tried in small quantity on the land as a manure?

8. Has limestone, or any other rock been ground and used as a manure?

9. Do fish cause the production of as large a crop, when spread upon the soil, as when ploughed in fresh?

10. Has peat been rotted and tried as a manure?

11. Have harbor mud and pond-hole mud been tried?

12. Have clay soils been dressed with sand, sand soils with clay, and marshes with gravel or sand?

13. Are banks of shells known, except such as have been left by the Indians, and which are either superficial, or buried by a small depth of turf, drift sand, or earth washed over them, where the water flows?

Are there caves, land-slips, sink-holes, (formed by the sinking down of small tracts,) rocking stones, natural ice-houses, or curious or interesting natural phenomena of any kind that have come under your observation, not embraced in the preceding queries?

Suggestions for collecting Geological Specimens, and observing Geological Phenomena.

1. Collect specimens of all those rocks, earths, sands, clays, peats, marls and lignites observed, and note the relative quantities, whether abundant or rare.

2. If any of these materials be applied to useful purposes, note their particular applications, the places where used, the amount of industry and capital employed, and the articles produced.

3. If they be not used, note whether in your opinion any one or all may be usefully employed, and for what; and what facilities the adjacent country may present for manufacture or transport, or from its contiguity to a market.

4. Note the order of superposition of the different beds of rock, earth, sand, clay, &c. with regard to each other; the amount and di-

rection of the dip; whether dislocations or faults, dykes, veins, &c. traverse the strata, and the direction and inclination of these dislocations, veins, dykes, &c. Sketches should generally be made to illustrate the thickness and relative position of strata, particularly if the strata be contorted.

5. Note if any traces of organic existence be observable in any of the materials mentioned, whether animal or vegetable, either as impressions, casts, or petrifactions; whether imbedded or loose in these materials.

6. The excavations in mining, quarrying, cutting canals, railroads, &c. offer particular facilities for observing the phenomena of stratification, of the superposition of rocks, &c.

7. In boring for coal, salt springs, &c. it is hoped that specimens of the rock, clay and sand, of every foot in depth passed through will be preserved, and accurate minutes made in writing on the spot.

8. In deep wells, mines and salt springs, the temperature of the water should be measured as it issues from the strata.

9. The temperature of copious springs should be measured, noting if it be different at different seasons of year.

10. In mines, is there a local variation of the compass, and are there evidences of the passage of electrical currents?

11. What is the mean temperature of the bottom of the mine? and of the rocks at the ends of the levels, at such a depth as to be beyond the influence of the heat of the air of the mine?

12. Specimens to illustrate the various kinds of minerals, rocks, clays, marls, peats, &c., should generally be about two by three, or three by four inches, and one to two inches thick, of a rectangular form, and free from hammer marks and weathering.

13. Fossils, or rock specimens containing fossils, must be taken of such a size as may be necessary to illustrate to the best advantage; still, where fossils are imbedded in stone, much taste may be displayed in getting them out with a good shape and free from hammer marks.

14. The occurrence of bones, tusks, teeth, shells, &c. where wells, cellars, canals, roads, &c. have caused excavations to be made, should be particularly noted.

15. Every specimen from the same *stratum* at any *one locality* should be marked with a similar mark, and each specimen to correspond in its mark with that of the stratum from which it was taken, on the sketch or section.

16. Each specimen should be wrapped securely in a separate paper, and packed tightly in a box, so that it may not be rubbed and injured by transportation from one part of the country to another.

17. It is important that rock specimens and fossil remains should be taken from ledges of rocks in their natural position and not from loose masses.

18. Soils should be taken from a depth of about 8 inches below the surface.

19. The name of the county, township, and the estate, should be distinctly marked on a small label, which should be enclosed in the wrapper of the specimen.

W. W. Mather, } *Committee in behalf of*
T. A. Conrad, } *the board of Geologists.*

Art. XI.—*Notice of the Meteors of the 9th and 10th of August, 1837, and also of Nov. 12th and 13th, 1832*; by George C. Schaeffer, of New York.

TO THE EDITOR.

Having had the good fortune to witness another "meteoric display," and one which, as far as I can ascertain, has not been generally noticed, I furnish you with the result of my observations, which if not rendered valueless by some other and better notes on the same subject, by some of our citizens, are entirely at your service.

Since November last, when I observed the annual appearance of the 12th and 13th, (a short and hastily written notice of which I made for one of our papers, and which was copied into your Journal,) I have constantly watched the meteors of nightly occurrence, with reference to their direction and number. At the expiration of the six months when it was thought that a return might be expected, particular attention was paid, but few or none were seen; the nights, however, were cloudy, and unfavorable for observation.

For two or three weeks previous to the 9th of August, a large number was seen, chiefly radiating from some point in a line from Vega, to the point mentioned below.

About 8 o'clock on the evening of the 9th, my attention was directed to several meteors, which, notwithstanding the bright moonlight, were very conspicuous. Following up the usual observations upon direction, it was soon found that there was a common center of radiation.

It is to be remarked, however, that comparatively few were seen near this point, by far the greater number averaging a distance of 90° from it. On this account, I found it more difficult to designate the radiating point, than in November last, when I determined its place with considerable accuracy. On this occasion, (August 9th,) as near as could be ascertained, the center of radiation was not far from 55° R. A., 60° N. D., or near a point of a line from β to α Urs. Min. produced rather more than the distance between the two stars.

These meteors in every respect, resembled those of November last, a large number having trains of some length and duration, and hardly less brilliant than on that occasion.

From 8 until near 3 o'clock, between two and three hundred were seen. During the last hour the number seemed to diminish, and not having taken any precaution to ensure wakefulness, we were obliged to yield to the solicitations of Morpheus.

The night was a favorable one for observation, and a curious coincidence is to be remarked in the fact that the same sort of lightning was visible in the northeast, as in November last. A shower had passed over us in the afternoon, but as this had not been the case on the former occasion, I am inclined to suspect some connexion between the appearances. There was a close resemblance to what is commonly called heat-lightning, though this appeared farther from the horizon.

In the early part of the evening, the attention of a numerous party was directed to the heavens, and I found that when each observer selected a separate portion, the number noticed was greatly increased: from this I judge that a large number escaped notice.

In the various notices of meteors in your Journal, I recollect but a slight mention of their appearance in 1832.

I was not aware that I had seen them myself, until the latter end of the year 1834, when, describing to a friend a beautiful display of meteors that I had witnessed off Pernambuco, in a voyage home from Buenos Ayres, the resemblance to the meteors of 1833, (as described to me,) for the first time struck my attention. I turned to my journal, and found to my surprise and delight that the minute of their appearance was made on the morning of November 13th, as being viewed during the previous night.

The notice is to the following effect: that numerous meteors of exceeding brightness and beauty were seen, the least of them being more brilliant than Jupiter, then not far from opposition. Many of them had trails, described by the men as similar to a comet, and one was said by them to have remained five or six minutes, though this doubtless was an exaggeration. They also were described by them as having "split off from each other," evidently referring to a radiation from some point. As I remained on deck but a part of the night, I did not see some of the most brilliant meteors as described to me by the men.

Meteors were seen the night before, and as the extreme brilliancy on this occasion induced us to refer them to the atmosphere immediately above us, they were carelessly ascribed to the unusual heat; the minute was made and forgotten until more than two years after.

At the time we were in sight of Pernambuco light, the night was one of the most splendid that I have ever seen in any latitude or under any circumstances.

I very much regret that I have no data for the point of radiation, but as far as it goes, the testimony is good, the note having been made long before any notion was entertained of meteors being other than random fires of unknown origin.

Art. XII.—*Questions relative to Mineral Veins, submitted to Practical Miners;* by Robert Were Fox,* England.

1. Name of the mine, as well as of the parish or district in which it is situated.

2. Number of metallic veins or lodes, and the description of ore which each contains.

3. Average *size, direction by compass*, and *underlie* of each lode, and whether very variable or not in these respects; and do the lodes generally increase or diminish in size in descending into the earth?

4. Nature of the rocks or country traversed by each lode, whether *granite, killas, elvan*, &c., or all of them; and the bearings of the different rocks with respect to each other.

5. If any elvan courses, (porphyritic dykes;) their appearance, hardness, sizes, directions, and underlie.

6. In which of the rocks have the respective lodes been found most productive of ore, and has there been any difference in this respect, between those of copper and tin, or of any other metal?

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* Received through Dr. J. H. Griscom, of New York.—The eminent service rendered by Mr. Fox to the cause of science, especially in relation to the electricity of mineral veins, entitle his queries to insertion in this place.—*Editor.*

7. If copper lodes; do they consist of yellow or gray ore, or of any other variety, and how are the varieties of the ore situated with respect to each other in the lodes?

8. If copper and tin occur in the same lodes, are those metals in different parts of them, or if near together, are they at, or near the opposite walls of the lodes, or are they intimately mixed?

9. If near the opposite walls of underlying lodes, which of these metals is the nearer to the upper or hanging walls, and which to the lower or foot walls;—are these ores separated from each other by "*spar*" (quartz,) or other substances; and do the hanging and foot walls differ much in hardness?

10. If other metals exist in the lodes, under what circumstances do they occur; and what minerals have a tendency to crystallize, and how are the crystallized masses situated with respect to the contiguous ores?

11. Was there "*gossan*" or other substance observed resting upon, or above the copper ore in the lodes, or if *strictly tin lodes,* were they found to be without gossan?

12. Are the walls or "*capels*" of the tin lodes harder than those of the copper lodes, and if in the case of a copper lode, one wall is harder than the other, is it the nearer one to the copper ore, or that which is the further from it?

13. Are the lodes, generally speaking, most productive of ore on the side of the hanging, or of the foot walls?

14. Is the rock or country immediately contiguous to the walls of any of the lodes, usually softer or harder than at a distance from them; is there any difference in this respect between tin lodes, and lodes of copper, &c.; and is the hardness or softness of the lodes, in any *direct* ratio or *inverse* ratio, to the hardness or softness of the rock or country contiguous to the walls.

15. Are not the lodes often contracted into small veins or branches, and have any of these been found to open again into large lodes containing ore? In such cases, do not the opposite small veins or branches sometimes overlap each other, or become "*spliced,*" as I believe it is termed?

16. Do the lodes materially vary in size in traversing different rocks, and in which rocks are they the largest? Moreover, in passing from one rock into another, from killas, to elvan or granite, for instance, do they suffer any interruption, or break in their course, and if so, how much, and in what direction?

17. Are there any marks in the walls of a given lode, showing that one of its walls is at a lower level than the other, and, if so, to what extent; and is it not usually the hanging wall which is so circumstanced?

18. Are all or any of the walls, smooth and well defined, or are they imperceptible or indistinctly marked? In either case, are the lodes more or less hard than the ground in which they occur?

19. Are the hanging or foot walls most indistinct, and which of them are the hardest?

20. When the tin lodes meet other lodes, are they intersected by them, and if the intersections take place in their underlie, are they thrown up by them, and how much?—The same question may be asked as it respects other lodes.

21. Are there smaller veins *having distinct walls or divisions* included between the walls of the lodes, that is, are the lodes "*comby*" near the surface, or at a greater depth, and are such small included veins parallel, or oblique, as it respects the walls of the lodes, and of what do the former consist?

22. Are there any veins of clay, or veins, or portions of the containing rock, or country, in the lodes, and are they respectively near the hanging or the foot walls?

23. Have any masses of rock been found in the lodes, termed "*horses*" by the miners, and did they appear to be completely separated by the branches of any given lode from contact with the outer walls or country?

24. What circumstances or appearances in the lodes are considered the most favorable indications of any given ore, and what the least so?

25. Is not an increase in the underlie of lodes usually less favorable for ore than when they become more vertical, and are they not generally more contracted in size, and more filled with mechanical deposits when their underlie is considerably increased?

26. If any of the lodes have crossed or intersected other lodes, has it occurred horizontally, or in their underlie, and at what angles; and have they been found more productive of ore at the intersections, or less so?

27. At what depth below the surface have the different lodes been found most productive of their respective ores; and have many cavities, or "*voughs*" been observed in them, and at what depths?

28. Have the arseniates of copper, iron, or lead, or much fluor spar, occurred in any of the lodes; and how were such substances situated in relation to the ores?

29. Is the "*spar*," or quartz immediately contiguous to copper ore, often more porous or friable, (locally termed "*honey comb* or *sugary spar*,") than that which accompanies tin ore, and even more so, than the spar which is at a distance from the copper ore in the same lode?

30. Are there any *cross courses* or *flucans* intersecting any of the lodes, and what are the directions by *compass*, underlie, and average sizes of the former; and are they larger or smaller at the upper than at the lower levels?

31. Are the cross courses "*comby*," or subdivided into smaller veins of clay and quartz, or other earthy matter?

32. How far do the cross courses partake of the nature of the country through which they pass?

33. Do they dislocate or heave the lodes and *elvan* courses, and how much each of them; stating the underlie of the two last, at or near the places of intersection; and are the heaves greater or less at the upper than at the lower levels?

34. Are there any branches, small veins, or "*leaders*" of ore in any of the cross courses between the dislocated extremities of the lodes, or only detached stones of ore; and are the ores in the cross courses the same, or different in their nature or appearance from those in the lodes?

35. Are the lodes more productive of ore near the cross courses, and on both sides, or only on one side of a given cross course, and on which side?

36. Are there any branch veins of ore nearly at right angles to the bearings of the lodes;—of what ores do such rectangular veins consist;—how far have they been seen to extend; what is their underlie;—and are they near the hanging walls of any cross courses?

37. Are there any beds, or "*floors*" of tin, copper, or other metal, and under what circumstances do they occur?

38. Have they walls like lodes, or are they interposed between the beds or laminæ of the rocks?

39. Are they connected with other veins, or quite distinct from them; in what rocks or country are they most prevalent;—and have any of the ores been observed to occur disseminated, or diffused in the rocks, not as veins, but at a distance from lodes or beds of ore?

40. What are the directions of the joints, heads, or natural divisions of the granite, killas, elvan, or other rocks, and do such joints agree, or not, with the general directions of the lodes and cross courses?

R. W. Fox, takes the liberty to submit the accompanying questions to practical miners, hoping that they will kindly reply to them, or to some of them, and add such general observations on the subject of lodes as may appear to be worthy of notice. He hopes that it will not be inconvenient to them to furnish him with the desired information without much delay; it will be quite sufficient merely to refer to the numbers marked against each question.

In any cases in which plans and sections of lodes and cross courses have been made, rough sketches of them will be much valued.

Art. XIII.—*Descriptions of two species of Trilobites, belonging to the genus* Paradoxides; by Mr. James Hall, Corresponding Member of the Yale Nat. Hist. Society.

Read before the Yale Nat. Hist. Society, March 21, 1837.

The following remarks and the accompanying figures are offered to this Society as illustrations of two species of fossil trilobites, which hitherto have been imperfectly and in many respects incorrectly described. The buckler of these species was first observed by Prof. Eaton, and described as the abdomen and tail of an unknown trilobite, which he named in honor of the distinguished Brongniart, *Brongniartia Carcinoidea.* The buckler is often found in great numbers, and almost invariably separated from the abdomen. This circumstance and the peculiar appearance of the fossil, led Prof. Eaton to the above conclusion respecting its nature, which, I believe, was sanctioned by Brongniart. Similar imperfect specimens of the two species were afterwards described by Prof. Green, (with the same views as to the nature of the fossil,) under the new designation *Triarthrus Beckii.* More recently Dr. Harlan has corrected the principal error of preceding authors, (that of considering the buckler as the abdomen and tail,) and has described the specimens as constituting two species of the genus *Paradoxides.* About two years since, while engaged in investigating specimens of unusual perfection from several localities, I observed some inaccuracies and omissions in the last author, arising probably from the imperfection of his specimens, which appear to be of sufficient importance to require new descriptions, generic as well as specific.

Fig. 1.

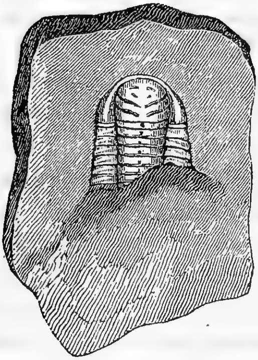
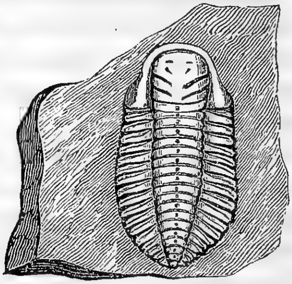


Fig. 2.



From the accompanying figures of these species, it is obvious that they do not strictly belong to the genus Paradoxides, as established by Brongniart; for they are destitute of what this author gives as the most essential characteristic, viz. the extension of the arches of each of the lateral abdominal lobes, beyond the membrane above. This character, however, is scarcely discernible in the P. gibbosus; and as these specimens have a strong resemblance in other respects to the Paradoxides, I concur with Harlan in referring them to this genus. This is an additional instance of the transitions among the genera of trilobites, which interfere with the institution of perfect generic distinctions.

Dr. Harlan observing the incongruities, modified the generic description as follows:*

"Buckler destitute of oculiform tubercles; anterior border semicircular; middle lobe marked with transverse furrows or bands. Abdomen composed of transverse bands or articulations continuous with those of the lateral lobes."

This generic description is evidently faulty. The anterior border in the several species of Paradoxides is seldom *semicircular*, though generally curved and forming the segment of a circle; the transverse furrows, instead of extending across the middle lobe, as might be inferred from the description, are in general interrupted; finally the character with respect to the abdomen is not sufficiently

* It should be remarked that the most perfect specimen examined by Dr. H. presented but four abdominal articulations.

characteristic. I therefore propose the following, as a statement of the essential characters of the genus:

Clypeus antice curvatus: lobis lateralibus antice conniventibus: lobo medio sulcis transversis tribus; sulcis sæpius medio interruptis.

Abdomen lobis tribus bene declaratis; articulis duodecim vel pluribus.

In addition to the above characters of the genus I would state the following, as possessed in common by the two species under consideration.

The *buckler* is much broader than long, with the margin curved anteriorly and truncated posteriorly. The lateral lobes form a narrow border in front of the middle lobe and are expanded behind, and marked with a single transverse furrow, near their posterior margin. The posterior sulcus of the middle lobe is continuous and parallel to the posterior margin of the same; the two preceding sulci, curve slightly backward and are interrupted near the medial line. In front of the sulci, there are two distant slightly oblong depressions, directed obliquely outward and forward, which evidently mark the situation of the eyes. Nearly in front of each of the ocular depressions, there is observed on the fresh specimen, a short transverse line scarcely elevated; with respect to their nature I can only conjecture, that they were occasioned by antennæ lying directly below them, and this appears probable, from the position of these organs in some of the recent Entomostraca most analogous to this genus of trilobites, as for instance the species of the genus Argulus.* A small rounded protuberance occupies the centre of the posterior border of the medial lobe of the buckler.

The *abdomen* is not distinct from the *post-abdomen;* in all there are nineteen articulations, with a small rounded expansion beyond the posterior one. The middle lobe presents a longitudinal row of small spines, one on the centre of each articulation. Near its base it is wider than either of the lateral lobes; from the base it gradually tapers with a slight curve, to the extremity. The lateral lobes increase somewhat in width from their base and attain a maximum width about one third the length of the abdomen from the posterior extremity, where each about equals the corresponding width of the middle lobe; from this point it gradually diminishes to the tail. The following characters distinguish the species.

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* See a figure of an American species of this genus, A. Catostomi, in Vol. XXXI. of this Journal.

Paradoxides Beckii. (Fig. 1.)

Buckler bounded in front and laterally, by a nearly uniform curve scarcely exceeding a semicircle, distinctly convex: lateral lobes cuneiform, broader posteriorly, gradually narrowing from behind forward, and passing into the narrow border which bounds the middle lobe anteriorly; greatest width of each lateral lobe, about one half that of the middle lobe; width of each opposite the centre of the middle lobe, more than two thirds its greatest width: medial lobe somewhat broader than long, rounded posteriorly, convex; sulci deep and well defined, with the intermediate portions arched.

The buckler of this species occurs abundantly in graywacke slate at the Cold Spring on the Erie Canal, eight miles east of Little Falls. This slate lies upon the lower transition limestone, of that part of the state. A small slab from this locality, scarce a foot long and two and a half inches wide, in the cabinet of this society, contains the remains and impressions of near forty specimens of the buckler. I have never met with a perfect abdomen in the Cold Spring slate, though specimens exhibiting a few articulations are common. I have restored the original specific name of this species given it by Green, partially on account of its priority, but more especially because of the inappropriateness of the specific name *Triarthrus* (three-jointed) applied by Harlan. This term, as employed to designate the genus by Green, who supposed that the buckler was the abdomen and tail, and three-jointed, was sufficiently appropriate. But with the present light on the subject, the buckler is very incorrectly described as "triarthritic;" and moreover the existence of the sulci is a generic character.

Paradoxides Eatoni. (Fig. 2.)

Buckler convexly curved on the front margin, with a concave curvature laterally; nearly flat: lateral lobes broader posteriorly, greatest width about one half the breadth of the middle lobe; abruptly diminishing in breadth and much less than half their greatest breadth opposite the centre of the middle lobe: middle lobe somewhat longer than broad, nearly flat; sulci distinct, with the intermediate portions scarcely convex.

This species is abundant in the graywacke slate in Turin, Utica, Fort Plain, and elsewhere in the state of New York. As Dr. Harlan's name, P. *arcuatus*, is not applicable to this species, I have taken the liberty of substituting the above, in honor of Prof. Eaton.

Art. XIV.—*On the Aurora Borealis of July* 1, 1837.

1. *Observations made at Rochester*, by Prof. C. Dewey.

On the evening of July 1st, the Aurora Borealis was very splendid; indeed it far exceeded the splendor of that of the 25th of January last, as that appeared in this part of the state. The day had been pleasant and warm. About two P. M. the temperature was 86°, and a shower was collecting rapidly in the northwest, which in the next hour and a half had been blown over us and dissipated with very little rain. The temperature changed, and the sun shone forth in all his glory. The remainder of the afternoon was delightful. The evening was cool, the temperature being about 58°. Soon as the twilight had ceased, the aurora was seen in short *flocculent*, cloudlike forms all across the northern sky. Soon it extended quite round to the east and west points, at both of which broad and bright arches arose and extended more than half way to the zenith, while a multitude of streamers rose all round the northern sky towards the same point. About half after nine the broad belt of brilliant white aurora, rising from both sides of the east point, shot towards the zenith, near which it was met by a corresponding but less brilliant zone of light from the west. The general appearance continued very brilliant till ten minutes after ten, when the point a little south and east of the zenith, and towards which all the streams and pillars were directed, became a bright rose red, and soon sent off brilliant coruscations in every direction but the south, with distinct flashes of white light much resembling that which is commonly called *heat lightning*. This soon ceased, and the white aurora again appeared as before. Near half after ten, a dark brown aurora rose in the N. W. and extended upwards; soon after appeared on all sides the rose red or deep crimson, rising to the vertex near the star ζ in the constellation Hercules, nearly in a right line between Alpheus in the Northern Crown and Lyra. The whole expanse except the south was most splendid. Soon the flashing from all sides towards the vertex mentioned, was renewed with great power. Great and constant changes in the color were occurring. The white beams and streams intermingled with the red, added to the splendor of the scene; at length the brilliant flashing and waving of the aurora ceased. The vertex became clear of it, except as it flashed up in long and broad waves, and showed itself in serpentine forms for an instant and then disappeared. Soon however the whole scene was repeated. The vertex retained its place, as the constellations moved westward, and was now near μ in Hercules, and all the splendid light, beams, pillars, arrows, waving and flashing, were, if possible, more splendid than before. This was at eleven o'clock. The colors were constantly changing their hues. From all the northern, eastern and western parts, the flashing light rose to the vertex, and seemed to shoot back again as it came. Often the light would flash through thirty or forty degrees, disappear within twenty degrees of the vertex and reappear flashing as before, for the last ten degrees, as if it passed for ten degrees behind some opake substance. The sky was cloudless for the whole time. At a quarter after eleven the red light disappeared, while long, arrowform, splendid streams continued to play for some time till they gradually subsided and only a luminous sky remained for most of the night. On the next evening, there was a slight aurora. Whatever of beauty, splendor or grandeur, others may have seen in this phenomenon, no aurora has ever come under my observation of equal brilliancy and variety.

Rochester, July, 1837.

2. *Observations made at New Haven, and elsewhere.*

This very brilliant display of northern lights was witnessed as far south as Columbus, Ga. (lat. about 32° 35′ N., long. 85° 11′ W.) It was seen there for about half an hour, commencing at 9*h.* 30*m.* Many streamers of a red color were observed, but their altitude is not stated. We have also observations of the phenomena from Cleveland, Ohio; Fayetteville, N. C., and various places in Virginia, which, so far as they go, substantially agree with those made here. At Richmond, the display between two and three A. M. of the next morning, was distinctly noticed by a friend who happened to be there; but the printed statements make no mention of it. The observations below given, were made by several persons of this place, and are in the main the same as were published in the [New Haven] Daily Herald of July 6, 1837. E. C. H.

An Auroral display of unusual variety and splendor was witnessed in this city on the night of Saturday last, the first of July. The day was one of the warmest of the season: at 2 P. M., therm. 84° Fah.; wind S. W. Towards the latter part of the afternoon, dark clouds arose in the northwest and gave promise of a thunder storm, but about an hour before sunset they passed off to the northeast without much rain. At 6 P. M. therm. 78°, barom. 29.67 in., wind light from N. N. W.

At 9*h*. 25*m*. just before the departure of twilight, the northern sky was observed to be faintly illuminated from W. N. W. to N. N. E., but much obscured by clouds. It soon became clear. At 9*h*. 38*m*., streamers began to form in the N., and soon after in N. E. and N. W., gradually becoming more frequent and increasing in brilliancy. At 10*h*. 30*m*., the action was most energetic, and the scene eminently animated and beautiful. From E., N., and W., and all points between, streamers shot up from near the horizon in quick succession, with wonderful celerity and passed beyond the zenith, while others starting from an altitude of about 30° in the S. met the former about the corona in the constellation Ophiuchus. Auroral waves soon appeared, flashing upwards with great rapidity across the streamers and rolling up in wisps and sheets around the coronal point. The color of the streamers and waves was mostly a phosphoric white, but about 10*h*. 40*m*. for a short time a fine rose-red predominated.

At 11*h*. 10*m*. the display was on the decline. By midnight it became quite faint, and the heavens were at the time much obscured by clouds. About this period the light was mostly confined to the eastern horizon, where among the clouds were seen indistinct columns of red and white. About 1*h*. A. M., (July 2d,) the clouds dispersed, and the sky became exceedingly clear, and thus continued during the remainder of the night.

At 2*h*. the Aurora began to revive, and soon presented a spectacle in many respects surpassing the former. At 2*h*. 10*m*. an indistinct arch about a degree wide, appeared, with vertex about 8° high in the N., between which and the horizon, the sky, although clear, seemed to be covered with dark vapor. From this arch arose broad streamers of a vivid yellowish white. Some of the streamers, however, occasionally started from points in the dark space below the arch. About 2*h*. 30*m*., the display was at its maximum. From W. N. W. to E., the sky was filled with streamers, passing over head, and forming a corona in the constellation Cygnus. Along these columns or streamers, swept upwards immense auroral waves, nearly unbroken from the horizon to the magnetic equator. These columns remained in unabated splendor for fifteen minutes, and were visible until about 3. At 2*h*. 38*m*. the arch was extinct, and the streamers were becoming shorter and less frequent. They were, however, for a long time, numerous about the N., and were visible until overpowered by the superior light of the advancing sun. They were distinctly observed as late as 3*h*. 30*m*., or about an hour after day break.

Many observations on the position of the corona were made during the night: those which are the most trustworthy are the following, viz.

2*h*. 31*m*.	centre of corona,	alt.	75°	25′	azim.	S. 4°	27′ E.
39	"	"	74	55	"	3	30
42	"	"	74	40	"	5	07

These positions correspond nearly to the direction of the dipping needle at this place, if we make due allowance for the perturbations which the Aurora may have occasioned, and for the difficulty of determining with precision the central point.

The horizontal needle was much disturbed. Between 10*h*. 44*m*. and 11*h*. it traversed 3° 4′. In general, the north end of the needle was carried to the east of its mean position at this place, which is now about N. 5° 55′ W. After midnight, the range of variation did not exceed one degree. The needle was not observed on the 2d or 3d inst.

From sunset to 2*h*. 30*m*. the wind was from N.W. and faint; after that time, from N. N. W. and somewhat stronger. At 11*h*. 40*m*. the dew point was 67°, therm. being at 72°. The barometer rose during the night: at 2*h*. 30*m*. A. M. (2d inst.) it stood at 29.76, at 6*h*. 29.80. Thermometer at 2*h*. 30*m*. 71°, at 6*h*. 69°.

It is worthy of notice, that on this occasion there were two well marked and distinct *seasons of greatest brilliancy* or *fits of maximum intensity*, at an interval of about four hours. It will be found on examination of former accounts, that this is a common feature of Auroral exhibitions of unusual brilliancy, and that the first fit occurs within about an hour after the end of twilight. Future observations continued during the entire night, must determine the number of these seasons and the interval between them.

The Aurora appeared on the night of Sunday, 2d inst. and was observed until 1*h*. 30*m*. of the 3d inst. It was not very conspicuous. At 9*h*. 30*m*. there appeared a low dim arch, with vertex about 5° high, sending forth occasional streamers to an altitude not exceeding 30°, after which no special change was noticed. The day was clear and fine; therm. at 2 P. M. 78°.

On Monday night, 3d inst. the Aurora was again seen. It was less conspicuous than on the 2d. The evening was showery, but at 9*h.* 45*m.* the clouds began to disperse. The North was illumined with a faint light, now and then adorned with a solitary streamer. Observations were continued until near midnight, but no increase was seen.

The hours and minutes above given are of apparent time.

A. C. C. E. J.

Art. XV.—*On Spontaneous Combustion;* by James Mease, M. D.

In my "Archives of Useful Knowledge," vol. iii. p. 167, I recorded three cases of the spontaneous combustion of large masses of bituminous coal from Virginia, two in cellars, and a third under a close arch, all of which occurred in Philadelphia.* A fourth case was stated of one thousand two hundred chaldrons of coal "in a close compact magazine" in Paris, and a fifth of one thousand six hundred tons of the same article in the royal ship-yard in Copenhagen and all consumed, together with one thousand four hundred houses. This happened in the year 1794.†

Bituminous coal has on other occasions taken fire. In the year 1822, October and November, three cases occurred of this in the navy yards of Brooklyn, New York, Portsmouth, New Hampshire, and Washington city. The coal was from Virginia, and lay exposed to the air and rain.

In the year 1828, one hundred chaldrons of coal which had been placed several weeks before on wet ground in Boston, took fire, with a volume of sulphurous matter rising in a state of ebullition. It was remarked that this was the third instance of the kind within the past year in that city.

Another case was mentioned in the newspapers as having taken place in Ridgley's coal-yard, Baltimore, some years since, in the

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* This last was from Dr. Seybert's paper on Spontaneous Combustion, in New York Medical Repository, Hexade 3d, vol. iii. Two similar facts are given by Bartholdi, *Annales de Chimie*, No. 144: and translated in Tilloch's Philos. Mag. vol. xviii.

† In my additions to the article "Inflammation," in Willich's Domestic Encyc., I have given nine cases of spontaneous combustion from various causes.

month of August. This coal also was doubtless from Virginia. A similar accident has recently occurred in the coal yard of Nutter & Co., New York, to sixty tons of Virginia coal. (July, 1837.)

Mr. Dupont, the late extensive manufacturer of gunpowder, informed Dr. Seybert, that charcoal was also liable to spontaneous combustion when in powder and piled in a heap. He had suffered loss from this cause, and a similar accident had occurred near Paris.

The French commissioners charged by the French government to examine into the causes of the explosions of powder factories, ascertained that charcoal in the lump, by attrition took fire. Charcoal inflames according to M. Caussigni, by the pressure of millstones, and has taken fire in the box of the bolter, into which it had been sifted; the coarse powder experienced no alteration.—*Annales de Chimie, No.* 35.

Mr. Sage saw the roof of one of the low wings of the mint at Paris set on fire by the spontaneous combustion of a large quantity of charcoal that had lain in the garrets.

Two instances of spontaneous combustion took place in the powder manufactory of Essone, in the year eight and ten of the French republic; the first in the box for sifting the charcoal, and the second in the charcoal repository. Bartholdi attributes them to phosphorus in the charcoal.

May not one or more of the conflagrations of powder mills, which have taken place in the United States during the two past years, have been caused in this way?

Linen, cotton, and woolen cloth, or the raw materials of these fabrics impregnated with flax-seed oil, or paint, or varnish, have frequently proved the causes of spontaneous inflammation.

Several years since a piece of canvass, forty yards in length, painted with white lead and oil, and exposed to the sun for some hours, was rolled up and put under cover. The next morning it was found smoking, and the whole except a yard, burnt to cinder, with a hole through the bottom of a wagon. This happened at Mount Pleasant, Virginia. A large piece of coarse muslin, thoroughly oiled for the purpose of making covers for boxes, was left over night, folded loosely in a shed in a yard in Market street, Boston; in the morning, it was found burnt entirely through, and about to blaze. (1831.)

A quantity of wool prepared with the usual proportion of oil for carding, and thrown into a heap in the evening, was found the next morning ignited, and the floor to a considerable extent on fire. This happened at Hamlin & Bates' factory; and another instance occurred at the establishment of Warner & Whetton.* Lamp oil was used. (1831.) A quantity of cotton clothing for seamen's suits, had been oiled and hung up at Duxbury, Massachusetts, for a fortnight to dry, and were then taken down, rolled together, and placed in a shed; the next day they were found on fire. (1831.)

The Schr. Hiram, laden with wool, when on a voyage from Bilboa to New York, in March, 1825, was set on fire, in consequence of some linseed oil having been spilt on the cabin floor.

Two pounds of wool greased with flax-seed oil, near Germantown, Pennsylvania, set fire to the building next morning. (1818.) The closet in which the paint and oil were kept at Boshor's carriage factory, Richmond, Virginia, having been smeared with linseed oil, burst out in a flame. (1832.)

Some cotton used in cleaning the cabin of the ship Birmingham, became partially filled with flax-seed oil, and after some time it ignited. An express experiment proved that cotton thus impregnated would inflame in two hours. (New York, 1831.)

Cotton rags, while delivering from the cellar of a store, 24 Broad street, New York, were found on fire. Oil had been spilt on them. (June, 1834.)

Mr. Durant's large balloon, varnished for the first time, exposed to the sun through the day, and rolled up in the evening, and deposited upon chairs in a house in Jersey City, was found the next morning entirely consumed. The varnish was composed of oil, turpentine and caoutchouc. (June, 1832.)

Mr. Atkinson of Ellicott's mills near Baltimore, stated that flax-seed oil spilt on [wood] ashes in an iron kettle, caused the ashes to inflame in twenty four hours. He made an experiment to test the fact, with success. Mr. Patterson, President of the United States' Mint, repeated the experiment with cold hickory ashes, and one pint of flax-seed oil; in forty six hours after, the mixture was fairly ignited, and in a short time emitted flame, which continued upwards of an hour. After the flame had ceased, the ignition continued for eighteen hours, and the ashes were then poured out of the vessel. (1820.)

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* Both at Plainfield, Massachusetts. Ample experience has taught European manufacturers that no oil should be used for greasing wool, but that of rape seed.

A canvass recently painted with flax-seed oil, and then dried and rolled close, took fire after being three hours exposed to the sun on the deck of the Schr. Olive, at Troy, New York. (August, 1820.)

A piece of old packing-sheet, which had lain long about an oil and color warehouse, and was besmeared with different kinds of vegetable oils, on being thrown behind some casks pretty much confined from the air, inflamed.—*Edinburgh Phil. Jour.* vol. vii. p. 219.

A cask of oat meal left from May to August in a kitchen in Glasgow, caught fire and was totally consumed together with the barrel. —*Thomson's Annals*, vol. xvi. p. 390.

A parcel of hops well dried, were put into a home-spun cotton gown and placed on a heap of cotton seed; after three months they inflamed. Cotton it was remarked has frequently been known to take fire spontaneously in a moist and heated atmosphere.—*Milton, N. Carolina paper.* (1824.)

Certain ochres ground in flax-seed oil, inflamed during the act of trituration.

Alder charcoal has taken fire in the warehouses in which it was stored.* One of sixty three casks of lampblack on board the ship Catherine, bound to India from England, ignited, but was discovered by the fumes before it had burst into a flame.—*Old Monthly Mag. Lon.*, 1827, p. 91.

Wet Cotton.—The ship Earl of Eldon, in August, 1834, was set on fire, by reason of having shipped cotton in the rain at Bombay.

A similar occurrence took place in 1836, on board a vessel which had taken in cotton at Apalachicola, Florida, during rain.

A piece of red cedar about two ounces in weight, broken in two, and laid upon the shelf of the store of Mr. Adam Reigart in Lancaster, Penn. inflamed after two years had elapsed, in June, 1834. It was part of a tree found in excavating the deep cut of the rail road, at the "Gap in the Mine Ridge," Lancaster County, thirty feet below the surface. The combustion was proceeding so rapidly, that the shelf would have been in a few minutes on fire, and it evidently commenced in the interior of the wood, as some of the outer fibres were sound.—*Hazard's Register of Pennsylvania,* vol. xiii, p. 399.

Haussman relates that several dozens of skeins of cotton, dyed red, and impregnated with an alkaline solution of alumina, with ex-

* B. G. Sage. Walker's Archives, vol. iii., p. 80.

cess of boiled linseed oil, were placed on a straw-bottomed chair, under a window, and at midnight they inflamed.*

A heap of horse manure inflamed in the month of May, 1822, at Sharon, in Connecticut. The fire was two feet in circumference. *American Journal of Science*, vol. v, p. 201.†

ART. XVI.—*Notice of "A Report on the Geological Survey of the State of Connecticut;* by Prof. CHARLES UPHAM SHEPARD, M. D., &c. &c."—*with extracts and remarks*, by the EDITOR.

IN consequence of a recommendation by his excellency Gov. Edwards, the Legislature of Connecticut, in May, 1835, resolved—that the Governor be, and he is hereby authorized to appoint a committee of suitable persons to make a geological survey of the State of Connecticut, and to report the same to the General Assembly at their May session of 1836. In consequence of this resolution, the Governor appointed Dr. James G. Percival and Prof. Charles U. Shepard to make and report on the proposed examination.

These gentlemen having divided the labor, Mr. Shepard has reported on the economical mineral resources, and on the scientific mineralogy of the State.

Dr. Percival's report on the geology, is, by permission of the legislature, deferred another year, that he may have time to finish his work.

It is impossible for any competent judge of the matter to peruse Mr. Shepard's report without being convinced that he has brought to the task all the industry, perseverance, and science that were demanded, and that he has been particularly attentive to the practical interests of the community. The result of this examination, as far as it is completed, does much honor to those who recommended, and to those who executed it, and we shall now give an analysis of the report of Professor Shepard, with copious extracts, since the

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* His theory of this is as follows: "In all cases where the oxygen of the atmosphere is rapidly attracted and absorbed, the caloric, which serves as a base to the oxygen, giving it the qualities of gas, or elastic properties, is disengaged in such abundance, that if the absorbing bodies are susceptible of taking fire, or if combustible bodies are in the neighborhood, a spontaneous inflammation will take place."—*Annales de Chimie, No.* 144. *Tilloch, Vol.* 18.

† It appeared subsequently, that this case of supposed spontaneous combustion was the work of an incendiary; the communication of both facts was from the same person, a respectable physician.—*Editor.*

details are numerous and important, and do not always admit of abridgment.

In his introduction, after giving credit to those who have preceded him in examining the mineral resources of Connecticut, Prof. Shepard remarks—" I am far from entertaining the opinion that her mineral wealth is yet fairly laid open to view. On the contrary, a glance only has been obtained, but enough it is believed, to awaken fresh zeal and confidence in relation to what remains concealed.

" The opinion which has until recently prevailed respecting the metallic treasures of Connecticut was certainly erroneous. Her iron mines have often been represented as fast tending to exhaustion, and her iron manufacture as being attended with little advantage. One of these mines however, has long yielded its proprietors a clear annual profit of about five thousand dollars; while many handsome fortunes have been realized from the iron business in that section of the State. Instead of a failure in the supply of ore, it may confidently be asserted, that not one half of the workable beds in that district are as yet fairly uncovered; while it is equally true, that as soon as proper economy in the burning of charcoal and the radical improvement of the hot air-blast are introduced, cast iron will be afforded at one half its present cost, and this without any diminution of profit to the manufacturer. An iron resource also, of great value, in the steel-ore of Roxbury, has hitherto been wholly unappreciated. And if our copper region has not as yet been a source of income to the State, it is not surely because we are deficient in this valuable metal, as the plainest indications show; but for the reason that enterprise and capital have been wanting to open these deposits: for workable veins of copper, unlike the other metals, rarely attain the surface of the earth. The neglect of these mines however, until the present time, will prove less a detriment to the public wealth from the fact, that the working of deep mines (in consequence of the economy introduced into the system of furnishing supplies requisite to such undertakings, and the saving of power in the improvement of the steam engine) is now carried on, at less than one half the cost incurred twenty-five years ago. Cobalt, zinc, lead, bismuth and silver, are also to be included on the list of metals which will one day augment the wealth of the State; nor are the indications of tin, a metal most of all to be desired, wholly wanting. Without wishing by unauthorized statements to allure the inconsiderate, and those not possessed of the necessary resources, into a branch of business where the chances of success would be greatly against them, I still feel it a duty to give it as my decided conviction, that the iron and copper mines of the State constitute a legitimate object for the investment of capital; and that if the enterprise of opening these resources is committed to persons of integrity and skill, it must prove eminently remunerative in its result, both to those immediately interested and to the population generally. For it is most obvious, that the working of rich mines will not only react in a favorable manner on the agricultural interest, by advancing the price of farming produce, but will also promote the public prosperity by leading to the free circulation of capital, the improvement of roads, and to habits of increased industry in the people.

"The advantages possessed by the State in respect to materials for architecture, decoration and porcelain,—for flagging, quicklime and cements,—if on the whole better known and admitted than those connected with her metallic resources, are still far from being appreciated to their full extent. This report it is hoped will make it evident, that they are not only bestowed upon us with a liberal hand, but that they have their value greatly enhanced by the topographical features and geographical position of our territory. The Sound affords a navigation secure almost as a river along the whole face of our southern boundary, while the Connecticut flows like a canal across the center of the State, and smaller streams and harbors cleave and indent the coast. Large and growing maritime cities must still continue to depend upon us for the supply of much of their most valued architectural materials; and in the improvement of harbors and the construction of fortifications, we are doubtless destined to contribute as largely as heretofore. To an agricultural people, the possession of so many quarries under such circumstances, is peculiarly favorable; surpassing perhaps in direct advantages to them, the existence of mines. For the working of these, together with the smelting of ores, are arts of slow and difficult acquisition, requiring in many instances the investment of an immense capital, which, in the fluctuating successes that often attend such operations, must sometimes remain unproductive for an entire generation. But the working of a stone quarry is little more than a branch of agriculture. A farmer, supplying himself with a few additional instruments and materials, may work his ledges as well as his soil, according as one or the other rewards him best for his labor; or he may manage both, without prejudice to either. His labor in each case, is alike conducted in the broad light and fresh air of open day.

"As it appeared important to connect with this report whatever seemed likely to promote the future development of valuable minerals in the State, I have felt myself called upon to introduce occasional details respecting the uses of minerals not commonly understood, and also to give very briefly the rules for detecting and recognizing such substances. And as encouragement to research, as well as for the purpose of making the public generally acquainted with our resources, I have included frequent statistical notices relating to the number of hands employed in various mines and quarries, and to the amount of products annually afforded.

"How far the results I am herewith able to submit concerning the economical mineralogy and geology of the State will be thought valuable, I am unable to predict. I have however, discharged this part of my duty to the best of my ability, though the restricted period allowed, has compelled me to content myself in many instances with hasty examinations and brief descriptions. That there was room for the performance of many useful services in affording information to individuals in different parts of the State who were occupying themselves with mineral explorations, I am abundantly satisfied; and both my colleague and myself have the satisfaction of knowing, that we have dissuaded from many profitless enterprises not a few of our fellow citizens who stood in need of such advice, while we hope that we have been able also to furnish suggestions to others that will ultimately be promotive of their interests. Without wishing to speak disrespectfully of a community which has never been placed second to any other in the Union for its widely diffused intelligence and general sagacity of character, I may still be permitted to say, that information relating to the mineral kingdom was almost every where found to be singularly deficient. Other communities no doubt share with us in this defect. Many persons, not otherwise wanting in intelligence, were met with, whose belief in the virtues of the divining rod was unshaken; iron-pyrites was often explored for gold, talcy rocks were ground for plaster, and plumbaginous mica-slate extensively mined for coal! Most fortunate would it have been, could this deficiency have been supplied at an earlier period, as it could not have failed to check an immense expenditure of labor which has been worse than thrown away; since it has always operated more or less to interrupt the industry of neighborhoods, and to bring into unmerited discredit even scientific researches connected with the mineral kingdom.

"A scientific report, embracing notices of all the simple minerals of the State, independently of their relations to the other sciences or even to the arts, though uninteresting to the general reader, still seemed to be demanded, not only to supply the wants of the many students of mineralogy in the public institutions of the State where the science is taught, but also for the purpose of indicating with accuracy the numerous productions which still lie dormant as respects any useful applicability, but which the progress of the arts may ere long call into requisition. It may be added also, that it was presumed the scientific community generally, were in the expectation of finding in this report a summary at least of the leading features of our mineral productions, since mineralogy has longer been cultivated and taught as a branch of education here, than in any other section of the country. The subject, for want of space, has necessarily been treated in an imperfect manner; though I venture to hope, that inasmuch as many of the facts are new, it will not be found wholly devoid of interest to the mineralogist. It was certainly an unexpected result to myself, to be able to detect in so small a territory as that of Connecticut, and one whose strata had been so little perforated by mining operations, nearly one half of the well established mineral species hitherto discovered thoughout the world, and fully three quarters of all the elements as yet made known to us by chemical analysis; much less was it anticipated at the outset, that it would become necessary, in the progress of this work, to add several new species to the productions of the mineral kingdom."

Mr. Shepard's labor is included under the three heads,

Economical Report, Scientific Report, and Descriptive Catalogue.

Under the Economical Report, there are the following divisions—1. *Metals*, 2. *Coal*, 3. *Plumbago*, 4. *Gems*, 5. *Polishing and Grinding Materials*, 6. *Soapstone and Potstone*, 7. *Materials for Alcaline and Earthy Salts*, 8. *Materials for Bricks, Pottery, Porcelain and Glass*, 9. *Fire-stones*, 10. *Fluxes*, 11. *Quick-lime and Water-cement*, 12. *Stone-Paints*, 13. *Decolorizing carbonaceous slate*, 14. *Materials for Architecture and Decoration*, 15. *Materials for Flagging, Tiling and Paving*, 16. *Mineral Springs*, 17. *Materials for Agriculture.*

The State possesses many good deposits of iron ore.

Of *Magnetic Ore*—there is a powerful bed at New Preston, on land of Alvan Brown—in the Buck Mountain, on the Housatonic river—in Reading, on land of Mr. Gregory.

Magnetic iron is found also at Judson's quarry, Newtown—in Winchester, &c.

Magnetic iron sand is found on the sea board, from New Haven quite to Stonington Point, and even beyond, upon the Rhode Island coast. It is derived from the rocks that border the Sound, and at Seldon's Point, in Hadlyme, it is found in place in granite, constituting sometimes one-fourth or one-third part of the rock.

Hematite in all its varieties, and *bog iron ore,* are found in many parts of the State. They contain from one-half to four-fifths their weight of peroxide of iron.

"The fibrous brown hematite, compact hematite, and the ochrey mixtures of the two, are generally confined to primitive rocks, as gneiss and mica-slate. They afford materials for very large iron-works in many countries, and are universally regarded as the best ores for yielding a malleable iron, and for being easily converted into steel. Although these ores (which may be referred to under the general name of hematite) are confined to a limited district of the State, they nevertheless appear to constitute its richest metallic resource. The towns in which they exist are Salisbury, Sharon, and Kent; and the principal deposits hitherto explored, are those of the "Ore-hill," Salisbury,—the Indian pond ore-bed, Sharon,—and the Kent ore-bed. The two first form beds in mica-slate; the last in a micaceous gneiss and quartz-rock. At Sharon and Salisbury, the ore is disposed in vast beds with a stratification every where obvious, and perfectly conformable to that of the adjoining mica-slate. It is moreover, free from secondary aggregates. At Kent on the contrary, the order of arrangement is less visible in the bed, which at first view appears to be a confused accumulation of broken, decomposing (and in some instances re-cemented) rock, at the foot of a high ledge.

"The Ore-hill mine of Salisbury, is by far the most important of these deposits. It is situated about two miles west of the Furnace-pond, and covers an area of several acres, forming the southeastern slope of a slight elevation of land. It is worked like a quarry, open to the sky. The entire surface of the slope is destitute of vegetation, and every where excavated by diggings and pits."

"The ore is reduced in high furnaces, and yields on an average from forty to fifty per cent. of pig-iron. This is principally converted into bar-iron at the furnaces where produced, or at the forges in Winsted and Canaan, and is there manufactured into bar-iron for musket and rifle-barrels, and for common uses for the blacksmith; anchors, axle-trees, iron-bars and tires for wheels, irons for grist and saw-mills, shafts for steam-engines and manufactures of all kinds; large screws for clothiers, paper-makers, and for pressing bales of cotton and hay. The best Salisbury iron has obtained a decided preference over all other iron, either foreign or domestic, for the construction of musket and rifle-barrels.

"The Kent bed was formerly considered as a very important deposit of ore. It supplied several extensive forge establishments for a great number of years with ore of an excellent quality; but partly in consequence of the unskillful and improvident manner in which the original workings were conducted, and partly from the limited extent and peculiar situation of the bed, it has now sunk into almost total neglect. It is situated on the western declivity of a low mountain, near its base. In length the mountain is about three miles, and in height two hundred feet. Its length corresponds with the edges of stratification in the vicinity, which do not differ essentially from north by east.

"At present the workmen are directing their attention to a more recent opening, situated seventy or eighty rods north of the old mine, on the same slope and at the same elevation above the valley. It has been worked more or less for a period of thirty years. Until lately, the ore was obtained exclusively by burrows; but they have now formed a deep drain, open to the air as at the old bed, and from the sides of this drain they carry in burrows, where the workmen operate to advantage during the winter.

The following is an approximation to the annual yield of furnaces in cast-iron in this section of the State:—

	The ore from N. Y.	The ore from Conn.
"Housatonic manufacturing co.,	500 tons.	
Macedonia furnace co., -	850 "	
Kent furnace co., -	600 "	
Sharon valley-furnace, -	- -	800 tons.
Raumaug iron co., -	500 "	
Chapinville, - -	- -	400 "
Canfield & Robbins, -	- -	400 "
Cornwall iron co., -	- -	500 "
Cornwall-bridge iron co., -	- -	1000 "
Limerock furnace, -	- -	400 "
Mt. Riga, - -	- -	500 "
	2450	4000"

About 900 tons of ore go annually from the Salisbury beds to the Ancram iron works, and 300 tons of the Kent ore are consumed near the ore bed.

The annual produce of cast iron from the hematite of the State, may therefore be estimated at 4500 tons.

Mr. Shepard has the following valuable remarks and citations on the subject of the manufacture of iron.

"In the fabrication of cast-iron it must be obvious, that a certain temperature is necessary to secure the favorable working of the furnace. If this is not reached, all the stock added, is (in the language of the furnace-men) "cut to pieces" without any reduction of the metal. The manner in which the hot-blast secures the heat required, is at once understood if we reflect upon the ascertained fact, that in a furnace whose charges of stock amount to two tons per hour, the weight of air driven in, is six tons for the same time. The difference between the admission of this prodigious weight of air at 50° and 600° is most apparent, especially when it is considered that it enters the hottest part of the furnace. In both cases, the effect it produces to support combustion is the same; in the latter, however, it does not rob the combustion of the heat it produces. But before quoting the verification of the rationale given, and which experience has furnished, it is proper to allude to the method by which the air is heated, and to state how it is forced into the furnace. A number of arrangements have been adopted in Scotland for heating the air, but no one in particular seems hitherto to have proved itself superior to the rest. In general, the method may be described to consist, in maintaining at a red heat, the cast-iron tubes through which the air from the blowing apparatus to the furnace is conveyed. But as the temperature of the furnace near the nozzles becomes so much elevated, it is necessary in order to prevent the melting of the cast-iron lining to employ the water-tweer; which consists of an iron lining, cast hollow instead of solid, so as to contain water within, which is admitted by means of one pipe, and allowed to escape by another as it becomes heated. It thus becomes practicable to lute up the space between the blowpipe nozzle and the tweers, whereby all loss of air is prevented, and the bellowing noise formerly produced completely suppressed.

"To exhibit in a satisfactory point of view the operation of this arrangement, the results obtained at the Clyde iron-works, in Scotland, may be instanced.

"'During the first six months of the year 1833, when all these changes had been fully brought into operation, one ton of cast-iron was made by means of 2 tons 5¼ cwt. of coal, which had not previously to be converted into coke. Adding to this 8 cwt. of coal for heating, we have 2 tons 13¼ cwt. of coal required to make a ton of iron; whereas in 1829, when the cold blast was in operation, 8 tons 1¼ cwt. of coal had to be used. This being almost exactly three times as much, we have from the change of the cold blast to the hot, combined with the use of coal instead of coke, *three times as much iron made from any given weight of splint coal.*

"'During the three successive periods that have been specified, the same blowing apparatus was in use; and not the least remarkable effect of Mr. Neilson's invention has been the increased efficacy of a given quantity of air in the production of iron. The furnaces of Clyde iron-works, which were at first three, have been increased to four, and the blast machinery being still the same, the following were the successive weekly products of iron during the periods already named, and the successive weekly consumpt of fuel put in the furnace, apart from what was used in heating the blast:—

			Tons.		Tons.		Tons.	
In 1829,	from 3	furnaces,	111	Iron, from	403	Coke, from	888	Coal.
1830,	" 3	"	162	" "	376	" "	836	"
1833,	" 4	"	245	"		"	554	"

"'Comparing the product of 1829 with the product of 1833, it will be observed that the blast, in consequence of being heated, has reduced more than double the quantity of iron. The fuel consumed in these two periods, we cannot compare; since in the former, coke was burned, and in the latter, coal. But on comparing the consumpt of coke in the years 1829 and 1830, we find that although the product of iron in the latter period was increased, yet the consumpt of coke was rather diminished. Hence the increased efficacy of the blast appears to be not greater than was to be expected, from the diminished fuel that had become necessary to smelt a given quantity of iron. On the whole then, the application of the hot blast has caused the same fuel to reduce three times as much iron as before, and the same blast twice as much as before. The proportion of the flux required to reduce a given weight of the ore has also been diminished.'

"'In Scotland, Mr. Neilson's invention has been extensively applied to the making of cast-iron, insomuch that there is only one Scotch iron-work where the invention is not in use; and in that work, apparatus is under construction to put the invention into operation.'—(*On the application of the Hot Blast, in the manufacture of Cast Iron, by* Thomas Clark, M. D., Professor of Chemistry in Marishal College, Aberdeen. Transactions of the Royal Society of Edinburgh, Vol. xiii, p. 373.) For additional details respecting this improvement, see a treatise 'on the use of hot air in the iron-works of England and Scotland, translated from a report made to the Director General of mines in France, by M. Dufrenoy, in 1834. London. Murray. 1836.' "*

Bog ore is abundant, and has long been wrought in the State, particularly in the central and eastern parts.

The iron works of Stafford produce 350 tons of cast iron annually—but a part of the iron comes from Massachusetts.

Spathic iron.—Of this ore, there is a great deposit at Roxbury, near New Milford. This ore consists of more than half protoxide of iron, and the rest is carbonic acid with a little manganese, lime and magnesia.

This mine was wrought, many years ago, for silver, and then deep and expensive excavations were made, of the origin of which Mr. Shepard has given an interesting account. This ore is usually called the steel ore, because it affords steel directly from the bar without cementation, and its nature has in this case been repeatedly verified of late years by the fabrication of cutting instruments from it.

Iron pyrites are found in many parts of the State, and the magnetic variety in abundance in the towns of Trumbull, New Fairfield, and Litchfield; in the latter town, it is particularly abundant. It is easily converted into copperas, but as yet there is no manufactory similar to that which is so well known at Stratford in Vermont, 12 miles west of Dartmouth College.

Copper.—Most of the ores of copper are found in Connecticut; and there have been many exportations, particularly in the early part of the late century.

A mass of native copper, weighing nearly 100 pounds, was found a few miles from New Haven, many years ago; and more recently (about 20 years ago) near Wallingford, one weighing 6 pounds, which is in the cabinet of Yale College, and it has been discovered repeatedly in Farmington. The excavations formerly used as a State Prison, in Granby, were made a century ago, in digging for

* The greater part of the extracts commencing at the top of the preceding page, was printed in Vol. xxxi, at p. 181 of this Journal, but we allow them to stand here again for the sake of the connexion.

copper, and since the removal of the convicts to Wethersfield, this mine has been wrought again.

"The following is the report of Mr. John B. Jenkins of Swansea, Wales, of his trial made in 1830, upon four parcels of the ore:—

		cwt.	qrs.	lbs.		per cent.		cwt.	qrs.	lbs.
"'No. 1,	wt.	4	1	17	produce	$13\frac{1}{2}$	metal	0	2	5
2,		4	2	4		$12\frac{1}{8}$		0	2	2
3,		4	1	4		$4\frac{3}{4}$		0	0	21
4,		4	2	24		$10\frac{7}{8}$		0	1	26
		17	3	21				1	2	26

"'The quality of the copper in each parcel is very much the same, and may be said to be of the average quality of English copper; but their smelting qualities are below the average, being rather refractory. The expense of smelting the above ores, per ton of 21 cwt. will be for No. 1, £2 11 9; No. 2, £2 9 9; No. 3, £1 18 8; No. 4, £2 8 0, exclusive of all custom house charges. The ores, if there were any quantity of them now for sale, would bring the following prices, viz:—

"'No. 1, about	£9 9 6	At the present rate of exchange,	$44 84
2,	8 9 6		40 10
3,	2 19 6		14 08
4,	7 9 6		35 38
Average,	£7 2 0		$33 60

"'These are the prices as near as I can judge of them, or as much as a smelter could now give for them at Swansea, the miners to pay freight to this place, and all expenses of ware-housing, sampling, &c. &c.'

"In order to show the richness of these ores when compared with those of Cornwall, the following statement of the produce of the English mines for three years, is subjoined from the same document."

Years.	Tons of ore.	Tons of cop.	Rate p. c.	Value per ton.	Total value.
1815	79,984	6,607	$7\frac{8}{10}$	£6 13 0	£532,108 0 0
1816	82,442	6,968	8	6 10 5	537,621 0 0
1817	73,727	6,608	$8\frac{4}{10}$	6 11 6	410,936 0 0

Variegated copper ore, in rich veins, has been uncovered by G. W. Bartholomew, in Bristol; the veins are in a granitic rock and in place, and it is suggested by Mr. Shepard, that the copper found in the red sandstone and in the trap of Connecticut, may have resulted from the breaking up of a regular formation of copper in the primitive.

Copper ore is found in Hamden and Cheshire, near New Haven, as well as in many other places. In addition to the forms which have been enumerated, we may mention vitreous copper, yellow copper pyrites, and the green and blue carbonates. For many details relative to the indications of copper in Connecticut, we must refer to the report itself.

Lead.—The number of places where lead has been found is very considerable, and mines have been wrought at Middletown, Wilton, &c. Some very rich specimens were brought, a few years since, to Yale College, from Brookfield, but they appear not to have belonged to a continuous vein. Lane's mine, in Monroe, is worthy of commemoration, on account of the large proportion of silver—from 2 to 3.5 per cent. of the metallic lead; this ore is not hitherto abundant, but the mine has been merely opened, and not wrought deeper than a few feet. Since the proportion of silver is so large, this deposit of argentiferous galena ought to be explored.

Zinc.—Blende, or the sulphuret of zinc, is found in various places, and calamine (the carbonate) in small quantity at Brookfield; cadmia, an oxide of zinc, sublimes in the iron furnaces of Salisbury.

Native Bismuth is found at Monroe.

Arsenic—in the form of arsenical iron, (mispickel) exists at Derby, Monroe, Chatham, Wilton, &c.

Cobalt and Nickel are found at Chatham.

Molybdenum in Haddam.

Titanium—in Monroe, Plymouth, Granby, North Greenwich, and Middletown.

Uranium, in the feldspar quarry, Middletown.

" *Columbium.*—The State of Connecticut furnished the first sample of this ore to science; and in consequence of its American origin it received in England the name of columbite, and the new metal it was found to contain, that of columbium.

" The china-stone quarry at Middletown has furnished the most extraordinary specimens of columbite yet described in the world. A single group of crystals obtained at this place weighed fourteen pounds.* It occurs in crystals disseminated through the feldspar, many of which are very remarkable, not only for their size, but for their perfection of form. It is also found in small

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* See this Journal, Vol. xxx, p. 387.

quantity at Haddam, in the granite-vein which contains the chrysoberyl.

"The first sample was sent by Gov. WINTHROP to Sir HANS SLOANE, and was deposited with the collection of this gentleman in the British museum, where it was examined by Mr. HATCHETT, and afterwards by Dr. WOLLASTON. The specimen was supposed to have been found near New London, which was the residence of Gov. WINTHROP; but as the ore has not been re-discovered in that vicinity, it is more probable that it was obtained from the region of Middletown."

Tungsten is found at Monroe—both the wolfram, ferruginous tungsten, and the calcareous, besides the free oxide, which was there first identified.*

Coal.—Connecticut being mainly a country of primary rocks, and accordingly, in three quarters at least of our territory,—in all but the secondary region of the valley of the Connecticut, and the limited basin of Woodbury and Southbury,—the existence of coal is as certainly denied as that of rock salt in the same district.

"The great central valley of the Connecticut abounds in a conglomerate-rock, obviously composed of fragments derived from the contiguous primitive; nor is it wholly wanting in bituminous shales and dark colored sandstone-slates, which are the more immediate attendants of coal deposits. Still these have not yet been found collectively arranged in that order of alternation, and penetrated and interleaved by vegetable remains and argillaceous iron-ore, circumstances which are at least requisite to constitute safe indications for boring. The hopes that have been entertained have been founded chiefly on bituminous shale and limestone, black fissile slate, and thin interrupted seams and grains of indurated bitumen in sandstone and amygdaloid.

"Impressions of plants are of very rare occurrence at the places where excavations have been made, and in many instances altogether wanting. A cupriferous sandstone-slate in Suffield at Enfield falls, occasionally embraces compressed stems, apparently of calamitæ, which are converted into brown coal. Similar remains were noticed at Southington, in one of the quarries of hydraulic lime. The coal-digging in Durham also afforded some obscure vegetable impressions. The coal from these plants burns with a feeble flame and a disagreeable peat-like odor. That found in trap at Far-

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* See Vol. iv, pp. 52 and 187 of this Journal.

mington, Southbury, and at Rocky Hill, Hartford, ignites slowly, and burns without flame or odor: it is therefore, rather referable to anthracite than to bituminous coal. The coaly matter, occurring in seams with crystals of dolomite in marly shale at Berlin, and in the bituminous shales of Southbury, is compact bitumen. In many instances when freshly taken from the quarry it is semi-fluid, or only so much inspissated as to form what is called the elastic bitumen, or mineral-caoutchouc. It burns with a white flame and much smoke."

"*Plumbago.*—A plumbago-mine was worked to some extent, seventy or eighty years ago, in the northwest corner of Ashford, on land then owned by Mr. Adonijah Backus. It had been previously opened, but at what period is not now known. At the time here mentioned however, a number of tons of plumbago were obtained. The mine was worked in the manner of a quarry, and an excavation made of considerable extent. This is now completely filled up with stones, which have been carted thither from the contiguous fields; a road also passes quite across one end of the trench. The rock of the vicinity is gneiss, analogous to that embracing the plumbago at Sturbridge, which is about six miles in a northeasterly direction from this place. And such is the conformity of this direction with that of the stratification of the gneiss, as almost to justify the opinion, that the Ashford and the Sturbridge deposits of plumbago have a connexion with each other. This suggestion is the more probable from the fact, that the gneiss rock is similar at both places, and contains scales of the mineral in question at several intermerdiate points."

A number of persons from Colchester, in 1813, from the loose materials thrown out eighty years ago, obtained in a short time a wagon-load of plumbago.

"Another depository of plumbago is in the western part of Cornwall, on a mountain nearly three hundred feet high, and situated directly upon the eastern bank of the Housatonic river. It is the property of Mr. Gideon P. Pangman. The rock is gneiss, and wherever it comes into view on its western slope, this mineral may be detected as entering more or less into its composition,—sometimes in large proportion, forming a plumbaginous gneiss. A trench has been excavated at an elevation of about one hundred and fifty feet above the river, nearly six feet wide and twenty long, into a rock containing large laminæ of plumbago."

Gems.—*Topaz* at Monroe in profusion in a vein of fluor spar—numerous crystals—some beautiful, but often large and coarse.

Sapphire at Litchfield—chrysoberyl at Haddam—emeralds and beryls at Haddam—tourmaline at Monroe, Haddam, &c. Zircon at at Haddam and Middletown—garnets in many places—agates in East Haven, Southbury, Farmington—corundum in Litchfield.

"*Soapstone.*—The rock referred to under this name in Greenwich, Stanwich, Litchfield, New Hartford, Wilton and Colebrook, is entirely composed of asbestiform tremolite, and might with great propriety be called asbestus-rock, since in some of these places it forms extensive beds. All attemps to quarry and to split it, must be attended with so much difficulty, that it can never come into competition with genuine soapstone. Rudely shaped blocks of it are used to some extent in furnaces, in the chimneys of smiths and for common chimney-backs.

"A soapstone better entitled to the name, though not of the best quality, exists in Somers, where it has been quarried for many years. The quarry is on the eastern side of Durfee mountain, about one hundred and fifty feet above its base. It occurs with talc-slate in interstratified masses in hornblendic gneiss. It abounds too much in tremolite crystals, and grains of magnetic-iron, to admit of the most valued applications of this substance as a fire-stone; besides it is injured by possessing too shistose a texture. The uses to which it has been applied are, for hearth and grave-stones, and for jambs. At present however, it is but little worked.

"The chlorite of Newtown is well adapted to the manufacture of ink-stands and similar articles, and has already been employed to some extent for this purpose. The true soapstone or steatite is found at Bartholomew's factory in Bristol, and at two places farther south, where it exists in a limited formation of hornblendic serpentine, forming coatings and veins. It possesses all the requisites for the purposes above described as pertaining to this substance, and it has already attracted the notice of tailors, who have found it possessed of the same properties as the French chalk of the shops."

The best soapstone in New England is obtained from Orford and Francistown, N. H., also near Bellows' Falls, Vermont, and from Middlefield, Mass.

"*The materials for the fabrication of bricks are every where abundant,* and of the best quality, throughout the secondary region of the State." In New Milford there is a bed of porcelain clay proceeding from the decomposition of granite, covering several acres. It forms an excellent material for small furnaces, and for lining anthracite stoves; the fire-bricks made from it are nearly equal to those of Stourbridge, England, and cost about two-thirds as much. Porcelain clay is found also in Sherman, Kent, Cornwall, Granby, &c.

The feldspar quarry, below Middletown, affords inexhaustible and excellent materials for the manufacture of porcelain. Seven hundred tons were delivered at Middletown last year, of which 600 tons were shipped to Liverpool, and 100 to the porcelain manufactory at Jersey City.

Siliceous sand of excellent quality for the manufacture of glass, is found in Middlebury.

Fire-Stones.—Quartzy graywackes, micaceous gneiss, mica-slate, and steatitic or asbestus-rocks, are often employed as fire-stones. Quartz rock and micaceous quartz rock are used for the same purpose. A rock of the latter kind used at Stafford "is arranged in laminæ of such thinness, that it requires at least fifty repetitions of them to form an inch. Each layer is completely coated with an almost unbroken film of white-mica. The rock cleaves with the utmost facility, and perfectly strait. The layers of quartz, moreover, are made up of slightly cohering, transparent grains, in consequence of which structure the rock is a very weak one, and may be broken with a slight force even in slabs of considerable thickness, and it may be cut and dressed on the edges with much more facility than the softest sandstone. It occurs at the quarry in strata nearly vertical; and is shaped into blocks two feet square on the broadest face, by sixteen inches thick. In this condition it sells for sixteen dollars per ton. The demand for the stone at present is sufficient to afford constant employment to two quarrymen. The blocks simply require to be so arranged in furnaces as to have their edges perpendicular to the surface of melted metal. Some of these fire-stones at the furnace in Stafford, after they had been subjected to this use, were observed to have undergone a semi-fusion only, even where they had been exposed to the most intense heat. The silica on the exterior of each siliceous lamina had apparently been adequate to the saturation of the earthy bases contained in the mica, leaving the centre unaffected; while the glass produced, had on the whole been sufficient to convert the stone from a friable, into a closely agglutinated mass. Those fragments and masses of the rock not adapted to use in furnaces are reduced to sand, and employed to some extent along with lime, in the preparation of a handsome finish for the walls of rooms."

Fluxes.—The minerals generally used are limestone, quartz, and fluor spar, and magnetic pyrites.

Silex combines with the bases and forms silicates as they are termed.

Quick Lime and Water Cement.—The State abounds with materials for these most useful compositions; much of the limestone is magnesian, which answers well for the purposes of the arts, and although said to be injurious as a manure, Mr. Bakewell asserts that it is only necessary to employ it in smaller quantity. In pure limestone, "the carbonate of lime is present in a proportion not lower than eighty-five per cent., the remainder consisting of magnesia, alumina, the oxides of iron and manganese, and of silica. The magnesian lime is the product of rocks in which carbonate of magnesia is associated with the carbonate of lime in a proportion, between fifteen and forty-five per cent. Hydraulic lime is derived from rocks containing between ten and thirty per cent. of clay, (a mixture of silica and alumina in nearly equal proportions.) These varieties are essentially different from each other. The two first are alike adapted to atmospheric uses; the last, as its name signifies, to subaqueous applications,—having the extraordinary property of hardening under water.

"Pure limestone as well as dolomite, is extremely scarce throughout the whole eastern half of the State. It is probable that the bed of dolomite in North Stonington may be found extending itself for a few miles, both in a northerly and southerly direction from Geer's kiln, but beyond this no indications of limestone appear except in the mica-slate of Bolton mountain. At the notch in Bolton, several thin beds of pure limestone make their appearance, and the same strata occur again nearly two miles north in the flagging-stone quarry in Vernon. The overlie of the flagging-stone here, for a thickness of thirty feet, chiefly consists of a calcareous mica-slate, in some layers sufficiently rich in carbonate of lime to be burnt for agricultural purposes, if not for the fabrication of mortar. The same stratum is no doubt continuous through the range, and in some part of it may be still richer in lime.

"The western part of the State on the other hand, is in general well supplied with the varieties of calcareous rocks, although the dolomitic kind greatly prevails. Still even within the dolomite, it is believed that extensive beds of pure limestone exist."

Stone Paints.—These are made from soapstone at Greenwich, where fifty tons were ground in 1835. Serpentine and sulphate of barytes are also used.

Architectural Materials.—" The building stone of Connecticut, both ornamental and common, constitute one of the most valuable resources of the State, whether considered as affording a supply to its own wants, or materials for exportation. The principal kinds at present in use are granite (the term being used in its widest sense,) gneiss, sandstone, marble, sandstone-conglomerate and trap. The two last mentioned are employed only as a common building material.

" The ornamental granite found in the State presents numerous varieties; in treating of which, it will be convenient to refer them to several general types under distinct names. 1. *Gray granite.* 2. *White granite.* 3. *Flesh colored granite.* 4. *Red granite.* 5. *Epidotic granite.* 6. *Porphyritic granite.* *Green porphyritic granite.* *Gray porphyritic granite.* 7. *Chloritic granite.* 8. *Sienitic granite.* The gray granite is the most abundant and the most useful. A beautiful granite of this kind is wrought at Waterford.

" Mine-hill in Roxbury has been much resorted to, for a more shistose and lighter colored granite (strictly gneiss) than that just described. It is easily obtained in very large tabular blocks, and might with as much propriety be embraced under flagging stones, as it is employed for paving as well as for building stone. Its leading use, however, is for underpinning and for stepping stones. At present, it employs but two or three hands. A similar use is made of the Willimantic quarry and of several others. The quarries in Greenwich afford several light colored varieties of gray granite, but are wrought almost exclusively as a common building stone, and are taken in large quantities to New York city.

" Other localities deserving to be indicated as likely to furnish valuable deposits of this stone, are the following: Stonington, Groton, the country between Norwalk and Darien, North Fairfield, north part of Wilton, region in vicinity of Torringford and Wolcottville, Winsted, western part of New Milford, Canada village (Goshen,) Warren, Marlborough, and Voluntown.

" There is but one quarry of the white granite which is wrought at present. It is in Plymouth, near the woolen manufactory of Mr. Henry Terry. The bed is extensive, forming apparently the western side of a hill, which is above a mile long, though concealed to a considerable extent by soil. It is the most beautiful granite in the State; nor is it surpassed in whiteness and transparency of material by any granite in the country. The distance from water-communication alone prevents it from being a source of great value to the proprietors."

The number of quarries of beautiful granite is so great that we cannot quote them, but must refer to the original report.

White marble is extensively quarried for architecture at New Preston; the average yield of the quarries here is seven to eight thousand dollars for the rough stone, and nearly as much more for preparing it in the neighboring shops.

Sandstone is more extensively used than all other materials derived from rocks. This rock is often soft when taken from the ground but hardens in the air, and its nearly horizontal stratification make it very easy to remove it from the quarry.

"It is unnecessary to enter into details respecting the sandstone quarries of the Connecticut valley. There is scarcely a neighborhood not affording this valuable material in sufficient quantity for its own demand; while the great quarry at Chatham which employs two hundred men, furnishes blocks to all the maritime cities in the United States. Its very great facilities for supplying, added to its contiguity to the river, give it an advantage in shipping this stone, which it is doubtful whether any other quarry in the country will ever be found to possess. As a very peculiar variety on account of its color, the quarry at Wapping (East Windsor,) is entitled to mention. The sandstone here is of a bright and uniform brick-red.

"The most interesting deposit of sandstone for ornamental architecture yet developed in the State, is situated in North Haven, at the east end of Mount Carmel, on the middle road between New Haven and Hartford.

"Upon the common building materials of the State it may be remarked, that we have but few rocks unfit for cheap and ordinary structures. If we except mica-slate, argillite, talcose and chlorite-slate, the more fissile shales and marly slate of the secondary, all the others are more or less employed. Trap is most used in the valley of the Connecticut, and is not surpassed for strength and inalterability by any other stone. It is frequently quarried without the aid of gunpowder, the seams of the rock presenting natural divisions.

"Common building stone is quarried at several places in the State, for exportation. It is generally spoken of as foundation-stone, or as fort or block-stone. Large quantities are shipped from the quarries situated immediately on the banks of the Connecticut and the Thames, to be employed in New York and in the public works along the coast. The quarries on the east side of the river at Haddam are particularly engaged in this business, and employ forty or fifty men. LORD's quarry in Lyme is well located for affording this kind of stone. In 1832 and 1833 it employed upwards of thirty hands, being then engaged in furnishing stone for the construction of canal-locks in New Jersey. The stone for the foundation-work of the Merchants' Exchange in New York was supplied during the last season from this quarry.

"CHAPMAN's quarry of granitic-gneiss on the east side of the Thames in Groton, a few miles above New London, is also extensively engaged in furnishing block-stone. Twelve hands were employed here last summer. The stone is quarried at an expense of twelve cents the foot, and its freight to New York costs from six to eight cents. A quarry for similar stone on the opposite of the river in Waterford, was worked five years ago to furnish stone for the public works at Pensacola. Common building stone is extensively quarried also at Greenwich, both for the construction of public works and for ordinary building in the city of New York."

The verd antique marble of Milford is a beautiful ornamental stone of inexhaustible variety. It is not fitted for outside decoration, because its fine colors become dull in the weather, but within doors they are permanent. It is true that all the marble obtained at Milford is not verd antique; but we cannot agree to confine it within the narrow limits drawn by Mr. Shepard, as we are sure it is not so limited in the fine tables, vases, &c. seen in Europe, and sometimes in this country.

Stones for Flagging, Tiling, &c.—"The flagging-stone of the State is referable to the following rocks,—gneiss, micaceous quartz-rock, mica-slate, and sandstone slate; and together constitute a resource fully equal to its building-materials. The quarries of gneiss on the Connecticut river rank very high in importance, not only on account of the intrinsic excellence they possess, but from their proximity to the river. They are situated at Middletown, at Chatham, at Haddam on both sides of the river, and also at Chester, Hadlyme and Essex; and they are remarkable for the uniformity of their character in every place where they are explored in these towns, as well as further southwest in Madison, where extensive quarries also exist. It is difficult to ascertain the number of hands employed in quarrying this rock; but from such facts as could be collected, it is believed that they ordinarily fall but little below five hundred. The properties of the gneiss are in a measure peculiar: at least, no rock precisely resembles it in any part of the State. Its leading peculiarities depend upon its black mica and transparent grains of albite. These are arranged in thin, strait, and parallel layers, giving to surfaces produced by cross-fracture a banded appearance of black and gray; while the surfaces resulting from cleavage are almost black. Both the mica and the albite possess high degrees of lustre, which impart to the rock a very brilliant effect,—rendering fresh slabs of it almost insupportable to the eyes, in a strong light of the sun. The cleavages do not take place with the greatest freedom, and can rarely be effected, so as to divide the rock into slabs of less than six inches in thickness.* They are particularly prone to occur where the mica is most abundant, and this in general is contiguous to those layers of albite which are made up of larger individuals than the average size. The rock contains very little quartz. Hornblende is occasionally present, which is of a black color, highly crystalline, and brilliant in its lustre. The process of quarrying appears to be conducted with the greater facility, from the highly inclined position of the strata. Slabs of any dimensions are easily procured. Its great use seems to be for flag and curb-stones, though it is also employed extensively in the construction of wharves, bridges, breakwaters and fortifications, for which purposes its strength and inalterability render it very desirable. It is likewise used for underpinning stones, and for posts to gateways and fences which in some instances are covered by wood. As it is a material of great importance in paving, it is sought for in all the large cities, being extensively used in Boston, New York and Philadelphia, and of late has been introduced into Charleston and New Orleans, where it is likely to prove highly important in the paving improvements recently commenced in these cities. It may well be doubted whether any material will be brought to light in the country, better adapted either in quality or local situation than the gneiss of the Connecticut river, for satisfying these demands.

"In the northwestern part of Lebanon, a little east of what is called Hearth-stone hill, a very valuable flagging is quarried. It consists of a feldspathic gneiss. It is very thinly stratified, strait

* Many of the flagging stones sold in New Haven are not more than one, two or three inches thick, and come, we believe, from Haddam.—Ed.

and easily separable. Much of it consists almost wholly of feldspar. Flags are quarried here of great size and any desirable degree of thinness; and although the transportation by land to market (to Norwich) is above fifteen miles, they are yet afforded so low as to compete with the Bolton stone."

"Next in importance to the gneiss, the mica-slate of Bolton mountain deserves to be noticed as a flagging-stone. No material of this species has yet been discovered in the United States or elsewhere, capable of being compared with this invaluable stone. Slabs five feet by eight, and even larger, are furnished by these quarries, whose surfaces are as true and smooth, as any granite or sandstone could be rendered by the nicest process of dressing, and yet with a thickness not above six or eight inches. The rock derives its color from the mica, which is of a silver gray. It is so abundant that its cleavage surfaces exhibit no other mineral, and its lustre is no less brilliant than that of the Haddam gneiss. The stratification of the rock is extremely uniform and always thin, sometimes apparently consisting of upwards of an hundred thicknesses of mica in one inch. The layers interposed between the mica in one variety of the rock, consist of an aggregate of grains of quartz, feldspar and garnet; but each so small as to require a microscope for detection. The use for which this stone is especially fitted is for side-walks, market-houses, cellars, and foot-paths generally about houses, as well as for water-gutters. Its strength is inadequate to the support of carriage-wheels. It should, therefore, in the paving of streets, be employed along with the Connecticut river gneiss, whose firmness admirably fits it for foot-paths across streets and for curb-stones. The quarries extend for two miles along the Bolton mountain. The stratum which affords the flagging-stone is from fifteen to twenty feet in thickness; and of this the upper part, to the depth of six feet is of inferior value, affording only a small proportion of flagging-stone. Above this stratum is an overlie of nearly forty feet, of dark, gray micaceous limestone or calcareous mica-slate.

"The strata dip westerly from 25 to 30°. The thin stratum between the garnetiferous mica-slate and flagging-variety is called the diamond-reef by the workmen, on account of the rhomboidal fragments into which it separates. The labor of quarrying the flagging-stone is very considerable. The superincumbent strata require to be removed as fast as the workmen advance in the removal of the flagging-stone. Thus, they are obliged to reject more than two-thirds of the stone in working the quarry; this stone is sold in Hartford at from ten to twelve cents the square foot."

"The quarries of Killingly have but recently been opened; and although highly promising in their character, are comparatively but little known to the public at large. The stone is altogether peculiar in its character. It is the micaceous quartz-rock, consisting almost exclusively of the species quartz. The mica present is nearly undistinguishable, and would quite escape ordinary observation but for its hair-brown color. It is most obvious on the cleavage-surfaces, where it is seen collected together into clouded patches; but so small is its quantity on the whole, that it seems almost inadequate to account for the free and strait cleavages by which the rock separates, and yet no other cause can be adduced for their production. The mica sometimes has a yellowish tinge, in which case we have a rock so exactly identical in structure and appearance with the avanturine of Spain that samples of it are well worthy of being submitted to the wheel of the lapidary. The cleavages occur at distances, of from half an inch to four and six inches apart, and seem perfectly parallel often for ten or fifteen feet in each direction. The surfaces of the slabs are as smooth and even, as those of the best moulded tiles. In strength, it is not inferior to any other flagging-stone, if we except perhaps the hornblende-slate. It is not liable to disintegration from exposure to the weather, or from immersion in water. In these respects it surpasses in value the more micaceous slates. Judging from weather-beaten masses of the rock, it grows whiter on exposure; an effect resulting from the loss of the brown mica, which is more abundant on the cleavage surfaces than through the general mass of the stone.

"The uses to which this flagging-stone may be applied are numerous, and many of them quite new. As a paving for side-walks it must be pre-eminently valuable, not only on account of the size of the slabs and their smoothness, but from the hardness of the material. The friction to which it will be subjected in this situation cannot it would seem, make the slightest impression upon it; for its hardness is superior to that of the firmest and most imperishable granite. For this reason, flag-stones from this rock which have been long in use will not require to be roughened up with the chisel, as is the case with some of the softer mica-slates. In the paving of door-yards, warehouses and cellars, its value is equally obvious. It must surpass all other materials also, for lining drains, water-sluices and canals; and it is even possible that it may prove useful in the roofing of small buildings. It is a fortunate circumstance that the supply of this stone is unlimited, and that it is favorably situated in the quarries for working. Excellent stone, essentially of this kind, has been obtained at various places on one and the same range, for several miles in extent. The most important opening made at present however, is that of BOLLES and TYLER. It is about three hundred and fifty feet long, fifty feet wide (of uncovered rock), and twenty-five above a narrow valley separating it from a higher ledge on the west. The direction of the strata is north by east, and the dip northwesterly 40 or 45°. The rock is almost without cross-seams, which renders the quarrying somewhat difficult. Those which do occur, are from ten to thirty feet apart, and have a direction northwest by west. The rock is singularly striated in the direction of the edges of stratification. The average thickness of the layers is between two and four inches."

Slate for tiling exists in the Woodbridge hills near New Haven, and was formerly quarried; it is firm and does not exfoliate, and is easily pierced by a nail.

Excellent paving stones are found on the sea shores—often inland and upon the river banks, and the trap regions abound with them.

The mineral springs of Connecticut are almost universally mild chalybeates—carbonate of iron being suspended by carbonic acid gas. "The most important are those of Stafford. Ample accommodations here exist for invalids, and during the warm season they are a favorite resort. No perceptible escape of gas from the water is observed. The sides of the reservoir are lined with a thick flocculent precipitate of the oxide of iron, occasioned by the decomposition of the carbonate of iron from the access of air." It is a mistake that some of these springs are sulphureous: from examination on the spot we know that they do not tarnish muriate of bismuth or acetate of lead.*

The soils of Connecticut are such as might be expected from the nature of its rocks, and are generally deficient in the important ingredient of lime. Lime may doubtless be used with advantage, and Mr. Shepard informs us that Mr. Platt, of Danbury, is about preparing it for farmers. We much doubt however the validity of the caution as to the use of the magnesian limestone, provided the quantity be diminished or be mixed with other manuring materials.

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* Editor.

The rich marls of the Chesapeake and its confluent rivers are now beginning to be introduced into the port of New Haven as a manure to be transported by the Farmington canal into the interior. It remains to be seen whether the price and efficacy will sustain the undertaking. If this material should enable us to restore the culture of wheat it would be a very important advantage.*

The Scientific Report scarcely admits of analysis or condensation. It presents a rich variety of minerals—natives of the small territory of Connecticut, scarcely one hundred miles by sixty. Its fluor spar, feldspar, andalusite, chrysoberyl, topaz, emerald, tungsten, columbite, native copper, &c. are among its mineral attractions, and Mr. Shepard has well set forth the claims of the State to the consideration of mineralogists. No man is better acquainted with American local mineralogy. We cannot however but regret that he has in his scientific report rendered the dryness and repulsiveness of mineralogical language doubly difficult and disagreeable, by introducing the uncouth names of the school of Vienna.

What advantage is gained by extending the term baryte, or mica, or pyrites, heretofore perfectly definite, to many substances besides those to which they were formerly applied with so much felicity? and what advantage do we gain by such words as Atelene-Picrosmine for Serpentine, Kouphone-Spar for Prehnite, Eruthrone-Ore for Sphene, Malacone-Metal for Bismuth and Copper, Sclerone-Metal for Native-Iron, Eruthleucone-Pyrites for Copper-Nickel and Mispickel, Polypoione-Glance for Galena, &c. &c.? Happily, however, his descriptive catalogue, in which he has judiciously placed the old familiar names in front, and ordered these foreign auxiliaries into the rear—especially when aided by the specimens themselves, well selected, arranged, and preserved as they are, will redeem the effect of this strange nomenclature, and his work will stand as a lasting and honorable monument to his industry, skill, science, zeal and fidelity in accomplishing an arduous and responsible labor, for which he deserves the gratitude, not only of all the citizens of Connecticut, but of all lovers of science and of sound improvement in the great interests of society; and Gov. Edwards will be remembered with honor as the patron of this survey, when the party distinctions of the times, and all whose ephemeral fame depends upon them, shall have passed into eternal oblivion.

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* We are glad to observe during a recent tour, that there are numerous fine fields of wheat in New Hampshire, and we are assured there are many more in Maine.—(*September* 21, 1837.)—Ed.

Art. XVII.—*On the Shooting Stars of August 9th and 10th*, 1837; *and on the Probability of the Annual Occurrence of a Meteoric Shower in August*; by Edward C. Herrick.

The investigation of the causes of the luminous meteors called *shooting stars*, is a matter of great and increasing interest; and it is therefore important to collect and place on record, every particular of consequence regarding the unusual display of these bodies witnessed on the night of Wednesday, August 9th, 1837. The few facts here given are in addition to those stated in the interesting communication of Mr. Schaeffer, (p. 133 of this No.,) in which article are contained the only definite observations of this phenomenon, which have come to my knowledge.

Between 9 and 10 P. M. of the evening above mentioned, I noticed in the northeastern quarter of the heavens, (that being the only portion visible at my station,) from twelve to fifteen shooting stars of uncommon brilliancy, most of which left trains of considerable extent. The moon was about two hours high in the west at the time, and doubtless concealed some of inferior lustre. No attempt was made to ascertain the radiating point of the meteors, but I noticed that many of them proceeded in a southwestern direction from a region in the northeast. My observations ceased at ten o'clock. From persons who were abroad after midnight, it appears that from about 1 A. M. until the morning light, the meteors were numerous and brilliant, and attracted the notice of many who commonly give no heed to celestial appearances. I have no data for estimating the number seen during the night; but there can be no doubt that it far exceeded the amount commonly visible during the like period of time. It is no less doubtful that the display was greatly inferior to the ever-memorable spectacle of the night of the 12th of November, 1833.

Over what extent of country this phenomenon was seen, we have not at present the means of determining. The whole amount of information concerning it which has hitherto reached us from a distance is very limited. It is earnestly to be desired that all who have in their possession any accurate observations upon it should give them to the public. It was seen as far south as Macon, Ga., (lat. 32° 52′ N., long. 73° 44′ W.,) as appears by the following article, quoted from the *Messenger* of the 17th August, through the (New Haven) Daily Herald of September 4th.

"*Shooting Stars.*—On Wednesday night the 9th, a considerable display of this kind took place in the heavens. For several hours from one to a dozen could be constantly seen shooting towards every point of the compass at various angles, and often horizontally. In many cases they were very near the earth, representing a mere spark, and shooting with great velocity, and again they were in appearance equal to stars of the largest magnitude, leaving a long train after them, which was sometimes visible for two minutes. Most of them were of a yellowish or flame color, but we noticed one of the very largest size of a deep red, which moved off slowly and majestically with a brilliant train. We noticed them from 1 to 3 o'clock, but we are told they commenced early in the night."

On the probable periodicity of the meteoric shower of August 9th and 10th.

In Prof. Loomis's article on shooting stars, (vol. xxviii, p. 95, of this Journal,) in which he gives an abstract of observations made in Germany from April to Oct. 1823, by Prof. Brandes and his associates, it is stated that on August 10th, 1823, "one hundred and forty shooting stars were noted in less than two hours," besides many which were of necessity left unrecorded. The near coincidence of this date with that of the display of this year at once suggested to me the possibility of its periodical nature, and incited me to an examination of such sources of information as could be readily obtained. I have had neither the time nor the means necessary for making a very extensive exploration, but as the facts which even this hasty search has brought to light are of much interest, I think best to make them public without delay. Those who have access to extensive libraries will I trust, push the inquiry farther.*

These facts appear to me sufficient to render highly probable the *periodical occurrence of an unusually large number of shooting stars on or about the 9th of August.* The particulars of the evidence are the following.

* Many works which would probably throw light on the subject are beyond my reach; e. g. various volumes of Gilbert's Annalen der Physik; Quetelet in Bib. Univ. de Genève, Mars, 1837.—Analyst, August, 1834. Dodsley's Annual Register for 1783, p. 214, speaking of two meteorites seen August 18th, 1783, says, "The phenomenon which appeared in 1716, and continued from 8 P. M. till 3 in the morning was like the present, not local, &c." Was this a shower of shooting stars?

1. The observations of Prof. Brandes above mentioned.

2. In the meteorological observations appended to the "Report of the Regents of the University of the State of N. York, made March, 1837," is the following entry, p. 169. "August 9, 1836, meteors frequent during the night, Bridgewater, N. Y." No other like entry occurs throughout the year.*

3. "During the extreme heat which introduced the pestilence of the last summer, 1798, about the 9th of August, the small meteors or falling stars were incredibly numerous for several nights. They almost all shot from the northeast to the southwest, and succeeded each other so rapidly as to keep the eye of a curious spectator almost constantly engaged." *Dr. N. Webster's "Brief History of Epidemic and Pestilential Diseases,"* &c. (2 vols. 8vo. Hartford, 1799,) vol. ii. p. 89. It will be noticed that these meteors coincided very nearly in direction with those of 1837.

4. Mr. Caleb Gannett in a Historical Register of the Aurora Borealis, contained in the Memoirs of the American Academy, vol. i. (Boston, 1785, 4to.) p. 327, states that on the night of August 8th, 1781, "Meteors appeared in great numbers, shooting, in general, from N. W. to S. E."

5. An unusual display appears to have been witnessed in Worcestershire, (England,) August 10th, 1833, but the notices of the event, within my reach, are so scanty, that the case cannot at present be considered a very strong one. Mr. W. B. Clarke, in a meteorological summary for 1833, (Loudon's Mag. Nat. Hist. May, 1837, p. 232,) reports—"1833, August 10th. Falling stars and meteors in Worcestershire 10 to 12 P. M.," and again (idem. vol. vii, 1834, p. 386,) in speaking of the meteors of November, 1833, he asks, "Why may we not suppose that the meteors of precisely

* P. S. Since this article was sent to press, I have received the following important additional facts concerning this case, from Prof. B. F. Joslin, to whom I had written for information. He has kindly furnished me with a transcript of his meteorological record for that evening, viz. Tuesday, August 9th, 1836. I regret that there is room here only for his results. "Combining the above observations, I conclude that during most of the evening, at least when observations were made, late or early, the shooting stars fell in the observed and unobserved quarters of the sky at the rate of about *one hundred and fifty per hour;* that those which did not leave trains were small; that the trains were real; that the long trains were all small; that the large brilliant trains were all short; that all the meteors descended; and that they appeared at a time when an aurora might have been expected had not the barometer become stationary; yet it had been rising, and the thermometer falling." The observations were made at Schenectady, N. Y.

similar character seen on August 10th, 1833, in Worcestershire, at 10 to 12 P. M., were cometic fragments?" He refers to Mr. Lees's paper on the Aurora in the Analyst, No. 1, p. 33, for August, 1834, which probably contains the particulars.*

6. The next extract may perhaps have no bearing on the point in question. It seems to be however proper to quote it, as it may lead to further disclosures from other witnesses. It is found in the meteorological observations for 1809, contained in the Edinburgh Annual Register for 1809, vol. ii. part 2, p. 508.

"On the 10th of August, (1809.) during the night, there was a good deal of thunder, lightening and rain at London. During this storm, about half past one o'clock in the morning, the whole of the sky appeared to be covered with one unbroken mass of black pitchy cloud, in which no break was visible, even during the vivid flashes of lightening which seemed to come from an inferior region of the sky. Over, or rather below this dark surface were spread light and flocky clouds, broken into large fleeces, and apparently luminous throughout. They seemed full of little dazzling and dancing specks of light that sometimes shone as stars through a misty cloud. Some of those increased gradually, and then died away; but one of them increased to such a degree as to equal Venus in size and lustre. This luminous body moved with considerable rapidity round the edge of that mass in which it appeared. Another brilliant meteor of the same kind appeared in a similar cloud at a considerable distance. It was distinctly observed by M. Staveley, to whom we are indebted for an account of the preceding phenomena, that no lightening broke from the luminous clouds, but they emitted a light of a pale phosphoric color."

7. The following notice, although brief and indefinite, seems to deserve a place here, as it may when fully developed prove important. It is copied from an account, (contained in the London Athenæum of March 25, 1837,) of M. Von Hammer's communication on falling stars, to the French Academy of Sciences. "In the history of Cairo, by Soyorite, we find the following, 'In this year, (1029 of our era,) in the month of Redjeb, (August,) many stars fell with a great noise and brilliant light.'"

The very interesting discovery made by Prof. Olmsted of the periodicity of the meteoric shower of November, has invested these bodies with an importance unthought of in former times. "A new

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* The following fact came to my notice too late for insertion in the text. Mr. J. P. Espy, in Jour. of Franklin Inst. vol. xv. 1835, p. 234, has recorded letters from Messrs. S. C. Walker, W. H. C. Riggs and John Black, which state that on the night of 7th–8th August, 1833, "numerous luminous bodies, on all sides, falling quite thick," were observed for a short time at Philadelphia. They were not in all points like *shooting stars*, but resembled them more nearly than they did any thing else. Further consideration of this case is unavoidably deferred.

planetary world," says M. Arago, "is beginning to reveal itself to us." Before the final settlement of a theory for the phenomenon, extensive and exact observations, continued during all the favorable nights of the year, and for many years, are greatly needed. Such observations we can scarcely expect to obtain; yet much might be accomplished if the watch at the various military stations throughout the world and on board national vessels could be induced to lend their aid. The connection between these meteors and the *Zodiacal Light* which Prof. Olmsted has suggested, renders it also highly important that this appearance should be observed with the most careful attention.

New Haven, Conn.

MISCELLANIES.

DOMESTIC AND FOREIGN.

Bibliographical Notices.

1. *Boston Journal of Natural History, containing papers and communications read to the Boston Society of Natural History.* Part I. No. 4. Boston. Hilliard, Gray & Co. 1837.—A notice of an earlier part of the transactions will be found in Vol. 31, p. 185, and in our last number we republished the annual report of the Society. It gives us pleasure to announce the appearance of the fourth number of their Journal, completing the first part of the first volume. Mr. Say's Descriptions of New Species of North American Hymenoptera, &c. is completed. Art. 18. Description of a new species of the genus Hydrargyra; with some additions to the catalogue of the fishes of Massachusetts in Prof. Hitchcock's "Report." By D. Humphreys Storer, M. D. Art. 19. Remarks on the Positions assumed by George Ord, Esq. in relation to the Cow Black Bird, (*Icterus Agripennis*) in Loudon's Magazine for February, 1836. By Mr. Thos. M. Brewer. Art. 20. Some additions to the catalogue of the Birds of Massachusetts in Prof. Hitchcock's "Report." By Mr. Thos. M. Brewer. Art. 21. Descriptions of a new species of the genus Marginella, (Lam.) with some observations on the same. By Capt. Joseph Couthouy. Art. 22. Anatomical de-

scription of the Galapagos Tortoise. By J. S. B. Jackson, M. D. Art. 23. Description of a new species of the genus Gasterosteus. By D. Humphreys Storer, M. D. Art. 24. Description of a new species of Marginella. By D. Humphreys Storer, M. D. Art. 25. A Monograph of the Helices inhabiting the United States. By Amos Binney, M. D. Catalogue of the Library—Donors to the Library—Donations—Index. These papers are all valuable and of a highly scientific character. Mr. Binney's Monograph of the Helices is peculiarly interesting to American conchologists, as clearing up much uncertainty that hung over many of the species—restoring them in some cases to their original discoverer, and presenting us the whole of this natural family at one view. All the other papers are interesting in this way, and will no doubt receive the attention they deserve.

2. *Catalogue of the Library of the Academy of Natural Sciences of Philadelphia.* Phil. J. Dobson. 1837. 8vo. pp. 300.—This is an important document, inasmuch as the library is the largest and the most important on its own peculiar branches in this country. What is of more interest, however, is that the whole library, with the exception of five hundred and fifty eight volumes, is the result of the munificence of one individual—the venerable Wm. Maclure, now residing in Mexico, the pioneer of American Geology, and ever the most efficient patron and still a laborer in the fields of science. It has been owing chiefly to his efficient aid that the library of the Philadelphia Academy has been formed, while its members have labored ably and faithfully, and the result of their labors may be seen in the valuable Journal of the transactions of the society noticed frequently in our pages.

It appears from the report prefixed to this catalogue that the library contains exclusive of tracts, six thousand eight hundred and ninety volumes, which may be classed according to size in the following manner:

Folio, - - - -	674
Quarto, - - - -	1,595
Octavo, - - - -	3,723
Duodecimo, &c. - - -	898
	6,890

Besides these there are four hundred and thirty five separate maps and charts. Of the above, Mr. Maclure has presented the following:

Folio, - - - -	612
Quarto, - - - -	1,131
Octavo, - - - -	2,699
Duodecimo, &c. - - -	790
	5,232

The report, speaking of the donations of Mr. Maclure, says—"It is with no ordinary pleasure and gratitude that the committee take this occasion to record the fact, that of the above volumes no less than five thousand two hundred and thirty two have been derived from the munificence of a single individnal, William Maclure, Esq., President of our institution. To these are added nearly all the separate maps and charts."

The catalogue is divided under heads according to subjects, and these are arranged alphabetically by the names of the authors, and at the end is a general index of the whole. In a library for reference the value of the arrangement must of course depend on the facility with which that reference can be made; this, in the present instance, the committee in their report assure us is very great. This library is not exclusively confined to natural history, but embraces books on many other departments of science and useful knowledge.

3. *Lyell's Geology. First American from the Fifth and last London Edition,* 2 vols. 8vo. Philadelphia. James Kay, Jun. & Brother. 1837.—For our opinion of this admirable work we would refer to Vol. XXIX. p. 358, of this Journal. Since those remarks were made, a fifth edition has appeared in London with various additions and improvements, and from this last edition the one before us has been published with all the cuts. The style and mechanical execution of the American edition are creditable to its publishers; the four duodecimos of the author are comprised in two handsome octavos of about five hundred and fifty pages each. Few American republications of English scientific books, so far as we have seen, will bear a very close comparison with the originals; particularly in the paper, engravings and cuts. In some instances we are sorry to say, these republications have done little credit to our character and the state of our arts; cheapness and an extensive sale have too often

been the primary considerations. But we would not be understood as applying these remarks to the work before us; we rejoice that the American scientific public have this unequalled work placed in their hands in so neat a form, and at the same time at a price not beyond their means. We trust the enterprising publishers may find sufficient encouragement to repay them for their exertions; while we could still more earnestly wish that the overtures for a reciprocal recognition of the rights of literary property on both sides of the Atlantic, which were made by numerous English authors during the last session of Congress, may be promptly accepted both for the protection of authors and the encouragement of all good learning.

4. *Flora Cestrica. An attempt to enumerate and describe the Flowering and Filicoid Plants of Chester County, in the State of Pennsylvania;* by Wm. Darlington, M. D. 2d edition. West Chester, Penn. 1837. 8vo.—The author of the volume before us has been long and favorably known to the cultivators of botanical science in this country; and valuable papers from his pen have at various times appeared in the pages of this Journal. That the present has been a work of great labor no one after glancing at its pages can doubt; and many years have been occupied in its arrangement and completion. During its progress the author has held correspondence and exchanges with all our most distinguished men in this science, and with not a few abroad. The arrangement is according to Linnæus, though the author seems to be aware of the value and importance of the *natural method* of De Candolle and others. Speaking of this subject in his preface, he says: "An apology will doubtless be expected from me for still adhering to the *Linnæan arrangement* when the modern botanical world have so generally abandoned it for the *natural method.* I am fully conscious of the old fashioned garb in which this work is arranged, and have a thorough conviction of the value and importance of studying plants according to their natural affinities; but observing that the natural method is yet kept as it were in a continual state of fermentation, by the labors and researches of the great masters in science, and feeling my inability to co-operate or aid in adjusting its details, I thought it most advisable in the present attempt, to adhere mainly to the Linnæan classification." The number of plants described by Dr. Darlington in this local Flora, is 1073—comprising 128 of Lindley's natural orders=482 genera.

Of these species there are cultivated,	92	
Introduced and naturalized, about	138	
		230
Indigenous, - - - - - - -		843
Total,		1,073

We could wish to see more of these local Floras from botanists in various parts of this country; it is a subject which is commanding great attention abroad, and as a means of determining the geographical distribution and extent of plants, aside from many other advantages, they are of high importance. This volume is accompanied by a map of Chester County, colored according to the geological structure of the country; this is an idea of importance in reference to the local distribution of plants as affected by soil and other geological causes.

5. *Animal Magnetism.*—Mr. Thomas C. Hartshorn, of Providence, R. I., has translated the treatise of J. P. F. Deleuze, on animal magnetism; and appended notes referring to cases in this country.

6. *General Species and Iconography of Recent Shells, comprising the Massena Museum, the collection of Lamarck, the collection of the Museum of Natural History, and the recent discoveries of Travellers;* by L. C. Kiener, Curator of the collections of Prince Massena, member of the Nat. Hist. Soc. of France, Attaché to the Museum of Natural History of Paris, &c. &c. *Translated from the French,* by D. Humphreys Storer, M. D. Boston. Wm. D. Ticknor. 1837. No. 1, 8vo.—By the kindness of the publisher, we have early received a copy of this valuable translation of Kiener's magnificent work. The plan is the most extensive of any which has yet appeared on the important subject of Conchology, and when completed it will fill a wide gap which has hitherto existed in Conchological literature. It will be nothing less than an accurate and lucid description of every species in every genus, so far as they have fallen under the author's observation in the extensive collections of which he has the charge, or to which he has access. Hitherto we have had no translation of the description of *species* either from Lamarck or from Blainville. It is the object of Dr. Storer to give us the whole text of Kiener as fast as it appears,

in numbers containing about one hundred and fifty pages each, and extending to sixteen numbers, which will make eight volumes of three hundred pages each, at $3 a volume. The cost of the *original* work to subscribers in this country will be about $187; of the translation, (which is of course without the plates,) about $24. Speaking of the French edition, the translator says: "The high price is of course dependent on the matchless plates, but independent of these it remains a *chef d'œuvre:* The descriptions are simple, accurate, and exceedingly perfect. The student is able to distinguish at once the object of his research; and however delightful it may be to possess the illustrations he can do without them." We trust the publisher and the translator may both be gratified, and Conchological science advanced, by a list of subscribers to this important work sufficiently extensive to warrant the undertaking. The first number contains the genera *Buccinum*, (of which one hundred and one species are described,) Dolium, Tornatella, Pyramidella, Thracia, and Harpa. The mechanical execution of the work is very superior, and worthy of the reputation of the city from which it emanates.

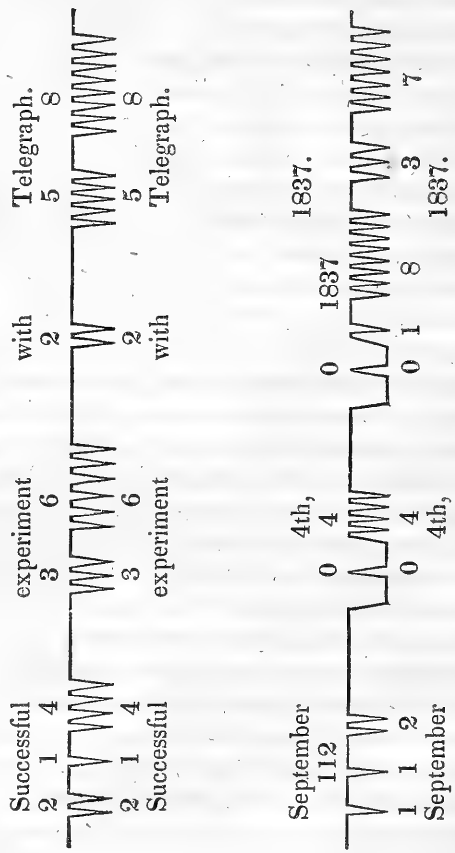
SCIENTIFIC INTELLIGENCE.

1. *Morse's Electro-Magnetic Telegraph.*—While a contest is waging in several countries of Europe—in England, Scotland, France and Germany, for the discovery and invention of the Electric Telegraph, it may not be amiss to state, that America also claims to be an independent discoverer and claimant for priority in the invention. The dates, the names of the inventors, and other circumstances will doubtless ere long be published, and then the world can judge between the conflicting parties. In the mean time it is well ascertained, that Prof. Morse, of the New York City University, conceived and planned, five years ago, an electric Telegraph, while on his passage home from France, and immediately on his landing, he commenced the machinery. Early last spring, *in April,* the general features of his plan were very extensively published in the newspapers, and very lately, *in August,* we learn that several telegraphs on the basis of electricity are in various stages of progress in Europe.

The distinguishing features of Prof. Morse's telegraph are a ***Register***, which permanently records in characters easily legible the fullest communication, and the use of but *one wire* as a conductor; although for greater convenience of communicating at all times, and of having a whole circuit at command from each extremity of the line he will use four wires.

On Sept. 2d, Prof. Morse tried an experiment with a circuit of copper wire one thousand seven hundred feet in length, and of the minimum size of No. 18 wire. The record of the Register was sufficiently perfect to demonstrate the practicability of the plan. On the 4th of September some slight changes were made in the machinery, when the Register recorded perfectly the following signs:

Specimen of Telegraphic writing made by means of electricity at the distance of one third of a mile.



The *words* in the diagram were the intelligence transmitted.

The *numbers*, (in this instance arbitrary,) are the numbers of the words in a Telegraphic dictionary.

The *points* are the markings of the Register, each point being marked every time the electric fluid passes.

The Register marks but one kind of mark, to wit, (V). This can be varied two ways. By intervals thus (V VV VVV) signifying one, two, three, &c., and by reversing thus (Λ); examples of both these varieties are seen in the diagram.

The single numbers are separated by *short*, and the whole numbers by *long intervals*.

To illustrate by the diagram, the word " successful" is first found in the dictionary, and its telegraphic number 214 is set up in a species of type prepared for the purpose, and so of the other words. The types then operate upon the machinery and serve to regulate the times and intervals of the passages of electricity. Each passage of the fluid causes a pencil at the extremity of the wire to mark the points as in the diagram.

To read the marks; count the points at the bottom of each line. It will be perceived that two points come first, separated by a *short* interval from the next point. Set 2 beneath it. Then comes one point likewise separated by a *short* interval. Set 1 beneath it. Then come four points. Set 4 beneath it. But the interval in this case is a *long* interval, consequently the three numbers comprise the whole number 214.

So proceed with the rest until the numbers are all set down. Then by referring to the Telegraphic Dictionary, the words corresponding to the numbers are found, and the communication read. Thus it will be seen that by means of the changes upon *ten* characters, all words can be transmitted. But there are *two points* reversed in the lower line. These are the *eleventh* character, placed before a number to signify that it is to be read as a *number*, and not as the representative of a word.

Since the 4th of September, one thousand feet more of wire No. 23 have been added, making in all two thousand seven hundred feet—more than half a mile of a reduced size of wire; the Register still recorded accurately.

Arrangements have been made for establishing a circuit of several miles, and for constructing new and accurate machinery. Prof. Gale, of the New York City University is engaged with Prof. Morse in making some interesting experiments connected with this invention, and to test the effect of length of wire on the magnetizing influence of voltaic electricity.

2. *Notice of a Revolving Electro-Magnetic Instrument, by* Dr. Benjamin Rush McConnell.*

Mauch Chunk, Pennsylvania, June 25, 1837.

Prof. Silliman.—*Dear Sir*—Up to this date, I had entertained the hope of having ready for the ensuing number of the "Journal of Science," a digested series of "electro-magnetic experiments," the results of some inquiry involving something of novelty at least, if not of much interest. The pressure of professional duty, however, as colliery surgeon, and the physical character of my district, (which you are personally familiar with,) have hitherto prevented me. I now take advantage of a leisure hour, which after all may be too late for your next number, to place on record the subjoined facts, about which I confess I feel anxious. I have,—and have had for nearly a twelvemonth,—in operation, an *electro-magnetic engine,* of a construction and upon a principle essentially different from any thing hitherto announced. In the course of a series of galvanic experiments, which for several years past have assisted to beguile the intervals of professional labor, my attention was drawn to the mutual action of *rectilineal* and *circular* currents, as a highly promising source of motive agency for practical purposes. After innumerable failures, I eventually succeeded in constructing a machine which may be fairly pronounced *perfect* upon the *actual scale* of its construction; its value upon a *working scale* remains to be proved. The general arrangement of my machine is not unlike the philosophical toy, invented, I believe, by Mr. Sturgeon, of London, as long since as 1828 or 9, of two copper discs, one at either end of a common shaft, revolving each in its own trough of mercury, between the poles of two horse shoe magnets. Such is my machine in general, with the addition of a band or cog-wheel on the center of the same shaft, intermediate between the discs, which revolve between the poles of electro-magnets, without the intervention of a fluid medium of any kind as a part of the circuit; the mode of accomplishing this constitutes the peculiarity of my claim, and you, sir, are competent to appreciate its novelty and its value. My electro-magnets are *hollow*, (another new feature,) and have been made with nearly equivalent results of bar iron, of tinned iron, and of copper.

* *Remark.*—This letter was too late for the July No. of the Journal. We had hoped to give a figure of Dr. McConnell's machine, but have received no reply to an application for that purpose.—Ed.

The magnets I now have in use, are one inch in diameter, one inch and three quarters between the poles, and five inches and a half in length, each wrapped with one hundred and fifty feet of iron (bonnet) wire. My battery is rectangular, and consists of two concentric boxes of sheet copper, with a zinc box included, the whole constituting a square box open in the middle. The exterior box is seven inches square, the zinc seven deep by six and a half in each of its other dimensions, the interior box of copper seven by six; the whole will contain something more than a quart of the acid menstruum, and presents about two-fifths of galvanic surface in the aggregate. The driving or band-wheel is sixteen inches in diameter, (the discs being nine inches each,) the shaft of iron three-eighths of inch thick and five inches long, working in brass bearings. The battery is charged through a cock in the platform, (which is of cherry, one inch thick by twelve square, and is attached to the battery by screw-bolts,) and discharged when necessary to cleanse or replenish, by a cock near the bottom. The whole swung in *gimbals* between two turned posts, communicates motion from the band through the platform and center of the battery to the propelling wheel, on the axle of a small carriage. The driving wheel revolves when not loaded, (sixteen inches diameter) about two hundred times in a minute, traversing upwards of eight hundred feet! and will revolve *seventy times* per minute, carrying a load of forty pounds, through a space of two hundred and eighty feet, in that time, being a performance nearly equal to the power of three men. The entire machine occupies a space of two feet in height by a foot in breadth, and weighs, when charged for service, seventeen pounds. Touching a small *lever* reverses the action of the engine instantaneously; raising another *arrests* its action, or technically, throws it out of gear. Thus, sir, as you will perceive, my engine differs totally from the ingenious arrangement of Messrs. Davenport & Cooke, of whose galvanic machine your April number contained a notice. Justice to myself, without intending to depreciate in any degree the labors of others, requires from me the statement that my engine, *as it stands*, substantially, was in existence *nearly two years since*, the greater part having been made to my order by the mechanics of this village, in the summer of 1835; an improved portion of the moving parts (of finished workmanship) was made in Philadelphia, as long since as January of the present year, by Mr. J. Mason, philosophical instrument-maker, of Greenleaf's court. I may also state, that Professor Hare, Mr. Isaiah Lukens, Mr. S. V. Merrick, Mr. E. Hazard, and other scientific and personal friends whom I met in society on occasion of a visit to that city at the period above referred to, were cognizant of my experiments and objects many months previous to the public announcement of results of a similar kind from *any other* experimenter. The field of investigation is large, and as yet not much explored, and Mr. Davenport may rest assured, should this notice chance to meet his eye, that no one will rejoice more sincerely than I shall to hear of his onward progress, while I myself hope also to advance in the march of improvement.

3. *Electro-Magnetic Apparatus and Experiments;* by Charles G. Page, M. D.

Salem, (Mass.) Aug. 23, 1837.

TO PROFESSOR SILLIMAN.

Dear Sir—Since my last communication, I have completed the following pieces of electro-magnetic apparatus, for exhibiting the rotation of conductors by magnets, without the use of mercury. The motory force in such experiments is very feeble, but by the use of solid conductors, as in figures 1 and 2, I attain a more rapid movement than when the wires run in mercury. The discovery alluded to in the article on the electro-magnetic engine, viz. the admissibility of oil between conducting surfaces, I conceive to be of great importance, and will doubtless soon change the whole aspect of electro-magnetic and dynamic apparatus. It supersedes the use of mercury, where freedom of motion and the constant passage of the galvanic current are required.

Fig. 1, represents the ring of De la Rive, mounted for rotation between the poles of a horse-shoe magnet. The ring *a*, is four inches in diameter, and consists of eight turns of copper wire, covered with cotton. Its two ends are brought down at *b, b,* and soldered to cylindrical segments of silver. These segments are secured upon, but insulated from the axis. Both are to be reduced in size as much as is consistent with strength, in order to diminish friction. The two conducting wires, connected with a pair of plates by the mercury cups on the stand, are bent into a spiral at *c* and *d,* in order to press them with a slight spring against the segments *b, b.* Where the instrument is used, a drop of oil is put on the segments. This is a pleasing experiment; the ring (if highly colored) revolving so rapidly, gives the appearance of a hollow sphere. Indeed it would be easy to exhibit two or more concentric rings, revolving different ways, and with different degrees of velocity. I believe this is the first instance of the rotation of a conductor, effected by reversing its tangential action.

Fig. 1. Fig. 2.

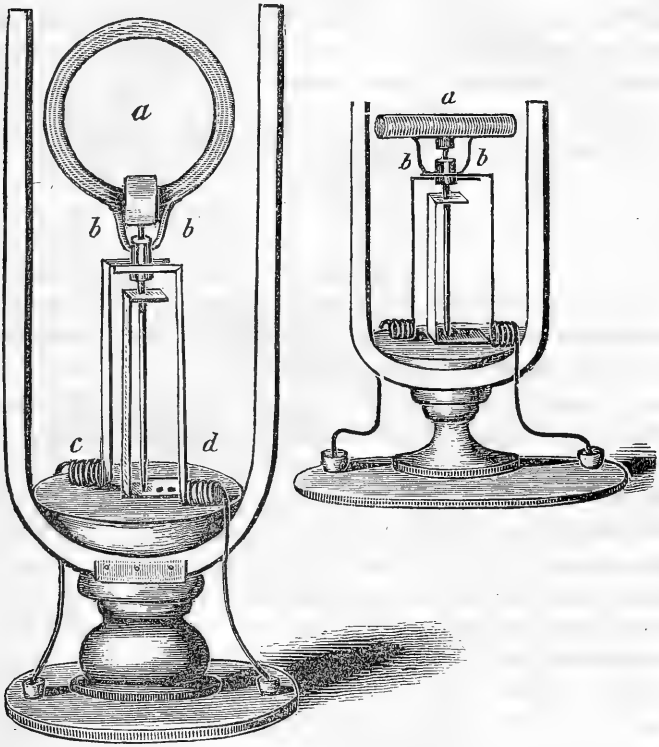


Fig. 2, represents the electro-dynamic cylinder of Ampere, mounted in the same manner as the ring, (fig. 1.) This helix* of wire (called by some the pure voltaic magnet) has its ends bent inward, passing through its axis and brought out at its center, to be soldered to the segments *b*, *b*. The arrangement otherwise is similar to fig. 1. The mode hitherto of exhibiting the magnetic polarity of this cylinder, has been to float it, with a battery, in a large basin of acid and

* The helix is wound on a cylinder of hard wood, loaded with two buttons, one at each end, to give it weight.

water. This inconvenience might have been obviated by mounting the helix as in the figure, and allowing its ends *b*, *b*, to descend into separate mercury cells; but the use of mercury is objectionable, and by adopting the arrangement described, the polarity of the helix is exhibited in a convenient and pleasing manner.

Fig. 3.

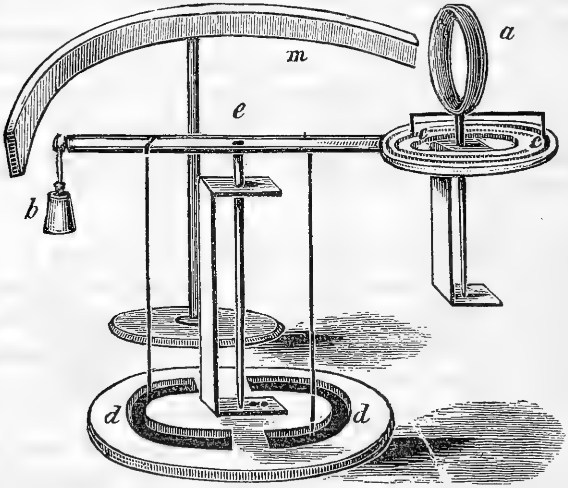


Fig. 3, is a plan for exhibiting the polarity and curious motions of De la Rive's ring, floating in the air instead of acid and water. The great advantage of this construction, and that of fig. 2, is that the ring and helix, and the batteries, may be of any desired size. *a* represents the ring, suspended as in fig. 1. The wire ends descend into concentric mercury cells, *c*, *c*. These separate cells communicate with the battery cells *d*, *d*, by wires passing along the slight lever beam *e*. The ring and cells are balanced by a small weight, *b*. The magnet, *m*, supported by its centre, is bent so as to form an arc of the circle described by the ring. Suppose the ring to be in equilibrium at the neutral point of the magnet, *m*. Reverse the battery wires in the cells *d*, *d*, and the ring starts off from the bar, turns round, presents its other face, and passes on to *m* as before; so that this motion can be produced on a large scale at pleasure, simply by changing the battery wires without disturbing the magnet, as in the floating apparatus. All this can be done with solid conductors, but there being no rapid motion in this experiment, the mercury cells are preferable, from their simplicity.

4. *Davenport's Electro-Magnetic Machine.*—Since the notice of this invention in the April number of this Journal, the proprietors have been engaged in experiments on magnets of different modifications, as well as on the proper distance between the magnetic poles of the circle. The form and arrangement of the magnets have been entirely altered, and the energy of the machine greatly increased. The proprietors have discontinued the use of magnets in the form of segments of a circle and now use them in something like the horse shoe form, changing the poles once in every $3\frac{1}{2}$ inches of the circle. On this arrangement, a machine with a wheel seven inches in diameter, (being but a trifle larger than the one formerly described in this Journal,) elevates ninety pounds one foot per minute, and will perform about twelve hundred revolutions in the same time.

A machine has also been constructed with a motive wheel one foot in diameter, which moves with great energy, but its power has not been tested by the elevation of weights. One of the machines with a motive wheel only seven inches in diameter, has been attached to a turning-lathe, and moves it with astonishing strength, compared with the small size of the propelling engine.

The experiments and improvements hitherto made serve to strengthen the hopes at first entertained in regard to the value and importance of this invention.

The proprietors are now engaged in constructing a machine with a motive wheel of about $2\frac{1}{2}$ feet in diameter, from which they expect to obtain sufficient power to propel a Napier printing press.

For the purpose of raising funds to carry on experiments, &c., a joint stock association has been formed in New York, of which Mr. Edwin Williams, No. 76 Cedar street, is agent. By this arrangement the principal interests of the patent for the United States and Europe, being placed in a stock of 3000 shares; the proprietors offer an opportunity to public spirited individuals to become associated with them in the enterprise, which it is hoped, for the benefit of mankind, may prove successful. A sufficient number of shares, we learn, have been already taken to provide ample funds for experiments on a liberal scale, and the public with interest wait the result.

5. *Pamphlet on Electro-Magnetism.*—A pamphlet of ninety four pages has been published in New York, containing a history of Davenport's invention—notices of it from periodical publications, and

a summary of our knowledge upon the subjects of electricity, galvanism, electro-magnetism, &c. by Mrs. Somerville. If the anticipations of some of the journalists appear extravagant; the summary of Mrs. Somerville, replete as it is with the most interesting and astonishing facts, may well account for the strength of impression produced on the minds of observers by the inexplicable movement of a machine, whirling around with vast rapidity, while there is no obvious cause, and the real cause when pointed out appears so inadequate to the effect.

We rather regret that this interesting application of electro-magnetism is attempted to be sustained by an appeal to the hope of immediate profit. Surely there are not wanting men, and we trust they are numerous, who will cheerfully pay, and, if necessary, cheerfully lose, the comparatively small sums, whose considerable aggregate will carry forward this interesting research, until the ratio and the extent of its power are ascertained; and, if it should prove that the limit is far beyond the demands of practical application, so much the better; but neither the ratio nor the extent can be learned without persevering experiments, the expense of making which and of sustaining all who are concerned in making them, will be, we trust, cheerfully borne by the public.

6. *British Association for the Promotion of Science.*—Extract of a letter to the Editor.

Philadelphia, August 30th, 1837.

My Dear Friend—On the 16th of this month, I sent to the venerable and celebrated Dalton, as chairman of the chemical section of the British Association, a letter, of which I now send you an extract. My motive for publishing this extract in your Journal, is my impression that I owe it to you and others of my scientific countrymen to communicate the facts which I have stated to men of science in the mother country, and that I owe to the latter a more public acknowledgment than I have yet made, of the grateful recollection which I entertain of the kindness with which I was received at their meeting at Bristol. This I am convinced, was intended as a mark of regard, not merely to me as an individual, but to American cultivators of science in general, of whom I was considered as a representative.

The Marquis of Northampton, who presided, stated to me that if there were others of my scientific countrymen present, he wished to be made acquainted with them, as he felt that it would be his duty to pay them attention.

As respects myself, I was received more like an old acquaintance than as a stranger. I was invited to a seat next the Vice President at the dinner, where I believe about four hundred of the members were present, and requested to sit as a member of the committee of the chemical section. On every occasion, I was treated with great deference and kindness.

In the extract sent to you, I have omitted some parts of my letter to Dr. Dalton, as they referred to facts already published in the number of the Franklin Journal for July.

I am faithfully yours, ROBERT HARE.

To Prof. SILLIMAN.

Part of a letter from ROBERT HARE, M. D., *Prof. of Chemistry in the University of Pennsylvania, to* JOHN DALTON, Esq., *Chairman of the Section on Chemistry of the British Association for the Advancement of Science.*

Philadelphia, August 14, 1837.

Dear Sir—I beg leave through you to communicate to the British Asssociation for the Advancement of Science, that by an improvement in the method of constructing and supplying the hydro-oxygen blowpipe, originally invented by me in the year 1801, I have succeeded in fusing into a malleable mass more than three fourths of a pound of platina. In all, I fused more than two pounds fourteen ounces into four masses, averaging of course nearly the weight above mentioned. I see no difficulty in succeeding with much larger weights. The benefit resulting from this process is in the facility which it affords of fusing platina scraps or old platina ware into lumps, from which it may be remodeled into new apparatus.* The largest lumps were fused agreeably to my original plan of keeping

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* I have, since this statement was made, been led to believe that fused platina will be free from a fault to which Wollaston's platina is more less liable, accordingly as the process is more or less skilfully managed. The fault to which I allude is that of scaling when extended under the hammer in order to form a crucible or capsule. I had a platina dish of nine ounces in which many scales existed. By fusion, this tendency in the metal appeared to be corrected.

During the fusion of some large lumps which had been imperfectly welded from the state of sponge, vitreous globules were observed to exude. Of this fact I can conceive of no other explanation than one founded on the allegation of Prof. Daniels, that during exposure to fire, platina absorbs silicon.

the gases in different receptacles and allowing them to meet during efflux. I have, however, operated in the large way upon the plan contrived and employed by Newman, Brooke, Clarke and others, having used at one operation nearly thirty gallons of the mixture of the gaseous elements of water.

This I was enabled to do with safety by an improvement in Hemming's safety tube. With this improved plan, I have allowed the gas to explode, as far into the tube of efflux as the point where the contrivance in question was interposed, at least a hundred times without its extending beyond it. Still, however, the other mode in which the gases are separate until they meet in passing out of their respective receptacles, is less pregnant with anxiety, if not with risk. As these elements are known to explode by the presence of several metals, other mysterious causes of explosion may be discovered.

How much do I regret, that an ocean now rolls between myself and those respected and esteemed brethren in science whom this time last year I had the pleasure to meet and greet at Bristol, and to whom I shall ever be grateful for their kind reception. How much would it gratify me, could I exhibit to them and their enlightened visitors, that splendid concentration of light and heat which I have latterly employed, by which a metal infusible in the air furnace or forge, is made as fluid as mercury, so as to be blown off in globules.

With the highest esteem, I am respectfully yours,

(Signed,) ROBERT HARE.

JOHN DALTON, Esq., *Chairman of the British Association for the Advancement of Science.*

7. *Notice of the effect of Solar Heat in raising a Balloon, in a letter to the Editor, dated Hamilton, Upper Canada, April 17th, 1837, from John Rae, Esq.*—By the action of the sunbeams I caused a body of some pounds' weight to ascend and float in the atmosphere, certainly at the height of a mile, probably of several. I will not detain you with an account of previous speculations and experiments but state the simple fact. Of paper blackened with China ink, of which I enclose specimens, I made a bag—the body of a cylindrical form, one of the ends tapering to a cone. The length of the axes of the cylinder and cone together eighteen feet, the diameter of the former ten feet and three quarters. At the apex of the conical part there was left an opening of about a foot in diameter secured by a circular piece of wire and having suspended

from its center a string eight feet long with a weight of four ounces at the end of it. The whole weighed about three pounds. On exposing this apparatus to the sun's rays, the black paper absorbing them, the interior air is heated and expanded, and the whole rises as a balloon filled with hydrogen gas, or common air heated by combustion. It was on the 10th inst. at half past seven, A. M. that I made my final experiment. It happened, that just at the moment we were engaged at it, an eddy of wind came upon us, a small rent was made in the paper, and we were obliged to let go, though it seemed to be only half filled. It floated, nevertheless, and soon began to expand more fully and to ascend. The wind at the surface of the earth was then about W. S. W., but as it ascended, this new aerial voyager, which, if I may be allowed, I would name the Sun Flyer, getting into other currents, went first south, and then a little to the west of south, disappearing in about fifty five minutes, bearing due south.

Hamilton lies at the head of Lake Ontario, on the western extremity of Burlington bay and immediately beneath what is here termed the mountain—the limestone ridge that surrounds the head of the lake from Niagara falls to near Toronto. From the point where I stood, the summit of this was exactly three quarters of a mile distant and at least two hundred and fifty feet high. At some distance above the trees which fringe the edge of the mountain, this new voyager of the air dwindled to a mere point and disappeared. The morning was very clear and our Canadian sky is very pure. I think therefore it must have been at least twenty miles off and therefore over a mile and a half high. I had calculated somewhat loosely, that it would rise, if no accident intervened, about six miles. These calculations were founded on previous experiments with a small cubical bag about two feet on the side, formed of similarly prepared paper. In this, when exposed to the sun's rays, the thermometer stood at 30°, 40°, 60°, or even 80°, higher than in the shade, (I mean Fahrenheit's thermometer,) and it weighed itself from three fourths to one and a half ounces avoirdupois less in the former than in the latter situation. I am unable to say what the precise buoyant power of the large bag may have been. In a previous essay I had attempted to ascertain this and other particulars by leaving a large opening in the bottom, into which I got, and keeping it fast with strings attached all round; but it then inflated so rapidly that before our preparations were completed the upper part tore away from the lower, and after ascending about one hundred feet upset and came down. It seemed to me from the strings, &c. broken, to have had a force of several pounds.

I have heard nothing of my apparatus since I dismissed it. In the course it took it would pass over a level, woody and thinly settled tract till it came near Lake Erie, then it would be at a high elevation, and might not catch the eye of many individuals. If I calculated its rate nearly correctly it would have gone over two hundred miles before sunset. This would carry it in a right line to the extremity of Ohio or Michigan. It may however have been tossed about by counter currents on Lake Erie and sunk there, or some accident may have happened to it from the rent, which however was near the bottom, and it may have had to come down in mid course and landed in the woods unseen. I do not think it has been caught by any one in Canada or I should have heard of it, as my address was attached to it.

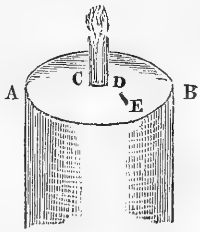
'*Cui bono.*' It is a new power and all such have at last become of use. But I think the Sun Flyer, if kept flying,—(and were its nature understood, this would be an easy matter, for, though it comes to the earth with sun set it would rise with him on the morning,) might be made to communicate to us interesting facts concerning the regions it visits—their temperature, currents, &c. Again, a large one, forty or forty five feet diameter, would easily carry up a man, and if made of proper materials would be safe and more manageable than a balloon, as by means of a valve its power of ascent and descent would be almost unlimited, and all advantage might be taken of varying currents, and the effect of inclined planes, giving diagonal movements. It is also to be considered that sunshine costs nothing.*

8. *Extract of a letter from Mr. Charles Fox, "relative to the motion of the melted grease in a candle while burning."*

My Dear Sir,—My attention was lately called to the motion of the melted grease in a candle while burning, and which I am puzzled to account for: did you ever notice the following?

* Clouds too come without cost, and the shading of the sky would of course bring down the voyager. Would this be prevented by artificial heat, or in what manner would the ingenious inventor propose to prevent a descent in dangerous circumstances—on the sea, or a dense forest, a mountain precipice, &c.?—Ed.

If the small black atoms which are generally floating in the liquid of a candle ready to overflow, be observed, it will be seen that they have a two-fold motion. They are slowly drawn up towards the wick in a straight line; but, when almost touching it, shoot off with great rapidity towards the edge of the candle, instead of being drawn up into the flame, the ends, at the same time, being always turned. For instance, let AB be the circumference of the candle, C the wick, and DE the atom. The end D is drawn up towards C till within the nearest approach it is able to make without touching, when it is suddenly and violently repulsed and turned round, so that D is towards the edge, E towards the wick. This is repeated, generally with much regularity, as regards time and speed, till the candle overflows.



There appear to be always in action two distinct powers, the one of attraction, which I suppose to be capillary, and more easily comprehended; the other of repulsion, which appears commonly, though not always, to act from distinct and fixed points in the wick, in determinate rays towards the edge. The repulsive power is the strongest, and yet extends a very short distance, as the atom is not acted on till it is as near the wick as it can well approach. Is this the action of the whole liquid or only of the extraneous bodies floating in it? These facts I have observed only in spermaceti candles, but presume they will be the same in tallow or wax.

New York, September 8th, 1837.

9. *Supplement to Dr. Mease's paper on Spontaneous Combustion.*—The editor has added a note to the statement of the spontaneous inflammation of horse manure, to show that the case alluded to, p. 151, was ascertained to have been the work of design. That manure will take fire spontaneously is rendered probable by a recent occurrence in Baltimore. In the "Patriot" newspaper of that city of September 26, it is stated that "the alarm of fire on Sunday, was occasioned by spontaneous combustion in a deposite of manure from the stable on the rear of the premises of Edward Patterson, Esq., in South Gay street, near Market street. The situation of the place forbids the idea of any other origin; and it was generally believed by those who saw it to be a case of spontaneous combustion." Who that reflects upon the chemical contents of stable manure can doubt that it contains the principles of combustion?

10. *Another case of the Spontaneous Combustion of Virginia Coal.*—In the month of October, 1837, two thousand bushels of Richmond Coal which had been deposited for some time under a shed on Mr. Lawrence's wharf, in New London, Conn., became ignited. The coal surrounded a post which supported the front part of an open shed. Smoke was discovered issuing from the mass, and on the removal of the coal, the post was found charred. The timely discovery of the fire prevented the extensive conflagration of contiguous wooden buildings.

11. *Meteor.*

Rochester, (N. H.) August 7, 1837.

Prof. Silliman.—*Dear Sir*—You have probably seen some account of the meteor that appeared in this region on Wednesday the 5th ult. I had the satisfaction of seeing it myself as I was walking in the street betwixt seven and eight o'clock in the evening. It first made its appearance from behind a dark cloud, a little to the southwest of this place, and flashed along through the heavens with great majesty and splendor. Its course was to the north, or a little northwest, inclining to the horizon. Its elevation above the horizon was about thirty degrees. Its size was about that of the sun in its zenith, and its color that of iron heated to whiteness. It was visible about a minute and exploded, as it was passing out of sight. Many fragments fell from it, throwing out an intense light of beautiful colors. Many say they heard a report as of distant cannon, though I did not. A long track was left behind it of a grayish color, which continued waving and expanding for some minutes and then vanished gradually away.

This meteor seems to me to confirm the truth of the remarks you made to our class* about the nature of such bodies; that they are not aerial concretions, nor volcanic, nor lunar ejections, nor fragments of a broken planet between the orbits of Mars and Jupiter; but terrestrial comets.

12. *Improved mode of constructing Magnets.*—A paper was read before the Royal Society of London, at a late meeting, "on an improved mode of constructing magnets," by James Cunningham, Esq. The material recommended by the author for the most economical, as well as effectual method of constructing magnets, is cast iron,

* The writer was a pupil in Yale College.

which should be formed in small castings in the shape of a horse shoe, each weighing about seven ounces; these he finds, on being touched in the usual manner by a small compound magnet, received and retained the impregnation better than any which he had previously constructed of steel.—*Athenæum, Aug.* 26, 1837.

13. *Bones of the Mammoth.*—A part of a mammoth has this day (Aug. 19th) been uncovered in excavating the Genesee Valley Canal, where it crosses Sophia street, in this city. Two ribs, a part of the skull, and of a bone of a leg, and an enormous tusk, have been found. The last, which must have been eight or ten feet long, was chiefly picked to pieces by the Irish laborers, who supposed it to be a *log*, as it had lost its gelatine; about a foot of the smaller end is entire, and there can be no doubt what it once was. It must have been eight inches in diameter in the middle. One rib, which seems to have been a *short* rib, is in a fine state of preservation. Whether the animal was an elephant or a mastodon is uncertain. These remains were found about four feet below the surface in a hollow or water-course, lying on and in a *very hard* body of blue clay, and about two feet above the *polished limestone*, which underlies so great a portion of this city.

The upper surface of the limestone, which is covered with soil and earth from two to six and sometimes to twelve and twenty feet deep under Rochester, is not merely smoothed, but actually *polished*, making a very good *transition* marble. It has in one line been dug through for a *hundred* rods; in others, it has been exposed ten to twenty rods in length; and again, opened only in digging wells. It seems to underlie many hundred acres. C. D.

Rochester, August 19th, 1837.

14. *Newly discovered Ichnolites.*—Facts or specimens in that department of natural history which may be termed Ichnology, or ths science of stone tracks, seem to be rapidly accumulating. Among other localities which have been lately discovered may be mentioned one at Middletown, Ct. where several successive tracks, belonging probably to the ornithichnites of Prof. Hitchcock, may be traced on a layer of micaceous shale in the sandstone formation, the tracks being of a medium size and about fourteen inches asunder. At the same locality, which is about one mile and a half southeast of the Wesleyan University, there have been also found several tracks of

a larger species, probably the O. giganteus of Prof. H. A single four-toed specimen found at this place has been deposited at the Wesleyan University, and which may have pertained to some unknown quadruped. Another locality has been discovered by Dr. Richard Warner, of Middletown, situated about four miles north of the foregoing. It is also understood that Prof. Hitchcock, to whom we are indebted for the development of this subject, has obtained many additional specimens, comprising a number of new species.—R.

15. *Hot Springs of Arkansaw, &c.*—A correspondent under date of July 2, 1837, writing from the hot springs states, that the temperature of the springs is about 154° or 156° Fahr.; that they seldom vary; that the hottest are the largest—that they are numerous, and that some of them discharge a barrel or perhaps fifty gallons of water per minute.

It is stated also that there is abundance of good salt water about forty miles southeast from the springs, and alum in a few places in such abundance and so pure that it is used for all the ordinary purposes. These springs are situated near latitude 34° 30′, and longitude west from Greenwich 93°.

16. *Fire bricks and hearth stones for furnaces.*—In the number of this Journal for April (1837) it was stated that excellent fire bricks had been made by Mr. Isaac Doolittle, then of Bennington, Vermont. That gentleman, now at Fort Ann, New York, requests us to state that the bricks were made by Messrs. L. Norton & Son, of Bennington. Mr. Doolittle adds—“during my connection with the Bennington Iron Works—a period of nearly fifteen years, we made repeated trials of all the most noted kinds of fire bricks, both English and American, and we have found that those manufactured by Messrs. L. Norton & Son, are decidedly superior to all others that we ever used; and I would add, that so far as I know and believe, the same result has been attained by all persons who have used these bricks for lining cupolas, and other purposes requiring a highly refractory and durable article.”

17. *Edwardsite.*—Perfect crystals of this mineral have of late been noticed which have the form of the annexed figures. Fig. 1, is the more common form; fig. 2, has been observed in a small translucent crystal. The dotted plane p, a basal face of the primary, often occurs as the result of cleavage, and presents a brilliant

lustre. The angles quoted were obtained by Prof. *Shepard* and Mr. *Dana;* those of observation by the former gentleman from the crystal represented in fig. 2, and those of calculation by the latter. The faces of this crystal, though quite bright, were somewhat curved, and consequently there was considerable variation in the angles obtained with the reflective goniometer.

Fig. 1.

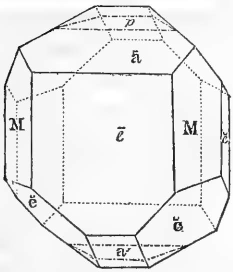
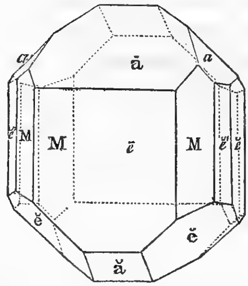


Fig. 2.



	Angles by the Reflective Goniometer.	Angles from calculation.*
P : ē =	102° 45′	103° 42′
P : M	100	99 45
P : ĕ		121 46
P : *a*	140 10	138 38
M : ĕ	133 30	133 30
M : ĕ	138	138 29
M : ē′		161 17
ĕ : ĕ	106 50	107 6
ĕ : ā	142 30	143 33
ĕ : ē	118	117 47
ĕ : *a*		141 50
ē : ĕ	92 20	90
ē : *a*		100 15
ĕ : *a*		131 22
ĕ : ĕ	126 25	126 27
ā : ă (over summit)	92 30	93 30

The description of Fig. 2, after the notation of Naumann, is as follows:

∞P∞ .	∞P .	∞P′∞ .	∞P′2 .	P∞ .	P′∞ .	−P .	−P∞ .
ē	M.	ĕ	ē′	ā	*a*	ĕ	ă

---

* The observed angles assumed as data for the calculation of the interfacial angles of the crystal are as follow: M : ē = 136° 30′; ē : ā = 140° 10′; ē : ă = 126° 25′. The axes, a : b : c = ·9277 : 1 : 1·024. γ = 76° 18′.

18. *Lethæa Geognostica,* oder Abbildung und Beschreibung der für die Gebirgs-Formationen bezeichnendsten Versteinerungen: von Dr. *H. G. Bronn,* Prof. an der Univ. zu Heidelberg, 8vo. with lithog. in 4to. *Stuttgart.* 1835.—This extensive work is devoted to the descriptions and illustrations of the numerous species of organic remains, and when completed will form one of the most valuable treatises on this subject. In the very abundant references to authors, the large number of synonyms given, and the full lists of localities accompanying the descriptions, the work evinces the industry, zeal and accurate science of its author. The lithographic plates which accompany the work, are elegant specimens of this art, and as far as we can judge from the specimens that have come under our observation, are accurate illustrations of the species. We observe among them quite a large number of the fossils of our own geological formations.

19. *Elemente der technischen Chemie*; zum Gebrauch beim Unterricht im Königl. Gewerbinstitut und den Provinzial-Gewerbschulen des preuss. Staats: von Ernst Ludwig Schubarth, Doctor der Philosophie, Medecin und Chirurgie, ausserordentlichen Professor an der Königl. Friedrich-Wilhelms-Universität zu Berlin, &c. Zweite sehr vermehrte Auflage. 2 Bande, 8vo, mit 20 Kupfertafeln. *Berlin,* im Commission bei August Rücker. 1835.—The work whose title is here given, is a treatise on the application of Chemistry to the Arts, and includes extended observations on the uses and modes of preparation of the substances employed in the various processes in the arts. There are very few of these processes, at the present day, that have not received signal improvements from the discoveries of scientific chemistry, and a knowledge of this subject is rapidly becoming of increased importance, both to those practically concerned and to the community at large. This addition to the small number of treatises on this subject, has therefore been received by us with extreme interest; an interest, which has been much increased by our perusal of the work.

The first volume commences with an introduction to the subject, occupying sixty pages, in which the different kinds of chemical apparatus and modes of operation are fully explained. The author next proceeds to an account of the elementary substances and their inorganic compounds, arranging the remarks in chapters treating severally of the different elements. After thus occupying about one thousand pages, he proceeds to the consideration of organic bodies, describing as before their qualities, uses, modes of application and methods of preparation, with which he completes the last volume of six hundred and fifty pages. The observations on the different substances, are made with sufficient fullness, and contain a vast fund of information, which makes the work interesting to the mere general reader. The descriptions of apparatus are illustrated by twenty folio copper plates of neat execution, in which are given all the details necessary for the construction of the instruments described.

This treatise has been adopted as a text book in the Royal and other institutions in Prussia and in other parts of Europe. The author writes that it is not in the bookstores, but may be obtained from him at a low rate.

20. *Protest of Lt. Mather.**—Many of the readers of the Naval Magazine have probably seen the late Geological Report of "G. W. Featherstonhaugh, U. S. Geologist," upon a geological tour to the Coteau des Prairies. There is no such office recognized by the acts of Congress as U. S. Geologist, a title assumed by Mr. F., in consequence of his having been a daily employé on geological duties under the orders of a Topographical Bureau, which is a sub-office of the War Department.

Mr. Featherstonhaugh and myself were associated under the orders of the Topographical Bureau, and were directed to make a geological survey of the country between Green Bay and the Coteau des Prairies, and were called on for separate reports. While engaged on that survey, I made a sketch of the topography of the country adjacent to the St. Peter's River, and took the bearings and comparative lengths of all the bends, so as to form a map of all the meanderings of the stream, with a view to illustrate the minute, as well as general geology, by references from my report. Mr. F. had no share in the original preparation of the materials for this map. In his published report of that survey is a topographical map of the St. Peter's, which he had plotted, from my original notes, by an officer in the Topographical Bureau, and it comes before the world as a map of the St. Peter's, "by G. W. Featherstonhaugh." It is a copy of mine on a smaller scale, except that he has extended the courses of the streams far beyond

* From the Naval Magazine.

where we saw them, and put on it the topography of the Coteau des Prairies as he supposes it, for great distances north, west, and south of where we saw it. The public will now understand, not my surprise at the course pursued by Mr. G. W. Featherstonhaugh, for I am not surprised, but my indignation that he should thus appropriate a portion of my labors *without acknowledgment.*

Under such circumstances, I deem it a duty to myself and the scientific public, to denounce Mr. Featherstonhaugh to the world, for this, as one instance of his appropriating the labors of others to his own uses without acknowledgment. W. W. Mather.

21. *New Silk Worm.*—At Maragnan and Rio Janeiro are several species of Bombyx, the caterpillars of which enclose themselves in a cocoon, after having spun a thicker and stronger silk than that of the ordinary silk worm. It has been tried by Padre Mestre, and forms a very solid material. A species of mulberry, the fruit of which is small and inedible, grows near Rio Janeiro, which it is proposed to cultivate for feeding the caterpillars.—*Athenæum, May,* 1837.

22. *New Voyage round the World.*—The King of the French has, by a decision of the 26th of March, approved of a proposal of the Minister of the Marine, for a new voyage round the world, the conduct of which is to be confided to Capt. Dumont d'Urville. Two vessels are to be employed in this expedition: the *Astrolabe,* commanded by Capt. d'Urville, and the *Zélée,* by Capt. Jacquinot. These vessels were to sail from Toulon at the beginning of September last. After a short stay at the Cape Verd Islands, they will go to the South Polar Sea, passing between Sandwich land and New Shetland, in order to explore those seas, in which Weddel alone seems to have been able to reach the 74th degree of south latitude. The expedition will extend its researches towards the Pole as far as the ice may allow; then, turning back towards the north, M. d'Urville will pass through Magellan's Straits, where, notwithstanding the labors of Capt. King, it is believed that an ample harvest of discoveries still awaits the navigators who may explore them. The island of Chiloe, to the west of Patagonia, will then be carefully examined; after which the expedition will go to Valparaiso, to give the crews the repose they will require, and to make such repairs as may be necessary to enable the vessels to prosecute their voyage. Leaving

that port in the spring of 1838, the ships will make for the Polynesian Islands; and, on arriving at Vavaoo, M. d'Urville will employ the first part of June in completing, by new observations, the work executed, in 1827, by the officers of the *Astrolabe.* The vessels will then visit Banks's Islands, to the north of the New Hebrides, which are hardly known, and Van Icoro, where, however, they go merely to visit the cenotaph erected to the memory of La Pérouse, and to obtain further information from the natives. Thence M. d'Urville will steer towards the Solomon Isles; and, if the condition of the vessels permit, he will proceed through Torres Straits, and visit the new Dutch colony, on the river Dourga, the Isles of Aroo and Key, and then go to Amboina. From Amboina the *Zélée* will be sent back to France, so that she will return a year before the *Astrolabe*, and will bring home the collections already made, and the result of the operations performed. The *Astrolabe* alone will then sail round New Holland, and will visit, about November or December, 1838, the colony at Swan River. Hence she will proceed to Hobart Town, and then sail to New Zealand. The months of February and March, 1839, will be devoted to important operations in that great island, especially in carefully exploring certain parts of Cook's Straits, which may afford valuable resources to English whalers. She will then visit the Chatham Isles, respecting which we have had no information since their discovery by Broughton in 1791. Then, steering to the north, M. d'Urville will pass two or three months among the Carolines; and about August he hopes to arrive at Mindanao, where no French ship, it is said, has ever touched; after which, he will visit some parts of the island of Borneo, pay a short visit to Batavia, touch at one or other of the ports of Sumatra, and return by the Cape of Good Hope to France, where he expects to arrive about March or April, 1840, after an absence of thirty or thirty two months. It is unnecessary to point out the interest which attaches to an expedition conceived on so large a scale, and calculated to produce very important results. Two vessels, perfectly well equipped, and commanded by officers accustomed to surmount the difficulties of voyages of discovery, hold out very reasonable prospects of success in such an enterprise.—*Athenæum, April,* 1837.

23. *Greece.*—A society of Natural History has been established in Athens. It was addressed at its first meeting by M. Nicolaïdes Levadiefs, a medical officer under the Greek government. After

pointing out the advantages to be derived from agriculture, of which the Greeks are now comparatively ignorant, although Sicily, a Grecian colony, was in ancient times the granary of Rome, and after adverting to Holland and England, as proofs of what skill and industry might do even with an ungrateful, and under comparatively rude climates, M. Levadiefs proceeded as follows:—"The Greeks formerly worked silver mines in Attica and in some of the islands in the Archipelago; but gold came to them through Macedonia and Thrace, from Pannonia and Illyria. Hence the gold coins of ancient Greece are so few, while those of the Macedonian kings are still numerous. The marble quarries of Pentelicus and Paros are too well known to need being mentioned. Chromium has been found in Eubœa; Milos is rich in sulphur, vitriol and alum; Siphnas possesses silver ores; Naxos maintains a trade in emery; Santorin is rich in steatite, or soap-stone, which is much sought for, chiefly to make the luting of water-pipes. I shall not say any thing of our numerous mineral springs, the waters of which are so serviceable to suffering humanity. Unfortunately, mines cannot be expected to repay the cost of working them, unless where coals are at hand and in abundance. It shall therefore be the business of the society of Natural History to prosecute the much desired examination, as to the nature and quality of the stone coal discovered at Negropont and at Argos, and to report on the uses to which it may be applied, whether as fuel for domestic purposes or for the making of gas; whether it be adapted for the use of furnaces, or smithies, and for steam navigation."—*Ib.*

24. *Geological Society.—April* 19.—Rev. W. Whewell, President, in the chair.—A paper was read by Mr. Owen, 'On the cranium of the Toxodon, a new extinct gigantic animal, referable by its dentition to the Rodentia, but with affinities to Pachydermata and herbivorous Cetacea.'

This cranium forms part of the series of fossils collected by Mr. Darwin in South America. It was found in the Sarandis, a small tributary of the Rio Negro, about one hundred and twenty miles N. W. from Monte Video, and had been imbedded in the whitish, argillaceous earth which forms the banks of that rivulet. The subsoil of the whole of the surrounding country is granitic, and Mr. Darwin considers the argillaceous covering to be an estuary deposit, accumulated by the river now called the Plata, and at a period when the land was at a lower level with reference to the ocean, than it is at present.

The dimension of this interesting fossil, the extreme length of the skull being two feet four inches, and the extreme breadth one foot four inches, amply attest that the species to which it belonged attained a magnitude comparable only with some of the gigantic Pachyderms or the extinct Megatherium.

From the structure of the molar teeth and their continuous mode of growth, Mr. Owen showed that the Toxodon is referable to the Rodentia; but that it differs from the existing animals of that order in the number and relative position of the incisors, and in the number and direction of the curvature of the molars. The Toxodon again deviates from the true Rodentia, and resembles the Wombat, in the form of the articular cavity of the lower jaw. It differs from the Rodentia and resembles the Pachydermata in the relative position of the glenoid cavities and zygomatic arches, and in many minor details. In the aspect of the plane of the occipital region of the skull, in the form and position of the occipital condyles, in the transverse extent of the frontal region of the skull, in the aspect of the plane of the bony aperture of the nostrils, and in the thickness and texture of the osseous parietes of the skull, the Toxodon differs from both the Rodentia and Pachydermata, and manifests an affinity to the Cetaceous order.

From these instances of aberrant characters in the Toxodon, considered as a gigantic Rodent, and which were described in admirable detail, Mr. Owen pointed out, that although the teeth, from their correspondence with many other important parts of the animal structure, and from the the facility of observing them, are highly important and useful zoological characters, yet they are not, in all cases, sufficient alone to determine the order to which a Mammifer belongs; and that upon due consideration it will appear, that dental characters must yield the precedence to the modification of the organs of progressive motion. It may, therefore, be inferred, that those orders in the present received systems of Mammalogy, which are founded on characters afforded by the teeth alone, are less natural, and less important groups, than those which are based on modifications of the locomotive extremities; and *à fortiori*, on those which combine such distinctive characters with equally characteristic peculiarities of dentition. At present there is no evidence to determine what was the nature of the extremities of the Toxodon, but Mr. Owen is of opinion, that although it cannot be positively affirmed the genus may not be referable to the Muticata of Linnæus, yet, from the development of the nasal cavity, and the frontal sinus, that it is extremely improbable the habits of the species were so strictly aquatic as the entire absence of hinder extremities would occasion.

In conclusion, he pointed out the interesting fact, that the recent animal most analogous to the Toxodon, combining the characters of a Pachyderm and a Rodent, and, from its aquatic habits, called the Water-hog, or Hydrochærus, exists only in South America, the same region in which this gigantic fossil, possessing similar aberrant peculiarities, has been discovered.

May 3.—Rev. W. Whewell, President, in the chair.

The first paper read was one by Mr. Darwin, describing the district in which had been found the remains of the Toxodon, described at the last meeting by Mr. Owen. The countries bordering the Rio de la Plata contain, in great numbers, the remains of extinct animals. The province of Bander Oriental consists of granite, and other primary rocks. The flat and extensive plains of the Pampas are very uniform in structure over a very extensive tract. A reddish argillaceous earth covers the surface, with irregular concretions of an aluminous limestone, or indurated marl, which sometimes unite and form a stratum, often replacing the former, both containing occasional layers of crystallized sulphate of lime. In the province of Entre Rios, these rest on strata consisting of sand, layers of clay, and a fine white crystalline limestone, containing shark's teeth, Arca Venus, and Pecten, all resembling recent shells. But it is in the superincumbent deposit that are found the fossil Mammalia, peculiar to this district, consisting besides the Toxodon, Megatherium, a lesser animal, protected by an armadillo-like covering, Mastodon, another singular animal, of which only half the head has been preserved, and, as Mr. Darwin believes, also the horse.

In several places Mr. Darwin observed clear proofs of a change of the level between land and water. These he considers connected with the greater changes on the opposite coast, and concludes that, within a period geologically recent, a great bay occupied the area both of the Pampas and the low parts of Bander Oriental. Into this the river poured, as in the present day, reddish sediment from the decomposition of the granites of Brazil, and charged lime with gypsum, perhaps, from the Cordilleras. The bodies of the animals, which formerly inhabited the surrounding country, must have been likewise swept into this bay, which has now been elevated into dry land.

An extract of a letter, dated 18th November, 1836, from Captain Cautley to Dr. Royle, was next read, permitting the announcement of a fact which had long been communicated to the latter, of the finding of the remains of a Quadrumanous animal in the Sewaliks, or Sub-Himalayan range of mountains. The animal must have been much larger than any existing one, and allied to Cuvier's Cynocephaline group. Captain Cautley also announced the discovery, by Major Colvin, of a specimen of the head of the Sivatherium; in which, in conformity to the conjectures of Dr. Falconer and Captain C., in their paper for which the Wollaston medal was this year awarded, it is found that the animal had four horns; two in front, and two huge trifurcated ones behind. He considers the animal as allied to the Dicranocerine group of Major Hamilton Smith.

A paper, by Messrs. Hamilton and Strickland, was then read, on a tertiary formation in the island of Cephalonia, near Lixouri, on the western shore of the Gulf of Argostoli. The parallel ridges composing it extend for two or three miles to the north and south of Lixouri, sloping to the east, according to the dip of the strata, or from 45° to 55°, and presenting a succession of steep and sharp escarpments towards the west. The conformable beds are of great thickness, and are remarkable, as well for the great beauty and number of the fossils, as for the variety of beds through which these extend. The beds, of which sixteen are enumerated, may be classed under three principal heads: 1. The calcareoarenaceous. 2. The argillaceous. 3. Gypseous beds. The fossils belong to numerous genera, and many of the species are identical with those existing in the Mediterranean.—*Athenæum, April and May*, 1837.

25. *Professor Afzelius.*—Professor Adam Afzelius, the Nestor of scientific men in Sweden, died at Upsal, on the 30th of last January, aged eighty-six years. He was the last pupil of Linnæus, and was celebrated for his travels in Asia and Africa. His African Herbarium, we believe, is now in the Banksian collection in the British Museum. His younger brothers, John and Peter, the first devoted to chemistry, and the second to medicine, are both distinguished for their talents, and have, for nearly half a century, occupied chairs in the University of Upsal.—*Athenæum, April*, 1837.

POSTSCRIPT.

26. *Notice of an Aurora, in a letter to the Editor.*

Burlington, Vt. Sept. 30, 1837.

Prof. Silliman—*Sir*—A few weeks since I observed two auroral phenomena, which seemed so well adapted by their distinctness and steadiness to be identified in other places, that I take the liberty of transmitting a description to you for insertion in your Journal, should you think proper.

On the 29th July, 1837, a luminous arch appeared, commencing 8° or 10° from the eastern horizon: it passed between Alpha and Zeta Pegasi, between Alpha and Beta Lyræ, just north of Arcturus, and terminated 19° or 20° from the western horizon. It was about 3° broad, and well defined. Thus I first saw it about 10 h. P. M. It moved slowly to the south, fading at the extremities: at 10 h. 15 m. it passed over Beta Cygni, faint but still well defined for some distance on each side of the meridian, about 2° broad, but soon vanished, the last traces appearing in the head of Hercules. There was at the same time a bright light along the northern horizon, but it presented no uncommon features.

It is rather remarkable, that about a month afterwards a similar arch should occur at exactly the same time in the evening, and occupying very nearly the same place, but so it was. On the 25th of August it was nearly repeated, the eastern part, however, being a little farther north, touching at 10 P. M. Gamma Pegasi, and in 12 m. or 15 m. moving over Alpha Pegasi, where it vanished; in the west below Arcturus, it sloped off to the northwest, making an angle of 45° or 50° with the horizon. The western part disappeared about 10 h. 15 m. by spreading. The northern light was brighter and more active than before, but too irregular and unsteady to admit a hope of recognition by others.

Within ten years I have seen four similar phenomena, and much to my disappointment they all evince a stubborn aversion to respecting the magnetic meridian.

Yours with high respect,

James Dean.

P. S. Burlington is in lat. 44° 28′, lon. 73° 15′.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

Art. I.—*A Description of a Magnetic Electrical Machine, invented by* E. M. Clarke, Magnetician, No. 11, Lowther Arcade, Strand, London.

This apparatus, with the exception of there being *rotating armatures* and a *magnetic battery*, differs from any magnetic machine which has hitherto been constructed.

The October number of the *Philosophical Magazine** for 1836, contains a brief account of this machine; it being the intention of the inventor to reserve a more detailed description for insertion in the "*Annals*,"† in consequence of its being the aim of the Editor of the latter named periodical to make this deservedly interesting branch of science one of the leading features of that work. Since that time, a most important improvement has been made, by the rejection of the mercury box. By the inventor's present arrangement, the necessity of using mercury is superseded. Fig. 1.

A, is the battery of bent bar magnets, placed *vertically*, and resting against four adjusting screws, which pass through the mahogany back board B, (two of them are shown at M, N, fig. 12.) C is a bar of stout brass, having an opening in the middle, through which passes a bolt with a screw-nut, the purpose of which is to draw the magnetic battery to the board B. By these means, the battery can readily be disengaged from the machine, without taking asunder the entire apparatus, and the battery is thus also freed from that vibra-

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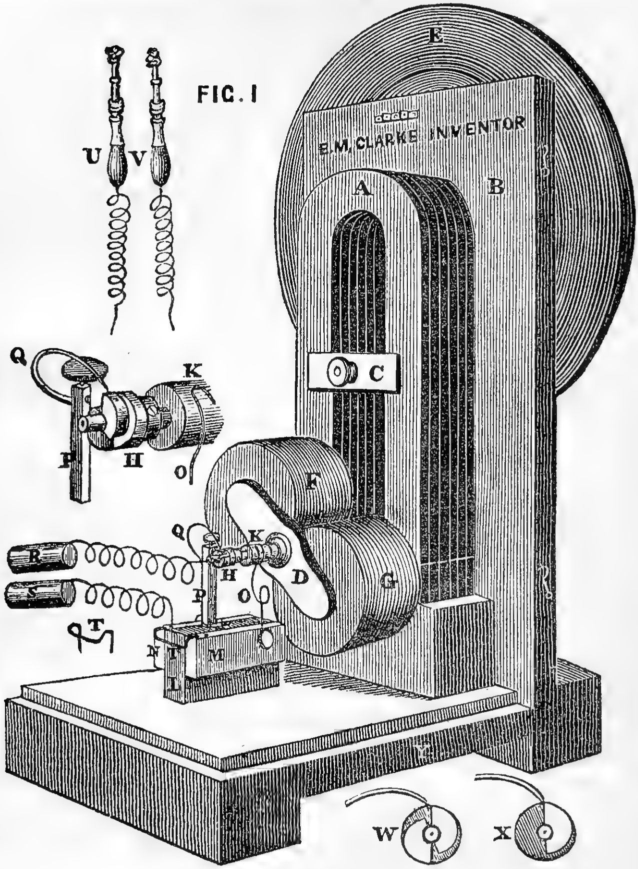
* I beg leave also to direct the attention of your readers to No. 55, p. 360, and No. 63, p. 455, of the same Magazine.

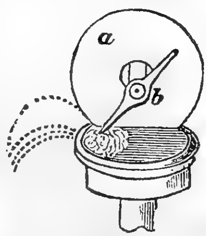
† The Annals of Electricity, published by Mr. Sturgeon, at Woolwich, England, and in which this communication was originally published. It has been recently sent with the stereotype plates to the Editor, for republication in this Journal.

FIG. I



tion which must necessarily be occasioned by the attachment of the rotating apparatus to the battery itself. D is the intensity armature, which screws into a brass mandril seated between the poles of the battery A; motion being communicated to it by the multiplying wheel E. This armature has two coils of fine insulated copper wire, one thousand five hundred yards long, coiled on its cylinders, the commencement of each coil being soldered to the armature D, from which projects a brass stem, (also soldered into D,) which carries the break-pieces, H and H. The break-piece is made fast in what position soever is required by a small binding screw. K and K, a hollow brass cylinder, to which the terminations of the coils F G are soldered, being insulated by a piece of hard wood attached to the brass stem. O and O are iron wire springs, pressing against the hollow cylinder K at one end, and held in metallic contact by a nurled head screw in the brass strap M, which is fixed to the side of the wooden block L. P and P, a square brass pillar, fitting into a square opening in the other brass strap N, and secured at any convenient height required. Q and Q, a metal spring that rubs gently on the break-piece H, and held in perfect metallic contact by the nurled head screw in P. T and T, a piece of copper wire for connecting the two brass straps, M, N; then D, H, Q, P, N, are in connexion with the commencement of each coil, and K, O, M, with the terminations. The advantages of this arrangement must be obvious to any person who has seen the magnetic machine in action in the Adelaide Gallery of Practical Science, where the old arrangement of the mercury flood is still used, where both disc and blades scatter the mercury about as in fig. 1′: *a*, the disc; *b*, the double blades; *c*, the mercury flood. The loss of mercury is not the only evil; for as you continue working the machine, you of course, lose the adjustment you had at starting, and the effect is constantly diminishing, and will at length cease, owing to the points *b* not having mercury to dip in. By the new arrangement, the metal spring Q presses gently on the break H; consequently, the effects here are unbroken, no matter how long you may require to keep the machine acting. This is not the only advantage it possesses; for in the mercury the surface is very rapidly oxidated; the oxide adheres to both disc and point, and preventing so perfect a metallic contact as that obtained by the spring and break.

FIG. I.



To adjust the intensity armature.

See that the faces of the iron cylinders that carry the coils F, G, fig. 1, are parallel to, and all but in contact with, the magnetic battery A; if not, unscrew the nut of the multiplying wheel E, and take it off its axis: you then have at your command the four screws against which the battery rests, (two of which are to be seen at M N, fig. 12;) by means of them and the nut of the strap C, you can adjust the battery to the greatest nicety. The next step is to adjust the break, so that the spring Q will separate from it just at the same time that the iron cylinders of the armature have left the poles of the magnetic battery; and lastly, see that the iron wire spring O, presses gently against the hollow brass cylinder K.

To give the Shock.

Grasp the two brass conductors, R S, in the hands,* put one of their connecting wires into the holes of either of the brass slips M or N, the other wire into the hole at the end of the brass stem that carries the break H. Connect M N by T, turn the multiplying wheel in the direction of the arrow, and a violent shock will be received by the person holding R S. The shock which is obtained from the intensity armature having one thousand five hundred yards of fine insulated wire, is such that a person, even of the strongest nerves will not readily volunteer to receive a second shock. Indeed the effects are so violent, that the inventor has proposed to many of his military customers that this instrument would be a good substitute for the lash, being capable of producing even greater torture than that brutal instrument, without producing any corporeal injury to the delinquent. Place R S in two separate basins of salt and water, immerse a hand in each basin, and the shock will also be felt very powerfully; this method is to be preferred, as it leaves the person who is electrified the power of quitting when he pleases; not so with the conductors; for the muscles of the arms contract violently, so as to close the hands completely on the conductors, taking away the power of letting them go. If the two connecting wires of R S are put in M N, the shock is not so powerful. The shock can be modified in different ways. By turning the wheel E very slowly, or increasing the distance between the battery A and the armature D, or by making the break H separate from the spring Q when the armature D is horizontal. U V a pair of directors, holding a piece of sponge, each to be used when the electricity is to be applied medicinally. The connecting wires are to be placed in the same way as the conductors are in the figure; the sponges must be wetted with a little vinegar or salt and water, so as to make them conduct the electricity. By those directors a succession of most powerful shocks can be given, when the case requires it; or they can be so modified as to be barely felt by the most nervous patient.† Remove T from

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* If the hands are wetted with vinegar or salt and water, the effect is considerably increased.

† To medical gentlemen, the instrument may be strongly recommended from the following advantages. Its portability; its being always in a fit state for action, even in the dampest weather; the nicety with which the power of the shocks may be increased or diminished. Indeed it combines the advantages of the electrical

M N, put the two pieces of iron wire with an end of each in its place; put the other ends of them into two holes that are in the sides of the battery A; let the wires be sufficiently long to allow the armature to rotate between them. If one wetted finger is placed on the brass stem that carries the break H, and another wetted finger is placed on the magnetic battery, the shock will be also felt. While the machine is so arranged, if you look between the face of the rotating armature and the magnetic battery, vivid flashes of light will be perceived playing between both. This light may also be frequently seen without the wires being in connexion with the battery. Sometimes it will be observed flashing between the coils F G.

To decompose Water, &c. &c.

FIG. 2

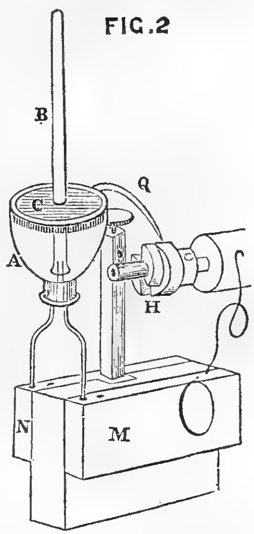

Fig. 2. E. M. Clarke's arrangement of the decomposition of water apparatus, (see Phil. Mag. for June, 1835.) A, a glass vessel, having a brass cap with hard wood bottom through which two pieces of copper wire pass, having pieces of platina wire soldered to them; place this in M, N; fill the tube B, with water,* thrust it over the platina wires where it will be held by the cork C. Q must rub on the cylindrical part of the break H. Here the gases are obtained mixed.

Fig. 3. E. M. Clarke's arrangement of the apparatus for obtaining the elements of water in separate vessels, or unmixed. A, a glass vessel having two glass tubes; here the platina wires are soldered to two pieces of copper wire, as in my other arrangement,

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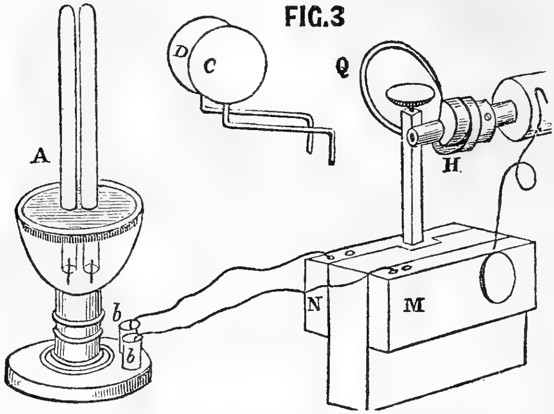
machine and the galvanic apparatus; at the same time that it does not labor under the disadvantages of either; for as has already been stated, it is not affected, like the former, by a moist condition of the atmosphere, nor, like the latter, is it necessary to make use of any acids; nay, since the improvement has been effected which is alluded to in the text, even the use of mercury is superseded.

* The advantages of this arrangement are obvious to any one who has been teased with bits of platina wires made to pass through small holes drilled in a glass vessel having loops turned on the projecting ends, and contact is obtained by merely placing the connecting wire in the loop: it was not only a bad connexion, but in nine cases out of ten the cement that is used to fasten in the platina wires, gave way, just as you were going to use the apparatus, as has frequently happened at lectures.

but differing inasmuch as that they are also soldered to the two brass cups *b b*, which are intended to hold a little mercury. Connect it by copper wire; a little acid or any salt will increase the effect by

FIG. 3



forming a better conductor with M, N, as in the figure. Here Q must work on the single break, H. C, D, two platina plates, having two copper wires soldered to them to connect them with M, N; on placing a piece of litmus or turmeric paper between them that has been previously wetted with some neutral salt, its decomposition is shown by the alteration in the color of the paper. You may even transpose the colors by altering the position of the break H.

Description of the quantity Armature.

This armature differs materially from that which is employed for intensity. The latter, as already stated, has two coils of one thousand five hundred yards of insulated copper wire $\frac{1}{96}$ of an inch in diameter. The inventor has also tried silver wire, which he found to be superior to copper in the proportion of nearly three to one. The quantity of iron in the cylinders also is much smaller than in the quantity armature, whose effects are greatest when the quantity of iron in the cylinders is increased, and the length of the copper wires diminished; the wire at the same time for quantity being much thicker. The quantity armature contains only forty yards of insulated copper wire $\frac{1}{18}$ of an inch in diameter.

To adjust the quantity armature and exhibit the spark.

Fig. 4. A, the magnetic battery; D, the armature, having two coils of insulated copper wire twenty yards each. Care must be taken that the spring separate from the break at the same time that the armature is vertical, being then in a neutral position as respects the poles of the battery.

FIG. 4.

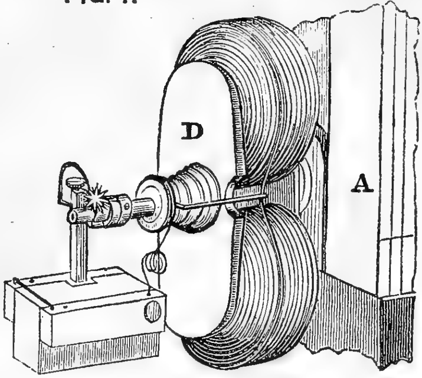
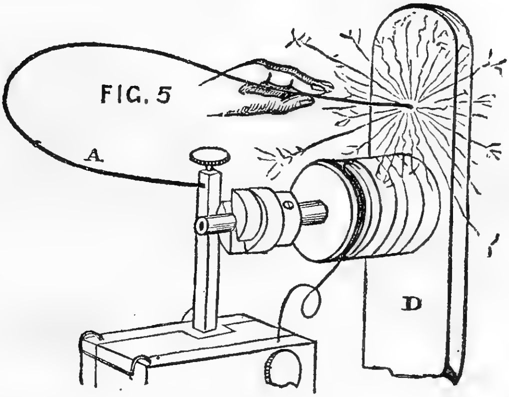


FIG. 5

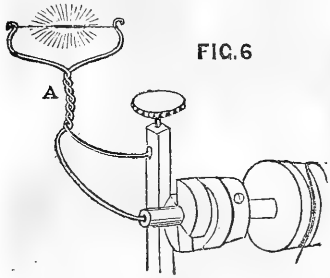


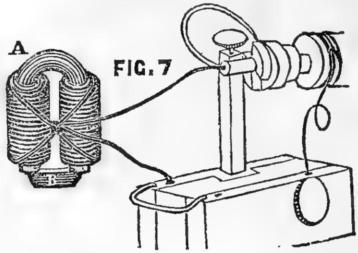
To scintillate iron wire.

Connect one end of a piece of iron wire with the square brass pillar, fig. 5, pressing the other end gently on the surface of the rotating armature, and brilliant scintillations will be obtained. This effect cannot be produced by any magnetic machine unless it be constructed similarly to E. M. Clarke's; the effect depending upon the wires being *soldered* to the armature; whereas, in other armatures the wire is insulated throughout.

To make platina wire red hot.

Fig. 6, shows the arrangement for this purpose, A being placed in contact with P and H. Whilst the platina wire is red hot, ether may be inflamed, gunpowder exploded, and other experiments of a similar nature be performed.



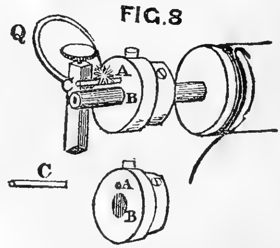


To render soft iron magnetic.

Fig. 7. A, a piece of iron bent as in the figure. B, a soft iron keeper, which adheres to the iron on the connexion being made as represented, so long as the machine is in action.

To obtain sparks of various colors by the use of different metals.

Fig. 8. Remove the break, and substitute the brass piece B. Into the small hole insert a piece of wire C, of any metal, for instance gold. Let the extremity of the spring Q be also of gold. On rotating the machine, sparks of a purple color will be obtained.

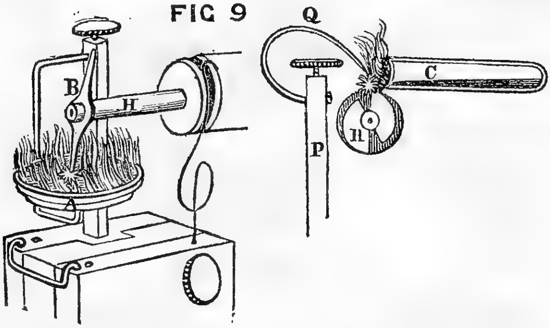


To exemplify the disadvantages attending the mercury flood.

Fig. 9. Remove the break, and fix the double blades B, in its place. Adjust the brass cup A so that the point will leave the surface of the mercury when the armature is vertical. The brilliancy of the spark, as thus obtained, appears much greater that it is in reality, the additional brightness being occasioned by reflection from the surface of the mercury. It is almost unnecessary to point out

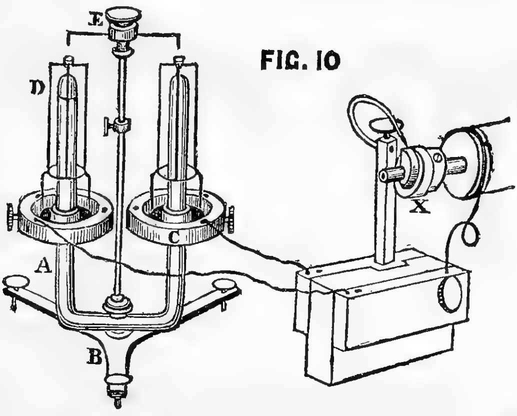
the evil that arises from the scattering of the mercury, not only in point of cleanliness, but expense. A little ether, spirits of wine, or naphtha, being poured on the mercury, is readily inflamed. The

FIG 9



same experiment may be satisfactorily performed, by pouring any of those liquids into a test tube C, and holding it over the break. The vapor will speedily be ignited by the magnetic spark; or, dip a piece of paper in ether and hold it over the break and it will soon ignite.

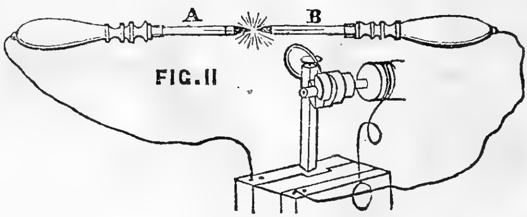
FIG. 10



To produce rotation by magnetic electricity.

Fig. 10. A, a vertical horse-shoe magnet, on a tripod stand B; C, improved flood cups; D, the wire frames, having two little cups at top to hold a drop of mercury; E, a connecting fork. Mercury being poured into the flood cups C, and the single break X being used, on placing the connecting wire as in the figure, continuous

rotary motion will be produced by this arrangement, the current being constantly in the same direction. But the experiment may be varied by substituting the double break H, (fig. 1,) the currents now alternating.*



To ignite Charcoal.

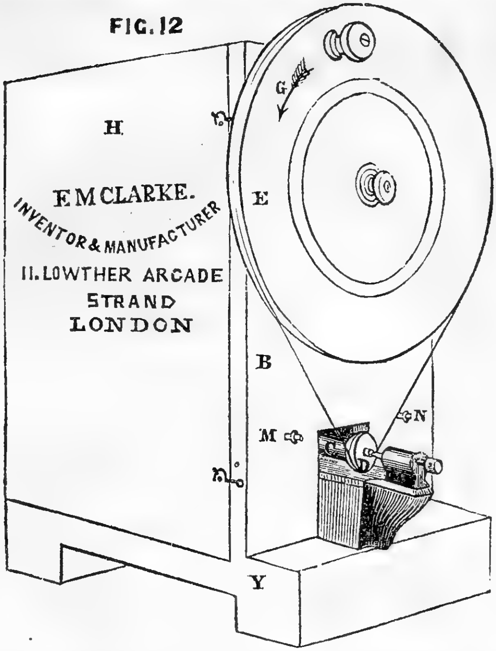
Fig. 11, represents the arrangement of the apparatus for this purpose. The same directors that are used to hold the sponges, may be used to retain the charcoal points A, B, in the proper position.

Fig. 12, shows the compactness of the machine. H, a mahogany case sliding on the bottom board Y, which locks against the back board B. The muliplying wheel is to be turned in the direction of the arrow G. D, the pulley, and C the mandril that carries the armatures.

E. M. Clarke on the occasion of his last visit to Paris, had the honor to exhibit the effects of the magnetic machine which forms the subject of the present paper, to several of the French savans, all of whom were pleased to express their unqualified approbation. M. le Baron Seguier, brought the inventor to the French Institute, accompanied by M. Chevalier. Amongst others present, during the exhibition of the machine, were MM. Melloni, Dulong, Savary, and Becquerel. Prof. Arago, who was that day officially engaged, having heard the result of the experiments with the machine, requested the inventor to attend the day following at the Observatory, which he did; and that learned professor also expressed his satisfaction. On the day following, in consequence of a note received from M. Pouillet, he attended at the Conservatory of Arts and Sciences, when that learned professor, who, of course was well acquainted with the previous magnetic machines, as Pixii's, Newman's, (the name by which Saxton's machine is known on the con-

* A singular fact connected with this experiment is the rotation of the two wire frames in the same direction, owing to passages of the electricity from one of the wire frames into one pole of the magnet, and then from the other pole of the magnet down the other frame.

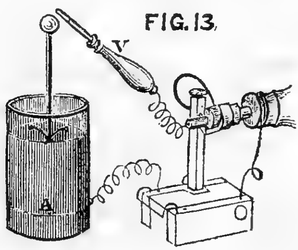
FIG. 12



tinent,) &c. gave the decided preference to E. M. Clarke's arrangement; in proof of which, he was pleased to direct that one should be constructed for the Conservatory of Arts, and another to be deposited in the cabinet of his royal pupil, the Duke of Orleans.*

To charge the Leyden jar and deflect the gold leaves of the Electroscope.

FIG. 13.



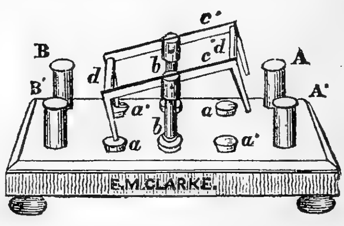
Twist a piece of copper wire round the outside coating of the Leyden jar, A, Fig. 13; connect it with the block of the magnetic electrical machine. Withdraw the sponge from the director V, and connect its wire with the end of the intensity armature, as in the figure. Rotate the armature at a moderate speed, hold the director by the wood handle, and make it touch the ball for a moment only, as on that depends the success of

* This order has been executed to the satisfaction of all parties.

the experiment, as it is only one spark that shows the fact. Should the director rest on the ball so as that two or more sparks are obtained from the armature you fail. Bring the ball of the Leyden jar in contact with a delicate gold leaf electroscope and the leaves will be diverged. Very little practice will make you perfect in developing their effect. The jar is charged to a very low intensity indeed; but I found that after diverging the gold leaves, if I put my hand on the electroscope so as to discharge it and the gold leaves collapse; on touching the electroscope with the ball of the jar, again the leaves diverged with as much energy as before. I again discharged the electroscope, and again produced a divergence: this I repeated thirteen times, with the same effect each time, from the one charge. I had not time to pursue the experiment further, but would be glad to know to what extent it could be carried. The jar I used was eight inches deep, five and a half inches diameter, open at the top; the tinfoil coatings were six and a half inches deep.

Art. II.—*Description of* E. M. Clarke's *Electrepeter;** from the Annals of Electricity, No. 1. Vol. I.

To W. Sturgeon, Esq.—*Dear Sir*—Understanding from you that descriptions of new philosophical instruments will find a ready insertion in your valuable work, I therefore send you a description of an instrument of my construction for changing the direction of electric currents, named by my worthy classical friend, Dr. Murphy, an *Electrepeter*. This instrument, you, sir, as a public lecturer, can fully appreciate; knowing the facility it affords of showing the changes that are produced when the directions of current are reversed.



The most interesting application of this instrument is that when applied to an apparatus of your invention for showing the attraction and repulsion of voltaic currents when induced in a mobile wire frame, timing

* It will be perceived that this apparatus bears a great resemblance to that of Dr. Page, described at p. 354, Vol. xxxii. of this Journal, and called the Dynamic Multiplier.—Ed.

the reversion of the electric currents, continuous rotary motion of the wire frame may be produced by the earth's magnetism.

A, A′, B, B′, four brass cups screwing into and passing through the bottom board. *b*, *b′*, two brass pillars also screwing into and passing through the bottom board, having slits filed in their heads, into which two movable brass frames *c*, *c′*, fit, being connected by the two ivory rods *d*, *d′*; four brass studs *a*, *a*, *a′*, *a′*, screw into and pass through the bottom board, their upper surfaces being slightly concaved. The cups, studs, pillars and frames, are connected underneath the bottom board by pieces of copper wire soldered to them, as follows:—

Cup A, and studs *a*, *a*.
Cup A′, and studs *a′*, *a′*.
Pillar *b*, and cup B.
Pillar *b*, and cup B′.

Consequently whichever pole of the voltaic, magnetic, or thermo-electric battery is in the cup A, the current passes on to the studs *a*, *a*, up the frame *c*, down the pillar *b*, on to the cup B. If you now reverse the position of the frames so as to bring their points in connection with the other two studs, then the direction of the same current will be from cup A, to stud *a*, up frame *c′*, down pillar *b′*, on the cup B. It is only necessary to pour mercury into the four cups for the convenience of connecting the Electrepeter with the battery at one end, and the apparatus for the experiment at the other; it being immaterial which end you use.

It may be necessary to mention that when I first constructed this instrument I showed it to Dr. Faraday, who thought he had seen one like it described in some of Arago's papers; but on referring to his writings, he found that he had a contrivance for producing the same effect, but not so simple as mine. The Rev. T. W. M'Gauley exhibited, in part of his very ingenious electro-magnetic experiments, an instrument to produce similar effects; but on referring to p. 307, of the Philosophical Magazine for October, 1835, you will perceive mine is more universally applicable.

Believing that no person is better qualified nor any one more deserving of success in your present undertaking,

I remain, sincerely, your obliged friend,

E. M. Clarke, *Magnetician.*

No. 9, Agar St. West Strand, London, Sept. 21, 1836.

Art. III.—*Some observations in Holland, connected with our Prairie region.*

Dry Prairies.

Ridgely, (near Portsmouth,) Va., Sept. 28, 1837.

TO THE EDITOR.

Dear Sir—In some early numbers of the Journal of Science there is I observe, a discussion respecting the origin of our western prairies, some of the writers attributing it to water, others to fire. My object in writing to you is not to meddle with the theory either of these Neptunians or Plutonians, but to state a circumstance which I observed a few years since in Holland and which may be useful to others in forming theories.

I spent the winter of 1831–2 in Indiana, and had then an opportunity of seeing some of our smaller prairies. My residence was on the border of what are there called "the barrens," a district sufficiently fertile, but so called from its being less productive than the rich open prairie country adjoining. As far as I could learn, the prairies are arranged in the following manner.

There commences near the southern termination of Lake Michigan, one of prodigious dimensions, being in many places one hundred and fifty miles in width. It extends transversely across the state of Illinois and passes down through Arkansas and Texas probably to the gulf of Mexico. It has numerous islands of trees scattered over it, and large promontories running out from its sides, but goes off in an unbroken stretch far to the south.

This great prairie is bordered on the eastern side by a district about fifty miles in width which is occupied by smaller prairies, detached from each other by wood land, and of various dimensions. They are often as much as sixty miles in length and twenty or twenty five in breadth: but generally they are smaller, the average being about one third of those dimensions. The soil and natural products in these do not differ from those of the large prairie just noticed. In my rides over them I sometimes carried an auger with me, and on boring, found the surface to the depth of about eight inches to consist of a black loam exceedingly rich: beyond this depth it began to change to a yellow color, and at twelve inches from the surface I came to a yellow clay. Below this they come in digging wells to rolled pebbles; the thickness of this stratum I am unable to state. Black walnut, which is considered as an evidence of good soil, is very common in all this region. The prairies are sometimes perfectly level but generally are rolling, the swells being often thirty or forty feet high and an eighth of a mile or more across. The prairie is seldom lower than the wood land that surrounds it, and the tops of the swells are frequently much higher: the soil in the wooded portions is very similar to that of the open prairie.

Having crossed this region of smaller prairies we come on its eastern border to a district entirely different. This is the strip of land two or three miles wide which they call "the barrens." This consists also of an intermixture of prairie and wood land, but the prairies here are quite small, are lower by ten or twenty feet than their adjoining wooded borders and are what are termed "wet prairies." In winter they are usually covered to a depth of from one foot to three feet with water and are dry only in midsummer. They produce a rank grass that often grows to the height of nine or ten feet, and the soil, a black tenacious mud, is of unknown thickness. In some places they have reached to a depth of fifteen feet without penetrating it. These prairies vary in extent from two acres to three or four hundred acres; it is not often, however, that they attain the latter size, the average being about eighty acres. The trees in this district are almost uniformly white oaks: hickory occurs sometimes but in most cases of small size. You are, I suppose, aware that throughout the woods of the prairie country, there is seldom any undergrowth. The oak trees of the "barrens" often attain a height of forty feet without a branch and are perfectly straight. The little prairies are numerous, occupying about half of the land; their outline is waving and abounding in every variety of form, one prairie often leading by a narrow passage into another: the trees are frequently grouped in a manner that art would fail to imitate, presenting glades and other openings: being free from underwood we can see among them to a great distance, and the appearance of this region either in solitude or when the roads winding over it are enlivened by passengers, or the deer are seen feeding on its luxuriant grass or bounding over its hills, is very beautiful. I have not seen a gentleman's park any where in England that I thought could equal what nature has here spread out with a lavish hand. I have spoken of the soil in these small prairies: that of the wood land which is intermixed with them is entirely different. The surface of the ground in the wooded portions is also quite unique. It is rolling, but the swells here instead of being long and regular as in the districts of the larger prairies, are short and abrupt. They are generally from twenty to forty feet in height, and bear a considerable resemblance to the waves of the sea as I have seen them in the Mediterranean when a heavy storm has been succeeded by a calm, except that these hills are higher. The swells of the larger prairies may be compared to the more dignified heavings of the Atlantic when similarly situated.

You will wonder what all this has to do with Holland, and that I am now going to state. I must further premise, however, that while the soil of the prairies in this last region is a thick black mud, that of the wooded portions is sandy. On the surface it is composed of a yellowish sand, mixed sufficiently with decayed grass and leaves to give it a kind of ash color. At the depth of three or four inches we come to a purer sand with a slight intermixture of clay. Having occasion for sand in building during my residence there, I dug into the side of one of the hills of the "barrens" and was surprised to find at the depth of thirty inches *sand almost entirely pure.* Whether this is the case in all this region I cannot say, but I should judge that it is.

On leaving this third prairie district with our faces eastward, we enter immediately into a region entirely flat, thickly covered with huge trees and undergrowth, with a rich soil and where any one has patience to clear it, well repaying the labors of the husbandman. We have in fact now left the country of the prairies.

I travelled through Holland in a manner, (i. e. on foot,) that allowed me to go whithersoever curiosity might lead. Having entered at its northern border and passed on to the sea-board, I determined at some spot along the coast to examine the natural dykes thrown up by the sea, of which I had no very definite idea. I had never met with any detailed account of them, and supposed them to be a strip of sand-bank washed up by the waves, eight or nine feet high and about twice as wide, on which a person might walk and look directly down on the sea on one side, with the meadow land immediately adjoining on the other.

Soon after leaving Leyden for the Hague, I turned from the thronged highway, and after crossing a rich cultivated district of two miles in width, found myself at the edge of the ocean dyke. But it was far different from what I had anticipated. I saw on approaching it that it was much higher than I had supposed, and when I sprung up the side of the huge bank, instead of having the North Sea directly at my feet, I saw before me what seemed as if it had been an ocean of fluid sand, (if I may use so unphilosophical a phrase,) arrested suddenly after a storm and set at rest. Having entered upon it, I was soon in as entire and dreary a solitude, as if I had been on the burning deserts of Africa. Not an insect crossed my path, and I wandered on from sand hill to sand hill till I grew weary of the labor. Only at one place was there any sign of vegetation. It was at a spot where, for some cause or other, a basin had been formed, capable of retaining moisture, and in this, some grass and a variety of bushes had grown up. All the rest was a succession of sand hills. I crossed this dyke transversely, but computed its direct breadth to be at least two miles. The hills of sand I judged to be from thirty to fifty feet in height.

As I walked on, the strong resemblance between the surface of this place and that of the wooded region in the "barrens" of our prairies struck me repeatedly and forcibly. I had here also the commencement of a little lake or prairie, and they appear also to be both composed of the same material, a pure sand. I had often while out in Indiana, been puzzled in attempting to account for what I saw there, and now a theory flashed upon me, with which I amused myself while toiling over the sands. But I began this letter by saying that I was only going to state facts, not theories; and indeed I soon became glad to shorten my speculations and make for the nearest point of the coast, for I found the hills of loose sand sometimes terminating with a perpendicular face, down which, if I had happened to stumble, I should have brought a torrent of sand after me, sufficient to bring my speculations and myself to an untimely end. I was really glad when the North Sea, covered with white caps, and studded with numberless sails, burst upon my sight.

It is easy for a person walking along the shore to see how this broad belt of sand hills has been formed. The coast is shoal and the waves wash up the light sand, which as soon as it is dry, is caught up by the wind and whirled into the piles which have been just described.

Abreast of the Hague is an opening or cut through this bank, apparently partly natural, and partly artificial. It is about fifty feet wide, is level, and planted with an avenue of noble trees, and forms the communication between this city and its little sea-port Schefeningen, if sea-port that can be called, where *port* there is none, and where vessels that would be safe must be drawn high and dry upon the beach.

My letter is already longer than I intended, and I will only add, that as I came down the banks of the Rhine, I passed at Eltenberg a very high ridge of sand, extending it appeared to me, across the valley of that river. After entering Holland I crossed, also, just south of Arnheim, another such a sandy ridge running from east to west, but much wider than the former, being about fifteen miles across. Then we come again to low flat land, and lastly to the sandy strip or dyke at the coast. Query.—May not the shore of the North Sea have been in remote times at Eltenburg, and then again near Arnheim, and those two belts thus also once have been ocean dykes?

Yours, respectfully, GEO. JONES.

*Prairies of Ohio.**

Although prairies have been almost universally admired, yet little has been said in relation to their special formation, or the geology by which they are distinguished from other lands. This is specially the case with the wet prairies, in the Northern sections of Ohio. It is true their origin has given rise to various conjectures among geologists, but their structure has never been studied, with sufficient care, to enable them to arrive at correct conclusions. Their botany and zoology have met with more attention than their geology, but, even here, much still remains to be done.

The natural history of dry prairies has been less neglected than that of the wet. The magnificence of their scenery has invariably been the theme of the traveller, and the extent of their boundaries, and varieties of production, both animal and vegetable, have contributed largely to the embellishment of the pages of descriptive writers. The poet and the painter have also resorted to them, in search of objects to engage either the pen or the pencil. The wide unbroken plain, covered by a rich carpet of green, gold and purple; the tall grass waving in the summer breeze; the immense variety of flowers mingling their odors with the winds; the occasional clump of trees rising above the other vegetable growth; the distant herd of buffalo, cropping the grass or flying from the hunter, and the sun sinking amidst grass and flowers, must furnish a scene which can be but faint-

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* From the Western Monthly Magazine, of February, 1836.

ly described by either, but well worthy the genius of both. Late in the autumn, the fires which destroy the growth of the preceding year, in both wet and dry prairies, are frequently awfully sublime. When seen, at night from a distance, a chain of fire seems to extend, in every direction, as far as the eye can reach. The blaze often rises, in vast coruscations, far above the plane of the horizon. All beyond, presents to the imagination, a chaotic waste, while the earth and the heavens seem to be fast terminating in one grand conflagration. But we will leave the description of such scenery to the graphic pen which has already delineated it, and proceed to the proposed detail of our observations, on some of the wet prairies in the northern sections of Ohio.

These marshy plains, though frequently quite extensive, are always much less so than many of the dry prairies of the Western States. They are always surrounded by hills, which vary in height according to the extent of the prairie. Their bases contain large quantities of water-worn pebbles, with a few fragments of fresh-water shells, in a state of partial preservation. The soil of the prairie consists of a deep vegetable loam, covered by tall grass and flowering herbs, except where it is too wet to produce any thing but moss and other water plants. In every part of the prairie the tufts of grass and flowering plants rise three or four inches above the most inferior surface, which is covered, except in the dryest part of the season, with water to the depth of from two to six inches. These tufts, however, are so nearly connected, that the water is never seen, except where the grass is cut, or thrown aside. The soil and productions gradually change, as we proceed from the edge to the interior of the grassy flat. Here we find a number of ponds, or small lakes, varying in size from a few rods to one or two miles in circumference. The largest of these ponds are well stored with fish, many of which differ but little, except in size, from those found in the northern lakes. The only woody plant that grows on the edges of the ponds, belongs to the *Salix*, or willow tribe, except in a few instances, where they are thickly surrounded by a dense growth of alder, (*Alnus serrulata.*) These ponds, however, from causes which will be presently noticed, are gradually disappearing, and their places being supplied by the surrounding prairie growth.

The bogs, or marshy flats, so abundant in wet prairies, constitute one of their most singular features. They are occasionally covered, either by a thin sod, or large tufts of grass, similar to those constituting the grassy surface of the prairie, only much larger. Upon attempting to walk over either of these, the ground beneath will shake for the distance of several rods. Sometimes they are very narrow; at others, they cover an area of many acres. Animals are often lost when attempting to cross these shaking bogs. Their depth must be great, for poles have been thrust into them thirty feet in a vertical direction, without reaching a hard bottom. Horses and cattle were frequently lost by the early settlers in such humid marshes. These are, also, generally disappearing, by being covered with a dense sod, which supports a luxuriant growth of grass, and other vegetables. Still it is dangerous to drive heavily laden wagons or carts over them, for the surface occasionally gives way, and the whole sinks into the dark mud below. An instance of this kind occurred, a few years since, in the district which I have been attempting to describe.

But the woody islands, which rise far above the tall grass, contribute much to the beauty of a wet prairie. Their timber consists of oaks, and other trees and shrubs, similar to those found on the neighboring elevations. Pebbles and shells, even more perfect than those imbedded at the base of the surrounding hills, are also abundant below the soil, at the termination or shore of the islands.

A stream of water passes either through those prairies, or in their immediate vicinity. When it overflows its banks, so as to cover the low grounds with water, the whole presents the appearance of a fresh-water lake, with a variety of small islands scattered over its surface.

Marshes, thickly set with willows, alders, and a great variety of flowering shrubs, principally of the rose kind, are sometimes abundant along the margins, or even in the central portions of wet prairies. Here water animals, such as the muskrat, otter and mink, were once abundant, and are so still, except in the immediate neighborhood of settlements. The first of these animals appears to delight to dwell in villages, placed at some distance from each other, while they keep up a constant intercourse by travelling. This is done late in the evening. Their houses are usually six or eight feet in diameter, at the base, and about four feet in height, gradually rounded at the top in such manner as to turn the water in every direction. It is said, by most writers, that they build a new house every year; but this is not correct, for I have known them to occupy the same dwellings for several years in succession. I have counted fifty of these houses, in a shallow pond, within an area of one or two acres; and seen hundreds of their inhabitants playing in the evening, in one of their villages, apparently in the full enjoyment of all the pleasures of association. They always enter their houses by subterranean passages, which commence beneath the water some feet distant.

Beaver dams have been abundant along the streams in the vicinity of these marshes, but their remnants only are now to be seen; the animal having fled with the Indian and buffalo, far beyond the confines of civilization. It is singular that this animal always chose to construct artificial ponds, rather than occupy those already furnished by nature, though but a short distance from its adopted location.

The hills, bounding the wet prairies, which have fallen under my notice, are composed chiefly of a blue dense sandstone, or *graywacke*, with little or no calcareous deposit, or impress of organic remains. The *alluvion* of prairies rests upon a blue carbonaceous clay, abounding in roots and trunks of trees, with other vegetable remains, scattered from ten to one hundred feet beneath the surface. Salt water has been obtained, in the vicinity of these prairies, at the depth of six or seven hundred feet; but I have never been advised of the strata through which the auger passed. The water was procured about three hundred feet below the level of Lake Erie, and the same distance beneath the bed of the Ohio, at the mouth of the Muskingum.

So much for a description of wet prairies: let us now turn our attention to their origin.

Without stopping to examine the various hypotheses which have been suggested from time to time, to explain the origin of wet prairies, the facts already mentioned would seem to indicate, that they were either the basins of lakes, or excavations in the beds of ancient rivers, filled by natural causes. The water-worn pebbles and fragments of shells, the animal and vegetable remains, and the small lakes already mentioned, are sufficient evidence that large quantities of water must, at some period or other, have existed between the elevations now enclosing the prairies. It is also worthy of remark, that bowlders and other fragments of primitive rock, are scattered over the neighboring hills, and along the margins of these prairies, while they have never been found upon their surface. It is said they are scattered over the wet prairies of Champaign county, Ohio, but if so, these are entirely different in character from the prairies I have attempted to describe. They must have been formed *upon* the bed of some ancient lake, after its waters had escaped, while those to which I have so often referred, were the offspring of a filling up of a former basin, by the *debris* of the adjacent elevations, assisted by the peat moss of their waters, and the timber and remains of animals brought into them by the streams. It is in this manner that the small lakes in the interior of wet prairies are now gradually disappearing. At first, the water leaves a kind of shaking bog, similar to those already mentioned, but this eventually loses its humid character, and presents a deep black mould, differing in no respect from that found elsewhere in the low lands. The woody islands, or many of them, at least, were once undoubtedly surrounded by water, which must have beat against their shores for a long time; for if this were not the case, the quartz pebbles could never have either reached their present locations, or been reduced to a rounded form. It certainly required much water, time and attrition, to perform so important a change. The pebbles could not have been driven over the prairie, for none such are found upon its surface. Blocks, or large bowlders of granite, have been detected, when boring, deep beneath a wet prairie soil. These must have been transported here at the time the same species were lodged upon the surface of the surrounding country. The basin of the prairie must also have been filled with water, at that period, otherwise they could not have descended so far beneath the surface.

But wet prairies do not remain such continually. Many of the causes which aided in their formation, are now contributing much towards their destruction. The *debris*, consisting of sand, gravel, and clay, of the higher lands, is gradually converting their borders into a sandy soil, followed by a growth of timber, and other vegetables, peculiar to the upper lands. At first the ligneous productions consist principally of a variety of hazel and oak, none of which attain a large size. This growth, however, soon gives place to another, which continues to extend until a dark forest has taken the place of grass and flowers.

Cultivation also contributes much to the destruction of prairies, by the introduction of grasses and plants essentially different from the wild growth. The enclosures, likewise, arrest the fires, alluded to in the beginning of this paper, and thus prevent the annual destruction of shrubs, and the small sprouts of arborous plants. When these fires are prevented from sweeping over the surface of wet prairies, for several years, they are soon covered by a dense growth of alder, which eventually gives place to the vegetables named in the former paragraph. This change, however, does not take place, until the soil has changed its character, by the introduction of sand and gravel from the surrounding elevations. This is effected rapidly after the hills and table lands are cultivated; for when the soil is broken, it is easily driven downwards by rains and running streams.

Thus the immense natural meadow; the residence of the beaver, the otter, and the water-rat; the place of grass and flowers, is reduced, by natural causes, to a dense forest, furnishing timber, and other materials in agriculture, and the arts. The basin of the lake, over which the Indian paddled his bark canoe, is filled, and its place known no more, except to the philosopher, who can read in the rocks, the pebbles, the sand, and the trees, the records of the past. The watery sheet has given place to farms and villages, and the sound of the hammer, the axe, and the bell, is heard in the valley which once echoed with the shouts of the aboriginal, blended with the wild notes of the water-fowl.

The streams which pass through these prairies, though often large, flow with but little current, in a very serpentine direction, through a dark alluvial soil which contains but few pebbles, and no large bowlders. In many instances, a large vegetable growth, similar to that found in the neighboring ponds, arises from the bottom of the stream. Their shores are more elevated than the surfaces of the adjacent marshes, or prairies, and hence they are thickly covered by trees of a superior growth. The stately white elms, so abundant along their immediate borders, contribute much to the formation of a beautiful landscape. Their trunks seem to be placed at regular distances from each other, while their long branches meet and coalesce so completely, that they form a most extensive natural arbor. Early in the spring, multitudes of squirrels resort to them, from the neighboring hills, in order to feast on the expanding buds. Before the country was thickly settled, and the beauties of nature defaced by the hand of art, herds of deer might often be seen feeding on the undergrowth of these bottoms. At this period but few logs were found upon the surface. Occasionally a large prostrate elm, or sycamore, upon which a pheasant sat and thumped away the morning, pointed out the spot where the brawny squatter had feasted on wild honey, or labored to bring down a raccoon or a bear.

Wild fruits, especially plumbs, grapes, black and red haws, and black-berries, are abundant along the edges of wet prairies. In many places, in the vicinity of elevated lands, the ground is covered, for miles, with strawberries, but whether they are indigenous, or introduced by the very early settlers, I am unprepared to say. The blossoms of the crab, also, frequently fill the air, in the early spring months, with the most delicious odors. It is from these, together with the various other blossoms and flowers, that the wild bees chiefly obtain their honey. They usually store their sweets in the hollow limbs and trunks of the neighboring trees, where they sometimes accumulate immense quantities. But the most delicious fruit which grows in wet prairies, is the cranberry. The collection of this fruit furnishes occasion for pleasure parties of the young people, which are among the most agreeable of the rural diversions of the West.*

Many of the wet prairies are more elevated than those already mentioned. They are, however, small, containing but few acres, and distant from streams of water. Still their formation appears to be the same, with those already described. When ditched, the peat, which they contain, becomes very dry during summer seasons. A farmer once called my attention to a small boggy or shaking prairie, which had been ditched two or three years previously; but when the grass and small brush were set on fire, to prepare the ground for cultivation, the surface ignited, and continued to burn for the principal part of the summer. When the fire ceased, he found he had a bed of earthy ashes, from three to eight feet in thickness, instead of the productive soil he anticipated.

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* We have condensed into a single sentence a page descriptive of these excursions.—Ed.

Art. IV.—*Description of an Air Pump of a new construction, which acts either as an Air Pump, or a Condenser, or as both; enabling the operator to exhaust, to condense, to transfer a Gas from one cavity to another, or to pass it through a Liquid;* by R. Hare, M. D., &c. &c.

From the Transactions of the American Philosophical Society.

This pump has one iron chamber,* one piston, and four valves. When in operation, it is always simultaneously exhausting and condensing; and of course accomplishes as much in a given time, as two chambers of the usual construction, of the same calibre and stroke. A suction valve is placed at each end of a steel rod, which slides through the packing of the piston,† so as to be air tight, and to be pressed in opposite directions alternately. It is of such a length, that while it forces one valve, towards which the piston moves, against its seat, closing a corresponding aperture, it withdraws the other valve from its seat, and, consequently, opens the aperture with which this valve corresponds. Hence, with every reversal of the motion, the aperture previously opened will be shut, while that previously shut will be opened. Between the apertures thus alternately opened and shut, and the valve cock A, a communication is made by means of a forked leaden pipe, communicating with the valve cock at A, and with the apertures at B and C. The valve cock, by means of a gallows screw D, communicates, when desirable, with any receiver by another flexible leaden pipe P.

Two other analogous and corresponding apertures E R, which communicate in like manner with a valve cock G, are furnished with two valves opening outwards. These, when not subjected to any pressure from within the chamber, are kept in their places by spiral springs. They act as valves of efflux, and, like the valves in other condensers, are opened by the pressure of the air condensed by the piston as it approaches them, and are shut by the springs when the piston moves in the opposite direction. It is well known, however,

* The diameter of the chamber in the instrument represented in the figure is three inches; the length is ten and a half inches, allowing a stroke of about eight inches, taking off the thickness of the piston. In order to render this instrument insusceptible of injury from mercury, it was constructed altogether of iron or cast steel.

† This contrivance was suggested to me by an excellent pump with glass chambers, obtained many years ago from Pixii. In that pump a steel rod is made to open and shut one valve: in mine the same rod opens and shuts two valves.

that this mode of opening valves, if unassisted, always allows a small portion of condensed air to remain in that portion of the chamber and of the passage leading to the valve, which the piston cannot be made to occupy entirely. This disadvantage is diminished in the case of the valves which I am describing. A stem proceeding from each valve enters the chambers so far, as that the piston cannot finish the stroke without coming in contact with the stem, and moving the valve sufficiently to allow the air to escape, without suffering any resistance from the valve and its spring.

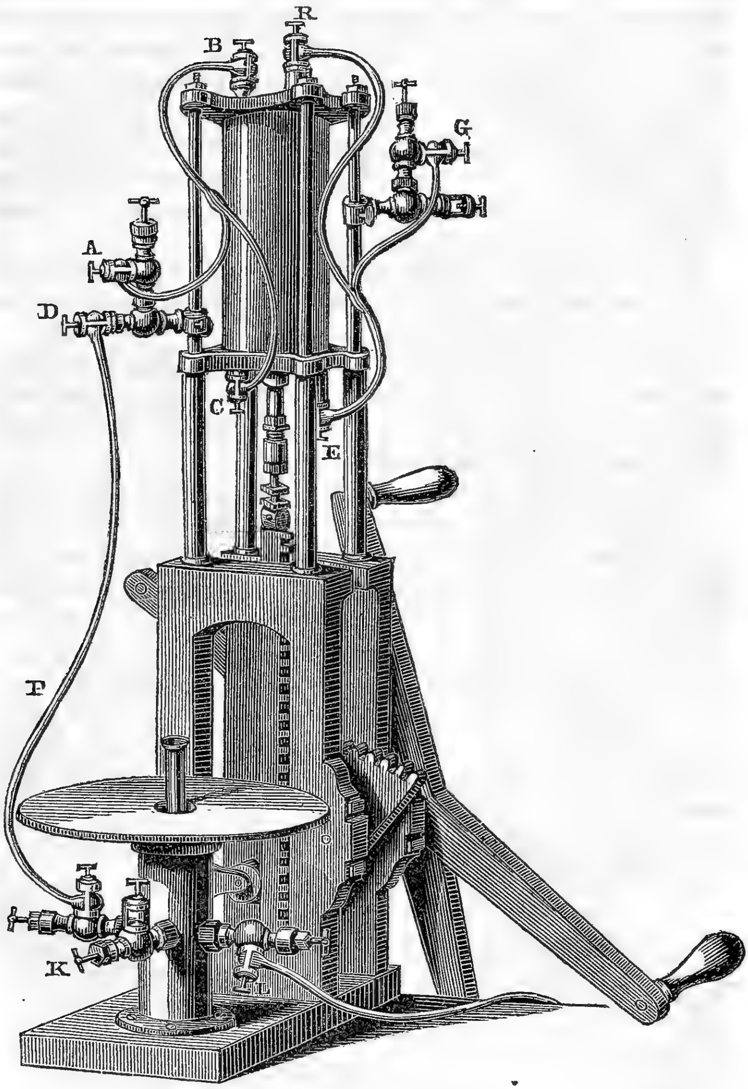
The means by which the apertures of the suction valves communicate with a valve cock A, and may be made to communicate with the receiver through the pipe P, have been explained. By like means the communication, existing between the apertures of the valves of efflux and a valve cock G, may be extended from this valve cock to any receiver. In fact, it is only necessary to vary the situation or number of the pipes, by which communications with the chamber are effected, in order to cause the apparatus to perform the part of an air pump, a condenser, or both. When employed to transfer air, it would be more correctly designated as a forcing air pump, than as a condenser.

The disk of brass in front of the pump, serves as an air pump plate, when connected with the pump by means of the pipe P, as represented in the drawing. It is supported on a hollow brass cylinder, furnished with valve cocks as at K L, in order to allow various experiments to be performed by means of the tube in the axis, surmounted by a cup of copper. The tube being open at the lower end, the cup is accessible to an incandescent iron. The contrivance facilitates the exposure of substances to heat, either in vacuo, or in any gas. When boric acid and potassium are thus heated, boron is evolved. By means of a similar arrangement, heating chloride of calcium with potassium, I obtained a potassuret of calcium, which decomposed water and yielded a solution which was rendered milky by carbonic acid.

When a glass globe of fifteen gallons is exhausted over this plate, and filled with oxygen gas, phosphorus having been previously placed in the copper cup, on heating the phosphorus, a combustion ensues of transcendent splendor.

For this and other experiments, the hollow cylinder, which supports the air pump plate, may be screwed into a hole in a table and placed at any convenient distance from the air pump. With this view, there is a conical screw cut upon the lower end of the cylinder.

Dr. Hare's Suction and Forcing Pump.



The mechanism by which the piston is moved, is too obvious to need description. There is, however, a peculiarity in the construction of the piston rod, which is of great utility. The rod is hollow, having been sufficiently reduced in diameter from a piece of gun barrel by the wire drawing process. The bore of this *hollow* rod is occupied by a solid rod, which extends from the metallic disk, at the farther end of the piston, to the rack. To the other disk, the hollow rod is fastened. The leather packing between the disks, being turned in the lathe so as to fit the calibre of the chamber accurately, is made more or less tight by the action of a screw just above the rack. Hence the pressure may be regulated without taking the pump apart, which is always troublesome, and at some periods impracticable within the time at command.

With respect to the efficacy of this pump, satisfactory proof was given some time since, at the Franklin Institute, when it raised the mercury very near to the height of that in the Torricellian tube.

Having been in possession for many years of an elegant air pump with glass chambers furnished by Pixii, we have been induced to give the preference to the new instrument, in all cases where a perfect exhaustion has been desirable.

Of the three valve cocks, one usually communicates with a gage; since, instead of an instrument of that nature permanently associated with the pump, and which is subjected to exhaustion by means of a lateral communication with the perforation leading to the cavity of the receiver, I employ a movable barometer gage, which is made to communicate with the receiver directly. The operator is thus enabled to observe the quantity of gas in the receiver, after the communication with the air pump is arrested by closing the valve cock through which it was established. An exemplification of this method of manipulating will be afforded by the apparatus and eudiometrical process, described in another article.*

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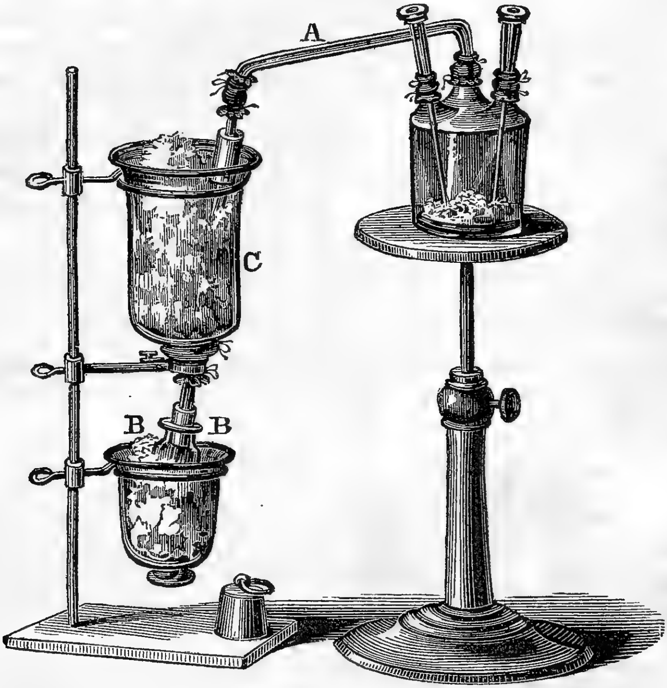
* See Vol. xxxii. p. 280, of this Journal.

ART. V.—*Process for Nitric Ether, or Sweet Spirits of Nitre, by means of an approved apparatus;* by R. HARE, M. D., &c. &c.

From the Transactions of the American Philosophical Society.

THE reaction of nitric acid with alcohol is so difficult to regulate, in the ordinary mode of making nitric ether, in which the whole of the materials are mingled at the outset of the process, that I was induced, about twelve or fifteen years ago, to introduce an apparatus in which they were gradually added together within a glass bottle, by means of glass funnels with glass cocks.



Subsequently I adopted the more simple apparatus represented in the accompanying figure.

Providing a bottle with three tubulures, let one tubulure communicate, by means of a recurved tube A, with another tube passing perpendicularly through an open-necked inverted receiver C, and entering a bottle surrounded with ice and salt, occupying a suitable vessel B B. The cavity of the receiver should likewise be occupied by a freezing mixture.

Into each of the remaining tubulures let a glass tube be introduced, ground or luted to fit air tight, and tapering so as to terminate in a capillary perforation near the bottom of the bottle.

Through one of the tubes introduce as much alcohol as will cover the bottom of the bottle, and then, by means of the other tube, introduce as much strong nitric acid as will cause an effervescence. Should the effervescence threaten to become explosive, the reaction may be checked by the further addition of alcohol, and when the reaction appears to decline too much, it may be re-excited by an additional quantity of acid. By these means, without applying heat, a quantity of nitric* ether will soon be condensed in the refrigerated bottle. To convert this ether into a liquid, fully equal to the officinal sweet spirits of nitre, let it be mingled with seven parts of alcohol and four of water.

The colder the freezing mixture, the greater will be the product; yet more or less may be obtained by refrigeration with cold water.

It may be proper to mention, that at the bottom of the phial an aqueous acid liquor is deposited, upon which the ether swims, and from which it should be carefully separated.

Art. VI.—*On the Cause of the Collapse of a Reservoir while apparently subjected within to great Pressure from a Head of Water;* by R. Hare, M. D., &c. &c.

From the Transactions of the American Philosophical Society.

In September, 1834, I was requested by Mr. Haydock, a respectable and intelligent plumber of this city, to call at his shop in order to see a copper reservoir, which had collapsed while apparently subjected to internal pressure, arising from a communication with the mains proceeding from the public water-works.

For the purpose of refrigerating the contents, the reservoir was placed in spring water, at the bottom of a well, so as to be at a small depth below the surface; receiving the river water by one pipe, it was made to deliver it by another.

The pressure of the water with which the city of Philadelphia is supplied, is known to be sufficient, when at its maximum, to com-

* The proper appellation of this ether being unsettled, I adhere to that generally used.

mand the most elevated rooms in our dwelling houses. Hence, had the reservoir been burst, it would not have excited surprise; but the converse appeared inexplicable. The figure delineated below, will convey a correct idea of the reservoir as it appeared when I examined it; or subsequently, when a drawing of it was made at the Franklin Institute, to which it had been removed, at the instance of some of the members of that institution.

A, is a pipe with a stop cock to allow the air to escape on first filling the reservoir. B, a pipe by which a communication with the mains of the public water-works was established. C, a pipe for delivering the water.

The height of the vessel was three feet; greatest diameter eighteen inches, least diameter twelve inches.

Some days had elapsed, during which I was unable to offer any explanation of the phenomenon; but having mentioned the occurrence to another highly respectable and intelligent plumber, Mr. Ewing, he alleged that facts no less surprising had fallen within the range of his experience. He had known an opening made in a leaden pipe at one time, to be closed at another, by some unaccountable inward pressure; and, upon one occasion, a small fish to be caught in the fissure.

It then occurred to me that the phenomenon of the collapse had been the consequence of circumstances the inverse of those which are known to take place in the water ram of Montgolfier, in which water, while flowing rapidly in a trunk, being stopped suddenly in front, is made to produce a jet rising above the level of the head to which the current arrested is indebted for existence.

The momentum of the water which is in that case expended in a jet, must, in the case in which an arrestation takes place in the rear of a given portion of the stream, continue to propel that portion directly forwards, causing an hiatus or vacuum between it and the valve or cock by which the stoppage has been effected.

The inward pressure, or suction, arising from such a momentum, was demonstrated by Venturi;* and has latterly been ingeniously

* Nicholson's Journal, 4to series, Vol. ii. p. 172.

applied to the filling of syphons, and removal of back water from water wheels.

In this view of the subject then, we find the rationale of the collapse of the reservoir.

The current through the main being arrested at a point nearer the head than that from which the pipe supplying the reservoir proceeded, there was an hiatus produced within the main, and cavities therewith communicating, which caused the atmospheric pressure to be inadequately resisted, and consequently the reservoir, as one of those cavities, was crushed. No doubt the pressure of the spring water, in which the reservoir was situated, cooperated. At times our springs rise much nearer to the surface of the earth than at others.

When steam is made to pass through a pipe into cold water, a succession of expansions and condensations ensue, producing much noise and mechanical jarring, consequent to the alternate absorption and expulsion of the water. Agreeably to the rationale respecting the collapse of the reservoir, these effects should be productive successively of an inward and an outward pressure upon the surfaces of the pipes employed.

Some years ago, a pipe was submitted to me by Mr. Ewing, which, while situated as above described, had been crushed by a force which seemed to have exceeded any which could, under any circumstances, be expected from the pressure of the atmosphere. Possibly an adhesion between the water and the metallic surface, may cooperate in the production of such results.

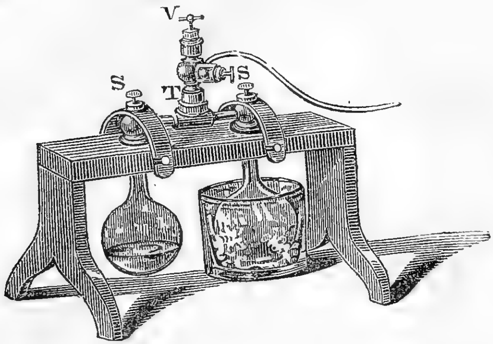
Art. VII.—*Sundry Improvements in Apparatus, or Manipulation;* by R. Hare, M. D., &c. &c.

From the Transactions of the American Philosophical Society.

Improved Cryophorus.

Two flasks, of which the necks have flanged orifices, are so secured in a wooden frame, that by the pressure of screws S S, and gum-elastic disks, the orifices of a tube are made to form with them severally, air tight junctures. The orifices of the tube are furnished with brass flanges, which correspond with those terminating the necks of the flasks.

Midway between the junctures a female screw is soldered to the tube for the insertion of a valve cock V, by means of which, and a flexible tube extending to an air pump, the flasks may be exhausted and then closed. A small quantity of water having been previously introduced into one of them, if, while the exhaustion is sustained, the other flask be refrigerated by ice and salt, the water will be frozen.*



The intelligent chemist will perceive that this apparatus may be applied to the purpose of desiccation by placing the article to be dried in one receptacle, and quick lime, chloride of calcium, or concentrated sulphuric acid in the other. The orifice of the receptacles may be made larger without inconvenience. Two large cylinders, for instance, may be used.

I propose, as soon as I have leisure, to apply the principle illustrated by this apparatus, to the distillation or desiccation of many substances which are liable to injury when exposed to heat or air. I conceive that there is, by means of analogous apparatus, a fruitful field for improvement in the arts. I conceive that it may be employed in the preservation of meat, milk, fruit, vegetables, and the making of cheese; also in pickling and preserving.

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* For the information of readers who may not be chemists, I subjoin the following explanation of the cause of the congelation of the water.

So long as no condensation is effected, of the thin aqueous vapor, which, when water is present, must occupy the cavity of the instrument, that vapor prevents, by its pressure, or tension, the production of more vapor: but when by means of cold the vapor is condensed in one bulb, its evolution in the other, containing the water, being unimpeded, proceeds rapidly. Meanwhile, the water becomes colder, and finally freezes, from losing the caloric which the vaporization requires.

According to Wollaston, one grain of water, converted into vapor, holds as much caloric as would, by its abstraction, reduce thirty one grains from 60° F. to the freezing point; and the caloric requisite to vaporize four grains more, if abstracted from the residual twenty seven grains, would convert them into ice.

Hydro-Pneumatic Cistern.

Fig. 1. In Silliman's Journal, Vol. xiv, p. 200, will be found an engraving and description of a pneumatic cistern, which I employed in the experimental illustrations of my lectures for more than ten years; and which I should probably continue to use now, had not the command of water from the public works, put it into my power to dispense with the mechanism for keeping the water at a proper level. As I am now situated, any deficit of water is easily supplied from the pipes known here as the hydrant pipes, by which the city is supplied with water; and any excess is carried off by a waste pipe. Many chemists designate as a pneumatic trough or tub, apparatus for the purposes to which that in question is applied. Neither of these names is, in my opinion, as applicable to the apparatus which I have hitherto used, as that of cistern, to which I resorted; and although the last term be less suitable to the apparatus which I am about to describe, yet I beg leave to adhere to it for want of a better appellation.

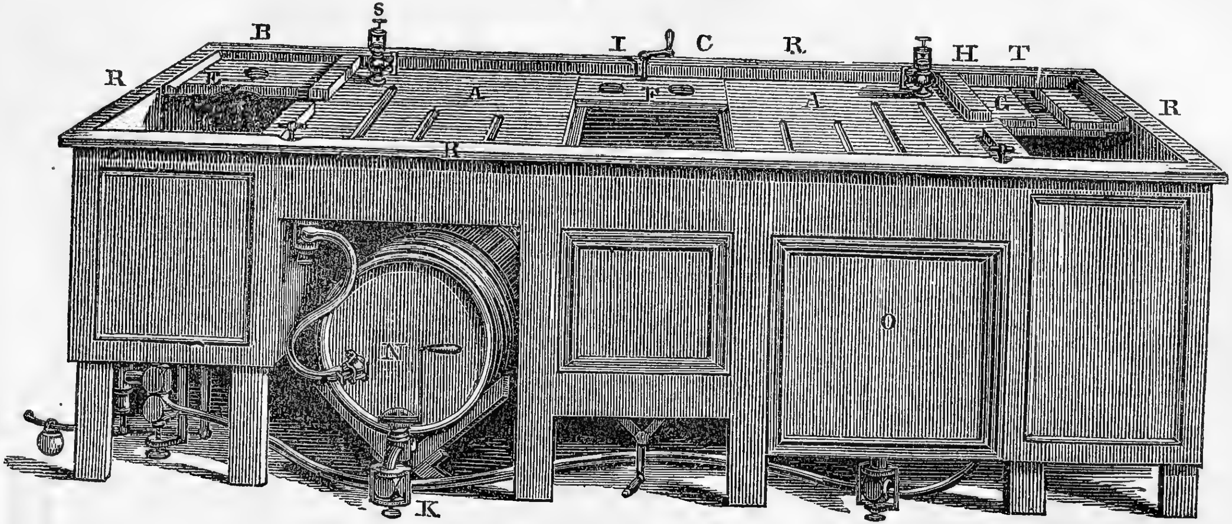
A A, a water tight platform, surrounded by a wooden rim, R R R R, rising above it about an inch and a half. B, C, D, three wells or cavities, each in the form of a hollow parallelopiped, with all of which the cavity bounded by the rim communicates, so that when supplied with water to the level of the waste pipe, this liquid fills the wells, and covers the platform to the depth of about three fourths of an inch.

E, F, G, shelves, which severally move in grooves over the wells, so that they may be placed in the most convenient position. Under H is a waste pipe. At I is a hydrant pipe. K, a pipe for emptying the wells and casks, with all of which it may be made to communicate by cocks, when requisite. N, O, casks which act as gas holders, each having a communication with the cistern at Q or *q*, for letting in water from that source; the orifices being controlled by valves. By means of a pipe proceeding from its vertex, each gas holder communicates with a pipe or cock, at S or *s*.

To these gallows screws, flexible leaden pipes may be attached, for transferring gas either from one of the holders to a bell glass, or from a bell glass to one of the holders. When a communication is established between the cavities, either of these offices may be performed, accordingly as the pressure within the holder is made greater or less than that of the atmosphere. It will be greater when the

Dr. Hare's Hydro-Pneumatic Cistern.

Fig. 1.



valve for the admission of water is opened, that for letting it out being shut: and less when these circumstances are reversed.

Fig. 2* affords a view of the lower side of the sliding shelf, in the wood of which it will be seen that there are two excavations, converging into holes. This shelf is loaded with an ingot of lead at L, to prevent it from floating in the water of the cistern.

Culinary Paradox or Ebullition by Cold.

This figure illustrates a new and instructive method of effecting ebullition by cold.

The apparatus consists principally of a glass matrass, with a neck of about three feet in length, tapering to an orifice of about a quarter of an inch in diameter. The bulb is bulged inwards, in the part directly opposite the neck, so as to create a cavity capable of holding any matter which it may be desirable to have situated therein. In addition to the matrass, a receptacle, holding a few pounds of mercury, is requisite. The bulb of the matrass being rather less than half full of water, and this being heated to ebullition, the orifice should be closed by the finger, defended by a piece of gum-elastic, and depressed below the surface of the mercury; the whole being supported as represented in the figure. Under these circumstances, the mercury rises as the temperature of the water declines, indicating the consequent diminution of pressure within the bulb. Meanwhile, the decline of pressure lowering the boiling point of the water, the ebullition continues till the mercury rises in the neck nearly to the height of the mercury in the barometer.

By introducing into the cup formed by the bulging of the bulb, cold water, alcohol, ether or ice, the refrigeration, the diminution of

* For this figure see Vol. xiv, p. 200, of this Journal.—Ed.

pressure and the ebullition are all simultaneously accelerated, since these results are reciprocally dependent on each other.

The advantage of this apparatus and method of operating, lies first in the certainty and facility with which the apparatus is secured against the access of the atmosphere; and in the next place, in the index of the diminishing resistance, afforded by the rise of the mercurial column.

Art. VIII.—*Notice of Oriental Minerals.*

1. By Professor F. Hall. 2. By the Editor.

1. By Prof. F. Hall.

A number of years ago, I received a box of minerals which were collected in Greece and the neighboring countries. For the collection and transmission of them I am indebted to my worthy friend, the late Rev. Pliny Fisk, American missionary to Palestine, who died at Beyroot, in Syria. The specimens were sent without names, but were all carefully numbered, and notice given, in most cases, of the places from which they were taken. The following remarks on them were prepared shortly after they came to hand, but, in the hurry of business, the paper was thrown aside, and never again came under my inspection, till a few days since. Thinking that the publication of it was due to the memory of the excellent donor, I take the liberty, sir, at this late period, to place it at your disposal.

From Sardis.

1. Milky quartz. A fine specimen—its aspect is slightly greasy.

2. "From the ruins of a church at Sardis." Calcareous breccia, composed of white angular fragments of carbonate of lime, held together by a calcareo-argillaceous cement.

3. Yellow quartz, or citrine, picked up "between Sardis and Philadelphia."

4. White granular marble—very beautiful, "from the palace in Sardis."

5. Grayish colored, disintegrating carbonate of lime, "from the market."

6. "From the walls of an ancient church." Marble sucrè, an elegant specimen.

7. "From a Corinthian capital in a church." Granular limestone.

From Pergamos.

1. Marble, made of compact limestone. "Broken from a pillar in the amphitheatre." It bears some resemblance to the Potomac breccia, but contains seams and thin veins of a blood-red color, produced, perhaps, by an oxide of iron; nitric acid dissolves it, yielding a brisk effervescence.

2. "Granite, taken from the walls of the same amphitheatre." The three ingredients which constitute granite, are all present, and well mixed, but strikingly different in color. The quartz is white, the feldspar a dull red, and the mica pitch black.

3. "From a statue in a castle near Pergamos." A rich, snow-white granular marble.

4. Granite, "from the castle wall." The feldspar is crystalline.

5. "From a Corinthian pillar, three feet in diameter, in the castle at Pergamos." It looks like the best Carrara marble.

6. Granite, similar to No. 2—"a common rock between Haivali and Pergamos.

From Smyrna.

1. Chalk, "picked up in one of the streets." Of a light gray aspect, a little soapy to the touch—is acted on violently by the acids, answers all the purposes of chalk, has on one side a little oolite, the *eggs* of which are harder than chalk, and some of them are hollow.

2. Jasper, of the finest quality; color red, fracture, when recently made, is resinous.

3. Concreted carbonate of lime, "near Smyrna," color dusky gray. A cylindrical cavity runs through its centre, which, it is probable, was once filled with some ligneous substance, now decomposed and absent.

4. Stalactite, "from the same place"—of a loose texture, and having several short branches.

5. "From the hill on which the castle stands near Smyrna." It is sienite. The feldspar is crystallized, and strongly resembles adularia.

6. "From Mount Sipylus, between Magnesia and Smyrna." Shining argillite, yielding a strong argillaceous odor when breathed on. Its color is bluish gray.

7. A beautiful specimen of calcareous spar, with argillite on two of its opposite sides. It is white and very brilliant.

8. Calcareous breccia, gray, porous, and containing angular fragments of argillite. "This," says the Rev. missionary, "is the common stone of Smyrna."

9. "From Mount Sypibus (or Sysibus) between Carrabar (or Canabar) and Magnesia, about twenty five hours N. E. of Smyrna. We rode two hours at the foot of a high mountain, composed of this kind of stone." A dark gray limestone, with seams of white calcareous spar.

From Ephesus.

1. A fine specimen of the *chaux carbonatée saccaroide* of Haüy, having a coarse grain, and somewhat of a pearly lustre.

2. Arragonite, connected with gray, granular limestone.

3. Common serpentine—color green, translucent at the edges.

4. Arragonite; it appears to have been a part of an ancient fluted column.

5. "From an Armenian burying ground near Thyatira. The date of the stone from which it was broken, was 1199." It is a compact limestone of a gray color, containing white veins of the same substance.

From Thyatira.

1. "From a hill near Thyatira." Compact limestone—has a smooth fracture, a little conchoidal.

2. "Near Thyatira." This is a singular product of the mineral kingdom. At first sight, I took it to be compact garnet, but soon perceived that its fracture was different from that of the garnet. It refused to give fire with steel. I applied to it nitric acid, and a copious effervescence occurred. Its color is a bright red, probably due to the oxide of manganese. In appearance, it resembles the Haddam manganesian garnet. It is, unquestionably, a carbonate of lime, and is partly surrounded by milky quartz.

3. "From a mountain between Pergamos and Thyatira, composed wholly of this stone, at the foot of which we rode four or five hours in a rich valley." Siliceous limestone of a light gray color, and yielding sparks with the steel.

4. "From an orchard of olive trees near Haivali." A white mass of calcareous matter, which seems to have been formed by art. It is, probably, an ancient cement.

5. Sienite, chiefly hornblende, "from the Haivali college."

From Philadelphia.

1. "From a wall near Philadelphia, which the people of the country say was built of men's bones. Some travellers are of the same opinion. Others think the stones of which it is constructed are petrifactions." Persons belonging to the civilized portion of the world will not long, it is to be hoped, remain so ignorant of the mineral kingdom as to allow them to place confidence on such ill-founded and foolish assertions. The substance in question is, *evidently*, a calcareous concretion, and much of it stalactical.

2. "From a tomb at Antipas." A specimen of coarse granular limestone.

From Cyprus.

1. A singular stone, part of a nodule, apparently rounded by water. The mass looks like uncrystallized hornblende, sprinkled here and there with small cuboidal crystals, having the lustre of metallic cobalt.

From Samos.

1. A good specimen of translucent arragonite of a whitish yellow color, in acicular crystals, radiating from three or four central points.
2. Greasy quartz, in which are a few specks of silver-white mica.
3. A mineral of a light green aspect, and very unctuous. It is a variety of talc. Its texture is fibrous, but the fibres are extremely minute, and crumble to pieces on being rubbed between the fingers.
4. Granular limestone of a sky-blue color, connected with partially crystallized calcareous spar.
5. Lepidolite, embracing thin layers of flesh-colored feldspar and a few half-formed crystals of the same substance. The lepidolite is pink-red, and composed of small scales.
6. Chlorite, soft, green, sectile—three specimens.
7. Fine grained siliceous sandstone, with minute veins of calcareous spar.
8. Quartz. Yields fire readily; a part of it white, and a part red.
9. Brown quartz, very compact and hard, differs little in appearance from the basanite.
10. Light-gray mica-slate, containing small spheroidal particles of oolite.

11. Disintegrating porphyry, comprising crystals of white feldspar, which crumble between the fingers—also rounded masses of the same substance.

12. Granular limestone, hard, and susceptible of receiving a fine polish.

13. Agaric mineral? Acted on by several of the acids—has nearly the whiteness of chalk.

14. A fragment of a beautiful red jasper.

15. Concreted carbonate of lime, belonging to the stalactitic variety, and broken, apparently, from the side of a stalactite.

16. Granular limestone, of a gray color, covered on one side with perfect triangular pyramids of dog-tooth spar.

17. Limpid quartz, with carbonate of lime.

The box contained twenty four specimens besides these, from the same island. Most of them were decidedly carbonates of lime, of the different varieties.

From Rhodes.

1. Calcareous matter deposited on a shell.

2. Reddish calcareous sandstone, evidently oolite, similar to the Portland building stone.

From Malta.

1. "Broken off from a column ten or twelve feet high, and in some places a foot in diameter." Manifestly part of an enormous stalactite.

2. "St. Paul's cave, three miles from Velletta." Light gray compact limestone, holding shells in different states of decomposition. It might perhaps be called *indurated marl.*

3. "Near the centre of the island." Much like No 2, except that it is friable. It answers for chalk, leaving a distinct mark on wood.

From Syra.

1. Magnetic oxide of iron, black and red. This is a rich ore, and might if it exists in sufficient quantities, be worked with profit. I have seldom seen an iron ore, which attracted the magnet more powerfully.

2. An aggregate of mica and crystallized hornblende.

3. Talcose slate, with a few particles of carbonate of lime.

4. This specimen resembles semi-opal, but is harder; yields fire more freely and abundantly. It is of a cream-yellow color, and porous.

5. Acicular hornblende, very beautiful; crystals irregularly arranged; some of them curved, and wearing a jet black aspect.

6. "From the ruins of a building belonging to the ancient capitol of Sira." Oolitic limestone of a reddish color.

7. Talc, green, indurated and filled with elegant flattened crystals of actynolite, very similar to those of the famous locality in Windham, Vt.

8. Mica slate, red on one side, and white on the opposite; a part of it resembles lepidolite. The whole is thickly sown with crystallized garnets, so much disintegrated that it is difficult to determine the number of their sides.

9. Mica slate, composed chiefly of layers of quartz and mica, the latter singularly contorted and twisted in every imaginable manner.

10. Magnetic oxide of iron, in small octohedral crystals, in chlorite.

11. Marble, white and fresh, as when taken from the quarry. "Broken from the statue of a woman."

From Egypt.

1. "Broken off from a rock near the pyramids. Some of the stones of which the pyramids are built are similar to this." Pisolite, a specimen as large as a man's fist, composed of particles of a lenticular shape, varying in size from a small pea to that of a walnut. These *lenses*, made up of thin layers of carbonate of lime, are hollow, or filled with sand, colored yellow.

2. "The common stone of the temple at Carnac, Thebes." A light gray, soft sandstone.

3. "A sample of the sarcophagus in one of the tombs of the kings, Thebes." Sienite; the feldspar is flesh-red, and the hornblende brownish, inclining to black.

4. A fragment of Pompey's pillar. "This specimen was given me by Capt. Skinner, of an English brig, who had been on the top of Pompey's pillar, and broke it off himself." Granite. The mica is black; the quartz white, vitreous, and sparingly distributed; the feldspar is red, and is the principal ingredient.

5. Granite, similar to No. 4. "Broken from the statue of Memnon at the temple of Memnon in Gornon, Thebes. The body of this statue, below the arms, is twelve feet in diameter from side to side; the arms four feet in diameter."

6. "Found on the banks of the Nile, a little below Tentyra, more than four hundred miles from the sea." Several specimens. It is a curious substance. It has the appearance of having once been an organized body, but to what species it belonged I cannot describe. Its description would occupy too much space. The different specimens are strikingly similar to each other in form, but unlike as to size. It gives fire reluctantly with steel, and is not acted on by the acids.

7. "From the mountains east of the Nile, near Minie." Gray siliceous carbonate of lime. It has, at some period, apparently been operated on by heat. On one side it seems to have been partially fused.

8. "From the temple of Carnac, Thebes." Jasper of an unusually resinous lustre. It yields sparks as copiously as any flint. Its color is red.

9. "The common stone of the mountains of Gornon, where are the tombs of the kings." A light colored, fine grained carbonate of lime.

10. Broken from a column in the Temple of the Sun at Balbec. Yellowish white granular limestone.

2. By the Editor.

Notice of Rocks, Minerals, &c.—from the Rev. Mr. Robertson, Missionary in Greece.

From the Island of Syra.

1. Beautiful aggregate of crystals of black hornblende, red garnet and epidote of a deep green; two pieces.

2. Quartz, tinged red and penetrated by crystals of epidote.

3. Crystallized hornblende, well characterized.

4. Crystallized actynolite, well characterized.

5. Deep green compact epidote, with distinct crystals of hornblende imbedded.

6. Talcose slate, well characterized; two pieces.

From Delos.

7. Summit of Mount Cynthus. Fine grained granite; quartz red; feldspar white; mica black.

8. Summit of Mount Cynthus. Granite with crystals of sphene.

9. Gneiss, not well characterized.

From Malta.

10. St. Paul's bay. Yellow calc-spar.

11. Catacombs of Malta. A beautiful soft tertiary limestone, with shells.

From the Island of Milo.

12. A beautiful soft tertiary limestone, with Pectens.
13. Obsidian, good; a pebble.
14. Sandstone.

From Santorini.

15. White trachyte, with specks of black mica; strong marks of fusion.

From Paros and Antiparos.

16. Calc-spar, very good.

From Eubœa.

17. Red jasper; near Chalcis.
18. Mass of quartz, with garnets; near Chalcis.
19. Compact deep green talc; near Chalcis.
20. Compact deep green epidote; near Chalcis.
21. Hornblende rock; near Chalcis.

From Athens.

22. Red porphyry.
23. Red calc-spar.
24. Red compact limestone. Mars Hill.
25. White saccharoid limestone. Parthenon.

From Tenos.

26. Compact deep green talc; same as 19.
27. Epidote, crystallized in quartz.
28. Serpentine, golden yellow color, with dark spots, probably chromiferous iron.
29. Mass of epidote, garnet and quartz.

From Smyrna and Gulf of Smyrna.

30. Calcareous deposit in distinct layers, two inches thick, like stalactite, nearly filling an ancient water pipe, made of baked earth resembling tiles: a portion of the pipe four inches long still remains attached to the deposit, and retains its form curved.
31. Siliceous deposit in distinct layers; near Vourla.
32. Compact limestone. Sahib Island.
33. Dark porphyry. Sahib Island.
34. Porous inflated lava. Sahib Island.
35. Brittle lignite. Sedicui.

From Elba.

36. Granite; feldspar white; quartz gray; mica black. Whole island said to be of the same rock.
37. Granite, with garnets.

Art. IX.—*Meteoric Iron.*

1. *In Texas.*

In Vol. viii. p. 218 of this Journal, is an account of the great mass of meteoric iron from the Red River, now in the cabinet of Yale College. Among almost forgotten files we find a letter, dated Sparta, Tennessee, Sept. 15, and another, dated Oct. 17, 1829, from Robert Cox, to the editor, containing the following statements.

A gentleman returned from a five years' absence in the province of Texas, during which time he had been frequently with the Camanche Indians, and a small party of them conducted him to a mass of metal lying on the bank of a creek. Its length was four feet, and it was about one foot square [at the end.] It required six of the Indians to raise it on end. A piece weighing two ounces was cut off by a tomahawk. It possessed great hardness and tenacity, and when hammered (in the cold) shewed great malleability, being easily beaten out very thin without cracking or scaling. The color was stated to be between that of gold and silver. Its lustre was remarkable, and could not be tarnished by any thing that was done to it, even by the application of heat. The large mass of metal seemed to defy every attempt to make an impression on it, except under the hammer, when it became pliable and soft. From the acquaintance which we have with the large mass alluded to above, we cannot doubt that the piece described in Mr. Cox's letters is nickeliferous meteoric iron. Those that saw the piece were disposed to make it out to be gold, and probably saw a yellow tint quite as strongly as it existed, if indeed it existed at all, for the malleable iron which we have from the same region is like that of Siberia, of a remarkable pure grayish white, with a high degree of lustre.

We have recently seen a gentleman, who stated that he knew of several large pieces of malleable iron in Texas, and we hope to obtain some more precise information concerning them.

2. *Meteoric Iron in France.*

The late Col. George Gibbs brought to this country some pieces of meteoric iron which he detached from a large mass lying on the mountains of Auvergne in France, and a notice of it was published in Dr. Bruce's Journal of Mineralogy, in connexion with one of the Louisiana iron.

The following extract is taken from a letter addressed to the editor by Mr. Wm. C. Woodbridge, the well known geographer, and dated Paris, Aug. 29, 1829.

"In passing through Bonn, upon the Rhine, I visited Professor Noeggeratti, a distinguished mineralogist of that university. He spoke with great interest of our efforts in reference to mineralogy, and especially of the American Journal. He observed to me that, singular as it was, he had received through that Journal the first account of an interesting fact in his own neighborhood.

"He had heard many years since of a large mass of iron lying on one of the mountains termed 'the Seven Mountains,' in this vicinity, but which was supposed to be a remnant of an old furnace. He designed to examine it, but delayed from time to time, and at length heard that a foreign officer had been there and taken away a large portion. He thought little more of it, until some time after, when he saw in the American Journal of Science, Col. Gibbs' account of his discovery of a mass of meteoric iron on this very spot. He immediately went to examine the fact: he found that the mass had been cut up and put into the forge, but the smiths not having skill to work it, it was again thrown aside, and lay buried under a heap of scoria. Prof. N., after some search, discovered a very large quantity of this iron, and verified the existence of nickel, and the truth of the account which the American Journal* had been the medium of announcing to the world, of one of the largest masses of meteoric iron yet discovered."

Art. X.—*On Natural Magic;* in a letter to the Editor.

The theory of accidental colors, so ingeniously developed by the successive labors of Scherffer, Epinus and Sir David Brewster, has been alluded to by the latter, in his treatise on natural magic, as probably adequate to account in some instances for spectral illusions, but for such only, in his opinion, it would seem, as may occur in full day light. Observation, however, has assured the writer, that appearances of this kind are not so peculiar to the strong light of day, nor so rare as seems to have been supposed.

The retina of the eye, by the action of light upon it, has its sensibility weakened, which it will again recover completely, in the ab-

* We are inclined to think that the account here referred to, must have been that originally published in Dr. Bruce's Journal.

sence, or partially by the mitigation, of this action. When therefore one keeps his eyes for a time directed to a portion of black surface surrounded by white, the sensibility of all that part of the retina on which the white surface throws its light, is weakened in a much higher degree than that which is occupied by the image of the black portion. Then on turning off the eyes to a quarter from which light comes nearly uniform, the effect on this now most sensitive portion, is contrasted with the slighter effect produced on the surrounding parts, and there appears to the observer, as it were, an image of light, in shape and size like the portion of black surface before viewed.

Now the *relative* amount of light reflected from white and from adjacent dark surfaces, is probably the same, whether the incident light be feeble or strong, and consequently the *relative* strength of their respective impressions on the retina is also the same. And indeed the eye, especially if it has been for some time previously in the dark, seems to be not less sensible to this difference of impression in a twilight than at noonday, provided the darkness be not too great, so as to render all objects nearly alike obscure. But however this may be, the appearance of ocular spectra in such fainter light, is favored by the fact that the attention does not then, owing to the partial obscurity in which the substantial objects before us lie, so readily and so almost unavoidably fix itself upon them, which if it should do, any image that may remain impressed on the retina is not regarded, for the mind it seems cannot attend to two things at the same time. Another reason why such phenomena are so seldom noticed by individuals who do not purposely take the preliminary steps necessary to produce them, is that the eye is usually a restless organ, rarely dwelling upon the same part of an object for more than a few minutes at a time. The design and effect of this is, on a compensating principle, to prevent the formation of any impressions of such a character as to be inconveniently permanent or embarrassing to our vision. This propensity to wander is, however, sometimes overcome, and the occasions when this may happen are various.

A day or two since, listening to a public speaker at such a distance, that, to catch his words I found it necessary continually to watch his lips, I at length cast a look towards the expanse of white ceiling beyond him, and saw a white picture clearly representing him, wherever I turned my eyes. The propensity before adverted to, is more commonly subdued involuntarily by grief, as for the de-cease of a friend. If in consequence, by the accidental presence before the eye of a proper object, or a suitable combination of light and shade, a spectral appearance is then produced, (it being supposed now partially dark), a superstitious person might very readily be led, with a little aid from imagination, particularly as the idea of his departed friend is now uppermost in his memory, to believe strenuously that he had seen the ghost of the deceased. The child who goes alone at dusk is prone to watch any *black* object, especially if it is made conspicuous by a prevailing whiteness of the objects about or beyond it. We can easily see how, on his looking round, his young imagination may, and not without a cause, be startled into a troublesome activity.

The writer well remembers with what sensations he has in childhood watched the spectres that on moonlight nights used to haunt the black garments hanging upon the white wall of his apartment. Any one may observe such phenomena very favorably on waking at dawn, by fixing the eyes for a considerable time (one minute or even less will suffice for an experiment) steadily upon a dark colored object projected or situated on a white or whitish ground, and then looking off towards the white ground, when directly he will perceive a white representation of the object he has been viewing, either upon the white ground, or between it and himself, according to his fancy. One can make it, when it is of a middling brightness, disappear and again reappear, by simply giving his attention for a moment to something beyond, and then again to the image. If the eye has been kept constantly upon the same point of the dark object previously viewed, the white image of the latter will be a distinct and faithful representation. Otherwise it will be varied, and might by a startled imagination be easily conjured into the most frightful shapes. If a person is at twilight travelling towards a hill (or even a level space) covered with snow, and steadily watches another person in a dark dress, advancing a short distance before him, whose figure is projected towards the snow, he sees on looking aside, a white spectre in human shape. It will in some instances appear to be roving, the observer all the time thinking that he follows it with his eyes, while in fact it depends for its motion upon this same movement of the eyes. Should it, before it fades into obscurity, arrive before some dark retreat, it there vanishes, for its appearance depends upon the light coming from objects beyond it. A result similar to those already described, might surprise a person who looks up, after having for some time gazed down upon the path he is walking in, the black soil of which is strongly contrasted with the bleached grass on either side.

Whoever will attentively watch the operation of this principle, in experiments which he can make almost any where and with very little trouble, will, we think, be abundantly satisfied that it must have acted no inconsiderable part, in keeping alive those superstitious impressions which in former ages have been so generally prevalent, and that it is the talisman which raises some at least of the apparitions that are occasionally alarming the young and the superstitious, at the present day.

S. Q. P.

New Haven, March 8, 1837.

Art. XI.—*Meteorological Sketches.*

(Continued from p. 65.)

Of Deserts.

The atmosphere is capable of absorbing aqueous vapor in proportion to its temperature, and as a current of air in passing from a colder to a warmer region necessarily increases in temperature, it thus acquires an increasing capacity for moisture, which tends to prevent the formation of clouds and rain. This condition pertains not only to currents which descend from high mountains and sweep over elevated plains, but is peculiar to a certain section or portion of the great natural circuits of wind which are found in various regions, on both sides of the equator. The necessary consequence, is a scarcity of rain in this portion of the aerial current, or in those places where the winds from the temperate or extra-tropical latitudes are found blowing towards the equator, either uniformly, or for regular and determinate periods. We perceive here the principal cause of those arid deserts, comprising almost every variety of geological formation, which occupy so large a space in the otherwise most fruitful latitudes.

On examining the map of the world, it may be seen that this absence of rain is found chiefly in countries lying between the 18th and 32d parallels of latitude, and situated upon the eastern side of the great oceans or of the great circuits of wind which are found to prevail in the temperate and lower latitudes. On the western shores of the Atlantic, in North and South America, where the aerial current is passing from the equator towards the higher latitudes, we find on the other hand that there are adequate supplies of rain. The same is generally true of the western shores and islands of the Pacific ocean; and the *westerly* monsoons being of this latter character, generally afford copious rains, while the easterly monsoons, or regular trade winds, which incline towards the equator, are equally remarkable for their dryness, at least within the latitudes above mentioned.

In the atmospheric basin of the North Atlantic, we have the most striking exhibition of this effect in the great African desert of Sahara. Continuing our survey eastwardly under the same parallels, we find also the great deserts of Lybia, Egypt and Arabia, which for the most part are subject to the same course of general winds, the blighting effects of which fully exemplify the position which is here assumed. In the atmospheric basin of the South Atlantic, we find also, in South Africa, an arid region, extending across the same parallels of latitude, where a southerly wind is found to prevail, which in its progress towards the equator, becomes merged in the southeast trade-winds. The same effects are produced on the eastern shores of the Pacific ocean, where, upon the coasts of Chili, Bolivia and Peru, we have a like section of the general winds, which, notwithstanding the near proximity of the Andes, causes the desert of Atacama, and a remarkable absence of rain on other parts of the same coast. The same general effect is produced by the corresponding winds which prevail upon the western coast of North America, where, owing to the peculiar direction of the sea-coast and mountain ranges, the arid influence is extended, as in some parts of Asia, far into the temperate latitudes. The phenomena attending the general winds in the basin of the Indian ocean, and New Holland, are of the same character. It seems to follow, that the general sterility, or periodical drought of the regions referred to, is not to be ascribed to the peculiar constitution or composition of the natural surface, or to excessive heat, but must be attributed to the peculiar *course* and the consequent hygrometric condition of the general winds which there prevail.

Of the Variations of the Barometer.

The fluctuations in the height of the mercurial column have long excited attention, and the proximate causes of these changes are deemed, by late European writers, to be as yet unknown. These fluctuations of the barometer appear to differ in their character and origin, and may be classed under the following heads.

I. *The regular semi-diurnal oscillation, which in the tropical latitudes is at its maximum from* 9 *to* 10 *A. M., and at its minimum about* 3 *P. M.* In the temperate latitudes, the effect appears to be nearly the same; but Professor Forbes has shown that in very high latitudes the effect is reversed, the minimum being at 10 and the maximum at 3 o'clock. This oscillation appears to indicate a system of atmospheric tides, resulting from the rotation of the earth and its relations to the solar system.

II. *The more striking and irregular variations which attend the presence and passage of storms of wind, especially in the higher latitudes.* This class of fluctuations is believed to admit of an easy and satisfactory explanation.

It appears from a careful examination of the phenomena of hurricanes and storms, as they occur in various regions, that the greatest depression of the barometer is found within the body of the storm,—that this depression constantly accompanies the storm during its progress from one region to another, notwithstanding the tendency of the air to move from all sides towards the point of least pressure,—and that the wind in these storms is found to blow in a lateral or circuitous direction, around the point of greatest depression, which is near the geographical center of the storm. Now when these facts are considered, it becomes evident that the centrifugal action of the air in this powerful rotative movement, effectually opposes the gravitating tendency towards the point of least pressure, and thus maintains, mechanically, the constant rarefaction which causes the depression of the mercury under the storm. Were it possible to produce a movement of the wind from all sides of a storm, in the direction of its center, the depression of the barometer would at once be terminated, and an accumulated pressure would immediately take place.

A demonstrative proof of our position is also found in the barometrical depression which is so constantly exhibited in the permanent atmospheric eddy at Cape Horn and the Strait of Magalhaens, which is caused by the westerly winds that press upon the Cape and are disgorged into the Southern ocean around the southern termination of the Andes. Capt. P. P. King, who surveyed this region and who was furnished with the best instruments, adjusted to the standard of the Royal Observatory, informs us that the mean height of the barometer was about 29.50 inches; and a register of the observations for seven months from February to August, inclusive, at the observatory at Port Famine, in the Strait, shows a mean of 29.43 inches. This result is confirmed by the observations of other officers; and may serve, also, to show the error of Mr. Daniell's position, that the mean pressure of the atmosphere during the year, at the level of the sea, is every where the same.

III. *The constant or periodical accumulation of atmospheric pressure, which arises from natural obstacles, opposed to the course of the general or trade winds; and the corresponding depression of the barometer, which results from the retardation of such winds by like obstacles or by an unnatural and forced route, in their progress towards the point of observation.*

The most remarkable variations of this character are found under the eastern and western monsoons, in Asia and the Indian and Pacific oceans. The N. E. monsoon or regular trade wind, obstructed in its natural course of deflection from the tropical to the temperate latitudes, by the great Asiatic elevations, is forced to continue a sluggish course across the equator, into the N. W. monsoon. The effect of this resistance in raising the barometer is such, that at Canton, in China, the mean height of the barometer during four months of the N. E. monsoon, for a period of seven years, has been found to be 30.20 inches. The mean height during four months of the S. W. monsoon, owing probably to the tardy passage of the S. E. trade from which it is derived, in its unnatural course across the equator, being, for the same period, only 29.86 inches.

IV. *The oscillation of an extensive region of atmosphere in the higher or temperate latitudes, causing a rise of the barometer of some days or even weeks continuance; and a corresponding depression for like periods at other seasons.* These extensive oscillations may, perhaps, be referred to the alternately predominating influence of gravitation toward the poles, and the counter force of the centrifugal action of the earth's rotation towards the equator, aided probably, by some of the other causes to which allusion has been made.

Although storms of wind, from the manner of their development, usually produce rain in some portion of the area which they occupy, yet the fall of the barometer, being chiefly dependent on mechanical causes, has no necessary connection with the fall of rain. It appears from the observations of the Marquis Poleni, that in one thousand one hundred and seventy five instances of the fall of rain the barometer sunk only seven hundred and fifty eight times, being six hundred and forty five to one thousand. In the United States the most copious rains not unfrequently occur during an unusual elevation of the barometer. R.

Art. XII.—*Seventh Meeting of the British Association for the Advancement of Science*—Liverpool, Saturday, Sept. 9.

The report of the doings of this meeting, (appropriately called by one of the speakers her majesty's parliament of science,) with a *condensed* abstract of most of the papers, fills fifty six pages of the London Athenæum, equivalent to about three hundred of this Journal. When the papers, or so many of them as may be thought worthy of that honor, shall be printed in full, it is easy to see that they will occupy a large volume, which, should the Association be fully maintained, will continue to form an annual contribution, of no small value, to science and the arts, several volumes of which have already appeared.

It is impossible, consistently with our limits, and with the obligations due to many persons and subjects, to do any thing more than cite from the printed reports of the Athenæum and of the Liverpool Standard and Mercury and other British papers received from valued friends abroad, some leading facts presented in the form of excerpts, and it may be with little connexion. In doing this we shall be obliged to pass over entire subjects, and which very possibly may be, in particular cases, more important, at least in the view of some of our readers, than those which we select.

The meeting was fully attended; many distinguished men were there, although others whose names we have been accustomed to see on these occasions were absent.

Magnets.—Mr. Cunningham, to try the efficacy of cast iron in forming magnets, "got three small castings made of the horse-shoe form, each weighing seven ounces; on touching these with a small compound magnet in the usual manner, he was very agreeably surprised to find them absorb and retain the magnetic influence in a degree superior to any steel ones he had ever previously constructed; and stated, that he had no doubt that they would be further improved if beaten red hot and very slowly cooled, which would make the metal softer, and the grain more uniform, and they might afterwards be hardened at the poles to produce the maximum effect. He considered this result of much importance, as it will enable us to construct compound magnets for magneto-electrical machines with great facility, and at a very trifling expense, as any number can be cast from one timber pattern."

"Mr. Holden said, that he had bestowed much time and attention on the construction of magnets. He preferred steel tempered blue, or to spring temper, and was on the whole, inclined to doubt the value of the material proposed. He knew that cast iron was capable of receiving strongly the magnetic influence, and bars of cast iron, as long as they retained their upright position, were found to possess polarity in a very high degree; but he doubted whether, if they were removed from their upright positions, they would long retain their polarity to any considerable extent."

"Mr. Snow Harris observed, that from many trials and much experience, he was convinced that hardened steel wire, just as it is to be had in the shops, without any further working it, or putting it into the fire, or altering its temper, was the best material for constructing small needles, intended to retain their magnetism permanently; and this latter consideration was of the utmost consequence when constructing needles for philosophic research, as, for instance, upon the magnetic intensity at various places, since the slightest alteration of power, in that case, would most materially and injuriously affect the result."

Mr. Scoresby preferred evenly tempered steel such as watch springs or ladies' busks.

Prof. Henry had tried cast iron and found it did not retain its magnetic power.

Tides.—"By a fortunate circumstance, the preservation of a register of the tides, kept for a short time during the 13th century, at London Bridge, by an abbot of St. Albans, John Wallingford, and which register had been preserved in the British Museum, it had had been clearly shown that the establishment for the port of London varied since that time by a quantity extending to between two and three hours: the cause of this could be as yet merely conjectured."

Iron.—On the use of Anthracite coal by the combination of heated air to the purpose of smelting iron ore.—"The reduction of the quantity of fuel expended to less than a third of that before required of the bituminous kinds for the production of one ton of pig iron, the increase of from forty to fifty per cent. upon the former, make by this process, and the increased strength of the metal, when compared with that before obtained by him from the native ores of the South Welsh basin, with the use of the coke of the bituminous veins and cold blast, were the leading points of the paper. Mr. Crane dwelt on the abundance of this variety of fuel, of which there are large deposits in Wales, Scotland, Ireland, Sardinia, France, Transylvania, and particularly America."

On the Crystallization of Metals by Galvanic Influence.—The Secretary then read a paper, by Mr. Golding Bird, 'on the crystallization of metals by galvanic influence.' To this department of knowledge popular attention has been peculiarly attracted by the well known experiments of Mr. Crosse, detailed at the last meeting of the British Association at Bristol; and it is in connexion with this gentleman's experiment that the present paper is more particularly interesting. It has long been a matter of extreme interest and importance to connect those changes constantly going on in the physical world with those which are observed in the laboratory of the chemist; to compare the researches of the experimental philosopher with the effects every where produced in the vast amphitheatre of nature. With this view the experiments about to be detailed were undertaken. Philosophers have long been accustomed to attribute the formation and crystallization of metals in mineral veins to voltaic action, but this could be regarded as little else than a matter of assumption until some experiments actually supported this point of view. To M. Becquerel we are mainly indebted for the knowledge of the power of a single galvanic circle in producing powerful voltaic decompositions, whilst to our own countryman, Dr. Faraday, we owe that most important piece of information, that poles, or *attracting surfaces*, are by no means requisite to the crystallization of a metal, and that all that is necessary for the reduction of a metal from a salt or oxide is the mere passage of a voltaic current. That this current may be of the weakest intensity has been shown by Dr. Bird in an essay lately read before the Royal Society of London. The apparatus contrived by Mr. Bird was very simple, consisting of an external cylinder of glass, capable of holding about half a pint of fluid, filled with a solution of common salt, (chloride of sodium;) into the contents of this cylinder was plunged a second and smaller cylinder, furnished at its lower extremity with a plug of sulphate of lime: this second glass cylinder was filled with a solution of sulphate of copper; into the latter a plate of copper, furnished with a conducting wire, was immersed, whilst into the solution of salt a plate of zinc, also furnished with its conducting wire, was plunged. Under these circumstances, a current of electricity is developed, the plate of zinc becoming positive, and the plate of copper negative, although the *intensity* of the current could be scarcely supposed sufficient to the production of chemical action. Mr. Bird has however shown, that when the connecting wires of the two plates of this elementary battery were immersed in a saline solution of a compound salt, the most important physical and chemical changes were produced; and that if, instead of immersing these wires in fluids, they are twisted together, so as to insure metallic connexion, it will be found that the electric current developed will produce most interesting and unexpected effects on the metallic solution present in the smaller; for although, it might be anticipated that the copper would be reduced, yet we should expect that this reduction would be most obvious at the surface of the negative electrode, which, however, Mr. Bird has shown not to be the case; for on examining the plug of sulphate of lime, (plaster of Paris,) closing the smaller cylinder, and separating the solution of sulphate of copper from the brine, it was found that beautiful and hard crystals of metallic copper were deposited in it, not in a confused manner, but in veins precisely resembling those met with in mines, of which, however, it is scarcely necessary to observe they presented but a miniature resemblance. From this, it appeared, that the *mere passage of an electric current*, independent of the presence of poles, was sufficient to effect metallic reductions, supporting in a satisfactory manner, the experiments of Dr. Faraday on this subject. The metallic crystals thus obtained were very hard and brilliant, resembling in a striking manner those produced in the vast theatre of nature, indeed, some specimens exhibited by Mr. Bird, obtained by the aid of his miniature apparatus, precisely, and, indeed, so closely resembled the most perfect forms of native and ruby copper ore, that they would probably defy the most expert mineralogist to discover their true origin. These effects were, moreover, by no means confined to salts of copper; for, when solutions of antimony, lead, tin, zinc, bismuth, silver, or other metals, were placed in the inner vessels, instead of a solution of copper, the metals were, in every case, reduced, partly on the plate of copper which served for the negative electrode, but chiefly in crystals imbedded in the mass of plaster of Paris closing the inner cylinder.

Other experiments, bearing upon this subject, were also detailed, which it is unnecessary to mention. They with those already noticed, were considered interesting in explaining the cause of the depositions of metals in veins; for, as the magnetic theory of Arago, Ampere, and others, requires that free currents of electric matter should be perpetually circulating around our earth in a direction at right angles to the magnetic meridian, so these currents, instead of merely causing the evolution of magnetic phenomena, are shown to be sufficient to produce most important chemical changes, causing, by their passage through masses of clay or earthy matter, the reduction and crystallization of the metals diffused through them in solution. To one circumstance, Mr. Bird particularly called the attention of the meeting, viz. the danger of considering the chemical changes produced in the bowels of the earth as in the first place depending upon metallic veins themselves; for, although it was evident that by the action of heat upon them, thermo-electric currents may be, and no doubt are, developed, yet we must regard the first physical cause which induced the deposition and formation of these very veins; and this cause, it is evident, can be none other than, in the first instance, chemical action. Upon this point, Mr. Bird's experiments, in conjunction with those of Dr. Faraday and M. De la Rive, are certainly interesting, as throwing light upon that most obscure of subjects, the formation of metallic veins in the bowels of the earth.

A valuable part of this communication appeared to us to be, that in which Mr. Bird suggested that the silification of wood is an electrical phenomenon. He has undertaken experiments to test this theory, and we are happy that so interesting a subject of inquiry should be in such competent hands.

Sediment.—The proportion of insoluble matter contained in the Mersey, amounts to twenty cubic inches in the flood, and thirty three inches in the ebb, in each cubic yard of water; evincing a preponderance of one in eight in the matter of the ebb, or 48.065 cubic yards of silt, &c. which is detained by the banks outside the Rock Narrows each tide, with the exception of what the succeeding ebb disturbs, at the exhausted stage of the former ebb. Thus, the ebb of to-day ranges over sixty four square miles, and the next ebb over forty four square miles, reducing by one third the first day's layer, that being the relative proportion of silt held in solution, and deposited over the outer area, at the northern margin of which the cross set of the Irish Channel ebbs, limits the deposit by sweeping into broad water what may extend so far. Now the excess of silt, on the seven hundred and thirty refluxes of tide that occur in a year, amounts to thirty five millions eighty seven thousand four hundred and fifty cubic yards, capable of spreading a layer, if equally disseminated, of twenty one inches thick over the first tide area; one third however is disturbed, and carried over the second tide area; or there is an uniform increase of the banks, and decrease of water in the channels of the estuary of the Mersey, amounting to seven inches per annum. This deposition of matter is however very unequal, some parts of the coast and of the banks receiving great accumulation, while others are often taken away. At the quarantine ground, the bed of the river shoaled up twenty two feet in eight years, and then eleven feet in two years, over a space of half a mile long by one quarter of a mile wide, and yet this was swept away in eighteen months. Captain Denham had been examining the port of Liverpool for fourteen years, and he infers from his observations, that a time will arrive when no access to this port could exist, unless man set bounds by his ingenuity, to the operation of tidal action. He made a number of local observations, which showed the diligence he had exercised in both planning and executing whatever he conceived might benefit this most important port; and he finished by an explanation of his principle of a constant sea level, which he had ascertained to be at three hours before, or three hours after high water, and by exhibiting the instrument which he had employed in drawing up water from different depths.

Fossil Plants.—The President called on the Rev. Mr. Yates, who exhibited to the section some interesting remains of fossil vegetables found in the new red sandstone of Worcestershire. He mentioned the discovery of similar remains in the same formation in other parts of England, as at Coventry, where trunks of trees, of a considerable size had been found; and stated that in the Royal Institution of Liverpool is preserved a fossil trunk found in excavating Prince's Dock. The specimens laid before the section were from two quarries between Worcester and Ludlow, one in the parish of Stanford, and the other in Ombersley; the former being where the new red sandstone joins the Silurian rocks. In this quarry the stone is rather greenish, like coal sandstone, and not unlike the Keuper of the Germans; but it may be traced in a line about ten miles, into sandstone of the usual red color. In the second quarry branches of trees have been discovered, and trunks partly converted into coal: each trunk seems imbedded in a cylindrical mass of ferruginous matter. Through this quarry, a trap dyke passes, altering the rocks on each side. A specimen of the metamorphic rock encrusted by chabasie was exhibited. The general appearance of the quarry led Mr. Yates to the conclusion that there had been a deposit formed by a current near the shore of a sea, which deposit had been fixed in a bay or recess where the remains of vegetables lay without being disturbed; and he alluded to the banks at Liverpool, where scarce any drifted plants had been discovered, owing to the continued motion of the currents, while they might be found in coves along the shores where the water was less agitated.

Impressions in sandstone.—The Rev. Mr. Clarke exhibited specimens of vegetable remains inclosed in new red sandstone from America transmitted to him by Prof. Hitchcock, who discovered the marks of the steps of birds in this rock a short time since. In a letter to Mr. Clarke, the Prof. has notified further discoveries of these singular steps, and also the remains of Saurians in this formation. In graywacke he had also discovered the remains of Marsupial quadrupeds.

Argas Persicus.—W. S. Macleay in the chair.—Dr. Traill exhibited a specimen of the *Argas Persicus,* or poisonous bug of Mianneh in Persia, giving a short notice of its effects. In some parts of Persia it is the prevalent belief that this animal not only produces fever, but often death from its bite. It is not a true insect, but belongs to the order Arachnidæ, and to the genus Argas, from which it was separated by Lamarck. Two districts in Persia are largely infested with it, and it is reported that to sleep exposed in these is certain death.

Dr. Bell, a resident, had never known a case in which death was produced, but had seen persons extremely ill from its effects.—The Chairman doubted whether there was sufficient authority to believe that the bite of the insect was mortal, and ascribed the dangerous effects to be the inflammation produced by pulling out a serrated proboscis, and stated his opinion that death would not be produced unless in a diseased and excitable habit of body.—Dr. Traill stated, that its fatal effects had been positively mentioned by Sir R. K. Porter, Mr. Morier and other travellers. During the time that Gen. White was envoy to the Persian Court, the Schah dispatched a messenger after him, who requested him not to pitch his tent on a certain part near the city, on account of the bites of the insects.—Rev. Mr. Hope referred to a similar species in St. Domingo, which attack horses in the ear, and often prove destructive; and the Chairman observed that it was rare to see a drove of oxen in Cuba exempt from the attacks of noxious insects, but which, instead of being prejudicial, were considered beneficial to the animals.

Mr. Halliday laid upon the table some plates of the Argas Persicus, exhibited by Dr. Traill; he stated that there were two genera, the Argas and Ixodes, that produced these poisonous bites.—The President observed, that 'bite' was an improper term for the wounds of these animals. They were produced by the introduction of their long serrated proboscis, and the ill effects frequently attendant on these wounds, he thought, arose from the violent extraction of this serrated rostrum.

Insects not produced by Galvanism.—Mr. Gray offered some remarks on the supposed production of insects, by the experiments of Mr. Crosse, and referred to two experiments made by Mr. Children in a manner perfectly identical with those of the former. The solution of silica was obtained from Mr. Garden in Oxford Street, and in one experiment it was sealed up, whilst in the other it was exposed to the air, but in neither case was there any appearance of insects. The insects had been very indefinitely described by Mr. Crosse, some having six, and others eight legs. It was no proof that they could not have been produced from the water used in the experiment because it was boiled, as that would not be sufficient to destroy the eggs of the insects deposited therein. Rev. Mr. Hope remarked one peculiarity, that no one had given the insects a specific name, and that they merely appeared to belong to the commonest species of Acari.—The Chairman mentioned the circumstance, that the seeds and germs of animals and vegetables are earlier and more quickly developed in a current of electricity, and that in all probability, these favorable circumstances operated upon the eggs of the insects produced in question. It was well known that seeds would retain their vitality for an indefinite period of time, and there was no reason why any limit should be put to the vitality of the eggs of animals.—Mr. Gray stated that prussic acid had lately been used for the purpose of destroying insects at the British Museum, particularly those infesting a mummy. Some of the larvæ of the common Musca having been put into the acid, remained uninjured after two or three days exposure.—Prof. Graham remarked, that other plants and animals might be kept for an indefinite length of time, when the powers of life were either retained or suspended. He also alluded to some curious experiments recently made at Edinburgh, although first by Sir Astley Cooper in London, with respect to the circulation of blood through the brains of particular animals. If the circulation be suspended by pressure for half a minute, the animal becomes torpid, but after giving a few convulsive sobs recovers, whilst if it is suspended for a minute the animal irrecoverably dies.—The Chairman observed that he had often dried to powder the eggs of various insects, which having been put into water were hatched.

On a Method of destroying Insects.—The Rev. Mr. Hope read a letter from Sir Thomas Phillips, on a method of destroying insects which affect books and manuscripts, particularly the *Anobia.* For the purpose of preserving books, he had used paste, in which corrosive sublimate was mixed, which would for some time resist their attacks. He had effected the destruction of *Anobium striatum* in his library, by placing in different parts of it pieces of beech plank, smeared over in the summer with pure fresh paste. It was soon discovered which pieces of the wood were infected, by the saw dust, and these were removed and burnt. So injurious is this species, that he considered that one impregnated female would be sufficient to destroy a whole library. He had also observed two other enemies—a small brown beetle; and one much larger, introduced from Darmstadt or Frankfort-on-the-Maine, which was not very abundant, although very destructive. This latter was about six times the size of the former, of a black color, with white spots or stripes, belonging to the modern family Curculionidæ, and being most partial to books bound in oak boards.

Mr. Curtis suggested the employment of spirits of turpentine, as the effect of corrosive sublimate, and other poisonous substances, lasted only a short time, and soon stained the leather.—The Chairman remarked on the destructive effects produced by Dermestes in his library in Cuba. It was probable that the insects which attacked the paper were different from those which attacked the paste, the former being Acari, and the latter small coleopterous insects. He had found no method of preservation so effectual as to give the books a free current of air, and, for this purpose, he was always accustomed to leave his book cases open, the books being placed about two inches from the wall, so as to allow a free circulation.—Mr. Hope remarked, that the infusion of quassia had been esteemed a preventive; and Mr. Gray stated, that, in Geneva, the water used in the manufacture of paper was that in which quassia had been in-fused.—Mr. Golding Bird referred to the observations of Mr. Gray with respect to the production of insects, as stated by Mr. Crosse in his experiments, which he had repeated on a large scale, but without any result, although he had continued them for some weeks, varying them in every possible form.

Statistics of the Deccan, &c.—The four collectorates of the Deccan, within the province of Bombay, contain a population of 3,285,985 souls, and 48,987 square miles, or about 67 inhabitants to the square mile,—lying on an elevated plateau, formed by the Ghauts, and descending by a succession of steppes to the Coromandel coast. The Poonah collectorate contains 8,281 square miles, 550,313 inhabitants, 1,827 towns and villages, and 114,887 houses, averaging about 4 inhabitants to a house, and 247 to a village, exclusive of the city of Poonah, which contains a population of 181,000. The rivers in the Deccan, during the monsoons, present magnificent streams of water, but, in the dry season, either a broad sandy plain, or a mere thread of water. The roads, with the exception of two great military roads, are untouched by art, and few of the rivers can boast of a bridge. With respect to Geology, there are no organic remains, and probably no country in the world in which the trap rock prevails to so great an extent. In the Deccan there are 200,000 square miles, without the intervention of any other rock whatever. This is succeeded by granite and other rocks of igneous origin, so that from the 25th degree of latitude, to Cape Comorin, including Ceylon, there are 700,000 square miles of igneous rocks and granite. The tides of the atmosphere are one of the principal features connected with the climate of the Deccan. These tides, like those of the ocean, rise and fall twice within the twenty four hours, at stated periods, and with a regularity which can almost be calculated upon. During observations of four years' continuance, made with different instruments, there was no variation in the order of the rise and fall, though there was occasionally some little variation in the degree. The atmospheric tides prevail from the equator to the pole, and are very observable to the 64th degree of latitude,—the maximum being at the equator,—the minimum at the poles. They exist even in our own latitudes, with all their variations. In the Deccan, as throughout the world, the barometer ranges highest in cold weather, and diminishes during the monsoon. The temperature, at half past nine in the morning, is the mean temperature of the year; so that a register kept at that hour, gives the mean temperature of the year. With regard to the quantity of rain, the clouds, containing the water drawn from the ocean by the action of the sun, beat against the Ghauts, and the rain which falls there is fourfold the proportion of that which falls 30 or 40 miles to the eastward. At Poonah, which is only 50 miles east, the annual fall of rain is only 25 inches, whilst in Bombay it is 100. Hail falls only at the very hottest season, with the temperature from 95 to 100. The air is perfectly clear;—suddenly the horizon is overcast, the dust is blown up in dense masses, with occasional violent claps of thunder, and showers of large hailstones. Dews are very copious,—fogs little known. The climate is very salubrious. In his (Col. Sykes's) camp, consisting of 100 persons, not a single death occurred in six years, and there was only one case of sickness which he did not cure without medical aid. In 1828, the deaths were 1.82 per cent., or one in 55 persons, not including cholera, or one in 40 including cholera, so that even in India, where this frightful disease originated, it appears to be much less serious than was supposed. Dr. Lawrence, the medical attendant at Bombay, had charge of 1000 natives for several years, and lost only 0.85 per cent., or less than one per cent. per annum.

Agriculture, though rudely carried on, is very productive; there are forty five cultivated fruits, including six or seven species of the grape, and twenty two wild fruits, including the mangosteen, the date, &c. &c. There are two harvests in the Deccan, one at the hot and wet season, the other at the cold or dry season, and both of distinct kinds of grain or pulse—the harvest at the wet season is principally of rice, which is produced chiefly in the hilly country. The productiveness of some of the grains is perfectly astonishing. Four species were mentioned—one producing 33 stalks, and 61,380 grains from one seed; another, 1,690; a third, 2,985; and a fourth, 1,850. One species of wheat, taken out of a field at random, and now in his possession, contained 25 stalks, and 1,450 grains, the average on tolerable land being 8 stalks to each plant. Besides this, there are corn, barley, peas, and sugar cane. There are 46 articles of garden culture. Edible fruits are numerous, and many wild plants and flowers are used as greens. Col. Sykes stated that the natives are quite as carnivorous as the inhabitants of Europe, so far, at least, as mutton is concerned. The grasses are innumerable, some of them useful for cordage. The inhabitants make no hay, but allow the grass to remain on the ground till dry, when they cut it with sickles. There are few fens, no heaths, and no oaks, elms, or hazels. The Zoology of the Deccan exhibits specimens of all the different varieties. The wild dog is a native of the Ghauts; there are three kinds of monkeys, and two of bats. The domestic poultry of this country is supposed to have originated in India, the two species being identical. Most of the wading and swimming birds are identical with those of Europe. In noticing the fish, Col. Sykes remarked that a certain species of fresh-water fish were found in pieces of water, two thousand feet above the level of the sea, exactly resembling our own salt-water fish. With respect to population, the proportion of male to female births, which in England is 100 to 93—in the Deccan is 100 to 87; and this difference obtains, with very little variation, throughout India, modified by the singular fact exhibited in the excess of grown-up women over men. Sir Stamford Raffles, in his account of the island of Java, states that the proportion of births was 100 males to 82 females, but that the same disproportion did not exist between grown-up people. In the Deccan, the preponderance of male over female children is very strongly marked, but a greater mortality amongst the males at a subsequent period makes the females outnumber the males. The same law, therefore, appears to prevail both within and without the tropics. The average number of deaths throughout the whole collectorate was one in 37, but that was in an exceedingly bad season, when the cholera prevailed. The proportion of marriages is very nearly the same as in England and France, it being one in 125 in Poonah, one in 128 in England, and one in 130 in France. With respect to education—in one province there is only one school to 2452 inhabitants; in another, one to 4639; in a third, one to 3337. The tenures of land are exceedingly numerous, and amongst them is the freehold, which has been acknowledged by the native governments; whilst there are many descendants of those amongst whom the land was originally divided, now in actual possession. Artisans of various kinds do the work of the farmers in their respective branches, and are paid by allotments of land, and a per centage on the produce; thus, the barber shaves for his land; the tailor makes clothes for his land, &c.—which land is cultivated by them to produce food. The revenue derived by the government was 82 per cent. in the aggregate from land, and altogether averaged 8*s*. per annum for each individual. The native manufacture of silk and cotton has been almost suppressed by the machinery of England.

There are few other manufacturing products of any value, and these are not produced in the Company's territories, with one or two slight exceptions. The transit duties on the conveyance of goods are exceedingly onerous, and form a great impediment to commerce.

Statistics of trade between the United Kingdom and the United States of America.—The British colonies which now form part of the United States of America, were, with the exception of Georgia, all founded in the seventeenth century. The date of the first settlement of each individual colony was as follows:—

Virginia - -	1607	Maryland - -	1633
New York - -	1614	Connecticut -	1635
Massachusetts -	1620	Rhode Island -	1636
New Hampshire -	1623	North Carolina -	1650
New Jersey -	1624	South Carolina -	1670
Delaware - -	1627	Pennsylvania -	1682
Maine - -	1630	Georgia - -	1733

It was not until more than a century had elapsed from the period referred to in the foregoing extract, and when they had secured their independence, that any part of the raw material employed in the cotton manufacture was received from the British plantations in America. A few bags of cotton, which arrived in 1785 and 1786, were apparently of foreign growth, and had been transmitted to America from the Spanish main. Cotton was raised in gardens in the United States before 1786; but that was the first year in which it was cultivated by planters as a crop, and 1787 was the earliest year in which any of the growth of the country was exported.

Before the separation of the British provinces from the mother country, the statements which were given concerning their trade exhibited that of each province separately. Attention was then directed to a table which contained the official value of imports and exports from and to each province, for the years 1701, 1710, 1720, 1730, 1740, 1750, and 1760, and thereafter for each individual year to 1783, when the independence of the United States was fully recognized. For a long period up to that event the operation of the navigation laws had given to this country a monopoly of the trade with its colonies; and Mr. Porter considered it worthy of remark, that so long as the American provinces continued thus connected with England, the increase of the commercial intercourse bore a very inadequate proportion to their increasing population. In

1749 the number of inhabitants in the provinces was stated to be 1,046,000, and the official value of exports and imports was £2,117,845. Assuming that the population between 1749 and and 1774 increased steadily at the rate afterwards exhibited by the census of 1790, the number of inhabitants in 1774 must have been 2,803,625. If the trade had increased in an equal ratio, the imports and exports in 1774 would have amounted to £5,676,523; whereas the actual amount was only £3,964,288, showing a deficiency of 30 per cent.

Another table exhibited the official value of our imports and exports from and to the United States collectively, in each year from 1784 to 1835.

The earliest census for the United States was taken in 1790, when the population was found to be 3,929,328. The official value of our trade with the United States in that year was £4,622,851. In 1800 the population was found to have increased to 5,309,758. At the same rate of increase the trade in that year should have been £6,246,925; but as it actually amounted to £9,243,432, the increase was greater than that of the population by 48 per cent. In 1810, the population was 7,239,903, and the trade £10,427,722. If the proportion of 1790 had been preserved, the amount would have been £8,517,739. The excess, after allowing for the increased population, was therefore 22 per cent.; but if the comparison is made with 1800, it appears that the increased trade is not quite 13 per cent., while the population was augmented at the rate of 36 per cent.; there is therefore a virtual deficiency of 23 per cent., which Mr. Porter considered ought to be ascribed to the operation of the Orders in Council issued in retaliation of the Milan and Berlin Decrees of Napoleon. Pursuing the comparison to 1820, we find that the population was then 9,638,166, showing an increase over 1810 of 33⅓ per cent.; on the other hand, there is a falling off in the official value of the trade between the two countries at the rate of 27 per cent. This circumstance Mr. Porter attributed to causes of a temporary nature, capable of easy explanation. On the renewal of the intercourse between England and America, after the peace in 1815, our merchants and manufacturers, stimulated doubly by the deficiency of British goods in the American market, and their superabundance and consequent low price at home, made such large shipments of manufactures to the United States, that a glut was there produced, and as this occurred simultaneously with a considerable derangement of the currency in the commercial cities of America, English goods were sacrificed at ruinous prices. In the mean time, the commercial distress which had visited our own country was passing away, and an effective demand for our products had arisen from other quarters, as appeared from the fact, that although the real value of British goods exported to the United States, which, on the average of the five preceding years, was near £9,000,000, fell in 1820 to £3,875,286, the general exports from the United Kingdom to foreign countries were greater in 1820 than they had been in the preceding year.

In 1830, the date of the last census, the population of the United States was 12,867,165, and the official value of the trade with this country £16,292,637. The increase, as compared with 1790, was 227 per cent. on the population, and 252 per cent. on the amount of trade. If the comparison is made with the remaining decennary periods, it will be found that the increase in 1830 was as follows:

	Increase per cent. Population.	Trade.
Compared with 1800	142	76
" " 1810	77½	56
" " 1820	33⅓	115

The increase of population in the United States, between 1820 and 1830, was at the rate of 3⅓ per cent. per annum. If we assume that the increase has since gone forward at the rate of 3 per cent. in each year, the number of American citizens in 1835 must have been 14,784,589. The official value of their trade with this country in that year was £25,671,602. A comparison of this amount with the value of the trade in the years of the different enumerations, exhibits the following results:—

	Increase per cent. Population.	Trade.
Compared with 1790	276	455
" " 1800	178	177
" " 1810	104	146
" " 1820	53	239
" " 1830	15	57

But Mr. Porter considered that it was not simply with reference to the numerical increase of the citizens of the United States that we should consider this question of the increase of our trade. During the forty seven years that have elapsed since the first census was taken, in 1690, at least 11,000,000 of inhabitants have been added to their number, being equal to an increase of 276 per cent. But during that time we are fully warranted in believing that the wealth of the country has been augmented in a much greater proportion; and it may be fairly presumed that, but for the untoward interference of wars, and of that which is scarcely less inimical to national prosperity than war—commercial jealousy, the dealings between the two countries must have become far more considerable than they are. During the period in question, America has added materially to her means of consuming foreign products by the extent to which she has carried the cultivation of exportable products. In 1791, the whole export of cotton from the United States was under 200,000 lbs.; and it is shown by accompanying tables that the average annual importation of American cotton into this country during the last ten years, has exceeded 225,000,000 lbs., the value of which cannot have been less than £7,500,000 per annum. In 1836 our importation was 289,615,692 lbs., which, at the average price of the year, probably produced more than £10,000,000 sterling.

The intercourse between this country and the United States is important, not only to our merchants and manufacturers, but also to our ship owners, and that in a continually augmenting degree. The tonnage of vessels which entered the ports of the United States from foreign countries, in each year from 1821 to 1836, distinguishing American and British from other shipping, was as follows:—

Years ending 30th September.	American.	British.	Other Foreign Vessels.	Total.	Centesimal proportion of British to American tonnage.
1821	765,098	55,188	26,338	846,624	7.21
1822	787,961	70,669	29,872	888,502	8.97
1823	775,271	89,553	29,915	894,739	11.55
1824	850,033	67,351	35,016	952,400	7.92
1825	880,754	63,036	29,891	973,681	7.15
1826	942,206	69,295	36,359	1,047,860	7.35
1827	918,361	99,114	38,475	1,055,950	10.79
1828	868,381	104,167	46,056	1,018,604	11.99
1829	872,949	86,377	44,366	1,003,692	9.89
1830	967,227	87,231	44,669	1,099,127	9.02
1831	922,952	215,887	66,061	1,204,900	23.39
1832	949,622	288,841	104,197	1,342,660	30.41
1833	1,111,441	383,487	113,218	1,608,146	34.50
1834	1,074,670	453,495	114,557	1,642,722	42.19
1835	1,352,653	529,922	111,388	1,993,963	39.18
1836	1,255,384	547,606	132,607	1,935,597	43.62

The most important part of our trade with America consists in our exports of manufactured goods. The following table exhibits the declared value of those exports in each year from 1805 to 1836, with the exception of 1812 and 1813, the records for which two years were destroyed at the burning of the Custom House in London.*

Declared value of British and Irish produce, and Manufactures, exported from the United Kingdom to the United States of America, in each year from 1805 to 1811, and from 1814 to 1836.

Years.	Amount.	Years.	Amount.	Years.	Amount.
	£		£		£
1805	11,011,409	1817	6,930,359	1827	7,018,272
1806	12,389,488	1818	9,451,009	1828	5,810,315
1807	11,846,513	1819	4,929,815	1829	4,823,415
1808	5,241,739	1820	3,875,286	1830	6,132,346
1809	7,258,500	1821	6,214,875	1831	9,053,583
1810	10,920,752	1822	6,865,262	1832	5,468,272
1811	1,841,253	1823	5,464,874	1833	7,579,699
1814	8,129	1824	6,090,394	1834	6,844,989
1815	13,255,374	1825	7,018,934	1835	10,568,455
1816	9,556,577	1826	4,659,018	1836	12,425,605

One thing which cannot fail to strike any one on inspecting this table, is the large amount of our exports in the three earliest and two latest years of the series, when compared with those occurring in the intermediate years. The extent of the shipments in 1815, Mr. Porter considered as the result of the renewal of commercial intercourse after the war. The years 1805, 1806, and 1807, 1835, and 1836, followed long periods of friendly intercourse. The serious falling off that occurred in 1808 and 1809, Mr. Porter, as already stated, attributed to the effect of our celebrated Orders in Council, issued in retaliation for Napoleon's Milan and Berlin Decrees. Nearly one third of our foreign export trade in 1805, 1806, and 1807, was carried on with the United States.

The high degree of importance to each country of the trade which it carries on with the other, was shown in Tables appended to the Memoir. The proportions which that trade bears to the entire foreign trade of each country are as follows:

* This omission is less to be regretted, because of the unfortunate state of hostility into which the two countries were plunged during those years.

Centesimal proportion which the trade between the United Kingdom and the United States of America bore to the whole foreign trade of each country respectively, in each year, from 1821 to 1835.

Years.	Centesimal proportion which the trade with England bore to the whole foreign trade of the United States.	Centesimal proportion which the trade with the U. States bore to the whole foreign export trade of England.
1821	35.95	16.95
1822	38.16	18.57
1823	32.70	15.41
1824	31.75	15.86
1825	37.67	18.31
1826	29.60	14.77
1827	35.03	18.87
1828	34.75	15.78
1829	33.75	13.45
1830	33.13	16.02
1831	41.78	24.36
1832	35.99	15.00
1833	35.41	19.36
1834	39.61	16.43
1835	41.76	22.31

The proportion which our export trade with the United States bore to our whole export trade was, in—

1805	28.91	1807	31.80
1806	30.31	1836	23.28

Mr. Porter stated that in the foregoing observations all remarks upon the state of convulsion into which this most important branch of our foreign trade has lately been thrown had been avoided, partly because its occurrence is too recent to allow of a sufficiently calm estimate being made of the cause or causes which led to the catastrophe, but chiefly because it would be difficult, if not impossible, to enter upon that subject without departing from that line of strict statistical research which it is desirable to preserve in the proceedings of this Section of the British Association. In conclusion, he remarked that the shipments of British produce and manufactures, in the year 1836, amounted, according to the value declared by the shippers, to £53,368,571, of which sum America took £12,425,605, or 23.28 per cent. The total shipments in 1835 amounted to £47,372,270, of which America took £10,568,455, or 22.31 per cent., the difference between the two years being, on the total shipments £5,996,301, and on the shipments to America £1,857,150. Without admitting or denying that these figures give evidence of over-trading, he called attention to the circumstances of the two people—namely, that the means of obtaining the comforts of life are enjoyed by a larger proportion of them than is the case with any other people; that the habits and predilections of the citizens of the United States lead them to give a preference to British goods; that ours is the cheapest market in which they can procure many articles necessary to them; and that we are, out of all proportion, their best customers for the raw produce of their soil; and he asked whether, if the trade of the two countries were put upon a proper footing, and conducted upon enlightened principles, that amount of traffic *could* be considered excessive which gives annually to every citizen of the United States articles of British growth and manufacture to the value of sixteen shillings and ninepence three farthings!

On the Mechanism of Waves in reference to Steam Navigation.—Mr. Russell had, at previous meetings of the British Association, given an account of his investigations on the resistance of fluids to the motion of vessels, and ascertained the law of interference of the wave in modifying the nature and amount of that resistance. Since the last meeting of the Association he had extended his observations to a variety of subjects of practical importance, and amongst others to the improvement of the navigation of such rivers as the Thames and the Clyde, in which steam navigation was extensively employed. In these rivers it was found that steam navigation was conducted under very great disadvantages when compared with the open sea. Mr. Russell had discovered that in shallow water one great impediment to high velocities was the generation of, what he termed, the great wave of translation of the displaced fluid,—not undulation of fluid, but translation of one part of the fluid, reaching to the whole depth with equal velocity. When the vessel is propelled, the water heaped on its side generates this great anterior wave of translation, which increases as the velocity increases; the section of displacement of water is increased in the ratio of the sine of inclination. In one instance, where the depth was five feet, the anterior wave was three feet above the level of the water, so that the bow was buried in it, and when the vessel stopped the wave moved at eight miles an hour, and though the vessel drew but twenty inches water, her helm was knocked off. This anterior wave moves with a given velocity proportionate to the depth of the fluid, equal, in fact, to the fall of a heavy body through half the fluid. In some cases, the boat being stopped, Mr. Russell had followed the wave for a mile, and found it advance at the same rate. The object then would be to make the centre of the vessel coincide as much as possible with the centre of the wave, thereby diminishing the anterior wave and diminishing the resistance. This wave is at present generated to so enormous an extent, that in one case the waves extended to a considerable depth for a mile and a quarter, the depth of the river being increased one and a half foot in a channel of five hundred yards. In six or seven feet water the immersion would be three feet more at stem than when the boat was at rest, the progress being doubly impeded by the anterior wave, and by the stern depression. The question then was to what was the wave due? and how was it to be got rid of? In general, the greater the difference between the velocity of the vessel and that of the wave, the more the impediment was diminished. The increase of the velocity of the anterior wave relieves the vessel, and this is obtained, not by widening, but by deepening the channel, while at the same time the velocity of the stern wave is increased, so as to come forward to the centre of the vessel. In one instance a vessel moved at the rate of four miles with twenty two strokes a minute, at six miles with thirty five strokes, and at five and a half miles with from sixty to seventy strokes. The next great impediment to steam navigation consisted in the formation of lateral currents on the side of the vessel, which, having the same direction with the motion of the paddles, had the effect of diminishing the relative difference of the velocity of the paddles and of the fluid, and thus diminished the propelling power of the paddles, the engine being obliged to make an additional number of strokes. The third evil arose from the stern or posterior wave or surge, by which great injury was done to the banks of the river, and to the smaller vessels navigating it. At an increased velocity this wave rises in a cycloid form into a breaking surface. The remedy for these evils was to be found, not in widening the river, as generally supposed, nor in giving gradual or gentle slopes to the sides of the channel, but in deepening the river and rendering its sides as nearly vertical as possible, by which the impediments were diminished to a very great amount. Mr. Russell had made experiments with different forms of channels, as:—

The general result was, that in a rectangular channel the velocity was that due to the fall through half the depth of the channel. Thus the velocity of a wave of one foot was three miles an hour, of one of four feet eight miles, of one of fifteen feet fifteen miles. In all cases the rectangular channel was found to be the preferable one. Such a channel would generally be the most expensive, but sometimes, where, as on the Thames, the land adjoining was of high value, and gentle slopes to the banks were therefore not attainable, the rectangular would be the cheaper form.

The next wave generated was what Mr. Russell termed the wave "of unequal displacement," arising solely, it was found, from the form of the vessel. This wave was seen diverging on both sides of the vessel, from the bow towards the stern, arranged in two straight lines extending to a great distance behind it. This wave might be greatly diminished, and sometimes almost entirely removed, by giving the lines of displacement a slight concavity towards the stern, the vessel being sharpened out. When the vessel does not raise the water in giving uniform progression, but is so bluff that certain points displace more than others, an anterior wave is formed of excessive displacement, the injury done by which is only inferior to that of the stern surge.

Mr. Fairburn, of Manchester, stated, in reply to a question put by Dr. Lardner, that the results of his experiments corresponded with those obtained by Mr. Russell, and mentioned one instance where, at a velocity of seven miles an hour, the channel being five feet deep, the stern was dragging on the ground.—Mr. Herapath inquired what posterior form of vessel Mr. Russell had found the best. Mr. Russell stated that on this point the result of his experiments indicated a form very different from that approved of by naval officers in general. They preferred a form bluff in front, and tapering towards the stern. Mr. Russell's experiments went to show that this should just be reversed, and he had made sixteen of them at different velocities, from three to fifteen miles an hour. In the navigation of the Clyde, the progress of the formation of vessels had been in accordance with this opinion. At first they were built very bluff, with their maximum breadth at a distance from the stern of one-third of the whole length; thus a wave of excessive displacement was generated, going off at right angles, and making a break more than was necessary to allow the stern to pass through. Now the vessels were built with full sterns and narrow stems, with their maximum breadth at midships. For working well, however, a very deep keel was, he knew, necessary to give the helm full effect. In answer to the question whether these experiments might be made with model vessels on a small scale, Mr. Russell said that experiments with models were generally very fallacious and complicated, and that his had been made with vessels from seventy five to one hundred feet long. When asked whether they were made with or against tide, he replied that the existence of a previous current modified the velocity of the wave, which was to be measured by the velocity of the water, not by the land.—Mr. Wenfall observed that Mr. Russell's statements were corroborated by an observation of his own, that in an instance where the tide rose thirty six feet, the effect of the lateral waves had been to form a rectangular excavation to four or five feet.

On the Corroding of Iron by Salt Water.—Mr. Hartley read a paper, 'on the corroding of iron by salt water.' The object of the paper was to show that brass protects both bar and cast iron in a very perfect manner. The brass did not appear to have undergone any action, which, as stated by the President, is rather opposed to received notions of electro-chemical action.

On some singular Modifications of the Ordinary Action of Nitric Acid on certain Metals.—Dr. Andrews next read a paper, 'on some singular modifications of the ordinary action of nitric acid on certain metals.' Bismuth in nitric acid of specific gravity 1.4, was rapidly acted upon, but this action immediately ceased when the bar was touched by platinum. On removing the platinum from the liquor, the bismuth will sometimes begin again to dissolve; at other times, its surface will become covered with a black crust, which is soon removed by the acid; but the metal, though now exhibiting a beautifully polished surface, is no longer acted upon by the acid, or, at least, is dissolved only with extreme slowness. Thus, a slip of metal, which, in its ordinary state will require only a few seconds to complete its solution, will, when thus slightly modified, resist, for many hours, the action of the same acid.

Copper and tin present similar phenomena, but zinc, when treated in the same way, has its oxidation and solution not arrested, but merely retarded. Arsenic was found to present a singular anomaly when heated in nitric acid, so as to give rise to effervescence: the contact of the platinum in the usual way did not produce any effect, whereas, when an acidulous solution of silver is used, platinum exercised its usual influence.

In the case of six metals, platinum checks the action of nitric acid, and three of them appear to be brought into a permanently peculiar state, opposed to chemical action. Platinum always separates any film of oxide as its initial function, but after its separation, it exercises a polarizing action, for example, it brings the other metal into a peculiar state, which enables it to resist chemical action.

On the conclusion of this paper, the President drew the attention of the Section to the analogy between the facts detailed by Dr. Andrews, and the preservation of iron by brass, as instanced in the communication of Mr. Hartley. In both cases, according to the known laws of electro-chemical action, effects, the very opposite of what are observed, should present themselves. The bismuth, copper, &c. should oxidize quickest when in contact with the platinum; and if, as would seem demonstrated by Mr. Hartley, brass protects wrought and cast iron, the brass itself should be acted upon with increased rapidity. The solution of these anomalies, he conceived quite within the range of science in its present state, and he urged upon the members of the Section the necessity of studying the phenomena in question, as their explication would constitute a very valuable addition to the existing state of our electrical knowledge.

Gravel, bowlders, &c.—Mr. Sedgwick had seen gravel on mountains two thousand feet high. Erratic blocks, he considered, could not be of fluviatile, but of marine origin, and organic remains of large animals were not likely to be abundant in gravel carried by currents of the sea, from the destruction caused by their violent action. Animal remains had been found in the clay gravel of the east of England; but this gravel he conceived as differing from that in other parts of the country.—Sir Philip Egerton said, that Mr. Strickland's flintless gravel, occurring to the N. W. of the Avon, could be only a partial formation, as he had observed, that in Cheshire the gravel always contained flint. At Cocknell he had obtained two grinders of an elephant, and many *marine* shells, and many like shells in other places, all of existing species, and occurring often with pieces of rolled coal.—Mr. Phillips stated, that one of the questions proposed by the Association, was the determination of the phenomena of the English gravel formations, but to the present time sufficient evidence had not been collected. He alluded to Mr.

Murchison's opinions, that a strait formerly divided England from Wales: into this strait gravel might be drifted from both sides; and Mr. Murchison had discovered, in Wales, local covered by erratic gravel. He himself had discovered in a valley of the Yorkshire Wolds at an elevation of six hundred feet, gravel drifted from Cumberland, and containing bones of the elephant.—Mr. Sedgwick had traced the gravel of the central parts of England to its northern sources; and he instanced a singular phenomenon of a mountain, near Buttermere, which appeared to be water-worn by a stream passing over it. The recent elevation of Siluria, he conceived, was proved by the morasses and lakes in its lines of valleys, which valleys, although shaped under the ocean, had been evidently modified by existing waters. He concluded by asserting, that all examination of nature, by means of accurately ascertained facts, must agree with moral or scriptural interpretation; and that we need have no fear as to the one clashing with the other, as truth cannot oppose truth, but must, in all cases, be coincident.

Geology of the Desert between Suez and Cairo.—In this desert travellers have always suffered great inconvenience from the want of water, and this was likely to prove a serious obstacle to the proposed communication by this route to India. In order to overcome the inconvenience, Mr. Briggs, the British consul, employed a Swiss engineer to bore for water. Mr. Gensberg, the engineer, caused the first boring to be made in the Valley of Kejche, but being unsuccessful, he transferred his operations to the Valley of Candelli, where water was found in clay underlying a calcareous rock. Considerable ingenuity was shown in the excavation. Besides the usual boring downwards, lateral openings were made to increase the supply of water: borings were made in other situations, and very singular results obtained. A great variety of strata were penetrated, and this variety existed even within a limited distance of superficial extent: thus, in one place marine sand was found; and a little way off, terrestrial or desert sand: gravel occurred only in one spot. But the most singular geological phenomenon was the existence of granite over clay, in which good water was obtained. The marquis mentioned that a notice of the intention of the British consul to bore for water, appeared in the first volume of the Journal of the Geographical Society, but that the communication now laid before the Section, was the first notification of the results obtained.

The Sclerotic Bones of the Eyes of different Birds and Reptiles.—Mr. Allis read a paper 'on the sclerotic bones of the eyes of different birds and reptiles.' He stated, that he believed the subject of his paper had not received much attention from comparative anatomists. With regard to their number, Cuvier had stated them to be twenty, but he had never found more than seventeen, and sometimes even only one. He then quoted the observations that had been made on this subject by Blumenbach, Cuvier, Carus, Yarrell and Buckland, and proceeded to state, that "the shape of the individual bones is so various, that it cannot be given in any general terms; the external edge of the bones is, in most instances, beautifully serrated, but the serration is not visible in the bony ring: this serration being generally destroyed by the process of boiling that is necessary to their preservation. The rings generally overlap each other, there being a depression on the under side of one bone, and a precisely corresponding one on the upper side of its fellow; so that when overlapping each other they present nearly an even surface, having one bone with both depressions on its inner surface, and forming an interior key to the arch; another, having two depressions externally, and forming an exterior key. They form a defense and protection to the eye, and those birds which are pugnacious, or have a peculiarly rapid flight, or vary their attitude in flying, &c., have the sclerotic rings of larger size and more convex form, and are of greater strength; the same remark holds good with respect to water-birds. Another use of these bones, is, altering the convexity of the cornea, as mentioned by Dr. Buckland." He then exhibited a great number of specimens of these bones, and observed, that in the eagles and vultures they were strong and large, and varied in number from fourteen to sixteen; in owls, soft and porous, and not hard, as Cuvier had stated; in the gallinidæ the the number varied from thirteen to seventeen; in the columbidæ they were small and feeble; in the ostrich tribe they were large; in the grallæ small and feeble; in the scansores the same, and twelve or thirteen in number; in the swimmers they were weak and small, and from twelve to sixteen in number; in divers, strong and large, and twelve to fifteen in number; in the passerinæ they varied considerably, but were generally weak; in reptiles they varied considerably in number, shape and size.

Chemical Composition of Vegetable Membrane and Fibre.—A paper 'on the chemical composition of vegetable membrane and fibre,' by the Rev. J. B. Reade, was read by the secretary. The author commenced by observing, that Professor Henslow, in his late work on Botany, had stated, that great difficulties existed in the way of obtaining an accurate analysis of the chemical composition of vegetable membrane and fibre. Having observed the accuracy with which his friend, Mr. Rigg, of Walworth, analyzed vegetable products, he recommended him to commence a series of experiments on this subject, and obtained the following results:—

Spiral vessels from the Hyacinth yielded—

Carbon	41.8
Hydrogen	1.1
Nitrogen	4.3
Water	51.8
Residuary matter	1.0
	100.0

Cellular tissue:—

Carbon	39.2
Oxygen	7.4
Nitrogen	3.9
Water	48.5
Residue	1.0
	100.0

An analysis of different parts of the flower-stalk of the hyacinth gave the following results:—

	C.	H.	O.	N.	W.	Res.
Epidermis and stomates	41.7	—	2.0	4.0	50.8	1.5
Cellular tissue beneath epidermis	41.8	—	2.1	4.1	50.5	1.5
Woody fibre under bark	39.2	0.5	—	5.7	55.6	1.0
Spiral vessels	35.8	1.7	—	3.9	58.1	0.5

In these experiments, the existence of nitrogen to so great an extent was pointed out as remarkable.

Vegetable Physiology.—Mr. Nevan detailed some experiments 'on vegetable physiology.' The experiments were performed on elms, forty years of age in February, 1836.

1. The stem of the tree was denuded, in a circle, of its cortical integument alone, leaving the alburnum beneath uninjured. On the May following the denuded part was filled up by the exudation of bark and wood from the upper surface of the wound, and the tree had not suffered in growth.

2. The bark and *cambium* were removed in the same manner. In August, 1837, this tree sickened, and there was no formation of wood or bark in the wounded part. Two developments, however, took place, one above the other, from below; the former having the appearance of roots, the latter were branches with leaves.

3. The bark and two layers of alburnum were cut away. The tree was at the time unhealthy; it, however, put forth its leaves on that and the ensuing spring, but shortly after died. No sap was observed above or below the wounded part. Roots were developed from the upper, and branches from the lower part of the section.

4. The bark and six layers of alburnum were taken off. The tree became much less vigorous, but did not die, and otherwise presented the same appearance as the last.

5. The bark and twelve layers of alburnum were stripped. The consequences were again similar to the last two; the alburnum above and below the cut being dry, but an accidental cut that penetrated into the heart-wood exuded sap.

6. This was a repetition of the experiment of Palisot de Beauvais, by cutting away a circular ring of bark around a single branch. The branch continued to grow, and roots sprouted from the under surface of the isolated bark and branch.

7. In this the whole of the wood of the tree was cut away, except four pillars, composed of bark and sap-wood. In this case, the sap first appeared from above, descending by the pith, and then from the heart-wood, the alburnum being dry. In this case the sap must have passed up the alburnum, and horizontally through to the heart-wood.

Mr. Nevan inferred from these experiments—1. That the life of the tree does not depend on the liber or cambium. 2. A descent of sap takes place before the development of leaves. 3. That new matter arises from below; which had not previously been allowed. He thought there were two distinct principles in the tree,—one, the ascending, or leaf principle; the other, the descending, or root principle. Mr. Nevan had also performed some experiments on the conversion of roots into branches, and came to the conclusion, that buds or branches might be developed from any part of the root above its extreme end, from which point it was impossible for buds to be developed.

Professor Lindley remarked that these experiments confirmed entirely the theory of the structure of wood adopted by Du Petit

Thouars. He did not think that the existence of any new principle could be inferred from the experiments. In the seventh experiment the horizontal circulation of the sap was proved, and confirmed the accuracy of Hall's experiment of cutting a tree nearly through on alternate sides, when the sap still ascended.

Suspended Animation.—Sir James Murray had seen two cases of suspended animation from blows on the stomach; one recovered, and the other died. The remedy he should recommend, would be to throw a bucket of cold water over the body—gasping would ensue, and respiration follow.

Iron.—Mr. Fairburn then read a Report on the comparative strength and other properties of cast iron, manufactured by the hot and cold blast.

At a previous meeting of the Association, Mr. Hodgkinson read a Report on the comparative strength and other properties of iron manufactured by the hot and cold blast.—In the prosecution of inquiries since made, it was conceived desirable to subject the metals operated upon to more than one species of strain; to vary their forms, and, by a series of changes, to elicit their peculiar, as well as comparative properties. 1st, they have been drawn asunder by direct tension; 2dly, they have been crushed by direct compression both in short and long specimens; and, 3dly, they have been subjected to fracture by transverse strain, under various forms of section, and at various temperatures. Ten bars of hot and cold blast iron were also loaded with different weights, from 112 lbs. to near the breaking point, and left for many months to sustain the load, and to determine the length of time necessary to effect the fracture. The bars thus loaded, are still (with one exception) bearing the weight, having been suspended upwards of six months, and, from what we can at present perceive, there is every chance of a long and protracted experiment. In making the experiment on transverse strain, a number of models of different sizes and forms were prepared, and the irons, both hot and cold blast, were run into the form of these models; but as there is usually a slight deviation in the size of the castings from that of the model, the dimensions of the bars were accurately measured at the place of fracture, and the results reduced, by calculation, to what they would have been if they had been cast the exact size of the model, assuming the strength of rectangular beams to be as the breadth and square of the depth, and the ultimate deflection to be inversely as the depth, the length being constant. In comparing two irons, the greatest care was taken to subject them as nearly as possible to the same treatment.

A series of experiments was also made to determine the strength of hot and cold blast iron at various temperatures, from 32° (the freezing point) to the boiling point; for this purpose, a cast-iron trough was employed, in which the bars to be broken were placed, and covered with snow or water, (which was kept at the proper temperature by a jet of steam,) as the case required; the weights were then gradually laid on until fracture took place.

The strength of bars made red hot was also tried, and, contrary to expectation, they retained their tenacity and power to resist the load to a considerable extent: the reduction of strength in a bar one inch square, in a range of temperature from 32° to that of redness, was rather more than one-sixth, the deflection being upwards of 1½ inch in a bar 2 feet 3 inches long.

RESULTS.

Carron Iron, No. 2. (Scotch.)

Mean ratio of transverse strength, assuming the cold blast iron at - - - - - -	1,000 : 9,799
Mean ratio of power to resist impact - -	1,000 : 1,038.9

Whence, in the transverse strength of Carron iron, No. 2, using a variety of forms of section, the strength of the cold blast is to that of the hot blast, as 100 to 98, nearly.

Devon Iron, No. 3.

Mean ratio of strength in sections of various forms (thirteen experiments) - - - -	1000 : 1409
Power to sustain impact - - - -	1000 : 2742

This is an exceedingly hard iron, with a singular appearance, the centre or more granulated parts of the fracture being surrounded with a circle having the appearance of hardened steel.

Buffery, No. 1, Staffordshire Iron, cold and hot blast.

Mean ratio of breaking weight - - -	1000 : 925
Mean ratio of power to resist impact - -	1000 : 965

In the buffery iron, the hot blast manufacture is weaker, whether we view it in its transverse strength, or its power to resist impact.

Coed Talon, No. 2, North Welsh Iron.

Mean ratio of strength in a number of experiments	1000 : 1014
Mean ratio of power to resist impact - -	1000 : 1219

Modulus of elasticity in lbs. for a bar of one inch square.

Cold blast	14,680,000 13,947,000	14,313,500 lbs.
Hot blast	15,810,000 12,835,000	14,322,500 lbs.

Elslear Cold Blast, No. 1, against Melton Hot Blast, No. 1, (Yorkshire Iron.)

Mean ratio of strength - - - - - -	1000 : 809
Mean ratio of power to resist impact - - -	1000 : 858

The modulus of elasticity in all the irons are computed; but only given in a few cases in the results.

Relative strength of hot and cold blast iron to resist a transverse strain at different degrees of temperature.

Cold blast 949.6 at 32°. Hot ditto 919.7, Mean.
Ratio of strength, 1,000 : 977.6.
Power to resist impact, 1,000 : 1,039.
Cold blast 748.1 at 191°. Hot ditto 823.6.

In these experiments, it appeared, that the cold blast lost in strength from 32° up to a blood red, perceptible in the dark as 949.6 to 723.1; whereas, in the hot blast the strength is not so much impaired, being as 917.7 at the freezing point, and 829.7 when perceptibly red in the dark.

In all former experiments on the transverse strain of cast iron, it has been assumed, that the elasticity remained perfect up to one third the breaking weight. In pursuing these experiments, discrepancies were noticed, and results widely different to those generally received were observed. It was found that one seventh, and, in some cases one eighth the breaking weight was sufficient to produce a permanent set. These facts induced an extended series of experiments, principally to determine what load was necessary to effect a permanent set; and, if such weight continued for an indefinite time, would break the bar. It became a question of great importance to know, if a weight, having once impaired the elasticity, would or would not, if continued, increase the deflection. The inquiry, therefore, was—To what extent can cast iron be loaded without endangering its security? To solve this question ten bars of hot and cold blast, differently loaded, were placed upon a frame, to ascertain the amount of deflection at stated periods, and to determine what was necessary to break the bars with their respective loads.

	Inches.
In the cold blast, with a load of 280 lbs., the deflection increased in 103 days from - -	1,025 to 1,033

Hot blast, ditto, from - - - - - 1,173 to 1,197
Cold blast, with a load of 336 lbs., increased in 105
days, from - - - - - - - 1,344 to 1,366
Hot, ditto, from - - - - - - 1,573 to 1,627
Cold, with a load of 392 lbs., increased the deflection
in 108 days, from - - - - - - 1,786 to 1,843
Hot, ditto, from - - - - - - 1,891 to 1,966

Cold blast, with a load of 448 lbs., continued to increase in deflection, and ultimately broke, after sustaining the weight 35 days. All the bars from the hot blast broke in the act of loading them with the above weight, 448 lbs.

Mr. Fairburn stated, that all the irons were made of the same materials, and under the same circumstances. The irons were of fifty sorts.

Mr. Cottam inquired as to the elastic forces. Dr. Young and Mr. Tredgold had found that the strength of the material would fail if loaded beyond its elastic force; he wished to know whether the loads had been more or less than 850 lbs. to the foot. Mr. Fairburn stated that some of the loads were more, some less, and that a weight of 280 lbs. produced a permanent set of an inch square bar. The President remarked, that the calculation as to elastic forces was scarcely to be confided in. Mr. Fairburn, in answer to another question, stated, that the hot blast iron was the more flexible and better capable of bearing impact; but that all the results of impact had been taken from calculations founded on cold blast iron. Mr. Fairburn stated, that the crystalline appearance was finer in hot than in cold blast. There were no experiments made on the loss by remelting, and none on wrought iron,—all on cast iron. In reply to Mr. Cottam, he mentioned, that all the Scotch irons had no cinder; the composition of the others they did not know. Great difficulty had been experienced on this point, because the different manufacturers were unwilling to give information.—Mr. Guest professed on his part the fullest readiness.—Some conversation took place with regard to the peculiarity of appearance in the broken bars. The President remarked, that when a rectangular bar of any substance is exposed either to fracture, or even to temporary deflection, a similar appearance was found: this was known from the experiments on glass by polarized light. Mr. Fairburn in assent said the crystals were always more compact in the edge than in the centre. Mr. Webster inquired whether the elastic weight was always less than one third of the breaking weight. Mr. Fairburn said, always—and afterwards replied to a question from Mr. Guest, that the Scotch hot blast iron showed a greater comparative strength as compared with cold blast, but that they had made no experiments on South Welsh iron. There was a perceptible permanent set from 280 lbs., the experiments being of from five to ten minutes in duration, and it being possible to judge the deflection to the one thousandth part of an inch.—Mr. Webster said it had been found that the first set was owing to the breaking of the first crust, and that beyond the first permanent set up to the elastic limit, the deflexion increases exactly as the weight. Some further conversation ensued, in which Mr. Smith and others took part, when Mr. Guest suggested the propriety of further continuing these researches, to which the President agreed, and suggested a recommendation to this effect from the committee of the section to the general committee. Thanks were then voted to Mr. Fairburn for the zeal and skill with which he had prosecuted these researches for the Association.

Rail Roads and Canals in the United States.—Prof. Henry, of New Jersey College, Princeton, U. S. then addressed the section, and said, he had been requested to present to the Association a map of the United States, in which were marked the railways and canals completed and in progress. They had been fully described in some French works lately published, and in the American Almanac. After enumerating several geographical facts well known to our readers, as to the three natural divisions of America, the Atlantic slope, the middle basin of the Mississippi, and the Pacific slope, &c. he mentioned that there were now one thousand five hundred miles of railway in operation in the United States, and two thousand miles of canals; and that three thousand miles of railway were in progress, which had been in a great degree interrupted, owing to the late commercial convulsions.—In answer to a question put by Mr. De Butts, he stated, that, on the Hudson, there being very little current, one hundred and fifty miles were frequently accomplished by the steamboats in nine hours.—Dr. Lardner much doubted, whether a speed of fifteen miles an hour could be generally attainable.—Mr. Webster stated, that Mr. Blunt, an American engineer, had, in a pamphlet which he quoted, declared, that the American boats had accomplished seventy four miles in five hours, and that the distance from New York to Albany, one hundred and fifty miles, was performed in ten hours by boats built principally with a view to speed.

(To be continued in the next No.)

Art. XIII.—*Remarks on the occurrence of the Aurora Borealis in Summer; with an abstract of Huxham's Auroral Register from* 1728 *to* 1748; by Edward C. Herrick.

At the recent meeting at Liverpool of the British Association for the Advancement of Science, Prof. Christie read a paper, in which he stated his belief that "the occurrence of an Aurora Borealis in England in the middle of summer, is a phænomenon hitherto unrecorded."* This belief is erroneous; and as the opinion is very generally entertained, that the Aurora Borealis is peculiarly a winter phenomenon, it may be worth while to show from published records that it pertains to midsummer no less than to midwinter.

Nearly a century since, John Huxham, one of the most learned physicians of his time, published at London a Treatise on Epidemical Diseases.† Supposing that much information concerning the causes of epidemics might be derived from observations of the weather, he devoted uncommon attention to meteorological studies. In his work, besides the ordinary phenomena of the weather, which he records with much apparent care, he furnishes a register of the Aurora Borealis for the space of twenty years. It cannot be supposed that his record is perfect; for without extraordinary care and good fortune, occasional omissions are unavoidable; yet it is probably a faithful and tolerably complete account of the Aurora Borealis, as seen at Plymouth in England during the time above stated.

A mere quotation from this work, of the great displays of the Aurora Borealis observed in summer, would be sufficient for my present purpose; but as a record of this kind furnishes valuable data for determining whether, as is commonly supposed, the phenomenon returns at certain epochs with unusual frequency and brilliancy, I will here note every case which the author has recorded.

In most of the instances which he has registered, the general character of the event is indicated by a single word; in other cases

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* See an account of Prof. Christie's Memoir, in the London Athenæum of Sept. 30, 1837, (No. 518,) p. 718.

† Observationes de Aëre et Morbis Epidemicis, ab anno 1728 ad finem anni 1737, Plymuthi factæ, etc. Auctore Joanne Huxham, M.D. R.S.S.—edit. secunda, Londini, 1752. 8vo.—Vol. alterum, ab anni nimirum initio 1738, ad exitum usque 1748. Londini, 1752. 8vo.—The first edition of the first volume was published about 1739. I quote from the second edition.

the date only is mentioned. In some of the more important cases, he adds a short and comprehensive description. The dates are given in "the Julian or old style."

1728.	Feb. 26.	Slight.
	Mch. 22.	
	23.	Slight.
	July 2.	Very great: corona.*
	4.	Slight.
	17.	Slight.
	22.	Unusual: slight.
	Aug. 18.	
	20 ?	
	Oct. 1.	
	14.	Slight.
	15.	
	22.	
	Nov. 22.	Slight.
1729.	Jan. 6.	Very great.
	14.	Great.
	Apl. 11.	
	21.	Slight.
	May 6.	Slight.
	Sept. 12.	
	Oct. 14.	
	Nov. 5.	Great.
1730.	Feb. 23.	Very great.
	Mch. 9.	Slight.
	Apl. 1.	Slight.
	Aug. 28.	Great.
	Sept. 24.	Slight.
	26.	Bright.
	27.	
1731.	Feb. 19.	Slight.
	Apl. 26.	Very great.
	Aug. 16.	Slight.
	Sept. 13.	Slight.
	27.	Very great.
	Dec. 19.	Slight.
1732.	Jan. 18.	Slight.
	Feb. 7.	Slight.
1733.	Feb. 2.	Slight.
	Mch. 21.	Slight.
	June 27.	Very great.
	July 10.	Great.
1733.	Sept. 8.	Great.
	29.	Slight.
	Oct. 27.	Great.
	Nov. 27.	Great.
	29.	
1734.	May 14.	Slight.
	15.	Slight.
	Sept. 9.	Slight.
1735.	Aug. 20.	Great.
	Oct. 3.	Slight.
1736.	Feb. 6.	Great: corona.
	7.	Slight.
	19.	Slight.
	Aug. 25.	Narrow zone fr. E. to W.
	29.	
	Sept. 26.	Slight.
	27.	Slight.
	Oct. 27.	
	Nov. 7.	Slight.
	8.	Greater than 7th.
	13.	Great and variegated.
1737.	Mch. 7.	Slight.
	18.	
	Aug. 9.	
	10.	Very gr't: corona: fiery.
	11.	do. do. do.
	12.	Slight.
	Nov. 1.	
	7.	
	Dec. 1.	Great. Uncertain.
1738.	Jan. 14.	Great.
	Apl. 5.	Slight.
	Oct. 21.	
	24.	
	25.	
	27.	
1739.	Feb. 23.	Great.
	Mch. 1.	Great.
	15.	Great: corona: fiery.
	30.	Great: corona.
	Apl. 20.	Great: fiery.

* The description of this case would apply very well to the display of July 1, 1837, as seen here. "Permagnum observavi Lumen Boreale, cujus Radii lucidi at non colorati, vibrantes, terminari videbantur in coruscante quasi Umbella, paulo ultra Zenith." Vol. i. p. 12.

1739.	Sept. 12.	
	13.	
1740.	Mch. 12.	Great.
	13.	Slight.
	14.	
	May 27.	
1741.	Mch. 5.	
	9.	Slight.
	21.	
	June 29.*	
	July 12.	Very great.
	Sept. 21.	Great.
	27.	
1742.	Feb. 20.	
	Mch. 5.	Slight.
	6.	Narrow zone from N. E. [to S. W.
	15.	Very great.
	16.	
	24.	
1743.	Jan. 12.	Great.
1743.	Mch. 8.	Very great.
	Apl. 1.	Slight.
	June 28.	Slight.
1744.	Mch. 22.	Brilliant.
	Dec. 14.	
	24.	
1745.	Feb. 9.	Great,
		and a slight one in Feb. without date.
1746.	Feb. 9.	
	27.	
	Mch. 14.	
	Oct. 7.	
	Dec. 28.	
1747.	Jan. 2.	Slight.
	Mch. 22.	
	Nov. 21.	Great.
	Dec. 6.	Very great: fiery.
1748.	Jan. 22.	Slight.
	Aug. 28.	Very great: fiery.
	Dec. 4.	Great.

From the above register, it appears that some of the most brilliant displays of the Aurora Borealis witnessed during the period of record, occurred in June, July and August.

Dr. Henry Gibbons, in a valuable essay on the Aurora Borealis, contained in "The Advocate of Science and Annals of Nat. Hist." 8vo. Philad. 1834, Vol. i. p. 21–25, gives a tabular view of all the Auroræ witnessed by him at Wilmington, Delaware, from Aug. 28, 1827, to the end of December, 1833, together with the meteorological circumstances of each occurrence. This record plainly contradicts the prevailing opinion stated in the former part of this paper. The following are the dates of each instance: 1827. Aug. 28; Sept. 8, 9, 25; Nov. 9, 18.—1828. Jan. 18; Sept. 26, 27.—1829. Jan. 28; March 18; Dec. 19.—1830. May 6, 14, 15; June 10, 11; July 14; Aug. 15, 20; Sept. 12, 15, 16, 17; Oct. 9; Dec. 11, 12.—1831. Jan. 6, 7; Feb. 6; March 8; April 20; May 8; June 10; July 4, 5, 10, 31; Oct. 29.—1832. Jan. 22; March 27; Aug. 22, 23; Sept. 30; Nov. 14.—1833. Jan. 2; March 21; May 17; June 17; July 10; Oct. 13; Dec. 15.

The Aurora has been abundant during the recent summer. It was observed here three times in June, seven in July, and six in August. There were fourteen evenings in June, seven in July, and ten in August, in which the sky was overcast, so that no Aurora could have been seen.

* This case is uncertain. "Arcus nempe igneus lucidus valde ab horizonte prope S. E. ad gradus saltem 90 projectus."

A display of the Aurora Borealis is often a very extensive phenomenon. That of February 18, 1837, which was seen in many parts of Europe, was also noticed here.* Prof. Christie, in his memoir above cited, mentions its occurrence in England this year, May 19, June 24, July 1, 2, 7, and August 25. At this place, on the night of May 19, the sky was entirely overcast, and rain was falling: observation on the Aurora was of course impossible. On the 24th of June, there was an unusual display here and in Vermont. On the 1st of July, the exhibition was very grand, and nearly equal to any ever witnessed in this region.† A slight appearance of it was seen on the 2d. The evening of the 7th was mostly overcast, and the moon was shining. No Aurora was detected, and none, unless uncommonly brilliant, could have been seen. On the 25th of August there was here a moderate display; at Castleton, (Vermont) a corona was formed, and the whole exhibition was one of great brilliancy and beauty.

It is greatly to be desired that careful contemporaneous observations on the Aurora Borealis should be made by persons stationed at many different and distant places. Within the last two hundred years, a vast multitude of isolated accounts have been recorded, most of which are of comparatively little value to science. A tenth part of the labor which they have cost, had it been spent in well concerted contemporaneous observations in different parts of the world, would long ere this have contributed important data for a satisfactory theory. The most probable opinion is, that the Aurora is in some way a result of magneto-electric action, but the laws which govern its capricious appearances have thus far eluded all investigation.

No facts have to my knowledge hitherto been published which throw any light on the question, whether during an appearance of the Aurora in the United States, attended by a disturbance of the needle, a correspondent magnetic disturbance and auroral appearance can be detected at about the same distance from the corresponding magnetic pole in New Holland. Is it too much to hope that some of the many American ships which traverse the Indian ocean, where opportunities for making the necessary observations must often occur, will hereafter bring home the desired information?

New Haven, Conn. Nov. 11, 1837.

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* See this Journal, vol. xxxii. p. 396. † See p. 144 of this volume.

ART. XIV.—*Some account of two visits to the Mountains in Essex County, New York, in the years* 1836 *and* 1837; *with a Sketch of the Northern Sources of the Hudson;* by W. C. REDFIELD.

NOTWITHSTANDING the increase of population, and the rapid extension of our settlements since the peace of 1783, there is still found, in the northern part of the state of New York, an uninhabited region of considerable extent, which presents all the rugged characters and picturesque features of a primeval wilderness. This region constitutes the most elevated portion of the great triangular district which is situated between the line of the St. Lawrence, the Mohawk, and Lake Champlain. That portion of it which claims our notice in the following sketches, lies mainly within the county of Essex, and the contiguous parts of Franklin, and comprises the head waters of the principal rivers in the northern division of the state.

In the summer of 1836, the writer had occasion to visit the new settlement at McIntyre, in Essex County, in company with the proprietors of that settlement, and other gentlemen who had been invited to join the expedition. Our party consisted of the Hon. Archibald McIntyre of Albany, the late Judge McMartin of Broadalbin, Montgomery county, and David Henderson, Esq. of Jersey City, proprietors, together with David C. Colden, Esq. of Jersey City, and Mr. James Hall, assistant state geologist for the northern district.

First Journey to Essex.

We left Saratoga on the 10th of August, and after halting a day at Lake George, reached Ticonderoga on the 12th; where at 1 P. M. we embarked on board one of the Lake Champlain steamboats, and were landed soon after 3 P. M., at Port Henry, two miles N. W. from the old fortress of Crown Point. The remainder of the day, and part of the 14th, were spent in exploring the vicinity, and examining the interesting sections which are here exhibited of the junction of the primary rocks with the transition series, near the western borders of the lake, and we noticed with peculiar interest the effect which appears to have been produced by the former upon the transition limestone at the line of contact; the latter being here converted into white masses, remarkably crystaline in their structure, and interspersed with scales of plumbago.

On the evening of the 13th we were entertained with a brilliant exhibition of the Aurora Borealis, which, between 7 and 8 P. M., shot upward in rapid and luminous coruscations from the northern half of the horizon, the whole converging to a point apparently fifteen degrees south of the zenith. This appearance was succeeded by luminous vertical columns or pencils of the color, alternately, of a pale red and a peculiar blue, which were exhibited in great beauty.

On the 13th we left Port Henry on horseback, and, after a ride of six miles, left the cultivated country on the borders of the lake and entered the forest. The road on which we traveled is much used for the transportation of sawed pine lumber from the interior, there being in the large township of Moriah, as we were informed, more than sixty saw-mills. Four hours of rough traveling brought us to Weatherhead's, at West Moriah, upon the Schroon river, or East Branch of the Hudson, thirteen miles from Lake Champlain. An old state road from Warren County to Plattsburgh passes through this valley, along which is established the line of interior settlements, in this part of the county. Our further rout to the westward was upon a newer and more imperfect road, which has been opened from this place through the unsettled country in the direction of the Black River, in Lewis County. We ascended by this road the woody defiles of the Schroon mountain-ridge, which, as seen from Weatherhead's, exhibits, in its lofty and apparently continuous elevations, little indications of a practicable rout. Having passed a previously unseen gorge of this chain, we continued our way under a heavy rain, till we reached the dwelling of Israel Johnson, who has established himself at the outlet of a beautiful mountain lake, called Clear Pond, nine miles from Schroon river. This is the only dwelling house upon the new road.

To travel in view of the log fences and fallen trees of a thickly wooded country, affords a favorable opportunity for observing the specific spiral direction which is often found in the woody fibre of the stems of forest trees, of various species. In a large proportion of the cases which vary from a perpendicular arrangement, averaging not less than seven out of eight, the spiral turn of the fibres of the stem in ascending from the ground, *is towards the left,* or in popular language, against the sun. It is believed that no cause has been assigned for this by writers on vegetable physiology. The direction, in these cases, coincides with the direction of rotation in our great storms, as well as with that of the tornado which visited New Brunswick in 1835 and other whirlwinds of like character, the traces of which have been carefully examined.

We resumed our journey on the morning of the 15th, and at 9 A. M. reached the Boreas branch of the Hudson, eight miles from Johnson's. Soon after 11 A. M., we arrived at the Main Northern Branch of the Hudson, a little below its junction with the outlet of Lake Sanford. Another quarter of an hour brought us to the landing at the outlet of the lake, nine miles from the Boreas. Taking leave of the "road," we here entered a difficult path which leads up the western side of the lake, and a further progress of six miles brought us to the Iron Works and settlement at McIntyre, where a hospitable reception awaited us.

Settlement at McIntyre.—Mineral Character of the Country.

At this settlement, and in its immediate vicinity, are found beds of iron ore of great, if not unexampled extent, and of the best quality. These deposits have been noticed in the first report of the state geologists, and have since received from Professor Emmons a more extended examination. Lake Sanford is a beautiful sheet of water, of elongated and irregular form, and about five miles in extent. The Iron Works are situated on the north fork of the Hudson, a little below the point where it issues from Lake Henderson, and over a mile above its entrance into Lake Sanford. The fall of the stream between the two lakes is about one hundred feet. This settlement is situated in the upper plain of the Hudson, and at the foot of the principal mountain nucleus, which rises between its sources and those of the Au Sable.

A remarkable feature of this mountain district, is the uniformity of the mineral character of its rocks, which consist chiefly of the dark colored and sometimes opalescent feldspar, known as *labradorite*, or Labrador feldspar. Towards the exterior limits of the formation, this material is accompanied with considerable portions of green augite or pyroxene, but in the more central portions of the formation, this feldspar often constitutes almost the only ingredient of the rocks. It seems not a little repugnant to our notions of the primary rocks, to find a region of this extent which is apparently destitute of mica, quartz, and hornblende, and also, of any traces of stratified gneiss. This labradoritic formation commences at the valley of the Schroon river, and extends westerly into the counties of Hamilton and Franklin, to a limit which is at present unknown. Its northern limit appears to be at the plains which lie between the upper waters of the Au Sable and Lake Placid, and its southern boundary which extends as far as Schroon, has not been well defined. It appears probable that it comprises an area of six or eight hundred square miles, including most of the principal mountain masses in this part of the state. So far as is known to the writer, no foreign rocks or boulders of any size or description are found in this region, if we are not to except as such, the fragments of the dykes, chiefly of trap, by which this rock is frequently intersected.

The surface of the rock where it has been long exposed to the weather, has commonly a whitened appearance, owing to its external decomposition. Blocks and boulders of this rock are scattered over the country in a southerly and westerly direction, as far as the southern boundary of the state, as appears from the Report of Professor Emmons* and other observations, and they are often lodged on the northern declivity of hills, high above the general level of the country. The most eastern of these transported boulders known to the writer, is one of about one hundred tons weight, at Cocksackie, on the Hudson, one hundred and thirty miles south from the labradoritic mountains. This block is found on a hill, three hundred feet above the river, and one hundred and fifty feet above the general level of the adjacent country.

First Expedition to the Mountains.—Encampment.

It has been noticed that the north branch of the Hudson, after its exit from Lake Sanford, joins the main branch of the river, about seven miles below the settlement at McIntyre. Having prepared for an exploration up the latter stream, we left McIntyre on the 17th of July, with three assistants, and the necessary equipage for encampment. Leaving the north branch, we proceeded through the woods in a southeasterly direction, passing two small lakes, till, at the distance of three or four miles from the settlement, we reached the southern point of one of the mountains, and assuming here a more easterly course, we came, about noon, to the main branch of the river. Traces of wolves and

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* Geological Report, p. 110.

deer were frequently seen, and we discovered also the recent tracks of a moose deer or the American elk. We had also noticed on the 16th, at the inlet of Lake Sanford, the fresh and yet undried footsteps of a panther, which apparently had just crossed the inlet.

The beaches of the river, on which, by means of frequent fording, we now traveled, are composed of rolled masses of the labradoritic rock, and small opalescent specimens not unfrequently showed their beautiful colors in the bed of the stream. As we approached the entrance of the mountains, the ascent of the stream sensibly increased, and about 4 P. M., preparations were commenced for our encampment. A comfortable hut, of poles and spruce bark, was soon constructed by the exertions of our dexterous woodsmen. The camp-fire being placed on the open side, the party sleep with their heads in the opposite direction, under the lower part of the roof.

On the morning of the 18th we resumed the ascent of the stream by its bed, in full view of two mountains, from between which the stream emerges. About two miles from our camp, we entered the more precipitous part of the gorge through which the river descends. Our advance here became more difficult and somewhat dangerous. After ascending falls and rapids, seemingly innumerable, we came about noon to an imposing cascade, closely pent between two steep mountains, and falling about eighty feet into a deep chasm, the walls of which are as precipitous as those of Niagara, and more secluded. With difficulty we emerged from this gulf, and continued our upward course over obstacles similar to the preceding, till half past 2 P. M., when we reached the head of this terrific ravine. From a ledge of rock which here crosses and obstructs the stream, the river continues, on a level which may be called the Upper Still Water, for more than a mile in a westerly and northwesterly direction, but continues pent in the bottom of a deep mountain gorge or valley, with scarce any visible current. To this point the river had been explored by the proprietors on a former occasion.

Lake Colden.—Mountain Peaks.

Emerging from this valley, we found the river to have a meandering course of another mile, in a northwesterly and northerly direction, with a moderate current, until it forks into two unequal branches. Leaving the main branch which here descends from the east, we followed the northern tributary to the distance of two hundred yards from the forks, where it proved to be the outlet of a beautiful lake, of about a mile in extent. This lake, to which our party afterwards gave the name of Lake Colden, is situated between two mountain peaks which rise in lofty grandeur on either hand. We made our second camp at the outlet of this lake, and in full view of its interesting scenery.

Previous to reaching the outlet, we had noticed on the margin of the river, fresh tracks of the wolf and also of the deer, both apparently made at the fullest speed, and on turning a point we came upon the warm and mangled remains of a fine deer, which had fallen a sacrifice to the wolves; the latter having been driven from their savage repast by our unwelcome approach. There appeared to have been two of the aggressive party, one of which, by lying in wait, had probably intercepted the deer in his course to the lake, and they had nearly devoured their victim in apparently a short space of time.

The great ascent which we had made from our first encampment, and the apparent altitude of the mountain peaks before us, together with the naked condition of their summits, rendered it obvious that the elevation of this mountain group had been greatly underrated; and we were led to regret our want of means for a barometrical measurement. The height of our present encampment above Lake Sanford was estimated to be from ten to twelve hundred feet, and the height of Lake Colden, above tide, at from one thousand eight hundred, to two thousand feet, the elevation of Lake Sanford being assumed from such information as we could obtain, to be about eight hundred feet. The elevation of the peaks on either side of Lake Colden, were estimated from two thousand, to two thousand five hundred feet above the lake. These conclusions were entered in our notes, and are since proved to have been tolerably correct, except as they were founded on the supposed elevation of Lake Sanford, which had been very much underrated.

August 19th. The rain had fallen heavily during the night, and the weather was still such as to preclude the advance of the party. But the ardor of individuals was hardly to be restrained by the storm; and during the forenoon, Mr. Henderson, with John Cheney, our huntsman, made the circuit of Lake Colden, having in their course beaten up the quarters of a family of panthers, to the great discomfiture of Cheney's valorous dog. At noon, the weather being more favorable, Messrs. McIntyre, McMartin and

Hall, went up the border of the lake to examine the valley which extends beyond it in a N. N. E. and N. E. direction, while the writer, with Mr. Henderson, resumed the ascent of the main stream of the Hudson. Notwithstanding the wet, and the swollen state of the stream, we succeeded in ascending more than two miles in a southeasterly and southerly direction, over a constant succession of falls and rapids of an interesting character. In one instance, the river has assumed the bed of a displaced trap dyke, by which the rock has been intersected, thus forming a chasm or sluice of great depth, with perpendicular walls, into which the river is precipitated in a cascade of fifty feet.

Before returning to camp, the writer ascended a neighboring ridge for the purpose of obtaining a view of the remarkably elevated valley from which the Hudson here issues. From this point a mountain peak was discovered, which obviously exceeds in elevation the peaks which had hitherto engaged our attention. Having taken the compass bearing of this peak, further progress was relinquished, in hope of resuming the exploration of this unknown region on the morrow.

Avalanche Lake.—Return to the Settlement.

On returning to our camp, we met the portion of our party which had penetrated the valley north of the lake, and who had there discovered another lake of nearly equal extent, which discharges by an outlet that falls into Lake Colden. On the two sides of this lake, the mountains rise so precipitously as to preclude any passage through the gorge, except by water. The scenery was described as very imposing, and some fine specimens of the opalescent rock were brought from this locality. Immense slides or avalanches had been precipitated into this lake from the steep face of the mountain, which induced the party to bestow upon it the name of Avalanche Lake.

Another night was passed at this camp, and the morning of the 20th opened with thick mists and rain, by which our progress was further delayed. It was at last determined, in view of the bad state of the weather and our short stock of provisions, to abandon any further exploration at this time, and to return to the settlement. Retracing our steps nearly to the head of the Still Water, we then took a westerly course through a level and swampy tract, which soon brought us to the head waters of a stream which descends nearly in a direct course to the outlet of Lake Henderson. The distance from our camp at Lake Colden to McIntyre, by this rout, probably does not exceed six miles. Continuing our course, we reached the settlement without serious accident, but with an increased relish for the comforts of civilization.

This part of the state was surveyed into large tracts, or townships, by the colonial government, as early as 1772, and lines and corners of that date, as marked upon the trees of the forest, are now distinctly legible. But the topography of the mountains and streams in the upper country, appears not to have been properly noted, if at all examined, and in our best maps, has either been omitted or represented erroneously. Traces have been discovered near McIntyre of a rout, which the natives sometimes pursued through this mountain region, by way of Lakes Sanford and Henderson, and thence to the Preston Ponds and the head waters of the Racket. But these savages had no inducement to make the laborious ascent of sterile mountain peaks, which they held in superstitious dread, or to explore the hidden sources of the rivers which they send forth. Even the more hardy huntsman of later times, who, when trapping for northern furs, has marked his path into the recesses of these elevated forests, has left no traces of his axe higher than the borders of Lake Colden, where some few marks of this description may be perceived. All here seems abandoned to solitude; and even the streams and lakes of this upper region are destitute of the trout, which are found so abundant below the cataracts of the mountains.

Whiteface Mountain.—The Notch.

At a later period of the year, Professor Emmons, in the execution of his geological survey, and accompanied by Mr. Hall, his assistant, ascended the Whiteface Mountain, a solitary peak of different formation, which rises in the north part of the county. From this point, Prof. E. distinctly recognized as the highest of the group, the peak on which the writer's attention had been fastened at the termination of our ascent of the Hudson, and which he describes as situated about sixteen miles south of Whiteface. Prof. E. then proceeded southward through the remarkable Notch, or pass, which is described in his Report, and which is situated about five miles north from McIntyre. The Wallface mountain, which forms the west side of the pass, was ascended by him on this occasion, and the height of its perpendicular part was ascertained to be about twelve hundred feet, as may be seen by reference to the geological Report which was published in February last, by order of the legislature. It appears by the barometrical observations made by Prof. Emmons, that the elevation of the table land which constitutes the base of these mountains at McIntyre, is much greater than we had been led to suppose.

Second Journey to Essex County.

The interest excited in our party by the short exploration which has been described, was not likely to fail till its objects were more fully accomplished. Another visit to this alpine region was accordingly made in the summer of the present year. Our party on this occasion consisted of Messrs. McIntyre, Henderson and Hall, (the latter at this time geologist of the western district of the state,) together with Prof. Torrey, Prof. Emmons, Messrs. Ingham and Strong of New York, Miller of Princeton, and Emmons, Jr. of Williamstown.

We left Albany on the 28th of July, and took steamboat at Whitehall on the 29th. At the latter place an opportunity was afforded us to ascend the eminence known as Skeenes' mountain, which rises about five hundred feet above the lake. Passing the interesting ruins of Ticonderoga and the less imposing military works of Crown Point, we again landed at Port Henry and proceeded to the pleasant village of East Moriah, situated upon the high ground, three and a half miles west of the lake. This village is elevated near eight hundred feet above the lake, and commands a fine view of the western slope of Vermont, terminating with the extended and beautiful outline of the Green Mountains.

We left East Moriah on the 31st, and our first day's ride brought us to Johnson's at Clear Pond. The position of the High Peak of Essex was known to be but a few miles distant, and Johnson informed us that the snow remained on a peak which is visible from near his residence, till the 17th of July of the present year. We obtained a fine view of this peak the next morning, bearing from Johnson's, N. 20° West, by compass, a position which corresponded to the previous observations; the variation in this quarter being somewhere between 8° and 9° West.

Descending an abrupt declivity from Johnson's, we arrive at a large stream which issues from a small lake farther up the country, and receiving here the outlet of Clear Pond, discharges itself into the Schroon river. The upper portions of these streams and the lakes from which they issue, as well as the upper course of the Boreas and its mountain lakes, are not found on our maps. From the stream last mentioned, the road ascends the Boreas ridge or mountain chain by a favorable pass, the summit of which is attained about four miles from Johnson's. Between the Boreas and the main branch of the Hudson, we encounter a subordinate extension of the mountain group which separates the sources of the two streams, through the passes of which ridge the road is carried by a circuitous and uneven route.

We reached the outlet of Lake Sanford about noon on the 1st of August, and found two small boats awaiting our arrival. Having embarked we were able fully to enjoy the beauty and grandeur of the lake and mountain scenery which is here presented, all such views being, as is well known, precluded by the foliage while traveling in the forests. The echoes which are obtained at a point on the upper portion of this lake, are very remarkable for their strength and distinctness. The trout are plentiful in this lake, as well as in lake Henderson and all the neighboring lakes and streams. We arrived at McIntyre about 4 P. M., and the resources of the settlement were placed in requisition by the hospitable proprietors, for our expedition to the source of the Hudson.

Barometrical Observations on the Rout.

The following table shows the observations made with the barometer at different points on our rout, and the elevation above tide water as deduced from these observations and others made on the same days at Albany, by Matthew Henry Webster, Esq. No detached thermometer was used, the general exposure of the attached thermometers to the open air being such as to indicate the temperature of the air, at both the upper and lower stations, with tolerable accuracy. In the observations with the mountain barometer a correction is here made for variation in the cistern, equal to one fiftieth of the depression which was found below the zero adjustment at thirty inches.

It is proper also to state, that the two mountain barometers made use of, continued in perfectly good order during our tour, and agreed well with each other in their zero adjustment, which is such as will give a mean annual height of full thirty inches at the sea level; but, like other barometers which have leather bottomed cisterns, are liable to be somewhat affected by damp and warm weather when in the field, and it is possible that this hygrometric depression may have slightly affected some of the observations which here follow.

Date.	Place of observation.	Hour.	Upper station.—Barom. corrected 1-50 for variation of cistern.		Lower station.—60 feet above tide at Albany.		Corrected height in feet, above tide.
			Att. Th.	Barom.	Att. Th.	Barom.	
July 29,	Lake Champlain at White Hall, - - -	9 A. M.	72°	29.91	-	-	90
"	Summit of Skeenes' Mountain at Do.* -	8.40 "	71	29.39	-	-	588
"	Lake Champlain at Port Henry, - - -	5 P. M.	73	29.91			
"	East Moriah, Four Corners,† - - -	5.45 "	71	29.09	-	-	880
July 31,	Road summit, 9 miles from Lake Champlain,	10.45 A. M.	71	28.42	72°	29.94	1.546
"	West Moriah, at Weatherhead's, Schroon valley,	1.15 P. M.	75	28.86	75	"	1.117
"	Road summit, pass of Schroon Mountain,	4 "	69	28.67	73	29.93	1.375
"	Johnson's, at Clear Pond, - - - -	5.50 "	67	27.93	72	"	2.012
Aug. 1,	Do. Do. Second observation,‡	6.20 A. M.	62	28 03	70	30.04	1.991
"	Road summit, ridge west of Johnson's, -	8 "	64	27.45	71	"	2.592
"	Boreas River bridge, - - - - - -	9.45 "	69	28.01	73	30.02	2.026
"	Hudson River bridge, - - - - - -	12.30 P. M.	78	28.19	79	29.95	1.810
"	Lake Sanford inlet, - - - - - -	4 "	76	28.17	78	"	1.826
"	Iron Works at McIntyre, - - - -	4.20 "	76	28.11	77	"	1.889
"	Lake Henderson outlet, - - - -	4.40 "	75	28.06	76	"	1.936

Lake Champlain is about ninety feet above tide water.

It appears from the above that the two principal depressions in the section of country over which this road passes, west of the Schroon valley, is in one case two thousand and in the other eighteen hundred feet in elevation.

Second Expedition to the Mountains.

We left the settlement on the 3d of August, with five woodsmen as assistants, to take forward our provisions and other necessaries, and commenced our ascent to the higher region in a northeasterly direction, by the rout on which we returned last year. We reached our old camp at Lake Colden at 5 P. M. where we prepared our quarters for the night. The mountain peak which rises on the eastern side of this lake and separates it from the upper valley of the main stream of the Hudson, has received the name of Mount McMartin, in honor of one now deceased, who led the party of last year, and whose spirit of enterprise and persevering labors contributed to establishing the settlement at the great Ore Beds, as well as other improvements advantageous to this section of the state.

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* Four hundred and ninety eight feet above Lake Champlain.

† Seven hundred and ninety feet above do.

‡ Mean of the two setts of observations two thousand feet, nearly.

On the 4th we once more resumed the ascent of the main stream, proceeding first in an easterly direction, and then to the southeast and south, over falls and rapids, till we arrived at the head of the Great Dyke Falls. Calcedony was found by Prof. Emmons near the foot of these falls. Continuing our course on a more gradual rise, we soon entered upon unexplored ground, and about three miles from camp, arrived at the South Elbow, where the bed of the main stream changes to a northeasterly direction, at the point where it receives a tributary which enters from south-southwest. Following the former course, we had now fairly entered the High Valley which separates Mount McMartin from the High Peak on the southeast, but so deeply enveloped were we in the deep growth of forest, that no sight of the peaks could be obtained. About a mile from the South Elbow we found another tributary entering from south-southeast, apparently from a mountain ravine which borders the High Peak on the west. Some beautifully opalescent specimens of the Labradorite were found in the bed of this stream.

High Valley of the Hudson.

Another mile of our course brought us to a smaller tributary from the north, which from the alluvial character of the land near its entrance is called the High Meadow fork. This portion of our rout is in the center of this mountain valley, and has the extraordinary elevation of three thousand and seven hundred feet above tide. We continued the same general course for another mile, with our rout frequently crossed by small falls and cascades, when we emerged from the broader part of the valley and our course now became east-southeast and southeast, with a steeper ascent and higher and more frequent falls in the stream. The declivity of the mountain which incloses the valley on the north and that of the great peak, here approximate closely to each other, and the valley assumes more nearly the character of a ravine or pass between two mountains, with an increasing ascent, and maintains its course for two or three miles, to the summit of the pass. Having accomplished more than half the ascent of this pass we made our camp for the night, which threatened to be uncommonly cold and caused our axemen to place in requisition some venerable specimens of the white birch which surrounded our encampment.

Phenomena of Mountain Slides.

A portion of the deep and narrow valley in which we were now encamped, is occupied by a longitudinal ridge consisting of boulders and other *debris,* the materials, evidently, of a tremendous slide or avalanche, which at some unknown period has descended from the mountain; the momentum of the mass in its descent having accumulated and pushed forward the ridge, after the manner of the late slide at Troy, beyond the center of the valley or gorge into which it is discharged. It appears indeed that the local configuration of surface in these mountain valleys, except where the rock is in place, ought to be ascribed chiefly to such causes. It seems apparent, also, that the Hudson, at the termination of its descent from the High Valley, once discharged itself into Lake Colden, the latter extending southward at that period to the outlet of the Still Water, which has been noticed in our account of the former exploration. This portion of the ancient bed of the lake has not only been filled and the bed of the stream as well as the remaining surface of the lake, raised above the former level, but a portion of the finer *debris* brought down by the main stream, has flowed northwardly into the present lake and filled all its southern portions with a solid and extensive shoal, which is now fordable at a low stage of the water. The fall of heavy slides from the mountains appears also to have separated Avalanche Lake from Lake Colden, of which it once formed a part, and so vast is the deposit from these slides as to have raised the former lake about eighty feet above the surface of the latter. In cases where these slides have been extensive, and rapid in their descent, large hillocks or protuberances are formed in the valleys; and the denudation from above, together with the accumulation below, tends gradually to diminish the extent and frequency of their occurrence. But the slides still recur, and their pathway may often be perceived in the glitter of the naked rock, which is laid bare in their course from the summit of the mountain towards its base, and these traces constitute one of the most striking features in the mountain scenery of this region.

Main Source of the Hudson.—Fall of the Au Sable.

On the morning of the fifth we found that ice had formed in exposed situations. At an early hour we resumed our ascending course to the southeast, the stream rapidly diminishing and at length becoming partially concealed under the grass-covered boulders. At 8.40 A. M. we arrived at the head of the stream on the summit of this elevated pass, which here forms a beautiful and open mountain meadow, with the ridges of the two adjacent mountains rising in an easy slope from its sides. From this little meadow, which lies within the present limits of the town of Keene, the main branch of the Hudson and a fork of the east branch of the Au Sable commence their descending course in opposite directions, for different and far distant points of the Atlantic ocean. The elevation of this spot proves by our observations to be more than four thousand seven hundred feet above tide water; being more than nine hundred feet above the highest point of the Catskill mountains, which have so long been considered the highest mountains in this state.

The descent of the Au Sable from this point is most remarkable. In its comparative course to Lake Champlain, which probably does not exceed forty miles, its fall is more than four thousand six hundred feet! This, according to our present knowledge, is more than twice the entire descent of the Mississippi proper, from its source to the ocean. Water-falls of the most striking and magnificent character are known to abound on the course of this stream.

High Peak of Essex.

Our ascent to the source of the Hudson had brought us to an elevated portion of the highest mountain peak, which was also a principal object of our exploration, and its ascent now promised to be of easy accomplishment by proceeding along its ridge in a W. S. W. direction. On emerging from the pass, however, we immediately found ourselves entangled in the zone of dwarfish pines and spruces, which with their numerous horizontal branches interwoven with each other, surround the mountain at this elevation. These gradually decreased in height, till we reached the open surface of the mountain, covered only with mosses and small alpine plants, and at 10 A. M. the summit of the High Peak of Essex was beneath our feet.

The aspect of the morning was truly splendid and delightful, and the air on the mountain-top was found to be cold and bracing. Around us lay scattered in irregular profusion, mountain masses of various magnitudes and elevations, like to a vast sea of broken and pointed billows. In the distance lay the great valley or plain of the St. Lawrence, the shining surface of Lake Champlain, and the extensive mountain range of Vermont. The nearer portions of the scene were variegated with the white glare of recent mountain slides as seen on the sides of various peaks, and with the glistening of the beautiful lakes which are so common throughout this region. To complete the scene, from one of the nearest settlements a vast volume of smoke soon rose in majestic splendor, from a fire of sixty acres of forest clearing, which had been prepared for the "burning," and exhibiting in the vapor which it embodied, a gorgeous array of the prismatic colors, crowned with the dazzling beams of the midday sun.

The summit, as well as the mass of the mountain, was found to consist entirely of the labradoritic rock, which has been mentioned as constituting the rocks of this region, and a few small specimens of hypersthene were here procured. On some small deposits of water, ice was also found at noon, half an inch in thickness. The source of the Hudson, at the head of the High Pass, bears N. 70° E. from the summit of this mountain, distant one and a quarter miles, and the descent of the mountain is here more gradual than in any other direction. Before our departure we had the unexpected satisfaction to discover, through a depression in the Green Mountains, a range of distant mountains in nearly an east direction, and situated apparently beyond the valley of the Connecticut; but whether the range thus seen, be a portion of the White Mountains of New Hampshire or the mountains of Franconia, near the head of the Merrimack, does not fully appear. Our barometrical observations on this summit show an elevation of five thousand four hundred and sixty seven feet. This exceeds by about six hundred feet, the elevation of the Whiteface Mountain, as given by Prof. Emmons; and is more than sixteen hundred and fifty feet above the highest point of the Catskill Mountains.

Wear of River Boulders.

The descent to our camp was accomplished by a more direct and far steeper rout than that by which we had gained the summit, and our return to Lake Colden afforded us no new objects of examination. The boulders which form the bed of the stream in the upper Hudson, are often of great magnitude, but below the mountains, where we commenced our exploration last year, the average size does not much exceed that of the paving stones in our cities;—so great is the effect of the attrition to which these boulders are subject in their gradual progress down the stream. Search has been made by the writer, among the gravel from the bottom and shoals of the

Hudson near the head of tide-water, for the fragmentary remains of the labradoritic rock, but hitherto without success. We may hence infer that the whole amount of this rocky material, which, aided by the ice, and the powerful impulse of the annual freshets, finds its way down the Hudson, a descent of from two thousand to four thousand seven hundred feet, is reduced by the combined effects of air, water, frost, and attrition, to an impalpable state, and becomes imperceptibly deposited in the alluvium of the river, or continuing suspended, is transferred to the waters of the Atlantic.

Great Trap Dyke.

On the 7th of August we visited Avalanche Lake, and examined the great dyke of sienitic trap in Mount McMartin, which cuts through the entire mountain in the direction from west-northwest to east-southeast. This dyke is about eighty feet in width, and being in part broken from its bed by the action of water and ice, an open chasm is thus formed in the abrupt and almost perpendicular face of the mountain. The scene on entering this chasm is one of sublime grandeur, and its nearly vertical walls of rock, at some points actually overhang the intruder, and seem to threaten him with instant destruction. With care and exertion this dyke may be ascended, by means of the irregularities of surface which the trap rock presents, and Prof. Emmons by this means accomplished some twelve or fifteen hundred feet of the elevation. His exertions were rewarded by some fine specimens of hypersthene and of the opalescent labradorite, which were here obtained. The summit of Mount McMartin is somewhat lower than those of the two adjacent peaks, and is estimated at four thousand nine hundred and fifty feet above tide.

The distance from the outlet of Lake Colden to the opposite extremity of Avalanche Lake is estimated at two and a quarter miles. The stream which enters the latter at its northern extremity, from the appearance of its valley, is supposed to be three-fourths of a mile in length, and the fall of the outlet in its descent to Lake Colden is estimated, as we have seen, at eighty feet. The head waters of this fork of the Hudson are hence situated farther north than the more remote source of the Main Branch, which we explored on the 4th and 5th, or perhaps than any other of the numerous tributaries of the Hudson. The elevation of Avalanche Lake is between two thousand nine hundred and three thousand feet above tide, being undoubtedly the highest lake in the United States, east of the Rocky Mountains.

The mountain which rises on the west side of this lake and separates its valley from that of the Au Sable, is perhaps the largest of the group. Its ridge presents four successive peaks, of which the most northern save one, is the highest, and is situated immediately above the lake and opposite to Mount McMartin. It has received the name of Mount McIntyre, in honor of the late Controller of this state, to whose enterprise and munificence, this portion of the country is mainly indebted for the efficient measures which have been taken to promote its prosperity.

Ascent of Mount McIntyre.

On the morning of the 8th, we commenced the ascent of Mount McIntyre through a steep ravine, by which a small stream is discharged into Lake Colden. The entire ascent being comprised in little more than a mile of horizontal distance, is necessarily difficult, and on reaching the lower border of the belt of dwarf forest, we found the principal peak rising above us on our right, with its steep acclivity of naked rock extending to our feet. Wishing to shorten our rout, we here unwisely abandoned the remaining bed of the ravine, and sustaining ourselves by the slight inequalities of surface which have resulted from unequal decomposition, we succeeded in crossing the apparently smooth face of the rock by an oblique ascent to the right, and once more obtained footing in the woody cover of the mountain. But the continued steepness of the acclivity, and the seemingly impervious growth of low evergreens on this more sheltered side, where their horizontal and greatly elongated branches were most perplexingly intermingled, greatly retarded our progress. Having surmounted this region we put forward with alacrity, and at 1 P. M. reached the summit.

The view which was here presented to us differs not greatly in its general features from that obtained at the High Peak, and the weather, which now began to threaten us with a storm, was less favorable to its exhibition. A larger number of lakes were visible from this point, and among them the beautiful and extensive group at the sources of the Saranac, which are known by the settlers as the "Saranac Waters." The view of the Still Water of the Hudson, lying like a silver thread in the bottom of its deep and forest-green valley, was peculiarly interesting. The opposite front of Mount McMartin exhibited the face of the great dyke and its passage through the summit, near to its highest point, and nearly parallel to the whitened path of a slide which had recently descended into Avalanche Lake. In a direction a little south of west, the great vertical precipice of the Wallface Mountain at the Notch, distinctly met our view. Deeply below us on the northwest and north, lay the valley of the west branch of the Au Sable, skirted in the distance by the wooded plains which extend in the direction of Lake Placid and the Whiteface Mountain.

Mount McIntyre is also intersected by dykes, which cross it at the lowest points of depression between its several peaks, and the more rapid erosion and displacement of these dykes has apparently produced the principal ravines in its sides. The highest of these peaks on which we now stood, is intersected by cracks and fissures in various directions, apparently caused by earthquakes. Large blocks of the same labradoritic rock as the mass of the mountain, lay scattered in various positions about the summit, which afforded nearly the same growth of mosses and alpine plants as the higher peak visited on the 5th. Our barometric observations show a height of near five thousand two hundred feet, and this summit is probably the second in this region, in point of elevation. There are three other peaks lying in a westerly direction, and also three others lying eastward of the main source of the Hudson, which nearly approach to, if they do not exceed, five thousand feet in elevation, making of this class, including Mount McMartin, Whiteface, and the two peaks visited, ten in all. Besides these mountains there are not less than a dozen or twenty others that appear to equal or exceed the highest elevation of the Catskill group.

Visit to the Great Notch.—Return to the Settlement.

The descent of the mountain is very abrupt on all sides, and our party took the rout of a steep ravine which leads into the valley of the Au Sable, making our camp at night-fall near the foot of the mountain. The night was stormy, and the morning of the 9th opened upon us with a continued fall of rain, in which we resumed our march for the Notch, intending to return to the settlement by this rout. After following the bed of the ravine till it joined the Au Sable, we ascended the latter stream, and before noon arrived at this extraordinary pass, which has been described by the state geologists, and which excites the admiration of every beholder. Vast blocks and fragments have in past ages fallen from the great precipice of the Wallface Mountain on the one hand, and from the southwest extension of Mount McIntyre on the other, into the bottom of this natural gulf. Some of these blocks are set on end, of a height of more than seventy feet, in the moss-covered tops and crevices of which, large trees have taken root, and now shoot their lofty stems high above the toppling foundation. The north branch of the Hudson, which passes through Lakes Henderson and Sanford, takes its rise in this pass, about five miles from McIntyre, and the elevation of its source, as would appear from the observations taken by Prof. Emmons last year, is not far from three thousand feet above tide.

Following the course of the valley, under a most copious fall of rain, we descended to Lake Henderson, which is a fine sheet of water of two or three miles in length, with the high mountain of Santanoni rising from its borders, on the west and southwest. It is not many months since our woodsman, Cheney, with no other means of offense than his axe and pistol, followed and killed a large panther, on the western borders of this lake. Pursuing our course along the eastern margin of this lake, we arrived at the settlement about 3 P. M., having been absent on our forest excursion seven days.

Elevation of the Mountain Region.

The following table of observations, as also the preceding one, is calculated according to the formula given by Bowditch in his Navigator, except for the two principal mountain peaks, which are calculated by the formula and tables of M. Oltmanns, as found in the appendix to the Geological Manual of De la Beche, Philadelphia edition. For the points near Lake Champlain, the height is deduced from the observations made at the lake shore, instead of those at Albany, adding ninety feet for the height of Lake Champlain above tide. The barometrical observations made at Syracuse, N. Y., at the same periods, by V. W. Smith, Esq., (with a well adjusted barometer, which has been compared with those of the writer,) would give to the High Peak an elevation of five thousand five hundred and ten feet. The observations at Albany have been taken for the lower station, because the latter place is less distant, and more nearly on the same meridian. Perhaps the mean of the two results may with propriety be adopted. In most of the other cases, the results deduced from the observations at Albany agree very nearly with the results obtained from the observations made at Syracuse.

Date.	Place of observation.	Hour.	Upper station.—Barom. corrected 1-50 for variation of cistern. Att. Th.	Upper station. Barom.	Lower station.—60 feet above tide at Albany. Att. Th.	Lower station. Barom.	Corrected height in feet, above tide.
Aug. 3,	Lake Colden outlet,	5.30 P. M.	70°	27.00	74°	29.78	2.851
Aug. 4,	Hudson River, above the Dyke Falls,	12.30 "	74	26.72	72	29.97	3.356
"	Do. in High Valley, E. of Mt. McMartin,	2.30 P. M	72	26.37	73	29.96	3.711
"	Do. one third mile above camp, in the High Pass,	4.30. "	52	25.66	72	29.97	4.344
Aug. 5,	Head of the High Pass, source of the main branch of the Hudson and a fork of the east branch of the Au Sable,	8.40 A. M.	47	25.43	64	30.20	4.747
"	Summit of the High Peak of Essex, one and a quarter miles S. 70° W. from the source of the Hudson,	1 P. M.	47	24.83	69	30.24	5.467
Aug. 8,	Summit of Mount McIntyre, between Lake Colden and West branch of the Au Sable,	1.30 P. M.	60	25.11	73	30.14	5.183
Aug. 12,	Summit of Bald Peak,* on the west shore of Lake Champlain, six miles N. 29° W. from Crown Point,	11 A. M.	65	27.99			2.065
"	Lake Champlain at Port Henry,	4 P. M.	75	30.02			
	Do. corrected as for 11 A. M.		73	30 03			

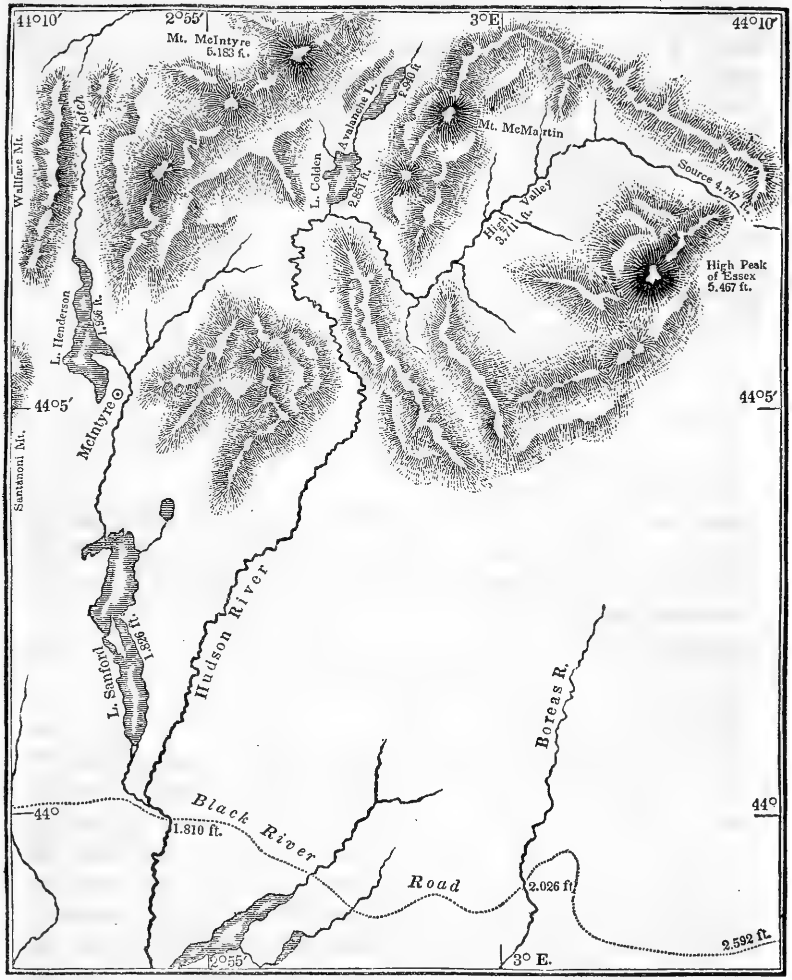
View of Lake Champlain.—Routs to the Head of the Hudson.

Bald Peak is the principal eminence on the western shore of Lake Champlain, about seven miles N. N. W. from Crown Point, and was ascended by the writer on our return to the lake. A good carriage road leads from East Moriah nearly to the foot of the peak, from whence the ascent by a footpath is not difficult, and may be accomplished even by ladies, without hazard. The summit commands a good view of some of the principal peaks in the interior, and the prospect of the prolonged basin of Lake Champlain, which is obtained from this point, is well worth the trouble of the ascent, and is worthy the attention of tourists who can find it convenient to land either at Port Henry or Westport.

The source of the Hudson and the High Peak of Essex, can be most conveniently reached from Johnson's, at Clear Pond, by a course N. 20° W. ; or by landing at Westport, or Essex and proceeding to the nearest settlement in Keene. By landing at Port Kent, and ascending the course of the Au Sable to the southeast part of Keene, and from thence to the Peak, the most interesting chain of waterfalls and mountain ravines that is to be found, perhaps, in the United States, may be visited. At Keene, Mr. Harvey Holt, an able woodsman, who was attached to our party, will cheerfully act as guide and assistant, in reaching the mountain. From the valley which lies southward of the peak, and near to the head waters of the Boreas and Au Sable, may be obtained, it is said, some of the best mountain views which this region affords. But travelers in these wilds, must be

* 1975 feet above Lake Champlain.

provided with their own means of subsistence, while absent from the settlements.



The above sketch must be considered only as an approach to correctness of topography, and is based in part upon the survey lines, as found on the County map; but the geographical position is approximated to Burr's Map of the State of New York, by means of bearings from known objects on the borders of Lake Champlain.

Mountains of New Hampshire.

The only point east of the Mississippi which is known to exceed this group of mountains in elevation, is the highest summit of the White Mountains in New Hampshire; the elevation of which is given by Prof. Bigelow from barometrical observations, reduced by Prof. Farrar, at six thousand two hundred and twenty-five feet.* Prof. Bigelow adduces the observations of Capt. Partridge, made several years since, as giving an elevation of only six thousand one hundred and three feet. But the writer is indebted to Dr. Barratt for a memorandum of observations made by Capt. Partridge in August, 1821, which gives the height of the principal peaks of the New Hampshire group, as follows:

Mount Washington,	above	the sea,	6.234 feet.
" Adams,	"	"	5.328
" Jefferson,	"	"	5.058
" Madison,	"	"	4.866
" Franklin,	"	"	4.711
" Monroe,	"	"	4.356

From this it appears most probable that there are a greater number of peaks in the Essex group that exceed five thousand feet, than in New Hampshire; although the honor of the highest peak is justly claimed by the latter.

Imperfect State of Geographical knowledge—Resources of the Mountain District.

It appears unaccountable, that the elevation of this region at the sources of the Hudson should have been, hitherto, so greatly underrated. Even Darby, in his admirable work on American geography, estimates the fall of the rivers which enter Lake Champlain from the west, as similar to those on the east, which he states to be from five hundred to one thousand feet.† The same writer also estimates the height of the table land from which the Hudson flows, at something more than one thousand feet !‡ The mountains of this region, appear to have almost escaped the notice of geographical wtiters, and in one of our best Gazetteers, that of Darby and Dwight, published in 1833, the elevation of the mountains in Essex county, is stated at one thousand two hundred feet. In Macauley's History of New York, published in Albany in 1829, there is, however, an attempt to describe the mountains of the Northern district of the State, by

* New England Journal of Medicine and Surgery, Vol. V., p. 330.
† Darby's View of the U. S. p. 242. ‡ Ib. p. 140.

dividing them into six distinct ranges. This description is necessarily imperfect, as regards the central portion of the group; but this author appears to have more nearly appreciated the elevation of these mountains than any former writer. He states the elevation of Whiteface at two thousand six hundred feet, and the highest part of the most westerly or Chateaugua range at three thousand feet. To the mountains near the highest source of the Hudson, including probably the High Peak, he has given the name of the Clinton range, and has estimated their elevation from six hundred, to two thousand feet!* He also describes the West Branch of the Hudson which rises near the eastern border of Herkimer county, as being the principal stream. The Northwest Branch, which unites with the main North Branch, a few miles below Lake Sanford, he describes as rising on the borders of Franklin and Essex counties and as pursuing a more extended course than the North Branch. Perhaps this description may be found correct, although information received from other sources does not seem to confirm this position.

It is understood that Prof. Emmons, in pursuing his geological explorations, has ascended another of the principal peaks situated easterly of the highest source of the Hudson, and made other observations which will be of value in settling the geography of this region. The Professor finds the northern district of the state, to be one of great interest to the geologist, and although from the deficiencies of our maps, he is constrained to the performance of duties which pertain to the geographical, rather than to the geological department of science, yet all that can be accomplished in either branch, with the means placed at his disposal, may be confidently expected from his discriminating zeal and untiring perseverance.

Owing, perhaps, to the soda and lime which are constituents of the labradoritic rock, and its somewhat easy decomposition when exposed to the action of the elements, the soil of this region is quite favorable to the growth of the forests as well as the purposes of agriculture. The beds of iron ore which are found on the waters of the Hudson, at McIntyre, probably surpass in richness and extent, any that have been discovered in other countries. In future prospect, this region may be considered as the Wales of the American continent, and with its natural resources duly improved, it will, at no distant period, sustain a numerous and hardy population.

New York, November 1, 1837.

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* Macauley's History of New York, Vol. I., pp. 2 to 9 and 20, 21. Albany, 1829.

Art. XV.—*Contributions to English Lexicography;* by Prof. J. W. Gibbs.

No. I. Account of some Arabic Words found in English.

Abuna, (Arab. أَبُونَا, Ethiop. አቡነ : *our father;* comp. Heb. אָבִינוּ ;) the title of Christian priests in Syria; also of the primate of Abyssinia.

Al, (Arab. أَلْ *the;* comp. Heb. ·הַ, for הַל ;) a prefix to many words derived from the Arabic, which, however, has amalgamated with the noun itself, and lost its original significancy; as, *alcaid, alchimy, alkoran,* etc.

Alcaid, (Arab. قَايِد *a governor,* with pref. أَلْ *the,* from قَادَ *to lead, govern;*) a name of office among the Moors, Spaniards and Portuguese. This word is not to be confounded with *cadi,* which has an entirely different origin.

Alchimy, (Arab. كِيمِيَا *kimia,* as if *the hidden art,* with pref. أَلْ *the,* from كَمَى *to hide;*) the more sublime and difficult parts of chimistry. Comp. *chimistry.* It is remarkable that Richardson adheres to the old derivation from Gr. χέω.

Alcohol, (Arab. كُحْل a pigment for the eyes made of the black oxyd of antimony, with pref. أَلْ *the,* from كَحَلَ *to blacken* or *paint* the eyes; comp. Heb. כָּחַל idem;) *pure spirits.* However difficult it may be to show the connection between *a pigment of antimony* and *pure spirits;* yet the fact of the connection is evident from Span. *alcohol,* which unites these two significations.

Alcove, (Arab. قُبَّة kubba, *an arch,* with pref. أَلْ *the,* from قَبَّ conj. ii. *to construct with an arch;* comp. Heb. קֻבָּה *a chamber, dormitory,* so called because *arched,* from קָבַב *to make curved* or *hollow;*) *a recess in a chamber to sit or lie in;* hence *a recess in a library.*

Aldebaran, (Arab. أَلدَّبَرَان liter. *the follower,* scil. of the Pleiades, from دَبَرَ *to follow;* comp. Heb. דָּבַר idem;) a star of the first magnitude in the southern eye of the constellation Taurus.

Alembic, (Arab. أَنْبِيقٌ or أَنْبِكٌ a chimical vessel for distillation, with pref. أَلْ *the;*) a chimical vessel for distillation.

Algebra, (Arab. جَبْرٌ *the reduction of parts to a whole*, or *of fractions to a whole number*, with pref. أَلْ *the*, from جَبَرَ *to bind up, to consolidate, to make whole;* comp. Heb. גָּבַר *to be strong*, as if *to be girded;*) *universal arithmetic, a general mode of computing by signs.* Richardson has given the Arabic word incorrectly.

Alkali, (Arab. قَلْي the ashes of a plant called *glass-wort*, from which alkali is obtained, with pref. أَلْ *the*, from قَلَي *to fry;* comp. Heb. קָלָה *to roast;*) the name of a peculiar class of chimical substances.

Alkoran, (Arab. قُرْآنٌ liter. *a reading*, with pref. أَلْ *the*, from قَرَأَ *to read;* comp. Heb. קָרָא *to cry, to call, to read;*) the sacred book of the Mohammedans. Also called *koran*, q. v.

Almagest, (Arab. magest = Gr. μέγιστος, *greatest*, with pref. أَلْ *the;*) the name of an astronomical work by Ptolemy.

Almanac, (Arab. مَنَاخٌ *a diary, calendar*, with pref. أَلْ *the;*) *a diary, calendar.*

Cadi, (Arab. قَاضِي *a judge*, from قَضَي *to decide, judge;* comp. Heb. קָצָה *to cut off, to judge;*) among the Mohammedans, *an inferior judge.* This word is not to be confounded with *alcaid*, which has an entirely different origin.

Caliph, (Arab. خَلِيفَةٌ khalipha, *a successor, vicegerent*, from خَلَفَ *to succeed;* comp. Heb. חָלַף *to pass along, to succeed;*) a title given to the successors of Mohammed.

Chimistry, (Arab. كِيمِيَا kimia, as if *the hidden art*, from كَمَي *to hide;*) the science which teaches the nature of bodies. In usage it is distinguished from *alchimy*, q. v.

Coffee, (Arab. قَهْوَةٌ kahwa, *wine*, also *a decoction of coffee*, from قَهِيَ conj. iv. *to drink frequently;*) the name of a berry, and of a drink made from it.

Cotton, (Arab. قُطْنٌ *cotton;* comp. كَتَّانٌ *linen,* also Heb. כְּתֹנֶת *a tunic;*) a soft, downy substance obtained from a plant.

Dragoman, (Arab. تَرْجُمَانٌ targoman, *an interpreter,* from تَرْجَمَ *to interpret;* comp. Chald. תַּרְגֵּם idem;) in the east, *an interpreter.*

Emir, (Arab. أَمِيرٌ *a commander, prince,* from أَمَرَ *to command;* comp. Heb. אָמַר *to say,* also *to command;*) in Turkey, a title of honor given to those who claim descent from Mohammed. The form *omrahs*, which is derived from the Arabic plural أُمَرَاءُ by annexing *s*, is not to be imitated.

Fetwa, (Arab. فَتْوَى *a legal decision* or *answer,* from فَتَا conj. iv. *to give a legal decision;* comp. Heb. פָּתַח *to open;*) *a written decision of the mufti.* Comp. *mufti.*

Hajji, (Arab. حَاجِّيٌّ *a pilgrim to Mecca,* from حَجَّ *to go on a pilgrimage to Mecca;* comp. Heb. חָגַג *to move round in a circle, to dance, to celebrate a festival;*) *a Mohammedan pilgrim.*

Harem, (Arab. حَرَمٌ *a sanctuary, a woman's apartment,* from حَرَمَ *to prohibit;* comp. Heb. חָרַם primar. *to shut up, to prohibit;*) in the east, *the woman's apartment.*

Hegira, (Arab. هِجْرَةٌ hijra, *flight, leaving one's country,* from هَجَرَ *to fly;* comp. Heb. הָגַר idem;) the flight of Mohammed from Mecca to Medina, from which the Mohammedans reckon time.

Imam, (Arab. إِمَامٌ *a priest,* from أَمَّ *to go before, to lead in sacred rites;*) *a Mohammedan priest.* The form *iman* is incorrect.

Islam, (Arab. إِسْلَامٌ liter. *devotion* or *submission,* scil. to God and his prophet Mohammed, hence *the Mohammedan religion,* from سَلَمَ conj. ii. *to submit to God;* comp. Heb. שָׁלַם *to be sound,* Hiph. *to make peace by submission;*) *the Mohammedan religion.* Comp. *Moslem* and *Musulman,* which are from the same root.

Islamism, the preceding word with the Greek termination *ism.*

Kebla, (Arab. قِبْلَةٌ *the region in front of a person, the direction of a person's face in prayer*, from قَبَلَ *to meet;* comp. Heb. קָבַל *to be before*, or *over against;*) *the direction of a person's face in prayer.*

Koran, in usage the same as *Alkoran*, q. v.

Mamluk, (Arab. مَمْلُوكٌ *possessed, a slave;* pass. part. from مَلَكَ *to possess, rule;* comp. Heb. מָלַךְ *to reign;*) in the east, a kind of mercenary soldier.

Minaret, (Arab. مَنَارَةٌ *a place for a light, the turret of a Mohammedan temple*, from نَارَ *to shine;* comp. Heb. נהר idem;) *the tower of a Mohammedan temple.*

Mohammed, (Arab. مُحَمَّدٌ *praised*, also *Mohammed*, from حَمِدَ *to praise;* comp. Heb. חָמַד *to desire earnestly;*) the proper name of the Arabian impostor.

Molla, (Arab. مَوْلًي maula, *a president, lord*, from وَلِيَ *to preside, govern;*) among the Mohammedans, *a superior judge.*

Mosk, (Arab. مَسْجِدٌ masjid, *a temple*, from سَجَدَ *to incline the head, to worship;* comp. Heb. סָגַד idem;) *a Mohammedan temple.*

Moslem, (Arab. مُسْلِمٌ *one devoted to God and his prophet Mohammed, a Mohammedan*, from سَلَّمَ conj. ii. *to submit to God;* comp. *islam* above;) *a Mohammedan.*

Mufti, (Arab. مُفْتِي *one who decides cases of Mohammedan law*, from فَتَا conj. ii. *to give a legal decision;* comp. *fetwa* above;) in Turkey, *the chief minister of religion and law.*

Musulman, the Persian form of the Arabic word *moslem.* The plural form *musulmen* has arisen from mistake and is incorrect.

Rais, (Arab. رَئِيسٌ *a captain*, from رَأَسَ *to be head or chief;* comp. Heb. רֹאשׁ *the head;*) in the east, *the captain of a ship.*

Ramadan, (Arab. رَمَضَانُ;) the month of fasting among the Arabians.

Sheikh, (Arab. شَيْخٌ *an old man,* also a name of office, from شَاخَ *to be old;*) among the Arabians and Moors, *a man of eminence.*

Sherif, (Arab. شَرِيفٌ *noble,* from شَرُفَ *to be noble;* comp. Heb. שָׂרַף idem;) a title of honor given to the descendants of Mohammed.

Sultan, (Arab. سُلْطَانٌ *a prince, ruler,* from سَلَطَ *to rule;* comp. Heb. שָׁלַט idem;) the title of the emperor of Turkey.

Wadi, (Arab. وَادٍ;) *a torrent* or *bed of a river.*

Vizier, (Arab. وَزِيرٌ liter. *one loaded with business,* from وَزَرَ *to bear;* comp. Heb. וָזָר idem;) among the Mohammedans, *a minister of state.*

Art. XVI.—*Lectures and Remarks of* Dr. Gideon Mantell.

No. 1.

We have received, from time to time, printed notices of the admirable lectures of Dr. Mantell on geology and other subjects, delivered at Brighton, England, and printed, (in an abridged form,) in the papers of that town.

Like all the productions of that highly gifted and enlightened man, they are replete with accurate science, with enlarged views of the relations of things, and with happy moral applications. We have, for some time, intended to publish in this Journal, parts of these lectures, and occasionally to give them entire, believing that we can in no way gratify and instruct our readers more effectually in the sciences of which they treat. To the adept, they will prove an interesting review, and to the student and especially the young lecturer, they will afford a fine model of a condensed, perspicuous and beautiful style, with as much of accurate science as can well be communicated in a popular lecture.

We are happy also in the opportunity of paying, (consistently with the plan of our work,) this mark of respect to a gentleman who is an ornament to his country, and to whom science, especially geology, comparative anatomy, and paleontology are greatly indebted.—Ed.

Dr. Mantell's Lecture on Zoophytes.

The subject* (says the reporter) which he had selected for illustration, was one of peculiar interest, and yet perhaps less understood by the general observer, than any other department of natural science; nor was this surprising, when we considered that notwithstanding the press had poured out books on natural history in such abundance and variety as absolutely to retard the progress of knowledge by the overwhelming mass of materials, yet there existed not in our language one good elementary work on that wonderful division of the animal kingdom which it was the purpose of his present attempt to elucidate. If it be necessary (said Dr. M.) for me on this, as on previous occasions, to defend investigations of this nature from the charge of inutility or frivolity, and answer the question—"To what practical end and advantage do such researches tend?" I might refer to the history of all science, where speculations even the most unprofitable, have invariably led to great practical benefits. But I will take a higher ground, and, in the language of a philosopher alike the pride of our country and the admiration of Europe, assert, that there is a lofty and disinterested pleasure in scientific pursuits which ought to exempt them from such questioning. "Communicating as they do to the mind the purest happiness, after the exercise of the benevolent and religious feelings, of which our nature is susceptible, I would allege *this* as a sufficient and direct reply to those who having themselves little capacity and less relish for intellectual pursuits, are constantly repeating this inquiry." The natural philosopher, accustomed to trace the operations of the laws which the Creator has established, in circumstances where the uninformed and unenquiring eye perceives neither novelty nor beauty, walks in the midst of wonders; every object which falls in his way elucidates some principle, affords some instruction, and impresses him with a sense of harmony and order, and of deep humility and dependence. Nor is it one of the least advantages of these pursuits that they are independent of external circumstances, and may be enjoyed in every situation of life; the calm and dispassionate interest with which they fill the mind, renders them a most delightful retreat from the agitations and dissensions of the world, and from the conflict of passions, prejudices, and

* In aid of the funds of the new Association for the Fishermen of Brighton.

interests in which we all find ourselves continually involved; in short, by directing our attention to the investigation of natural phenomena, we may realize the beautiful fiction of our immortal Shakspeare, and find—

> Tongues in trees—books in the running brooks—
> Sermons in stones—and good in every thing.

The beautiful world around us is every where full of objects presenting innumerable varieties of form and structure, of action and position; some of them being inanimate or inorganic, and others possessing organization and vitality. The organic kingdom of nature in like manner was separated into two grand divisions, the animal and the vegetable. The differences between organic and inorganic bodies were very numerous and manifest; but in this brief discourse he need only mention a few obvious and familiar characters. All the parts of an inorganic body enjoyed an independent existence: if he broke off a crystal from the mass before him, the specimen did not lose any of its properties—it was still a mass of crystal as before; but if he removed a branch from a tree, or a limb from an animal, both the one and the other were imperfect, and the parts removed underwent decomposition; the plant withered, the animal matter underwent putrefaction. Again, if crystals, which may be considered the most perfect models of inorganic substances, were formed, these crystals will continue of the same size and figure, unless acted upon by some external force of a chemical or mechanical nature: nor has the crystal any power of increasing or diminishing its bulk but by addition or subtraction externally. In organic bodies the characters are totally different: they acquire definite forms and structure which are capable of resisting for a time the ordinary laws that affect inorganic matter, and internally they are in constant change; from the moment of the first existence of a plant or animal, to the period of its dissolution, there is no repose, youth follows infancy, maturity precedes age. It is thus with the moss and the oak, the mite and the elephant, life and death are common to them all. The lecturer went on to describe the principles of vitality which existed in animals and vegetables, and by which their systems of vessels were enabled to attract and select nutriment, and maintain their existence till the period when the vital principle quitted the frame it had animated. Thus the body became subject to the laws which affect inorganic matter, the bough hangs down, and the slender stem bends towards the earth, the animal falls to the ground, the skin becomes distended, and the graceful form of life disappears, chemical changes begin to operate, decomposition takes place, and finally dust returns to dust and the spirit of man to Him who gave it. Dr. M. next described the essential characters of animal existence and contrasted it with that of the vegetable kingdom; defining the former as possessing certain determinate external forms, which were gradually developed, and having an internal organization possessing systems of vessels for effecting nutrition and support, combined with a nervous system communicating sensation and voluntary motion. The external forms are as various as the imagination can conceive, from the god-like image of man to the shapeless mass of living jelly that floats on the waves; from the elephant and whale to the insect and monad, of which five hundred millions are contained in a single drop of water: in short, so various and dissimilar are the forms of animals even on our own globe, that the opinion of astronomers that the inhabitants of the glorious orbs around us must of necessity, from the different description and conditions of the respective planets, be totally unlike any that exist on the earth, can no longer appear marvellous and incredible. The lecturer then observed, that of all the extraordinary forms, none were more unlike what the common observer would conceive of animals, than the sponges, corals, &c., which were known by the name of zoophytes, from two Greek words signifying animal plants. In this very town Mr. Ellis, in 1752, first discovered the animal nature of sponges, and many other forms previously supposed to be plants. Dr. Mantell then described the *flustra* which occurs on the rocks, and on almost every leaf of sea weed, appearing like a fine lace work. When viewed through a powerful microscope, every pore in this lace work is found to be the cell of a polypus or living animal, in form of a tube with the border fringed with bony feelers or tentacula. These were the instruments by which the animal obtained its prey, it might be seen expanding these feelers, then suddenly contracting them, and retreating into the cell, and then again protruding forth, the whole surface of the flustra exhibiting at every pore a living form. Dr. M. then pointed out on his beautiful drawings magnified views of these extraordinary beings, drawn from living specimens from the sea shore. The *flustra* (which the lecturer observed he took as the type of zoophytal animation, because it was so common,) is a compound animal, consisting of a fleshy substance with an internal calcareous skeleton, the foci of vitality consisting of polypi, by whose agency the life of the whole mass is maintained. How far each polype may possess sensation apart from the rest or from the general mass, whether they are separate centres of sensation, and susceptible of pain and pleasure individually, it is impossible for us to determine. We have a living proof, in our own species, in the Siamese twins, that there may be a united organization with distinct nervous system and individual sensation. However this may be, it is certain that the Almighty Creator of the universe has bestowed on these, as on all his creatures, the capacity and means of enjoyment. Dr. M. then mentioned the various and almost endless forms which this class of animals assumed, some being branched like trees, and flexible, others of a stony hardness; some in large blocks with convolutions on the surface, of which the brain coral was a familiar example; others not unlike large fungi, some of a beautiful blue color; while a well known species was of so exquisite a vermilion, that a comparison with it was the greatest compliment paid to the lips of beauty. This species, the Corallium rubrum, so much used for ornamental purposes, is common in the Mediterranean and other warm seas; and immense quantities are annually obtained for the manufactories at Naples, Leghorn, and other places. In a living state it forms a branched figure of about one foot in height, and is covered over with a fleshy substance of a pale bluish color, is studded with numerous starlike projections, from which issue polypi with six or eight feelers, the whole looking, when the animals are expanded, like a branch of a tree with a crimson base, a bluish bark and numerous flowers. The paintings exhibited by Dr. Mantell, of the red coral when alive, were very beautiful, and admirably illustrative of his description.

All the principal forms of corals were exemplified by drawings, and by a fine and numerous series of specimens, (of the *skeletons*, as the lecturer termed them,) of madrepores, astreæ, &c.

The appearance of the recent zoophytes when seen in tranquil water was described by Dr. M. as most beautiful; the bottom of the Red Sea was so enamelled with them in some parts as to appear like a bed of tulips or dahlias; and when we looked at the drawings of some of the large fungi, which had a crimson disk with a purple and yellow centre, we could not doubt the propriety of the comparison. From the wonderful structure of the zoophytes, Dr. M. proceeded to the consideration of the still more marvellous effects produced by such apparently helpless beings, the production of coral reefs, and finally of islands and even continents. A painting of a circular island produced by these animalculæ was exhibited, Dr. M. describing it from the graphic account of Capt. Flinders, and shewing how it first appeared above the waters, then gradually acquired a covering of soil in which a few plants took root; sea fowl frequented it and brought seeds of other vegetables; these grew, and cocoa nuts wafted thither by the currents, took root, and palms shed their beautiful foliage over the new isle; lastly, man discovered it, erected his hut upon it, and called himself lord of this new creation. Surely, said Dr. Mantell, it is to an insular paradise of this kind that our inimitable poet Moore alludes in those exquisite lines—

> Oh! had we some bright little isle of our own,
> In a blue summer ocean far off and alone,
> Where a leaf never dies in the still-blooming bowers,
> And the bee banquets on through a whole year of flowers, &c.

The lecturer then proceeded to the consideration of the fossil corals, which are found in various parts of England, illustrating his remarks with descriptions and the exhibition of specimens; and lastly, described the extraordinary animal called Encrinite, which is not a coral, but allied to the star fish, and has a long articulated column, on the top of which is a cup-shaped receptacle furnished with numerous tentacula or feelers on the margin; this contained the body of the animal, the mouth being in the centre, and the feelers serving and conveying the prey into it, as in the polypi of the zoophytes. The animal when spread out resembled a flower, and when closed, was very like a lily with the petals partially shut. The skeleton, which was alone found in a fossil state, consisted of an immense number of bones: upwards of thirty thousand had been counted in one individual. The Derbyshire limestone is entirely made up of the petrified bones of these animals, and owes its beautiful markings to the sections of their remains. We have seen, says Dr. Mantell, the marvellous organization of being so minute as to be invisible to the naked eye, their modes of life and action, and the important physical changes effected by such apparently inadequate agents. What beautiful, what striking proofs of the wisdom and goodness of the Eternal are here exhibited. Beings are called into existence, so minute as to elude our unassisted vision, yet possessing powers of voluntary motion and sensation, each with its system of muscles and vessels, and living upon beings still more minute, of which millions might be contained in a drop of water; nay, even that these last are supported by living atoms still less, and so on, and on, till the mind is lost in wonder, and can pursue the subject no farther. Next we see the results produced by these myriads of animated forms; the excess of calcareous matter brought into the waters of the ocean consolidated by the influence of these minute beings, and forming new islands and continents. Lastly, we find in the ancient natural records of our globe, evidence that the Almighty Creator acted by the same agents in past ages. The beds of fossil coral are now the sites of towns and cities, occupied by a people in the highest state of civilization who construct their abodes of the limestone, and ornament their palaces with the marble formed of the consolidated skeletons of the zoophytes which lived and died in an ocean that has long since passed away. Hence we perceive that He who formed the universe creates nothing in vain; his works all harmonize to blessings unbounded by the mightiest or most minute of his creatures; and the more our knowledge is increased, and our powers of observation enlarged, the more exalted are our conceptions of the wonders of creation. Thus, to use the eloquent language of an eminent divine, while the telescope enables us to see a system in every star, the microscope unfolds to us a world in every atom. The one teaches us that this mighty globe, with the whole burden of its people and its countries, is but a grain of sand in the field of immensity—the other, that every atom may harbor the tribes and families of a busy population. The one shews us the insignificance of the world we inhabit, the other redeems it from all its insignificance, for it tells us that in the leaves of every forest, in the flowers of every garden, and in the waters of every rivulet there are worlds teeming with life, and numerous as are the stars of the firmament; the one suggests to us, that beyond and above all that is visible to man, there may be regions of creation which sweep innumerably along, and carry the impress of the Almighty's hand to the remotest scenes of the universe; the other, that within and beneath all that minuteness which the aided eye of man has been able to explore, there may be a world of invisible beings, and that could we draw aside the mysterious curtain which shrouds it from our senses, we might behold a theatre of as many wonders as astronomy can unfold; a universe within the compass of a point so small as to elude all the powers of the microscope, but where the Almighty ruler of all things finds room for the exercise of his attributes, where he can raise another mechanism of worlds, and fill and animate them all with the evidence of his glory.

Art. XVII.—*Influence of the Great Lakes on our Autumnal Sunsets;* by Willis Gaylord.

Foreign tourists speak with rapture of the beautiful dyes imprinted by autumn on the foliage of our American forests; our leaves do not fade and fall, all of the same decaying russet hue, but the rich golden yellow of the linden, the bright red of the soft maple, the deep crimson of the sugar maple, the pale yellow of the elm, the brown of the beach, and the dark green of the towering evergreens, are all blended into one splendid picture of a thousand light shades and shadows. To the observer, our autumnal woodlands are gigantic parterres, the flowers and colors arranged in the happiest manner for softened beauty, and delightful effect. And when these myriads of tinted leaves have fallen to the earth; when the squirrel barks from the leafless branches or rustles among them for the ripened but still clinging brown nuts; the rural wanderer is tempted to throw himself on the beds of leaves accumulated by the wind, and while he looks through the smoke-tinted atmosphere, half imagines that he is gazing on an ocean of flowers.

But the claims of our American autumn upon our admiration, are very far from depending entirely on the rainbow-colored foliage of our woodlands, unrivalled in beauty, though they certainly are: to these must be added the splendors of an autumn sunset, the richness of which, as we are assured, has no parallel in the much lauded sunsets of the rose-colored Italian skies. In no part of the United States is this rich garniture of the heavens displayed in so striking a manner as in the valley of the great lakes, and the country immediately east or southeast of them, and this for reasons which will shortly be assigned. The most beautiful of these celestial phenomena begin to appear about the first of September, sometimes rather earlier, and with some exceptions last through the months of September and October, unless interrupted by the atmospheric changes consequent on our equinoctial storms, and gradually fade away in November with the Indian summer, and the southern declination of the sun. Not every cloudless sunset during this time, even in the most favored sections, is graced with these splendors; there seems to be a peculiar state of the atmosphere necessary to exhibit these beautiful reflections, which however often witnessed, must excite the admiration of all who view them, and are prepared to appreciate their surprising richness.

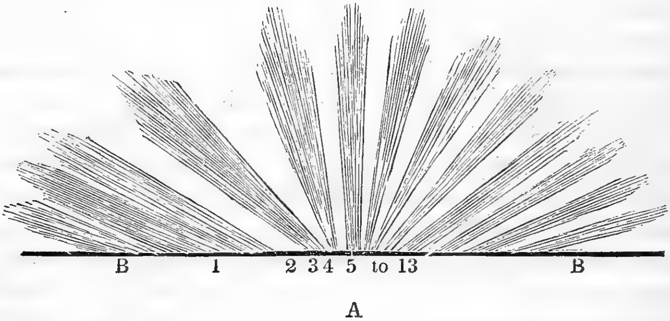
On the most favored evenings the sky will be without a cloud; the temperature of the air pleasant; not a breeze to ruffle a feather, and a dim transparent haze tinged of a slight carmine by the sun's light, diffused through the whole atmosphere. At such a time, for some minutes both before and after the sun goes below the horizon, the rich hues of gold, and crimson, and scarlet, that seem to float upward from the horizon to the zenith, are beyond the power of language to describe. As the sun continues to sink, the streams of brilliance gradually blend and deepen in one mass of golden light, and the splendid reflections remain long after the light of an ordinary sunset would have disappeared. We have said that not every cloudless sunset exhibits this peculiar brilliance; when the air is very clear, the sun goes down in a yellow light it is true, but it is comparatively pale and limited; and when as is sometimes the case in our Indian summers, the atmosphere is filled with the smoky vapor rising from a thousand burning prairies in the far west, he sinks like an immense red ball without a single splendid emanating ray. It is our opinion that the peculiar state of the atmosphere necessary to produce these gorgeous sunsets in perfection, is in some way depending on electrical causes; since it very commonly happens, that after the brilliant reflections of the setting sun have disappeared, the auroral lights make their appearance in the north, and usually the more vivid the reflection, the more beautiful and distinct the aurora. This fact the numerous and splendid northern lights of last September, succeeding sunsets of unrivalled beauty, must have rendered apparent to every observer of these atmospheric changes. Connected however with this state of the atmosphere, and cooperating with it, is another cause we think not less peculiar and efficient, and which we do not remember ever to have seen noticed in this connection, and that is the influence of the great lakes acting as reflecting surfaces.

Every one is acquainted with the fact that when rays of light impinge or fall on a reflecting surface, as a common mirror, they slide off so to speak, in a corresponding angle of elevation or depression, whatever it may be. The great American lakes may in this respect be considered as vast mirrors, spread horizontally upon the earth, and reflecting the rays of the sun that fall upon them, according to the optical laws that govern this phenomenon. The higher the sun is above the horizon the less distance the reflected rays would have to pass through the atmosphere, and of course the less would be the effect produced by them; while at and near the time of setting, the rays striking horizontally on the water, the direction of the reflected rays must of course be so also, and therefore pass over or through the greatest possible amount of atmosphere previous to their final dispersion. It follows that objects on the earth's surface, if near the reflecting body, require but little elevation, to impress their irregularities on the reflected light; and hence any considerable eminences on the eastern shore of the great lakes, would produce the effect of lessening, or totally intercepting these rays at the moment the sun was in a position nearly or quite horizontal. The reflecting power of a surface of earth, though far from inconsiderable, is much less than that of water, and may in part account not only for the breaks in the line of radiance which exist in the west, but for the fact that the autumnal sunsets of the south are inferior in brilliance to those of the north. We have been led to this train of thought at this time, by a succession of most beautiful sunsets, which, commencing the last week in August, have continued through the months of September and October, with a few exceptions, in consequence of the atmospheric derangement attending the usual equinoctial gales.

It will be seen by a reference to a map of the United States, that from the residence of the writer, (Otisco, Onondaga Co. N. Y.,) the lakes extend on a great circle from north to south of west, and of course embrace nearly the whole extent of the sun's declination, as observed from this place. The atmosphere of the north then with the exception of a few months is open to the influence of reflected light from the lakes, and we are convinced that most of the resplendent richness of our autumnal sunsets may be traced to this source. The successive flashes of golden and scarlet light that seem to rise and blend and deepen in the west, as the sun approaches the horizon and sinks below it, can in no other way be so satisfactorily accounted for as by the supposition, that each lake, one after the other, lends its reflected light to the visible portion of the atmosphere, and thus as one fades, another flings its mass of radiance across the heavens, and acting on a medium prepared for its reception, prolongs the splendid phenomena.

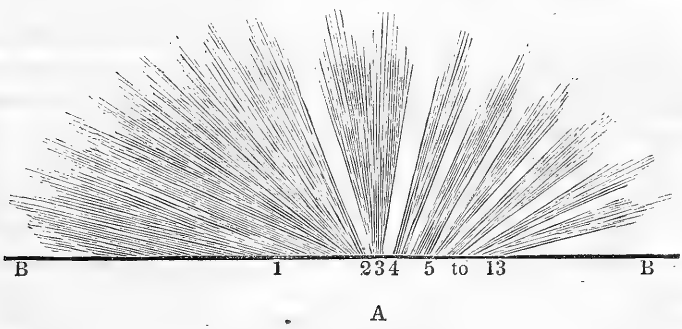
We have for years noticed these appearances and marked the fact, that in the early part of September, the sunsets are generally of unusual brilliancy, and more prolonged than at other or later periods. They are at this season, as they are at all others, accompanied by pencils or streamers of the richest light, which diverging from the position of the sun, appear above the horizon, and are sometimes so well defined that they can be distinctly traced nearly to the zenith. At other seasons of the year, clouds just below the horizon at sunset produce a somewhat similar result in the formation of brushes of light; and elevated ranges of mountains, by intercepting and dividing the rays, whether direct or reflected, effect the same appearances; but in this case there are no elevated mountains, and on the most splendid of these evenings the sky is always perfectly cloudless. We have marked the uniformity in the relative position of these pencils at the same season of the year for a great number of years; and this uniformity, while it proves the permanence of their cause, has led us to trace their origin to the peculiar configuration of the country bordering on the great lakes.

At the time of year these pencils are beginning to be the most distinct, a line drawn from this point to the sun would bear at sunset, about twenty five degrees north of west, passing over the west end of lake Ontario, the greatest diameter of Lake Huron, and across a considerable portion of Lake Superior. At this time, or about the first of September, the streamers or pencils exhibit somewhat the appearance shown in the following engraving:

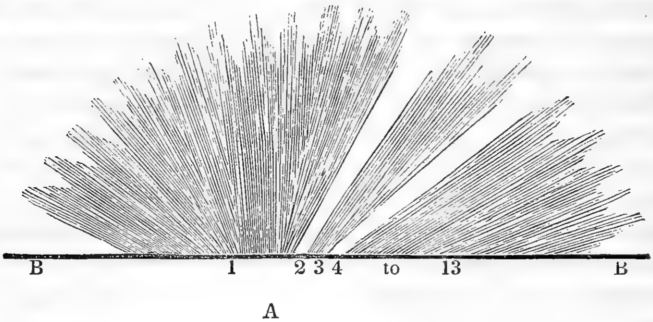


Here A, represents the place of the sun, some two or three degrees below the horizon B, B. Fig. 1, denotes the reflections from Lake Erie. 2, the comparatively dark space caused by the peninsula between Lake Erie and Lake St. Clair. 3, represents the reflected rays from St. Clair. 4, the now reflecting peninsula between the St. Clair and Lake Huron; and 5 to 13 the reflection from Lake Huron, broken into pencils by the elevated lands on the south-eastern margin of the lake.

From considerations connected with the figure of the earth, the relative position of the sun and the lakes, the nature of reflecting surfaces, and the hills that it has been ascertained border Lake Huron on the east, it appears clear to us, that the broken line of these hills acts the part of clouds or mountains in other circumstances, in intercepting and dividing into pencils the broad mass of light reflected from the Huron, and thus creating those beautiful streamers that appear in the north of west, and with which, as it were, the commencement of autumn and the Indian summer is marked. Farther to the south, appears distinctly the break occasioned by the land that intervenes between the Lakes Huron and St. Clair, and this as well as the one between the latter lake and Erie, is rendered more striking by the brilliant pencil streaming across the heavens from the St. Clair. The reflected light of this body of water, insulated as it is by the shaded spaces in the sky, and separated from the glowing masses to the north and the south, is, throughout the season, one of the most striking and best defined objects in the west. From the middle of September to the early part of October, during which time the sun sets nearly in the west from this place, the appearance of the reflected rays is somewhat like the representation below.



Here the letters and figures represent the same objects as in the former cut, and show that the cause of the pencils must be permanent or such a change in their inclination would not take place with the declination of the sun. The reflections from Erie at this time rise in a broad unbroken mass a little south of west, while that from St. Clair occupies the centre, and the maze of pencils from Huron begin to blend and show nearly as one body. As the sun returns still farther south, the light from Erie occupies a still more prominent place; the column of light from the St. Clair inclines still more to the right; the breaks from the isthmuses of Erie and Huron become less distinct; the reflections from the Huron are melted into an unbroken mass, the interruption from the hills being lost in the oblique position of the pencils; and the sun has scarcely time to leave this extensive line of reflection, before all these streamers and breaks are abruptly melted into the rich dark crimson that floats up from the Michigan, or the mighty Superior. At the close of October or the first of November, the splendor of the heavens, though sensibly diminished, is at times very great, and the outline of the reflections presents the following appearance.



The figures and letters are still the same, and taken in connection with the southern declination of the sun shows as before the fixed nature of the causes, and their relative position to the observer. Lake Erie now fills up the foreground in the direction of the sun; St. Clair is still distinct, and separated from Erie and Huron; the hills which in early autumn were between us and the sun, and broke up the light thrown from the Huron into such beautiful pencils, are now to the northward of any light reflected to us, if indeed they are not beyond the line of rays from the lake, and the streamers from this source disappear from the heavens, not to return, until, with another year and a renewed atmosphere, the sun is again found in the same position. Were there any elevated ranges on the peninsula of Michigan, we might reasonably expect that the reflected light from that body of water, would be broken as is the cone from Lake Huron. But Michigan is too level to offer in its outline any such interruption, hence the pencils must fade away with the disappearance of the sun from the line of the Huron, St. Clair, and Erie. It is possible too that as the season advances the atmosphere loses its proper reflecting condition, and renders it impossible for reflected light to produce the effects of September or October. The electric change denoted by the fact that in the region of the lakes, thunder rarely occurs after these phenomena become visible, and that these are usually accompanied or followed by the aurora, would seem to render such a supposition probable.

We have thrown out these hints—for we consider them nothing more—in the hope of directing the notice of other and more competent observers to the facts stated, and, if possible, thereby gaining a satisfactory solution of the splendid phenomena connected with our autumnal sunsets, (should the foregoing not be considered as such,) or should further observations show that any of the above premises or inferences have been founded in error.

Otisco, November 8, 1837.

Art. XVIII.—*Some Remarks on the Genus Paradoxides of Brongniart, and on the necessity of preserving the Genus Triarthrus, proposed in the Monograph of the Trilobites of North America;* by Jacob Green, M. D., Professor of Chemistry in Jefferson Medical College.

The genus Paradoxides, first proposed by Prof. Brongniart, and founded on a magnificent trilobite in M. DeFrance's collection, has embarrassed most fossil zoologists who have attempted to make use of it in arranging and describing their specimens. The late Professor Dalman, in his important memoir on the trilobites, published in the Transactions of the Swedish Academy, would not admit the genus as it now stands, into his work, but grouped some of the species included in it, under the generic name of *Olenus*.

The animal remain in M. DeFrance's cabinet, is called by Prof. Brongniart *Paradoxides spinulosus*, and was the only Paradoxides which he had examined when his valuable work on the Trilobites first appeared. Dr. Wahlenberg's fine figure of the old Linnean *Entomolithus paradoxus*, was so analogous in all its principal characters to the fossil of DeFrance, that he not only did not hesitate to consider it another species of the same genus, but he gave the generic name itself to this group, to preserve the memory of Linne's singular relic. Now if this genus had embraced those animals only, which exhibit, what its author considers, its *essential* characters, there would have been no difficulty on this subject. These characters are, that the animals should be *blind*, and that the arches of the lobes, and *especially* those of the *tail*, should be *prolonged beyond* the membrane which sustains them. But notwithstanding these remarks, and doubtless from a desire not to multiply names, Professor Brongniart has introduced into his genus Paradoxides, from *drawings*, three animals, which bear a very faint resemblance to those on which it was founded; these fossils he names P. scaraboides, P. gibbosus, and P. laciniatus. The first has an expanded tail, somewhat like an *Asaph;* the second has *no prolongation* whatever of the lateral and caudal arches, and the third is supposed to be furnished with *eyes*. I have but little doubt that Prof. Brongniart will exclude these fossils when he comes to examine them for himself from his otherwise natural genus Paradoxides, in some future edition of his most admirable work.

The practice adopted by some of amending, modifying, or in some essential point, altering the generic characters of one author to adapt them to new animals discovered by another, I suppose to be altogether inadmissible and contrary to the established canons of a correct nomenclature.

I have been led to these remarks in consequence of some recent attempts to force my genus Triarthrus into that of Paradoxides. It is not pretended, I believe, that the animal remain I have described as *Triarthrus Beckii*, bears the most distant resemblance to the *P. spinulosus* or the *P. tessini*, the only true Paradoxides of Brongniart, but that the *head*, according to one author, is like that of the P. scaraboides, and the tail, according to another, is similar to that of the P. gibbosus. It is obvious that by such a process of compression and amalgamation, of decapitation and curtailment, all generic distinctions would be of little value.

It is one of the fixed principles of nomenclature among naturalists, that the first name applied to a genus, should be invariably retained, and that the author himself of the genus should not be allowed, without the most cogent reasons, to infringe this law. From the great accumulation of species, and from the new discoveries with regard to old ones, in fossil zoology, it is plain that if we adhere to the genera as first established, and create no others; or if, on the plan of Fabricius, we make subdivisions of them, by introducing new characters to adapt them to new objects, then the genera will not only be overloaded, so as to be comparatively useless, but they will necessarily embrace animals very imperfectly characterized. Again, it is maintained by many, that an indispensable condition to the establishment of a genus, is that some species be at the same time exhibited as typical of the whole group. When this can be done, its expediency and propriety is exceedingly obvious; but when we consider our imperfect views of organized beings, taken as a whole,—and more especially our limited knowledge of fossilized bodies, a knowledge, however, which is almost daily increasing; it is manifest that species now at the head of a genus, will, in the progress of discovery, more naturally arrange themselves in some other position in the group. But when an author himself regards a particular species as the type of his genus, we must, I suppose, retain his generic name for that type, whatever may become of the other species which our imperfect knowledge may have led us afterwards to group with it.

Governed by the preceding principles, I would suggest the propriety of limiting the genus Paradoxides of Brongniart to those fossil remains only, which are allied in their structure to the P. tessini and P. spinulosus, and which must be regarded a typical species. On the same ground I would urge the necessity of retaining the genus Triarthrus, which was proposed in 1832. A slight comparison of some of the essential characters of the two genera, will prove the importance of separating them.

Paradoxides.	Triarthrus.
Body--depressed--not contractile.	*Body*—elevated—contractile.
Costal arches—with filamentous or spinous prolongations.	*Costal arches*—with no prolongations whatever.
Lateral lobes—wider than the middle lobe.	*Lateral lobes*—not wider than the middle lobe.

For these reasons, and some others which might be specified, I conceive that the genus Triarthrus ought not to be merged in that of Paradoxides.

The following may be considered as the generic characters of the Triarthrus.

Body slightly convex—contractile.

Buckler—with transverse furrows or folds.

Oculiferous tubercles—none.

Abdomen, with ten or more articulations.

Lateral lobes, not prolonged as in Paradoxides.

Tail simple, or furnished with a membranaceous expansion.

The peculiar organization of the tail naturally divides the genus into two sections, and all the species, as far as they are known, may be arranged as follows.

Genus Triarthrus.

Tail simple, or without membranaceous expansion.

T. Beckii.

T. Gibbosus. (P. Gibbosus of Brong.)

Tail with membranaceous expansion.

T. Scaraboides. (P. Scaraboides, Brong.)

T. Laciniatus? (P. Laciniatus, Brong.)

In the last number of your Journal there is a very interesting paper on some trilobites, by James Hall, Esq., and he has had the good fortune to discover and describe the first perfect specimen of our Triarthrus Beckii, the only American species of this genus which I suppose has yet been found. His excellent paper contains the figure and description of what he imagines to be another species, but judging from the representation he has given of it, and from the numerous *heads* or *bucklers* of the animal in my possession, the curvature of the external margin of the cheeks, which seems to constitute the principal peculiarity, has been produced by the manner in which the animal has been fossilized.

Before closing these remarks, I may mention an objection which has been urged against the genus Triarthrus, because it was founded on the supposition that the *buckler* was the abdomen of the animal. This objection, I think, will not be considered valid, especially as the term Triarthrus, which, though originally applied to the three divisions or articulations, of what was then supposed to be the abdomen, may now, without much latitude of interpretation, be considered as referring to the three lobes, or longitudinal divisions of the body, the name would then be analogous to *Trilobite*, *Trimerus*, and other appellations common in zoological nomenclature. At any rate, I now propose the name Triarthrus, for the group as above characterized.

ART. XIX.—*Remarks on the Barometer, with a table of Meteorological Observations, made on board of the U. S. Ship Peacock, from July 8th, to August 17th,* 1837, *during a passage from Peru to the United States, by way of Cape Horn, reported by* W. S. W. RUSCHENBERGER, M. D., Surgeon U. S. Navy, &c.

THE barometer has not been in general use in the Navy of the United States more than fifteen or twenty years. Though this period is sufficient for establishing its utility in foretelling states of weather, it has not yet gained the universal confidence of the officers. However certain the indications of this instrument may be on shore, where it is at perfect rest, and where the observations may be made with the nicest accuracy, the same cannot be said of it when at sea; where, from the incessant motion of the ship, in spite of the best mechanical contrivance for its suspension, the mercurial column is constantly fluctuating, and therefore the observations are obnoxious to error, and at best must be considered only as proximative to the truth.

In the British navy the same difference of opinion prevails, though we might infer, that it is implicitly relied on in some instances. We were told, when in China, that the commander of an English two-and-thirty gun frigate, in the month of August, 1835, actually threw overboard all his guns, because the rapid sinking of the barometer indicated an approaching typhoon. This gentleman took to himself the credit of thereby saving the ship, which was in a few hours afterwards thrown upon her beam ends by a violent storm, and with difficulty saved from total loss, even thus lightened of her battery. Such instances must go far in establishing the claims of the instrument to confidence.

It is pretty generally conceded that the barometer is more faithful in its indications in some positions than in others; and while it is almost altogether distrusted near the equator, it is confidently referred to in high latitudes. In the city of Lima, Lat. 12° S, Dr. Unànue, (Observaciones sobre el clima de Lima,) tells us, the barometer only varies from two to four lines throughout the year, without any established order, the range being two lines higher in the summer than in the winter. It should be borne in mind, that the atmosphere of this region is rarely affected by any very strong commotion; and in one instance, (April, 1808,) just before a fresh south gale, it rose between two and three lines above its ordinary maximum height. In the island of Ceylon, also near the equator, the barometer invariably foretells an approaching gale.

At places beyond the tropics, scarcely a difference of opinion exists on the subject. At Valparaiso, Lat. 33° S., any considerable fall of the mercury is almost always followed by a gale from the north, accompanied by heavy rain; and at the Cape of Good Hope, Lat. 35° S., the sinking of the barometer always precedes the storm. Off Cape Horn, Captain King, R. N., found its indications of the utmost value, and states that its variations "correspond to those of high northern latitudes in a remarkable manner, changing south for north, east and west remaining the same." In another place he says, "with respect to the utility of the barometer as an indicator of the weather that is experienced off Cape Horn, I do not think it can be considered so unfailing a guide as it is in the lower or middle latitudes. Captain Fitz Roy, however, has a better opinion of the indications shown by this valuable instrument: my opinion is, that although the rise or fall precedes the change, yet it more frequently accompanies it."*

The barometer is subject to a diurnal flux and reflux, which was first remarked, I believe, by Baron Humboldt, in 1802, at Lima, and since confirmed by various observers at other places. At that place, Dr. Unànue states, it rises from five o'clock, A. M. until nine, the time of its maximum height; from that hour until meridian, it remains stationary; then falls until four o'clock, P. M. and remains stationary; it again rises from seven till eleven o'clock, and again descends from midnight until four o'clock, A. M.

The variations of the barometer were noted every four hours, through the day and night, in a range of 93 degrees of latitude in the Atlantic, and 45 degrees in the Pacific ocean.

The first column in the table shows the day upon which the observations were made; the second, the position of the ship; the third, the hour of the day, beginning at the meridian, (marked m,) the figures 4 and 8, immediately following, are four and eight o'clock, P. M.; 0, is the sign of midnight, and the figures 4 and 8 are four and eight o'clock, A. M.; so that the divisions of the day are in accordance with the nautical method of reckoning time. The fourth column contains the variations of the barometer; the fifth and sixth, the temperature of the air and water by Fahrenheit's thermometer; the seventh, the direction of the wind; the eighth, the distance run by log each four hours, to show proximately the force of the wind,

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* Sailing Directions for the coasts of eastern and western Patagonia, &c., by Philip Parker King, Captain R. N., F. R. S., &c. London: 1832.

and the ninth, records the state of the weather. When not marked reefs, the ship was under full sail.

The temperature of the air and water were examined by the same thermometer, and therefore we may suppose the temperature of the air is marked lower than it actually was, as the mercury would fall something from the evaporation of the moisture left upon the glass after each immersion.

According to the table, the fluctuations of the barometer do not precede the changes of weather, but as Captain Fitzroy remarks, seem to accompany them. On the 28th of July, the ship was lying-to in a gale, the barometer standing at 29.76 inches; on the 29th, the barometer standing at 30.15, the ship is still lying-to, the weather moderating with the rise of the mercury. The barometer having fallen in the preceding five days from 30.50 to 29.75, on the 4th August, (lower than it was in the gale of the 28th July,) the weather was cloudy and the wind moderate. The mercury continued to fall until the 11th, when it stood at 28.40, yet in the mean time the weather, though somewhat boisterous, was not so heavy as to require the ship to lie-to. The same description of weather was experienced under almost all the variations of the barometer, though it was commonly fair when the mercury stood above thirty inches, but not invariably so.

The observations do not show that the mercury has a regular diurnal flux and reflux, though it was seldom stationary throughout the twenty-four hours.

It would seem, from our present knowledge, that the fluctuations of the barometer indicate changes of weather differently in different latitudes; while a rise of the mercury in some regions is followed by fresh gales, in others, the same phenomena follow the fall of the column. If this be established, it is clear that the barometer is not of universal practical use in navigation, but requires to be studied for particular regions.

Though we may generalize from the table before us, the observations are too limited to infer any general rules, or establish any one fact in relation to the practical use of the instrument; but, sufficient evidence, with very little labor, might very soon be accumulated by navigators, to put all questions at rest in regard to it.

The temperature of the water, both in the Pacific and Atlantic, was constantly higher than that of the air, and increased as we approached the land at Rio de Janeiro, as well as at Bahia.

U. S. Ship Peacock, Norfolk, Va., October 27, 1837.

*Meteorological Observations, made on board of the U. States Ship Peacock, on her passage from Huacho, (Peru,) to the United States, viâ Cape Horn,** 1837.

Date.	Position.	Hour.	Barometer.	Air.	Water.	Winds.	Distance.	Weather.
	Lat.	m.	29.95	66		Sd. Ed.		Pleasant.
	12°18′ s.	4	29.96			"		"
		8	29.99	68		"	10	"
July 8	Lon.	0	30.00	67	70	"	25	"
	78° 59′	4	29.98	66	70	"	24	"
		8	29.98	66	70	"	30	"
	Lat.	m.	29.98	67	69	Sd. Ed.	23	"
	14°14′ s.	4	29.93	66	68	"	25	"
" 9		8	29.96	65	68	"	30	Cloudy.
	Lon.	0	29.95	65	67	"	27	Cloudy, reefs.
	80°58′ w.	4	29.94	64	66	"	23	Squally.
		8	30.00	65	68	"	25	Cloudy.
	Lat.	m.	30.00	65	69	"	31	"
	16° 18′	4	30.65	66	68	"	28	Cloudy and squally.
" 10		8	30.00	66	68	"	31	"
	Lon.	0	30.00	66	70	"	29	Cloudy.
	82° 46′	4	29.98	66	68	"	28	"
		8	30.03	65	68	"	24	"
	Lat.	m.	30.03	67	68	"	24	"
	17°25′ s.	4	30.00	66	69	"	14	"
" 11		8	30.03	66	68	"	14	"
	Lon.	0	30.00	66	68	"	17	"
	84° 10′	4	30.05	65	68	"	18	Flawy.
		8	30.05	66	69	"	16	Pleasant.
	Lat.	m.	30.08	68	70	"	10	"
	17° 31′ s.	4	30.03	70	71	"	6	"
" 12		8	30.05	67	69	"	5	"
	Lon.	0	30.05	67	69	Calm.	5	"
	84° 29′	4	30.05	68	69	Sd. Ed.	3	"
		8	30.05	68	70	Calm.	0	"
	Lat.	m.	30.09	70	70	Variable	3	"
	18°3′ s.	4	30.00	69	70	"	10	Squally.
" 13		8	30.02	67	69	Sd. Ed.	22	Squally, reefs.
	Lon.	0	30.00	69	70	"	18	Cloudy.
	85° 42′	4	30.00	67	69	"	16	"
		8	30.05	68	70	"	13	Moderate.

* The observations after doubling Cape Horn, are, by permission of the author, omitted—as those now published give the most interesting, and the remainder, although valuable, are too extensive for our pages.—Ed.

Date.	Position.	Hour.	Barometer.	Air.	Water.	Winds.	Distance.	Weather.
July 14	Lat.	m.	30.05	67	69	Sd. Ed.	8	Pleasant.
	19° 08′ s.	4	30.00	69	70	"	14	"
		8	30.00	68	70	"	15	"
	Lon.	0	30.00	67	70	"	12	Squall.
	86° 50′	4	29.95	67	70	"	17	Cloudy.
		8	30.00	67	70	"	12	"
" 15	Lat.	m.	30.00	69	70	"	17	Pleasant.
	20° 10′ s.	4	29.98	69	70	"	17	"
		8	30.03	68	70	"	16	"
	Lon.	0	30.05	68	70	"	19	"
	88° 28′	4	30.00	66	70	"	19	"
		8	30.05	68	70	South'd.	22	"
" 16	Lat.	m.	.	68	70	Sd. Ed.	17	"
	21° 11′ s.	4	30.07	69	71	"	17	"
		8	30.07	70	71	"	4	Squally.
	Lon.	0	30.08	69	70	"	5	Pleasant.
	89° 54′	4	30.07	68	70	"	15	Cloudy, rain.
		8	30.09	68	70	"	23	Pleasant.
" 17	Lat.	m.	30.10	69	70	"	19	"
	22° 58′ s.	4	30.08	68	70	"	23	"
		8	30.07	68	70	"	25	Cloudy.
	Lon.	0	30.13	67	70	"	21	Squally.
	91° 36′	4	30.13	66	70	"	27	"
		8	30.15	67	71	"	27	Pleasant.
" 18	Lat.	m.	30.15	67	71	S. E.	30	"
	24° 34′ s.	4	30.15	68	69	"	29	"
		8	30.20	68	70	"	27	"
	Lon.	0	30.18	69	71	"	20	Squally.
	92° 26′	4	30.15	67	70	"	12	"
		8	30.18	68	70	"	5	Pleasant.
" 19	Lat.	m.	30.18	70	71	"	9	"
	25° 27′ s.	4	30.19	68	70	East'd.	18	"
		8	30.16	68	70	Variable	11	"
	Lon.	0	30.19	68	70	Calm.	2	"
	93° 26′	4	30.15	67	70	Sd. Ed.	6	"
		8	30.15	67	70	"	17	"
" 20	Lat.	m.	30.16	69	70	"	6	"
	26° 01′ s.	4	30.15	70	70	"	6	"
		8	30.17	67	69	"	7	"
	Lon.	0	30.19	67	69	South'd.	10	"
	93° 03′	4	30.18	65	69	"	7	"
		8	.	67	70	"	15	"

Date.	Position.	Hour.	Barometer.	Air.	Water.	Winds.	Distance.	Weather.
July 21	Lat.	m.	30.20	69	70	South'd.	19	Fine weather.
	26° 58′ s.	4	30.17	67	69	S. W.	13	"
		8	30.15	65	69	"	24	Cloudy.
	Lon.	0	30.15	66	68	South.	19	Cloudy, squally, reefs.
	91° 30′	4	30.12	64	69	S. E.	25	Cloudy, fresh.
		8	30.15	67	69	"	23	Cloudy, squall and rain.
" 22	Lat.	m.	30.15	66	69	"	19	Moderate, pleasant.
	28° 26′ s.	4	30.12	65	68	"	16	"
		8	30.17	64	67	"	30	Clouds.
	Lon.	0	30.18	64	67	"	29	Fresh, pleasant.
	93° 45′	4	30.18	62	66	"	14	Pleasant.
		8	30.22	64	67	"	20	"
" 23	Lat.	m.	30.22	64	66	"	22	Fine.
	29° 24′ s.	4	30.18	60	67	"	22	Pleasant.
		8	30.23	62	66	"	21	"
	Lon.	0	30.24	62	65	"	14	"
	94° 39′	4	30.25	62	64	Calm.	4	"
		8	30.24	63	65	Variable	4	Cloudy.
" 24	Lat.	m.	30.24	64	65	Calm.	2	"
	30° 07′ s.	4	30.20	64	66	"	1	Pleasant.
		8	30.26	63	64	"	1	"
	Lon.	0	30.25	60	64	Variable	4	"
	94° 05′	4	30.25	63	64	Nd. Wd.	4	"
		8	30.25	63	64	"	12	"
" 25	Lat.	m.	30.25	65	65	"	5	"
	32° 27′ s.	4	30.25	65	65	"	14	"
		8	30.25	65	65	"	24	"
	Lon.	0	30.25	64	63	"	26	"
	92° 53′	4	30.23	64	63	"	28	"
		8	30.25	62	63	"	30	"
" 26	Lat.	m.	30.25	63	64	"	36	Squally.
	35° 15′ s.	4	30.10	62	61	"	37	Squally, fresh.
		8	30.07	62	60	"	37	Reefs, squally, fresh.
	Lon.	0	30.00	62	59	"	36	Squally, fresh.
	90° 32′	4	29.95	56	58	Sd. Wd.	30	Squally, with rain.
		8	29.97	56	59	"	30	Squally and cloudy.
" 27	Lat.	m.	29.90	55	57	"	28	Fresh and clear.
	35° 41′ s.	4	29.92	55	57	"	18	Hove to.
		8	30.05	53	57	"	4	Fresh and squally.
	Lon.	0	30.10	53	57	South'd.	0	"
	89° 28′	4	30.12	53	56	Calm.	13	Moderated.
		8	30.10	55	56	"	12	"

Date.	Position.	Hour.	Barometer.	Air.	Water.	Winds.	Distance.	Weather.
	Lat.	m.	.	56	57	Calm.	1	Pleasant.
	37° 05′ s.	4	30.05	48	51	Variable	11	"
July 28		8	30.07	48	49	N. W.	25	Rain, reefs.
	Lon.	0	29.76	48	50	S. W.	34	"
	88° 07′	4	29.76	48	49	South'd.	27	Lying to.
		8	29.83	47	49	"	17	"
	Lat.	m.	30.00	48	50	"	4	Squally.
	37° 08′ s.	4	30.15	47	50	Sd. Ed.	0	"
" 29		8	30.15	44	50	"	6	Lying-to.
	Lon.	0	30.25	46	49	"	6	Moderate.
	88° 41′	4	30.26	44	48	"	5	"
		8	30.33	45	49	Calm.	1	Pleasant.
	Lat.	m.	30.35	49	50	"	0	"
	38° 39′ s.	4	30.30	49	50	"	0	"
" 30		8	30.36	47	49	Nd. Wd.	7	"
	Lon.	0	.	46	48	"	16	Moderate.
	88° 08′	4	30.38	47	49	Nd. Ed.	21	"
		8	30.40	48	48	"	22	Cloudy.
	Lat.	m.	30.45	48	49	"	31	"
	42° 18′ s.	4	30.45	47	49	North'd.	33	"
" 31		8	30.50	47	47	"	35	Squalls, rain.
	Lon.	0	30.45	46	45	"	36	"
	86° 25′	4	30.45	46	47	"	36	Cloudy.
		8	30.42	46	46	"	37	Squall, rain.
	Lat.	m.	30.40	47	46	"	40	Fine.
	46° 04′ s.	4	30.40	45	45	"	38	Cloudy.
Aug. 1		8	30.35	44	44	"	36	"
	Lon.	0	30.26	44	43	Nd. Wd.	36	"
	85° 25′	4	30.40	43	43	"	40	"
		8	30.15	42	42	"	40	"
	Lat.	m.	30.13	43	43	North'd.	40	Hazy.
	49° 39′ s.	4	30.05	42	42	"	38	Cloudy.
" 2		8	30.00	40	40	"	36	"
	Lon.	0	29.98	42	39	"	38	"
	83° 43′	4	29.83	41	39	"	39	"
		8	29.76	40	39	"	39	"
	Lat.	m.	29.70	40	39	"	36	"
	52° 04′ s.	4	29.62	42	39	Nd. Ed.	38	Rain.
" 3		8	29.54	41	38	Nd. Wd.	37	Reefs.
	Lon.	0	29.55	36	38	Sd. Wd.	29	"
	81° 50′	4	29.70	37	37	"	29	"
		8	29.74	38	37	"	25	"

Date.	Position.	Hour.	Barometer.	Air.	Water.	Winds.	Distance.	Weather.
	Lat.	m.	29.90	36	38	Sd. Wd.	25	Moderate.
	53° 50′ s.	4	29.90	42	41	Nd. Wd.	11	Cloudy.
Aug. 4		8	29.92	44	43	"	8	Reefs.
	Lon.	0	29.85	41	44	"	11	Cloudy.
	80° 09′	4	29.90	42	43	"	21	"
		8	29.75	40	42	Nd. Ed.	25	No reefs.
	Lat.	m.	29.72	41	42	"	32	Cloudy.
	55° 48′ s.	4	29.62	41	41	"	35	Rain, cloudy.
" 5		8	29.55	44	42	"	38	Rain, reefs.
	Lon.	0	29.38	44	42	"	32	" "
	76° 13′	4	29.29	43	41	"	26	Rain, no reefs.
		8	29.20	41	40	"	29	" "
	Lat.	m.	29.15	44	42	"	22	" "
	56° 26′ s.	4	29.22	41	41	Nd. Wd.	24	Rain, squally.
" 6		8	29.10	40	40	West'd.	22	" "
	Lon.	0	29.14	36	39	Sd. Ed.	33	Hail, squally.
	71° 36′	4	29.27	35	40	South'd.	32	Snow, squally.
		8	29.40	34	44	Sd. Wd.	36	" "
	Lat.	m.	29.43	32	40	"	30	Cloudy, reefs.
	56° 22′ s.	4	29.55	29	38	Sd. Ed.	30	Snow squalls, reefs.
" 7		8	29.65	31	39	"	27	" "
	Lon.	0	29.64	34	39	"	28	" "
	66° 24′	4	29.64	37	42	Sd. Wd.	34	Rain, squalls.
		8	29.62	39	41	"	32	Snow squalls, reefs.
	Lat.	m.	29.70	40	45	"	32	" "
	54° 43′ s.	4	29.70	36	42	"	32	No reefs, squally.
" 8		8	29.72	38	40	"	27	Rain and hail.
	Lon.	0	29.76	38	40	"	23	Rain and sleet.
	62° 13′	4	29.80	36	39	"	24	Moderated.
		8	29.75	35	42	Nd. Wd.	27	Pleasant.
	Lat.	m.	29.83	39	43	"	28	Squally, reefs.
	54° 41′ s.	4	29.70	38	40	"	33	" "
" 9		8	29.72	38	39	"	29	" "
	Lon.	0	29.55	38	40	"	19	Squally, hail.
	59° 06′	4	29.38	36	40	"	0	Lying to.
		8	29.15	38	40	"	0	"
	Lat.	m.	29.05	42	42	Nd. Ed.	8	Moderating.
	54° 01′ s.	4	29.00	41	40	Nd. Wd.	13	"
" 10		8	29.00	40	40	"	16	Clear.
	Lon.	0	28.95	41	40	"	18	"
	57° 11′	4	28.75	40	39	"	17	Rainy.
		8	28.52	41	41	Nd. Ed.	12	"

Date.	Position.	Hour.	Barometer.	Air.	Water.	Winds.	Distance.	Weather.
	Lat.	m.	28.45	41	40	Nd. Wd.	14	Fog.
	51° 34′ s.	4	28.40	39	40	Sd. Wd.	20	Cloudy.
Aug. 11		8	28.45	39	39	"	37	Reefs, cloudy, rain.
	Lon.	0	28.40	39	39	"	38	Reefs, rain.
	53° 43′	4	28.55	39	40	"	43	Cloudy.
		8	28.73	40	39	"	40	"
	Lat.	m.	28.70	42	39	"	33	"
	48° 51′	4	28.91	40	39	"	35	Moderate.
" 12		8	29.07	40	39	"	37	Clear.
	Lon.	0	29.07	40	39	"	36	"
	51° 07′	4	29.05	39	38	"	33	"
		8	29.00	40	39	Nd. Wd.	25	"
	Lat.	m.	29.09	42	41	"	28	Squally, reefs.
	46° 34′ s.	4	28.80	46	46	Variable	8	Nearly calm.
" 13		8	28.90	41	42	South'd.	16	Rain, cloudy.
	Lon.	0	29.04	40	42	Sd. Wd.	30	Pleasant.
	48° 55′	4	29.22	40	40	"	39	"
		8	29.32	40	39	"	40	"
	Lat.	m.	29.30	40	42	"	40	Moderate.
	43° 43′ s.	4	29.44	46	47	"	34	"
" 14		8	29.50	46	48	"	30	Squally, rain.
	Lon.	0	29.62	46	47	"	29	Moderate.
	47° 01′	4	29.69	46	46	"	29	Moderate, clear.
		8	29.75	47	47	"	33	" "
	Lat.	m.	29.80	48	48	"	36	" "
	41° 20′ s.	4	29.90	48	46	"	32	Fine weather.
" 15		8	29.90	48	48	"	27	"
	Lon.	0	29.91	49	50	"	26	"
	45° 09′	4	29.90	49	50	"	30	"
		8	29.96	49	50	"	29	"
	Lat.	m.	29.95	52	54	"	28	"
	39° 45′ s.	4	29.91	54	57	"	20	Cloudy.
" 16		8	29.93	54	56	Calm.	8	"
	Lon.	0	29.90	51	57	Nd. Ed.	1	"
	44° 15′	4	29.86	52	57	"	16	"
		8	29.86	54	56	"	25	"

Art. XX.—*Further proof of an annual Meteoric Shower in August, with remarks on Shooting Stars in general;* by Edward C. Herrick.

In a hasty communication published in the last number of this Journal, I stated my conviction of the high probability, that *there generally occurs on or about the 9th of August in every year, a remarkably large number of shooting stars.* In support of that opinion, it was shown that such a meteoric shower had been observed at that period, in at least six different instances. Since that article was written, I have continued the search, and have had the gratification of finding several additional facts, which confirm the proposition. These will be here recited.

(1.) Mr. T. Forster, in his *Pocket Encyclopædia of Natural Phenomena,* &c. 12mo. London, 1827, has a short article on meteors, which he divides into three classes. Of the third kind he says, "They are generally small, and of a bluish-white color, but their peculiar characteristic is that of leaving long white trains behind them, which remain visible for some seconds, in the tract in which the meteors have gone." * * * "*These kind of meteors abounded on the night of* 10*th August,* 1811, after a showery day." Part I. p. 40. In the same work, (p. 298,) in the *Rustic Calendar,* under date of August 10, he remarks, "Falling stars and meteors most abound about this time of year;"—and refers to *Calendar at end of Researches about Atmos. Phenom.,* and to the *Perennial Calendar.* Neither of these works is at my command. This 'Encyclopædia' is made up chiefly from manuscripts left by the author's father, T. F. Forster, Esq. who was long distinguished as an assiduous meteorologist.

(2.) In the Philosophical Transactions of the Royal Society of London, Vol. 70, (1780) is a letter from Sir William Hamilton, describing a series of eruptions of Vesuvius witnessed by him in the month of August, 1779. Not having access to the original Transactions, I quote the following extracts from that letter, through Dodsley's Annual Register, for 1780. London. 8vo.

"1779. August 9. Upon the whole, this day's eruption was very alarming: until the lava broke out about two o'clock, and ran three miles between the two mountains, we were in continual apprehension of some fatal event. It continued to run about three hours, during which time every other symptom of the mountain-fever gradually abated, and at seven o'clock at night all was calm. *It was* *universally remarked, that the air this night, for many hours after the eruption, was filled with meteors, such as are vulgarly called falling stars; they shot generally in a horizontal direction, leaving a luminous trace behind them, but which quickly disappeared.* The night was remarkably fine, starlight, and without a cloud. This kind of electrical fire seemed to be harmless, and never to reach the ground."—*Ann. Reg.* pp. 81, 82.

It is scarcely possible that these meteors came from Vesuvius. The writer says expressly, that at 7 at night all was calm, and gives us no intimation that there were, after that hour, until the morning of the 11th, any signs of disturbance in the mountain. If these bodies proceeded from the crater, they must have been visible in their ascent. Moreover, had they been either incandescent or burning particles ejected from the volcano, they must have fallen to the earth.

The constant expectation of a new volcanic eruption, doubtless induced many persons to maintain a vigilant watch during the night, and thus they happened to witness this display of shooting stars, which might otherwise have passed unnoticed.

(3.) The following extracts are taken from the "*Results of a Meteorological Journal for August,* 1826, *kept at the Observatory of the Royal Academy, Gosport, Hants,*" contained in Taylor's Philosoph. Mag. and Journal, 8vo. No. 341. London, Sept. 1826. Vol. 68.

"This high mean temperature is chiefly owing to the warm and sultry nights in which meteors were frequently seen. *In the night of the* 10*th instant, from* 9 *till* 12 *P. M., there was a fine display of meteors in all directions, amounting to* 42*;* the lower ones appeared the largest and most luminous, and several left long sparkling trains behind them. It is remarkable that these meteors appeared almost at regular intervals, viz., three, four, and sometimes five, in quick succession about every quarter of an hour. There were dark horizontal beds of cirrostratus of an electrical appearance moving about at the time, which with freshening breezes from the westward, seemed to favour their appearance. Two brilliant meteors, each about four inches [!] in apparent diameter, were also seen here in the nights of the 18th and 27th. They descended comparatively slow from an alt. of 44° or 45°, and in the mean time each separated into two distinct meteors before they disappeared. According to observations made here for some years past, meteors have been more prevalent in August, than in any other month." pp. 237, 238.

(4.) In the Philosophical Magazine and Journal, 8vo. London, No. 277, May, 1821, Vol. 57, p. 346, is a "Series of Queries regarding Shooting Stars and Meteors," by John Farey, Sen., in which he furnishes evidence that *on the night of August* 9, 1820, *there was seen at Gosport, a very unusual number of shooting stars.*

The following statements are from the remarks prefixed to the queries.

"Under the head of 'Atmospheric Phænomena' [in the Annals of Philosophy] the Doctor [William Burney, of Gosport] has of late years recorded the number of his observations on small *Meteors* or *Shooting Stars:* these, in the year 1820, were in January 7, Feb. 2, Mch. 1, Ap. 2, May 2, June 1, July 15, Aug. 80, Sept. 10, Oct. 4, Nov. 2, and Dec. 5; making 131 in this year: in 1819 the annual number of each observations was 121.

"The singular fact, of the month of August having furnished so very disproportioned a number of these observations, is accompanied by the mention, that 35 *of these were observed in one hour, which preceded midnight on the 9th of August* last;—they shot in different directions, and three of them whose visible paths lay between the constellations *Lyra* and *Ursa Major* were caudated or appeared with tails; and the Doctor adds 'their sparkling trains having been left brilliantly illuminated, for several seconds of time subsequent to the disappearance of the ignited bodies: this indeed was the grandest display of meteors we ever remember to have seen in so short a period, arising from the very gaseous or inflammable state of the air.'"

The two latter instances (1826 and 1820) may by some be deemed not at all uncommon; but it must not be forgotten that all the records of meteors seen at Gosport are most wonderfully diminutive. It is perfectly certain that these displays far surpassed any appearance of the kind, observed in those two years. During the entire year 1820, 131 meteors only were registered at that place; in 1819, 121; in 1824, 100; and in 1825, 159. In each of these years, August is the most fertile month. It is not easy to imagine how so few only could have been seen by a person who took any notice of them whatever.

(5.) *An unusually large number of brilliant meteors or shooting stars was seen in different parts of this country on the night of August* 10, 1834. The quotation below given in evidence is taken from the meteorological record of Dr. Henry Gibbons, whose writings evince him to be an attentive and faithful observer. The observations were made at Wilmington, Delaware (N. lat. 39° 41′, W. long. 75° 28′) and published in "The Advocate of Science and Annals of Natural History." 8vo. Philadelphia, Vol. I, 1834, p. 179.

"On the evening of the 10th of this month (August), and until it became cloudy next morning at 4 o'clock, an unusual number of brilliant meteors were visible. Their course at first was from north to south, and afterwards from east to west. Two or three were sometimes observed in a minute. On the night of the 11th they were again visible. I find by an account in some of the newspapers, that the same phenomenon was observed at Cincinnati, Ohio, on the same nights."

I have not been able to find the papers which contain the observations made at Cincinnati.

(6.) Mr. Luke Howard, in a meteorological table in Thomson's Annals of Philosophy, Sept. 1813, p. 240, reports, "1813, August 11. A Stratus after sunset, with Cirrostratus remaining above. *Small scintillant meteors now appeared, falling almost directly down, and seeming to originate very low in the atmosphere.*" As Mr. Howard, in his journal published in the Annals, rarely notices these meteors, it is probable that if they had not been on this occasion, uncommonly numerous, they would not have been mentioned.

(7.) For the following additional paragraph concerning the meteoric display seen at Breslau, on the night of August 10, 1823, I am indebted to Prof. Elias Loomis, of Hudson, Ohio, whose library contains a copy of Brandes's work on shooting stars.

"This evening was so still, the air so mild, and the heavens, though not entirely free from clouds, so rich in shooting stars, that even travelers, who felt no particular interest in these phenomena, had their attention attracted by the numerous and large fiery meteors." p. 9.

The above shows plainly that on this occasion the meteors were much more than usually abundant and brilliant. It is interesting to note that on the evening of the 8th next previous, the number seen at Breslau was above the average. No observations are given of the evening of the 9th, which may have been cloudy.

(8.) The meteoric shower of last August (1837) was more splendid than I before supposed. From a gentleman of this city who was abroad very early on the morning of the 10th, I learn that at about 3 A. M. he saw within ten minutes, in an eastern region of the sky, which comprehended not more than a fourth part of the hemisphere, at least fifty shooting stars. Many left brilliant trains, and three were often visible at once.

On the night of August 10, 1837, there was also an unusual display of meteors, but invisible here, as our sky during that night was entirely overcast. By permission of Professor Silliman, I copy the following from a recent letter to him, written by Mr. Davis B. Lawler, of Cincinnati, Ohio.

"On the night of the 10th of August last (1837), being at Springfield, in this State, about 70 miles N. N. E. of this city, sitting at the front of the hotel there in the evening with some friends, between the hours of 8 and 9 P. M. we were all struck with the uncommon number and brilliancy of the meteors or falling stars, which made their appearance, and commanded our attention without being in any wise attentive to them, being engaged in conversation. Their course or track was from the N. N. E. to S. S. W., and of various degrees of brilliancy,—some of them very large and splendid. No watch was kept for them, and no particular attention paid to them, and we soon retired into the interior of the house. The air was uncommonly transparent and the moonlight bright."

(9.) The display of shooting stars described in the following extract, must have been one of uncommon numbers, and although the time does not correspond with the other dates within a week, yet the case deserves to be copied in this connection. If the times of the occurrence of the meteoric showers have gradually changed within six hundred years, it is highly important that we should know it. The quotation is from *Matthæi Paris Historia Major, etc. Ed. W. Wats, S. T. D. fol. Lond.* 1640. p. 602.

A. D. 1243. "Et eodem annò, videlicet septimo Calend. Augusti, fuit nox serenissima, aërque purissimus, ità quòd Lactea, sicut solet placidissima nocte hyemali contingeie, manifestè apparebat, Luna existente octava. Et ecce stellæ cadere de cœlo videbantur, velociter sese jaculantes hac et illac. * * * In uno instanti, præter solitum, triginta vel quadraginta saltitare vel cadere viderentur, ita scilicet, quòd duæ vel tres simul uno tramite, volare se mentirentur. Unde, si veræ stellæ fuissent, (quod nullius sapientis est sentire) nec una in cœlo remansisset. Considerent Astrologi, quid hujusmodi portentum significet: sed omnibus intuentibus, videbatur nimis stupendum et prodigiosum."

This date is the 26th of July of the Julian style, and consequently about the 2d of August of our present calendar.*

(10.) Observations on shooting stars have of late engaged the attention of persons in various parts of Europe. The September No. (1837) of the Lond. and Edin. Philos. Magazine, which has recently arrived, contains three articles on this subject;—one by M. Wartmann, of Geneva, and two by M. Quetelet, of Brussels. The following quotations from the latter show that the author suspects a meteoric shower in August.

"M. Sauveur stated that being on the road from Brussels to Liége, in the night of the 8th of last August (1836) he observed a considerable number of shooting stars, of which several were remarkable for their size and brilliancy. M. Quetelet suggests that this epoch presents a singular agreement with that of the 10th

* There are on record several other well-marked instances of ancient star-showers, some of which it may be difficult to reconcile with the periodic times of the present day. If their dates are truly given, these displays have happened, at various times between A. D. 764 and 1243, in the months of March, April, October and December. There seems however good reason to suppose that the meteoric showers of antiquity did in fact occur at times of year somewhat removed from the present periods. A statement of these instances, with an inquiry into this change of period, may be expected in the next volume of this Journal.

of August, which the results of observations of shooting stars, point out as one of those which are to be remarked for the abundance of meteors of this kind." p. 270.

"It would seem that a cause exists which produces from about the 8th to the 15th of November, more frequent appearances of shooting stars. I have also thought that I remarked a greater frequency of these meteors in the month of August (from the 8th to the 15th)." p. 272.

From the preceding statements it then appears, that *on or about the 9th of August, in at least eleven different years* (viz. A. D. 1779, 1781, 1798, 1811, 1820, 1823, 1826, 1833, 1834, 1836, 1837) *there has occurred a meteoric shower*, or in other words, an unusually abundant display of shooting stars.

As no observations have yet been made for the purpose of detecting the August shower, it is somewhat remarkable that so many instances have been recorded. It should be noticed, that these August showers have rarely been watched later than midnight. Since shooting stars are found to come mostly from that region of the heavens towards which the earth is moving, it cannot reasonably be doubted that each of these displays would have been found to be more abundant, during the hours of the next morning. That region, (which for brevity may be called the *tangential region*,) rises of course about midnight, and comes to the meridian about 6 A. M. The memorable storm of stars of November, 1833, scarcely commenced before 11 P. M.; and it is altogether probable, that every November meteoric shower which has occurred since that year, would have passed unseen, had not special watch been maintained after midnight.

Characteristics of the August Meteoric Shower.

1. This shower appears to be longer than that of November. As far as can be gathered from the accidental observations hitherto made, its duration may be considered about three days. It may perhaps be found to extend through ten or fifteen days, and to arrive at its maximum about the ninth. See 1, 3, (1), (5), (6), (7), (8).

2. The 'radiant,' or apparent starting point of the meteors, appears to be farther north than in the November shower. On this point, however, nothing positive can be stated without more observations continued during the whole night. See Mr. G. C. Schaeffer's paper, p. 133 of this volume, and 3, (5).

3. Although its displays are in general superior to those of the November shower, yet it seems never to have risen to the mag-

nificence to which both the November and the April showers have occasionally attained.

On the number of Meteoric Showers in a year.

Three during the year may be considered as well established, viz. those of November, August and April. Of the latter, however, our knowledge is lamentably defective. It is certain that an unusual display of shooting stars was witnessed in this country about the last of April, 1803, and that very extensive meteoric showers occurred in April, A. D. 1095, and 1122. No proper efforts to discover the April shower have to my knowledge yet been made. A careful look out should be, and probably hereafter will be kept up, for ten days before and after the 30th of that month.

Having looked through many hundred volumes in search of meteoric showers, it seems to me rather improbable that any fourth periodical time will be found. There are however several uncertain statements which afford some slight reasons for supposing, that there may be a meteoric shower about the middle of February, and also about the middle of June. As the phenomenon is one which in most cases would escape ordinary observation, we must look for our evidence chiefly to the future. If the showers of A. D. 902 and 1202, now referred to October, (new style,) should be found correctly stated, then we shall be obliged to admit that in these two years a meteoric shower occurred in October; and we ought to lose no opportunity for ascertaining whether their successors can now be discovered.

On the nature, motions, and numbers of Shooting Stars.

Shooting stars are without doubt cosmical or celestial bodies, and not of atmospheric or terrestrial origin. No plausible reasons for the common supposition that they are particles of electricity, or in some way the result of electrical action, have, to my knowledge, ever been advanced.

If we consider them as a class of bodies wholly distinct from meteorites, then we have no knowledge of their constituent elements. The different colors and appearances which they present, clearly indicate however that they differ in constitution. The majority are white, many are yellowish-white, some are red, and a few are green. They probably also differ in density;—some appear to us like mere streaks of phosphoric vapor; others seem to be solid balls of fire, and leave behind them trains of scintillations, which are sometimes iridescent. These trains not unfrequently retain their lustre and their position several seconds, which, considering the excessive tenuity of the atmosphere at the place, is a fact quite unaccountable. I know of nothing which renders it at all improbable, that meteorites and shooting stars are bodies of the same class and have a common origin. No one can by the eye discriminate between them.

By well-planned simultaneous observations in distant places, Brandes* has proved that shooting stars come principally from that part of the heavens towards which the earth is tending. He has also proved that they do sometimes *actually move upwards.* This apparently anomalous motion is easily explained. His observations were made commonly between 9 and 11 P. M., when of course the tangential region is beneath the horizon; so that a meteor coming from that region must, if it comes into our field of view, move upwards. Observations made in this city on various days of the present month, between 7 and 10 P. M., show that at this season at least, three fourths of the shooting stars visible here at this time of day, move from the N. E. quarter towards the S. W. If the premises first stated are true, the reasons for this general tendency are sufficiently obvious. At a corresponding south latitude, we might expect this tendency to be from the S. E.

It must ever be exceedingly difficult to determine the velocities of shooting stars, and the statements on this point are not satisfactory. If their rate is found to be from 18 to 36 miles a second, it seems necessary to suppose that they move in a direction contrary to that of the earth's motion.

Shooting stars are wonderfully numerous. Leaving out of consideration the myriads which fall during the meteoric showers, *the average daily number for the whole globe is at least two millions.* It is of course impossible rigidly to determine this number; but there is no difficulty in showing that this statement is probably far within the truth. 1. The average number visible per hour at one place, M. Quetelet, who has devoted much attention to the subject, states at *sixteen.* This calculation is based on observations made in Germany and in Belgium, but there is no reason for sup-

* A valuable abstract of Brandes's account of his observations, was published by Prof. Loomis, in Vol. 28 of this Journal, to which I am chiefly indebted for my information concerning those researches.

posing that part of the world to be particularly favored in this respect. In fact these meteors are, according to scientific travelers, much more abundant within the tropics than in higher latitudes; and Capt. Parry speaks of them as not uncommon in the extreme north. This average number, however, appears to be the result of observations made before midnight, when of course shooting stars are least numerous, and also to be founded on the assumption, that "a single observer or several observers directed towards one and the same region," can detect half of the whole quantity visible at one place. This number is therefore too small. Observations made in this city, at various times in November, 1837, by three observers, (a number insufficient to secure all) give an average of rather more than 20 per hour.* Other observations justify the assumption of this number, as a fair hourly mean. During the entire day then, 480 might be seen at one place if superior lights did not interfere. 2. The distance at which shooting stars are ordinarily seen, I take at one hundred miles. A few may be seen at a greater distance, but very many more are probably invisible at fifty miles, and some, according to Quetelet, are discerned only by the telescope. Let this area be taken at 32,000 sq. miles. 3. The earth's surface contains at least 196,800,000 sq. miles, and there are consequently upon it 6150 such areas. The latter number being multiplied into 480, we have 2,952,000 as the daily number for the whole earth. This is an *average*. The actual number on any one day, (omitting the three yearly showers,) may be one fourth more or less than this.

The source of these meteors must be of vast extent, to be able to sustain for thousands of years such incessant and enormous drafts. It seems not unreasonable to suppose, that, in a long course of time, the amount of matter resulting from the combustion of these meteors must be very considerable.† Some may ask whether, if these bodies meet the earth advancing in a direction opposed to their motion, they must not deprive it of some small portion at least of its projectile force, and thus shorten the year? Past observation answers in the

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* More observations on this point, in all parts of the world, at all times of the night and of the year, are much needed. Nine observers at one place are required to do full justice to the subject; yet four persons might probably see about three fourths of the whole visible number.

† Prof. Rafinesque's "Thoughts on Atmospheric Dust," Vol. 1, p. 397 of this Journal, may be profitably consulted in this connection. See also Webster's Hist. of Epidemic and Pestilential Diseases, Vol. 2, p. 91.

negative, and no one surely will suppose there is any ground for immediate apprehension.

On the theory of Shooting Stars.

In the present very imperfect state of knowledge concerning many of the phenomena of shooting stars, there is much hazard in proposing any hypothesis on the subject. Without further observations, it is indeed impossible to state more than a small part of the conditions which a theory ought to fulfil. Besides accounting for the meteors of daily occurrence, it should explain the reasons for their appearance in unusually large but varying quantities every year, (or at least for many years in succession,) certainly at two periods in the year, viz., about Aug. 9, and Nov. 12, and probably also at a third, viz., about the last of April. The various characteristics of the November shower have been stated at large by Prof. Olmsted and Mr. A. C. Twining, in preceding volumes of this Journal; those of the August shower, (so far as they are known,) are contained in the present volume.

It is not impossible that these meteoric showers are derived from nebulous or cometary bodies with which, at stated times, the earth falls in. This hypothesis, however, does not satisfactorily account for the meteors of daily occurrence.

M. Arago (Comptes Rendus, 1835, pp. 394, 395. 4to. Paris,) proposes the hypothesis of an immense zone or ring, composed of millions of small bodies or asteroids, revolving about the sun, whose orbits meet the plane of the ecliptic at that part of the path of the earth, which it occupies from 11th to 13th November. This hypothesis, in some shape, will probably be found adequate to account for all the phenomena.

The facts at present known, seem to require that the earth should pass through some part of this zone in November and in April; and approach in August sufficiently near it, to receive an unusually large quantity of meteors. It is also necessary that the earth should constantly keep very near it, in order to obtain its daily supply. If however additional periodic showers should be discovered, it might be difficult to account for all by one such zone.

This zone probably lies partly within and partly without the orbit of the earth. When the earth is in that part of its orbit which is *exterior* to the zone, we might expect by the aid of the telescope, occasionally to detect these bodies passing across the disc of the sun. Owing to their distance and comparatively small size, they might however, while in their celestial courses, be totally invisible. Frequent observations of the sun, for the purpose of detecting these transits, are highly desirable. The only important facts known to me, which relate to this point are these:—on the 17th June, 1777, Messier saw myriads of small dark bodies passing over the sun; and at Geneva, May 19, 1830,* from 1 to 2 P. M., multitudes of "small luminous emanations" were discovered passing across the field of a meridian telescope. Both these facts are of great value and deserve attentive consideration.

When the earth is in that part of its path which is *interior*, it might not be unreasonable to suppose that we should see the zone by reflected light; but while we are ignorant of the density, numbers, size and distance of the bodies which constitute it, we cannot assert that it ought to be visible.

The only known celestial appearance to which this zone can be referred is the *Zodiacal Light*. Our great distance from the equator renders it impossible for us to make observations upon this light, which will determine whether its position at various periods of the year is such as to permit us to consider it the source of shooting stars. Satisfactory observations can be made only at or near the equator.

The limits which circumstances prescribe to this article, compel me to omit the consideration of many important particulars relating to this subject, and to speak of others with too much brevity.

My thanks are due to Prof. B. F. Joslin, for the important assistance which he has afforded me in relation to this inquiry; and also to various friends in this city, especially to Messrs. A. B. Haile and J. D. Dana, for whose coöperation and counsel I am under great obligations.

New Haven, Conn. Nov. 29, 1837.

P. S. Since the preceding article was written, I have, through the kindness of Mr. R. W. Haskins of Buffalo, N. Y., been furnished with his translation of M. Arago's reports to the Academy of Sciences, at the sessions of August 14 and 28, 1837, concerning unusual numbers of shooting stars seen that month in various parts of Europe. The translation is published in the Buffalo Daily Commercial Advertiser, of Nov. 25, 1837. There is no room to quote it here. With a single exception, its statements do not contravene any fact or conclusion contained in the foregoing paper.

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* The details are related by Gautier, at p. 206 of his account of the extensive meteoric shower of Nov. 13, 1832, Bib. Univ. de Genève, 1832, Sci. et Arts, tome 3, pp. 189—207. These bodies may possibly have been in our atmosphere.

ART. XXI.—*On a large and very sensible Thermoscopic Galvanometer*; by JOHN LOCKE, M. D., Professor of Chemistry in the Medical College of Ohio.* (From the London and Edinburgh Philosophical Magazine, and Journal of Science.)

TO RICHARD TAYLOR, ESQ.

Dear Sir—The announcement of a new galvanometer will, perhaps, scarcely attract attention. But as I have been kindly encouraged by several eminent British philosophers to communicate some notice of my modification of the thermo-multiplier, I venture to send you the following sketch. Although a great labor has already been performed in electricity and magnetism, yet the adepts are aware that much remains to be executed, and that among the numerous principles already clearly established, it is probable that those proportions and arrangements which will produce the *maximum* effect have been in few instances fully ascertained. The chief novelty of the instrument which I am about to describe, consists in its proportions and the resultant effects. The object which I proposed in its invention was to construct a thermoscope so large that its indications might be conspicuously seen, on the lecture table, by a numerous assembly, and at the same time so delicate as to show extremely small changes of temperature. How far I have succeeded will in some measure appear by a very popular, though not the most interesting experiment which may be performed with it. By means of the warmth of the finger applied to a single pair of bismuth and copper disks, there is transmitted a sufficient quantity of electricity to keep an eleven-inch needle, weighing an ounce and a half, in a continued revolution, the connexions and reversals being properly made at every half turn.

The greater part of this effect is due to the *massiveness* of the coil, which is made of a copper fillet about fifty feet long, one fourth of an inch wide, and one eighth of an inch thick, weighing between four and five pounds. This coil is not made in a pile at the diameter of the circle in which the needle is to revolve, but is spread out, the several turns lying side by side, and covering almost the whole

* Through the kindness of Dr. Locke we have received the fine instrument described in this paper, and as far as we have had opportunity to examine it, we find it to justify the statements made by its ingenious inventor.—ED.

of that circle above and below. The best idea may be formed of the coil by the manner in which it is actually modeled by the workman. It is wound closely and in parallel turns on a circular piece of board eleven and a half inches in diameter and half an inch in thickness, covering the whole of it except two small opposite "segments" of about 90 degrees each. The board being extracted, leaves a cavity of its own shape to be occupied by the needle.

The copper fillet is not covered by silk or otherwise coated for insulation, but the several turns of it are separated at their ends by veneers of wood just so far as to prevent contact throughout. In the spreading out and compression of the coil it is similar to Melloni's elegant apparatus, though in my isolated situation in the interior of America I was not acquainted with the structure adopted in his prior invention. In the *massiveness* of the coil my instrument is perhaps peculiar, and by this means it affords a free passage to currents of the most "feeble intensity," enabling them to deflect a very heavy needle. The coil is supported on a wooden ring, furnished with brass feet and leveling screws, and surrounded by a brass hoop with a flat glass top or cover, in the center of which is inserted a brass tube for the suspension of the needle by a cocoon filament. The needle is the double astatic one of Nobili, each part being about eleven inches long, one fourth wide, and one fortieth in thickness. The lower part plays within the coil and the upper one above it, and the thin white dial placed upon it, thus performing the office of a conspicuous index underneath the glass.*

I have not yet made any very extensive experiments with this instrument, being only just now prepared to do so. It is very sensible to a *single* pair of thermo-electric metals, to the action of which it seems peculiarly adapted; but the efficiency of such metals is increased by a repetition of the pairs, as in the thermo-pile of M. Melloni, especially if they be massive in proportion to the coil itself. With a battery of five pairs of bismuth and antimony, the needle was sensibly moved by the radiation from a person at the distance of 12 feet, without a reflector, the air being at the temperature of 72°.

In a recent interview with M. Melloni, to whose politeness I am much indebted, he expressed his opinion that with a thermo-pile

* This instrument has been made by Messrs. Watkins and Hill, Opticians and Philosophical Instrument Makers, No. 5, Charing Cross.

massive in proportion to the coil, my galvanometer might be made to exhibit his thermo-experiments advantageously to a large class. Some idea may be formed of its fitness for this purpose from the result of a single trial on "transmission." The heat from a small lamp with a reflector, at the distance of five feet, passed through a plate of alum, and falling on a battery or pile of five pairs of bismuth and antimony, deflected the needle only a fraction of one degree, but on substituting a similar plate of common salt, the same heat produced, by impulse, an immediate deflection of 33 degrees.

Although the instrument is finely adapted by its size for the purpose for which it was intended, class illustration, yet from the weight of the needle and the difficulty of bringing it to rest after it once acquires motion, it is not so suitable for experiments of research as the Mellonian galvanometer. When a massive thermo-pile, such as has lately been made by Messrs. Watkins and Hill of Charing Cross, is connected with the coil and excited by a heat of about 200°, the needle being withdrawn, a distinct spark is obtained on interrupting the circuit; in producing this effect it is less efficient however than the ribbon coil of Prof. Henry. The tube for suspension, placed over the center of the instrument, is so constructed as to admit of being turned round by means of an index, which extends from it horizontally over the glass cover, and thus any degree of torsion may be given to the suspending filament or wire. A wire of any desired thickness may be easily substituted for the cocoon filament, when the instrument becomes adapted to measuring the deflecting forces of the galvanic battery. By using a thick wire it was ascertained that the calorimotor of Professor Hare, having 40 plates, each 18 inches square, acted on the needle with a force equal to 92 grains, applied at the distance of 6 inches from the center. In attempting to force the needle by torsion into a line parallel to the coil, where the deflecting current acts with the greatest strength, I accidentally carried it too far and reversed its *position*, when instantly it became reversed in *polarity*, that which had been the north pole becoming the south. This showed how unfit is the magnetic needle to measure such a quantity of electricity as was then flowing through the massive conductor. The instrument was well adapted to show to a class the experiments upon radiating heat with Pictet's conjugate reflectors, in which the differential or air thermometer affords, to spectators at a distance, but an unsatisfactory indication. For this purpose the electrical element necessary is merely a disk of bismuth as large as a shilling, soldered to a corresponding one of copper, blackened, and erected in the focus of the reflector, while conductors pass from each disk to the poles of the galvanometer. With this arrangement the heat of a non-luminous ball at the distance of 12 feet will impel the needle near 180°, and if the connexions and reversals are properly made will keep it in a continued revolution.

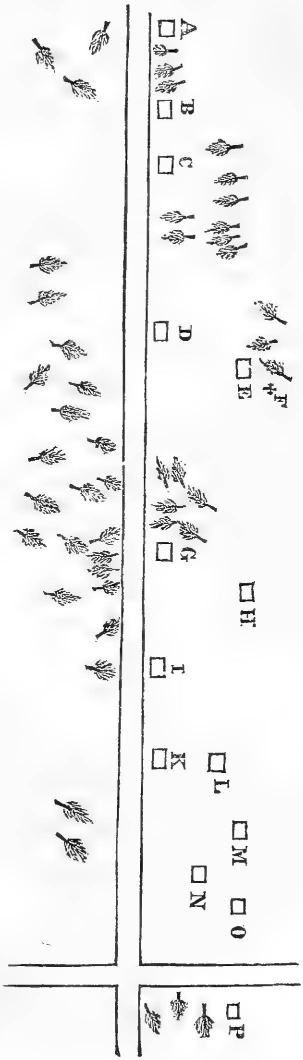
I have thus given you a brief sketch of an instrument which seems to supply a desideratum on the lecture-table, when the common thermometer is too small to afford to a class that direct and full satisfaction which, in a subject so important as that of heat, is very desirable to every professor. I have not so far attempted to use it extensively as an instrument of research, yet it shows evidently the importance of massiveness in conductors for feeble currents, such as those produced by thermo-combinations; nor am I certain that I have arrived at a maximum in this particular, for so far as I have proceeded in using thicker conductors for the coil, the deflecting effects have been increased.

I am, &c. JOHN LOCKE.

London, Aug. 30, 1837.

ART. XXII.—*Observations on a Hurricane which passed over Stow, in Ohio, October 20th,* 1837; *by* ELIAS LOOMIS, Professor of Mathematics and Nat. Philosophy in Western Reserve College.

ON the morning of October 20th, 1837, a hurricane, of destructive violence, passed over Stow, in Ohio. This town is situated about thirty miles south of Cleveland, in north latitude 41° 12′, and west longitude 81° 25′. As the hurricane occurred during the darkness of the night, we can collect little information respecting it, with the exception of the record which the wind has itself left of its progress. During the night of the 19th and morning of the 20th of October, there was a thunder shower at Stow, which extended into some of the adjoining towns. The lightning was rather vivid, the rain fell in torrents, and the wind blew fresh during most of the night. About three o'clock in the morning, a whirlwind formed near the center of Stow. It moved rapidly from west to east, over an extent of about three miles, its breadth varying from forty to sixty, and occasionally to eighty rods. For about a mile of its course, few objects were found of sufficient strength to resist the shock. The trees were almost entirely blown down or broken off—the fences were completely scattered—the houses and barns were generally unroofed, and one house torn literally into pieces. For the purpose of rendering my description more intelligible, I have drawn a plan of that part of the hurricane's track where most of the injury was done.



A, represents a house unroofed; B, a barn partly unroofed; C, a house uninjured; D, the house of Mr. Sanford, completely destroyed; E, the barn somewhat injured; F, the spot where the cart was dropped; G, a house not much injured; H, a barn unroofed; I and K, houses unroofed; L and N, barns unroofed; M, a two-story log-house with its upper story taken off; O and P, houses uninjured. The horizontal road runs east and west; the perpendicular road runs north to Hudson.

The hurricane commenced a little west of the house A. Its violence rapidly increased as it advanced eastward, and throughout that whole part of the track which is represented in the diagram, a large proportion of the trees were leveled. Where no trees are represented on the diagram, there were very few, if any, to be uprooted. Eight buildings were unroofed; three others were considerably injured, and the remainder of those on the diagram escaped with a few panes of broken glass. But it was the house D, upon which the storm poured its principal violence. This was a small frame house of one story, and had been built but two years. It was situated upon a slight eminence or knoll, and was not protected at all from the fury of the wind. The house was occupied by Mr. Frederick Sanford, his wife and mother, with three children. On the evening of the 19th, the family were absent from home to attend a wedding. They returned about midnight, and Mrs. Sanford states that it was then raining moderately, the lightning was somewhat vivid, and the wind fresh. They retired to bed and were soon asleep. Mrs. S. relates that she was awakened from a sound sleep by a crash, which she presumes was occasioned by the falling chimney; almost at the same instant she felt that the house was moving; there was a tremendous roaring noise, and further than this she has no recollection. In the morning the neighbors found the house a perfect wreck. Not a timber was left in its place. The foundation stones were not disturbed, but the entire frame of the house was lifted up, and carried in the direction of the barn E. A portion of the foundation frame was dropped almost immediately, and lay but a few feet from the foundation walls. The bricks of the chimney were, most of them, carried but a short distance, and were scattered along precisely in the direction of the barn. A considerable number of bricks, however, constituting, as is supposed, that part of the chimney which rose above the roof, were carried to a greater distance, and scattered mostly in a northeast direction. The barn bore N. 29° E. from the house, as I determined it by a compass, and was distant from it twenty-five rods. This entire space was strewed with the small fragments of the furniture and timbers of the house. About half-way between the house and barn, were found three corpses horribly mangled, being the bodies of Mr. Sanford's two sons and his mother. Mr. Sanford was still breathing, but died in about an hour. Mrs. Sanford and her daughter were unable to move in consequence of bruises and broken bones. They are, however, still living, and will probably recover. Animals of various kinds were lying dead among the ruins. There were pigs, geese, hens and turkeys, in considerable numbers, and several of the fowls were picked almost clean of their feathers, as if it had been done carefully by hand. Neither Mrs. Sanford nor her daughter are able to give any satisfactory account of the hurricane, for they were both of them awakened from a sound sleep by the crash of the house, and the next instant they were dashed senseless upon the ground. I have stated that the house was carried in the direction of the barn. About half of the roof and frame fell near the S. W. corner of the barn, and some of the timbers fell near the S. E. corner. Several heavy joists lay scattered forty or fifty rods beyond the barn, but all in nearly the same direction from the house. There were several very remarkable facts, showing the power of the wind, which I should not have been prepared to credit had I not observed them for myself. I visited the spot the day after the hurricane, and have observed it once since that time. An ox-cart, before the storm, was standing close by, and in the rear of, Mr. Sanford's house, and was loaded with potatoes. The cart was lifted up by the wind; it soon turned a somerset, so as to empty out the potatoes upon the ground, and nearly all in a heap. The cart itself was dropped a few rods *behind the barn,* and at a distance of thirty rods from the house. If the cart moved in a straight line it must have passed directly over the barn. Indeed, it is quite probable that such was the case; for the cart struck flat upon one wheel which buried itself to a considerable depth in the earth. The spokes were all broken, apparently by the severity of this fall, and there is no appearance of the cart's having been injured previously to the fall, with the exception of the loss of the boards which lined the body. There are no marks of the cart's having been dragged along upon the ground, but on the other hand, the wheel imbedded in the earth shows that the cart fell nearly perpendicularly, and from a considerable height. It is then probable that it passed directly over the barn. There was a heavy drag, moreover, taken from nearly the same spot with the cart, and which also fell by its side beyond the barn. The roof of the barn was somewhat injured, losing some shingles and boards, and it is conjectured that the drag might have struck the roof in passing over it. I attach but little importance, however, to the question whether the cart and drag actually passed over the barn. It is at least certain, that they were transported by the wind about thirty rods, and fell from a considerable height.

A wagon before the storm was standing in front of the house by the road-side. The next morning one wheel was found in the road about thirty rods east of the house; another wheel a little farther north over the fence; the two remaining wheels at a still greater distance from the house and in the direction of the barn H. The wagon box was found half a mile distant in a northeast direction.

There is another fact which appears to my mind still more remarkable. A very heavy cast-iron plough was lying between the two houses C and D; a massive iron chain was attached to it, and there was little wood-work about it. This plough was dragged along about four rods, and ploughed into the ground in several places. In one spot it appears to have been carried almost entirely around, removing all the turf from a space about four feet square, and throwing up the earth to the distance of six feet; the plough was broken so as to be worthless. Various light objects of clothing have been found in the neighboring towns; a sheet was found in Franklin, three miles east in a straight line, and a silk frock with a bonnet was found in Streetsboro', a distance of five miles in a direction east-northeast.

My principal object in examining the ground has been to determine the direction of the wind's motion. This may be done tolerably well by observing the bearings of the fallen trees. Trees will usually fall very nearly in the direction of the wind which uproots them. I have therefore measured with a compass the direction of a very large number of the trees throughout that part of the track where the wind was most violent. On the north side of the road and close by the barn B on the west side of it, one tree fell S. 7° E., another south, and another S. 9° W. Back of the house C, the trees fell S. 42° E.; S. 31° E.; and S. 12° E. A little farther east, between the houses C and D, several apple-trees fell in the direction S. 6° E.; S. 12° E.; S. 31° E.; S. 42° E.; S. 68° E. Those nearest the road were generally more inclined to the south than those near the borders of the track, but this rule was not without exceptions. Almost exactly north from the house D and at the distance of about thirty rods, a tree fell S. 49° W. A little farther east, an old tree but a stout one fell directly towards the barn E which bore S. 16° E.; and still farther east, being directly north from the barn, and distant about twenty rods, an oak tree two feet in diameter but somewhat decayed fell S. 54° W. In this neighborhood, the whole number of trees was very small. Still further east near the house G but west of it, the trees fell S. 26° E.; S. 82° W.; N. 86° W.

Passing over now to the south side of the road, a few rods beyond the barn B, the trees were generally turned northward, but some eastward. Opposite the houses D, G and I, was a white oak forest. Here the trees were not generally blown down, but broken off at an elevation from the ground of from twenty to forty feet. The stoutest white oaks of two feet diameter were snapped like a walking cane. I measured the bearings of a large number of the fallen trunks; they were N. 56° W.; N. 46° W.; N. 32° W.; N. 31° W.; N. 29° W.; N. 2° E.; and N. 14° E. Within these limits the bearings of nearly all the trees in this forest were embraced, if we except a few which lay very near the road. Here the trees were thrown down in much greater disorder; thus, directly opposite the house G and near the road, one tree of immense size fell N. 31° W. Only two rods distant were two others of about the same dimensions which fell S. 31° E., and then another N. 31° W. Thus here were four large trees side by side with their trunks as nearly parallel as they could well be laid, while the tops of two pointed northward and those of the others southward.

The preceding observations will shew the direction of the fallen trees as compared with the track of the hurricane, for the latter was almost due east and west, not following absolutely a straight course, yet very nearly so. I have introduced the observations here for the sake of shewing how great variety there was in the bearings of the fallen trunks, and also to shew that these bearings were actually measured and not loosely estimated by the eye. A general idea of the direction of the trees will be best acquired from the diagram, in which I have attempted to represent their relative positions and bearings. It will then appear from an inspection of the diagram, that in the midst of some disorder there was a degree of uniformity. Thus upon either border of the track the trees all incline toward some point in the center of the track. There is not an example of a tree being turned outward from the track, nor even one which lies in a direction parallel to it. I except from this remark those near the middle of the path, which were subject to a different law as will presently be seen. Of all the trees situated near the borders of the track, the bearing which approaches nearest to parallelism with the track was in the case of an apple tree about half way between the houses C and D. This bore S. 68° E., differing 22° from parallelism. This is a striking result and clearly shews that the wind blew from both borders of the track towards some point in the center of the track. This remark does not apply to one part of the track exclusively, but was a general characteristic of the hurricane. Moreover, there was one spot near the house A, where the fences on each side of the road were blown into the road.

We have then I think established that there were two powerful currents of wind blowing from the opposite side of the track; that is, within a few rods of each other, and with such violence that the stoutest oaks fell before it. What then became of the air thus accumulated in the centre? It must have some escape. Was this escape in a horizontal or vertical direction? The evidence I think is sufficient to decide this question; that there was a powerful current upward from the surface of the earth near the middle of the track, is proved by the objects which were actually elevated into the air. The house D was lifted directly from its foundations. The cart which was standing near the house was raised thirty or forty feet at the least calculation into the air. The feather bed upon which Miss Sanford was sleeping, was found next morning lodged in a tree nearly between the house and the barn, and at an elevation of forty feet from the ground. A coat which belonged to one of the men of the house was lodged also in the same tree. The light articles which have been found in the neighboring towns, prove not only a horizontal current, but an ascending one sufficient to counteract the effects of gravity during several minutes.

We have now established by a fair induction, that there was a powerful current of air from the opposite sides of the track towards some point in the centre of the track, and that here there was also a powerful current upward. What was the nature of this ascending current? Was it accompanied by gyration? This question I think we are able to answer. The furniture of the house D, was scattered in very various directions. The house itself and the more substantial part of the furniture were carried in the direction of the barn; portions of the wagon however, lay strewed in every direction from east to northeast; leaves of books were found attached to bushes by the road in an east direction; a tin pail and various light articles were found in the woods opposite the house G, and in a direction S. E. from D; and a piece of a clock was found in a N. W. direction from D, in the apple orchard. The plough which was between the houses C and D, was obviously carried round nearly an entire circumference, for it left clear marks of its course on the ground. We find the same evidence of a gyral motion in the directions of the trees which fell near the middle of the track. Take the case of the four trees I have mentioned in front of the house G. They lie parallel to each other, side by side, and fell nearly at right angles to the track of the hurricane. Yet the tops of two of them incline to the north, and those of the other two to the south. Here there were two winds which blew, we cannot suppose simultaneously, but successively, from opposite points of the compass at the very same spot, and the two winds must have succeeded each other at an interval not exceeding a minute, for the violence of the hurricane was past in about that time. The preceding, moreover, is a phenomenon which occurred not in one spot merely, but all along the centre of the track. Every where there is the same evidence of two currents in exactly opposite directions, having passed over precisely the same spot. I know of but one supposition which will explain all these phenomena; viz. that the air near the centre of the track had a whirling motion. A tree then which was levelled as this whirl was approaching it, would be turned to the right for example; and another which fell as the whirl was receding would be inclined to the left; so that we might have trees side by side, lying parallel to each other, but with their tops turned in opposite directions conformably with the observations. It appears, however, that this whirl did not extend over the breadth of the entire track, for then trees must have every where fallen, occasionally at least, parallel to the track, a fact which has been observed only near the middle of the path.

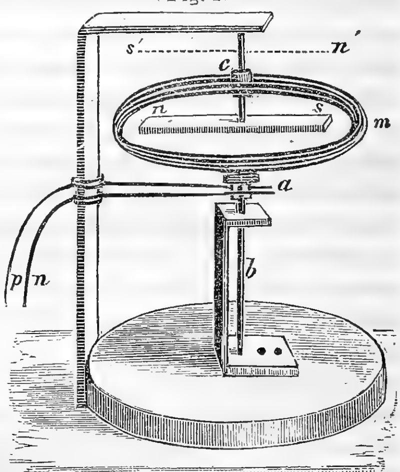
We are now I think, in a situation to explain nearly all the phenomena which have been observed. The wind blew from the opposite sides of the track, and doubtless from every point of the compass, towards some point in the centre of the track; here the wind rose violently with a gyral motion. This vortex itself had a rapid motion from west to east, sweeping along over the middle of the hurricane's path. Trees then upon the borders of the track would every where fall towards this vortex. Those which were prostrated as the vortex was approaching, would have an inclination to the west; but those which fell as the vortex was receding, would be found inclined to the east, and we should no where find trees falling outward from the track or even parallel to it. All this is in exact conformity with the observations. We may now, moreover, explain a fact which at first view might have seemed quite anomalous, viz. that the house D was carried in the direction of the barn, while a tree behind the barn fell towards the house. At the surface of the earth the wind must have blown at one instant from the barn towards the house; here however there was an upward and gyral current; the house was raised with it, and almost immediately thrown out of the vortex by its immense centrifugal force. Lighter objects which were carried up with it, were retained in the whirl a long time, and were finally thrown in very various and even opposite directions.

The preceding results as to the character of the wind's motion, are very similar to those which marked the New Brunswick hurricane of 1836. It is desirable that the leading features of every great hurricane should be faithfully recorded, that we may in time be enabled to decide whether the preceding characteristics pertain alike to all hurricanes; or if otherwise, into how many classes they are to be divided.

Art. XXIII.—*Rotary Multiplier, or Astatic Galvanometer;* by Chas. G. Page, M. D.

Figures 1 and 2 represent two new pieces of galvanic apparatus, completed in the beginning of September last. Fig. 1 represents a rotary or astatic galvanometer, with a single needle. *m* is the multiplier, composed of a number of turns of insulated wire. At *c*, an open collar passes through the center of the wires, to prevent any friction against the stem supporting the bar magnet *n s*. The multiplier *m* is mounted for revolution on a slender shaft *b*, and has the ends of its wires soldered to semi-cylinders of silver at *a*, upon which the battery wires *p n* press with a slight spring.

Fig. 1.

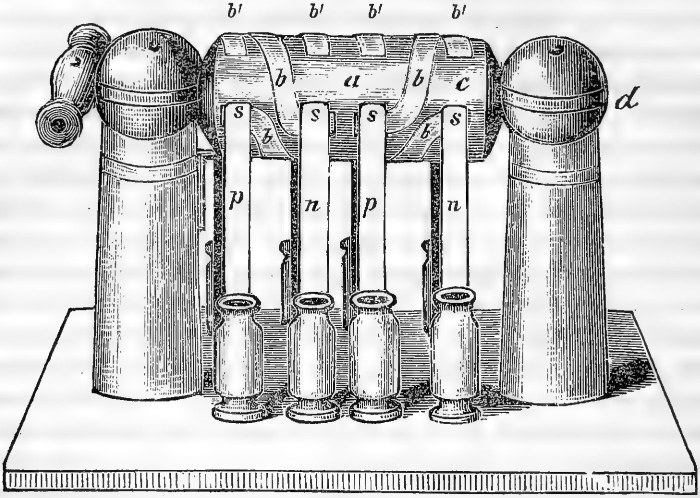


The cylindrical segments are not correctly represented in the figure. Their relation to the battery wires should be such that the direction of the current should change when the coil of wire is at right angles to the magnet. The magnet being stationary may be very large and powerful, and the mode of suspending the wire allows it to be brought much nearer the magnet than is represented in the figure; at the same time the friction is trivial. The apparatus would be much improved by the addition of another bar magnet *n' s'* above the coil. In that case the magnetism of both bars might be preserved, by arming their opposite poles when not in use. This instrument, though interesting, is not intended as a measurer of galvanic force. But the principle of making the conducting wires the indicators instead of the magnets, appears to be of value, for many reasons. The conducting wires may be considered as perfectly astatic, and affording constant results. It is difficult to obtain, and much more so to preserve a perfectly astatic needle. The needle of a galvanometer is readily disturbed by the approach of any ferruginous body. By substituting for the dissected cylinder at *a* two entire cylinders above and below, the rotary multiplier becomes a galvanoscope of considerable delicacy. In order to constitute an astatic galvanometer the whole should be inverted, the magnets supported from below, the multiplier by a torsion thread from above, and the extremities of the wire turn in small mercury cups in the centre of motion.*

Fig. 2, represents a new form of electrepeter. Its name purports a turner or changer of the electrical current. An ingenious apparatus of this kind, by Mr. Clarke of London, is described and figured in the first No. of Sturgeon's Annals; but it is not so simple in construction, and the connecting wires in his machine being out of sight, it is not so easily understood as the one here figured. The drawing represents a double electrepeter, or one to be used with two separate batteries, and two or more pieces of electro-magnetic apparatus. Divide the machine at *a*, and bring up the wooden pillar *r* to the left hand division, and you have the single electrepeter, answering for most purposes. The one I have constructed, was made for reversing the motion of an electro-magnetic engine, and has four parts. *a c* is a cylinder of mahogany $\frac{3}{4}$ inch diameter, mounted for semi-rotation between two wooden pillars. *b b b b* represent strips of silver passing each obliquely half round this cylinder, and fastened to it by pins of the same metal. *b' b' b' b'* represent rectangular studs of silver, (copper will answer, but not so well,) connected metallically through the centre of the cylinder with

* The wires here should be of silver, except the tips for the mercury connexion.

Fig. 2.



corresponding studs directly opposite. *p s*, *n s*, are stiff springs of copper, with silver tips at *s* pressing firmly against the studs on the cylinder, and connected with the mercury cups below. The back side of the instrument exactly corresponds to that exhibited in the drawing. The modus operandi is seen at a glance. The two springs *p n* are connected by the mercury cups with the poles of a battery. The corresponding springs of the other side, with the wires of an electro-magnet for instance. By turning the cylinder half round, it is obvious the battery current is crossed, and the poles of the magnet *reversed.*

New form of interruptor or electrotome.—As it is desirable that every distinct form of apparatus of general use should have an appropriate name, I have selected the term electrotome (divider of the electrical current) as applicable to the several varieties of apparatus figured and described in the July No. (1837) of your Journal. It is hardly necessary to premise, that secondary currents of great intensity, are obtained from a single pair of plates in connexion with the dynamic multiplier, when the primitive current is divided in any part of its course. The force of the secondary current so obtained, depends materially upon the mode of breaking the circuit of the primitive. The shocks and decompositions I have found to be greatest when the primitive circuit is broken by raising clean pencils of lead, zinc or copper, from the surface of mercury covered with water. The sparks are best exhibited over clean mercury with lead. The mechanical electrotome I have contrived with a view to combine the above advantages, at the same time that it is a useful instrument, affords a most brilliant exhibition of galvanic power. The connexion is rapidly broken by a long series of leaden bars, raised from the surface of mercury in succession by pins arranged at proper distances on a revolving metallic drum, similar to that of a barrel organ or musical box. The lead bars, or wires, of large size, are supported in a wood frame by projecting shoulders, to take the pins of the drum as it revolves. Their lower ends just dip into the mercury of a long narrow cell with glass sides. The drum is connected with the battery by a strip of copper pressing firmly against its metallic axis. The mercury in the cell is connected with the spiral by a wire. As the pins come round in successive order, they establish the battery connexion, and again break it by raising the piece of lead, and so each one in order. Revolved by a multiplying wheel the effect is exceedingly beautiful, while, in the dark, illuminated by its own light, the whole appears to be at rest.

MISCELLANIES.

DOMESTIC AND FOREIGN.

1. *On the Meteoric Shower of November,* 1837.

By Denison Olmsted, Professor of Natural Philosophy and Astronomy, in Yale College.

1. *Observations made at Yale College.*

Although, in conformity with a remark made in my account of the meteors of November, 1836,* I had little expectation of a repetition of the same phenomenon the present year, unless on a very limited scale, yet it was deemed proper to take such measures as would insure a full knowledge of the facts of the case, whatever they might be. Accordingly, I made early arrangements with a number of my young friends, who are conversant with the stars, deeply interested in the studies of nature, and much accustomed to astronomical observations, to maintain a strict watch during the whole of the night, between the 12th and 13th of November, and

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* American Journal, vol. xxxi, p. 386.

to have an eye upon the stars, especially the latter half of each night, for several nights preceding and following that.

In order that every part of the firmament might receive its due share of attention, our company, eight in number, divided itself into four parties, allotting two to each quarter of the heavens. To Mr. *R. B. Claxton* and myself was assigned the southeastern quarter; to Messrs. *A. B. Haile* and *E. C. Herrick*, the northeastern; to Messrs. *E. Strong* and *D. T. Stoddard,* the northwestern; and to Messrs. *H. L. Smith* and *E. P. Mason*, the southwestern. Each party selected a separate station for itself, and arranged to keep an accurate record of its observations.

The early part of the evening afforded some signals of promise. A copious rain which fell on the preceding night, attended by an easterly wind, had given place to a serene sky with the wind at the west; from the setting sun diverged six large columns of a rose colored vapor; and, before six o'clock, an auroral pillar of a crimson hue presented itself in the northwest; but before seven o'clock, every unusual appearance had vanished and left an unclouded sky. The full moon, however, shone with so strong a light as almost to hide the stars, permitting none to be seen below the third magnitude, and scarcely any indeed at so hasty a glance as the eye must take to observe the transient flash of ordinary shooting stars. Of course, no meteors but those of unusual brightness could be seen.

From the early part of the evening, a constant watch was maintained; but the several parties were not at their respective posts until about midnight. From this period, until broad day light, the observers were constantly in the open air, gazing, without intermission, upon the quarter of the heavens respectively assigned to them.*

No shooting stars were observed until five minutes past one o'clock, when they began to appear at considerable intervals. On collecting and comparing all the observations, we arrived at the following results.

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* We should not have thought it necessary to trouble the reader with the narration of all these circumstances, except by way of apology for having seen more shooting stars than were seen in other places. To some who have averred that there were on that night few or none to be seen elsewhere, but have ascribed the favors so much more freely bestowed here to the courteous attention paid them on former visits, we would respectfully recommend, that hereafter they use the ceremony to meet these celestial visitants out of doors, and in full dress. A constant gaze with the neck bent backwards, for six hours or more, in a frosty night, is the kind of etiquette they exact.

I. Number.

Time.	S. E.	N. E.	N. W.	S. W.	Total.
1h—2h	8	3	6	3	20
2—3	8	4	9	2	23
3—4	26	22	3	7	58
4—5	26	16	12	10	64
5—6	28	18	8	8	62
6—7	3	. .	. .	. .	3
Sum total,	99	63	38	30	230

Remarks.

1. On comparing notes, it was found that four meteors had been counted twice; these being deducted, the entire number is 226.

2. The greatest number were observed in the *southeast*, and the the least in the *southwest*, the former being more than three times as numerous as the latter.

3. Including all the observations, the *maximum*, or period of greatest frequency, occurred from 4 to 5 o'clock; but this was not uniformly the case in the several quarters taken separately. Thus, in the *southeast*, the most productive hour was from 5 to 6; in the *northeast*, from 3 to 4; in the *northwest* and *southwest*, from 4 to 5 o'clock. The maximum of the meteoric showers of November of previous years has been, always and in all places, about 4 o'clock.

4. In numerous instances, after a considerable interval, several meteors would start about the same time, from the same part of the heavens, falling in different directions. Thus, at 3h. 47m., four started almost at the same instant from Jupiter, then situated a few degrees east of Regulus.

II. Courses.

1. Of the 99 meteors which were observed in the S. E., 42 fell between E. and S., and 29 between E. and N., the remainder passed in different directions.

2. *Seven* were observed to *rise*. The particulars are subjoined with the hope of instituting a comparison with observations made elsewhere.

1h. 23m. from μ Leonis, (very bright.)
1h. 26m. " breast of Leo, (observations not definite.)
1h. 39m. " Pollux.

2h. 25m.	from	hind foot of Ursa Major.
3h. 35m.	"	Leo, (very bright.)
3h. 40m.	"	Ditto.
4h. 11½m.	"	Castor.

3. All the meteors, with the exception of ten or twelve, proceeded in lines of direction which diverged from the constellation Leo. Those which did not follow this regimen, were marked in our records as *unconformable.* They were generally remarked as having a *slower motion* than the others, particularly when moving horizontally from west to east. Each of our four parties made a separate location of the apparent radiant, and, on comparing notes, it was found that all agreed in placing it *somewhere* between ε and γ Leonis. It was conceded, however, that those whose attention was constantly directed towards the eastern quarter of the heavens, had better opportunities than the others, for determining this point with accuracy. The position of the radiant was at first near the star μ of the Lion, but afterwards moved southward and eastward a little, and soon after three o'clock, became stationary nearly equidistant from and μ.*

Position of the radiant in successive years.

1833,	R. A.	150° 00′	Dec.	20° 00′
1834,	"	144° 30′	"	30° 15′
1836,	"	145° 00′	"	25° 00′
1837,	"	146° 00′	"	24° 30′

III. Magnitudes.

1. It must be recollected, that a full moon was shining with so strong a light as to extinguish all stars below the third magnitude, and consequently, that none but very bright meteors could be seen at all. About 40 were of such a size and splendor, that they might be compared to Venus and Jupiter. These in a dark night must have been very splendid fire balls. The greatest part, however, were much smaller, and many were mere momentary flashes.

2. The major part of the meteors were followed by *trains.* These appeared to be, in most cases, merely the continued impression of light on the eye, resulting from the great velocity of the bodies; but

* This change of the place of the radiant was, we learn, also noticed by Mr. F. A. P. Barnard, of New York.

in several instances, the train remained visible so long as to leave no doubt of its being a deposit of luminous matter. It must evidently have required a train of singular brightness to have overcome a moonlight so strong, that a newspaper could easily be read by it. We will add, for the sake of comparison with other observers, the particulars of a few of the meteors most remarkable for the length and splendor of their trains.

1h. 40m.—From near ξ Leonis, length 45°.

2h. 42m.—Origin, 3° N. of Capella, extinguished 6° N. of Alpha Arietis—as large as Jupiter—train writhed for 3 seconds and then faded away.

4h. 6m.—Origin in the head of Perseus—extinguished near Mirach—brilliant train of 20°—remained 3 seconds.

4h. 59m.—Course towards Procyon—train 6° and swelled out in the middle.

5h. 6m.—Origin 4° above γ Leonis—extinguished 5° above δ Canis Majoris—length of train 16°—meteor as bright as Sirius.

IV. Velocities.

The velocity of most of the shooting stars was surprisingly great, the time of flight being in many cases not more than a quarter of a second, and rarely exceeding a second. It has already been remarked, that such as moved horizontally from west to east had a comparatively slow motion. On the evening of the 16th of November, at 10h. 25m., I saw a large dull red meteor sailing along the southern sky from west to east, at an elevation of 20°, which occupied 10 seconds.

2. *Observations made in various other places.*

I learn from abroad, that on the night preceding the 13th of November, a careful watch was maintained in various parts of the United States, both at literary institutions and by private individuals. Such results as I have been able to ascertain from the public papers, and from numerous communications obligingly made, either to myself or to my friends, Prof. Silliman and Mr. E. C. Herrick, I proceed to lay before the reader, regretting that the limits of this article do not permit the insertion at large of the copious documents in my possession.

In the *city of New York*, a strict watch was maintained by Mr. *G. C. Schaeffer* and Mr. *F. A. P. Barnard*, both well known as men of science, and as skillful observers. Their observations were wholly independent of each other. Mr. Schaeffer saw none until 2 o'clock, but from this time until sunrise he counted 70, most of them in brilliancy equal or superior to the brightest fixed stars, many of them leaving trains of considerable length. The point of radiation was nearly, if not quite, in the same place as in November, 1836. (*New York American.*)

Mr. Barnard counted between 40 and 50 shooting stars, between 2 and 6 o'clock. Most of them left behind them trains of great beauty. Many of the fainter kind were not included in this estimate. The meteors were most frequent from half past three to half past four. The first one that was observed, of very uncommon splendor, fell eastwardly, between Denebola in the tail of the Lion and the planet Jupiter, at about 20 minutes before four. But the brightest of all, and the most beautiful one he ever saw, occurred just about 5 o'clock, falling eastwardly also, near *Theta Leonis.* Its brightness was dazzling like that of the sun, and its size two or three times that of Jupiter. It left a magnificent train. Two or three usually fell about the same time, after which there generally occurred an interval of from five to fifteen minutes, in which none were observed. The display continued until all the stars were swallowed up in the broad light of day. All the meteors, traced back by the eye, seemed to proceed from a radiant point due north of *Regulus*, and between *Eta* and *Zeta Leonis.* They moved in all directions, but mostly on the east side of a meridian passing through the radiant point. To the west, however, the brightness of the moon was such as to extinguish nearly all the fixed stars. But one meteor out of the whole number was observed to be an exception to the general law of radiation ; and that one, apparently originating in the right foot of the Great Bear, crossed the lines of the radii to the east.

Mr. Barnard adds : "On the whole this exhibition, though not of astonishing brilliancy, was one of a very satisfactory nature to the philosophic observer. It was such as to confirm in a very remarkable manner, the general inferences of Prof. Olmsted regarding the meteors of November. All the observations of Mr. O. regarding the distinctive appearances of these meteors to the eye, were abundantly corroborated."—(*New York Commercial Advertiser.*)

There is some reason to believe that the splendid fire ball mentioned by Mr. Barnard as occurring about 5 o'clock, was seen at several places remote from each other. A meteor answering nearly to this description, though somewhat less splendid, was observed here about the same time, allowing for the difference of longitude. I learn also by a letter from President Humphreys, of St. John's College at Annapolis, Md., that, at the same time, "a very brilliant meteor was seen there, which fell from the direction of the zenith towards the east point." The occurrence of a meteor, attended with similar circumstances in respect to time, splendor and direction, is also mentioned in a letter from Mr. Frederic Merrick, Preceptor of Amenia Seminary, Dutchess Co., New York. Were these several observations accurately collected, they might perhaps afford sufficient data for determining the height of this meteor.

At *Mount St. Mary's College*, Emmittsburg, (Maryland,) as I learn by a communication from Mr. L. Obermeyer, several of the professors and students watched during the whole night. No meteors were seen until twelve minutes past one; from that time the number gradually increased until half past four, when they succeeded each other more rapidly than at any other time. My correspondent himself commenced his observations at fifteen minutes before four, and continued them until five. During this period he counted 52 meteors. He adds: "A great many had been previously seen by Prof. Clark and others, and comparing notes, I find the same principles prevailing throughout, as far as relates to the point of emanation, courses, velocities and trains. With few exceptions they all radiated from the constellation Leo, diverging towards every point. The interval between them varied from half a minute to five minutes. In one or two instances, two diverged from the same point at the same time, taking opposite directions."

At *Buffalo*, (New York,) a careful watch was kept up by Mr. Haskins, but dense clouds entirely covered the heavens. At *St. Louis*, (Missouri,) "a watch was maintained by a number of scientific gentlemen every night, from the 11th to the 14th, inclusive. On the 11th and 12th, the sky was constantly overcast. On the 13th and 14th, the sky was clear, but there was no appearance indicating a return of the pheuomenon."

At *Western Reserve College*, (Ohio,) very seasonable and efficient arrangements for observation were made under the direction of Prof. Loomis. The company consisted of twelve, each quarter of the heavens being assigned to a separate observer, who watched two hours at a time. The view was interrupted by clouds until a quarter before three, when it became perfectly clear, and remained so until half past four. At twenty three minutes before five, the sky had become so cloudy as to prevent further observations. In the clear interval they counted 74 meteors. The greatest number were seen in the southeast, and the least in the northwest; 29 being seen in the southeast, 23 in the northeast, 17 in the southwest, and 11 in the northwest.

It is granted that shooting stars occur in greater or less number at all seasons of the year, and that they are usually frequent in every clear night in the autumnal months; and before we are authorized to infer any remarkable exhibition of them on the morning of the 13th of November of the present year, it is necessary to compare the phenomena as observed on that morning with such as were observed on the mornings preceding and following that.

For many days before and since the 13th, Messrs. Herrick and Haile have watched together in the open air, commencing usually as early as 4 o'clock. Many shooting stars have been seen on every favorable morning. The greatest number seen in a single hour by the two observers, directing their attention different ways, was 32. There was then no moonlight; and the hour was at that period of the night usually most productive of shooting stars. On Saturday morning, November 11th, in the presence of the moon, then approaching the full, the same observers saw but *four* in a half an hour. The night preceding the 12th was rainy; but several of my young friends, determined to let no opportunity escape them to collect important facts on this interesting subject, sat up all night with the hope that they might at least catch a glimpse of the stars.

But the following observations of Mr. *E. Fitch*, of the Senior class in Yale College, supply us with very useful materials for making the comparison in question. I give them in his own words.

"The object of these observations was simply to determine, as far as circumstances would permit, how the meteors of the 13th of November compare with those of other mornings. Having, at the commencement of my observations, Oct. 16th, ascertained that the meteors diverged from the constellation *Gemini*, I directed my attention towards this point of the heavens, extending the field of view to thirty or forty degrees in every direction from this constellation. The following is the result of my observations.

Date.	Time of observation.				Num.	No. pr. h.	Average.	Remarks.
Oct. 16	3h.	30m. to	5h.	45m.	8	3.55		
17	4	00	6	00	12	6.00		
21	3	30	5	45	28	11.70		
23	5	00	5	45	8	10.66		
28	4	00	5	30	17	11.33		
30	4	15	5	10	16	17.45	10.13	
Nov. 1	3	00	5	15	38	16.88		
2	3	30	5	00	18	12.00		
3	3	30	5	15	29	16.57		
4	3	30	5	15	33	18.85		
8	4	15	4	30	5	20.00		
9	4	00	4	15	4	16.00		
"	5	00	5	15	3	12.00		
11	5	30	4	45	10	8.00		Moon fulls 12 d. 6h. 21m. M.
13	3	15	5	15	34	17.00		Moonlight, 1 day after full.
15	3	45	4	15	5	10.00		Ditto. 3 do.
"	4	45	5	15	6	12.00		Ditto. do.
16	3	45	5	15	6	4.00		Ditto. 4 do.
17	4	15	5	15	9	9.00		Ditto. 5 do.
22	4	05	4	30	6	14.04		Ditto. 10 do.
"	5	12	6	00	11	13.75		Ditto. 10 do.
28	4	10	5	15	36	33.23	14.58	New moon.
Dec. 5	5	00	5	30	13	26.00		
7	5	00	5	30	11	22.00	24.00	

"It has been already remarked, that when I commenced my observations, the meteors appeared to diverge from the constellation *Gemini*. As to a definite point of divergence, I was unable to fix upon any with certainty; the region of divergence however, manifestly moved on through the constellation *Cancer*, and on the morning of the 13th Nov. it was in the neck or breast of *Leo*. From the time when I commenced observing, the number of irregular meteors (that is, of those whose direction was not from the region of general divergence) has increased in comparison with the whole number seen; and since the 13th, it has been so great, that the most that can be said is, that the majority appear to come from the constellation Leo. The time when I have found the meteors most numerous, is during the hour *from half past three to half past four*. As far as can be determined from what observations I have made since the 13th, as many as *two thirds* or *three fourths* of those that are visible in the absence of the moon, would be invisible in the light of the full moon."

At this place (New Haven) the night of the 13th was cloudy. It appears, as before mentioned, (see page 385,) that it was clear at St. Louis, in Missouri, but that the observers there could detect no unusual number of meteors. On Tuesday night, the 14th, occurred one of the most magnificent exhibitions of the Aurora Borealis. Mr. Barnard observed this with great attention in New

York, being favored with a clear sky, while it was here partially or wholly covered with clouds. During the latter part of the night, after the aurora had disappeared, Mr. B. gave his attention to the shooting stars. He observes, "I watched steadily for an hour and a quarter, and saw only *three* trifling ones. I had seen one before, early in the evening."

On the morning of the 5th of December, when the moonlight was gone, and the sky was in all respects favorable, I kept up a strict watch of the eastern part of the heavens from 3h. 20. to 4h. 20m., during which time I counted 21 meteors. I kept my record in two columns, placing such as appeared as bright as stars of the third magnitude, and which might have been seen on the morning of the 13th Nov. in one column, and such as were feebler than stars of the third magnitude in another column. The footing of the columns was respectively 7 and 14, indicating that two thirds of the whole number would not have been visible in full moonlight. Mr. Fitch observed on the same morning, and made a similar estimate entirely independent of mine, but with precisely the same result. Messrs. Herrick and Haile express the opinion, that of those meteors observed by them on dark nights, *three fourths* would have been invisible on the morning of the 13th November. Indeed, the most they could ever see in an hour in full moonlight were only eight, while in a corresponding hour in the absence of the moon, they counted 30. The meteors seen by me on this occasion, nearly all proceeded from around the lower part of the constellation Leo. But the region of divergence, instead of being as on the 13th a definite point, was a circular space of more than twenty degrees diameter. The directions of the meteors were such also as frequently to cross each other's paths. Such too, I am authorized to say, have been the appearances as observed by Messrs. Herrick and Haile.

With the foregoing facts in view, we proceed to the inquiry, *Whether on the morning of the* 13*th of November, of the year* 1837, *there was or was not an extraordinary exhibition of shooting stars, analogous to the "Meteoric Shower," which had occurred at the corresponding periods for six years before?*

The peculiar characteristics by which this phenomenon has been attended, have been heretofore enumerated as follows;—(1.) a *number* greater than usual—(2.) a *radiation* of nearly all from one center, situated in the constellation Leo—(3.) *trains* more frequent and vivid than ordinary—and, (4.) a *maximum*, or period of greatest frequency, at 4 o'clock in the morning.*

With regard to the period of greatest frequency, it appears by the observations of Mr. Fitch, (p. 387,) that on a number of mornings previous to the 13th, four o'clock seemed likewise to be the time of the maximum. A very unusual proportion of the meteors seen on the present occasion were accompanied by vivid trains; but as the light of the moon would have prevented many others not accompanied by such trains from being seen, we cannot, in the present instance, employ this characteristic to prove the analogy of this exhibition with the meteoric showers of previous years, although we have much reason to believe that this characteristic would have been very obvious, had it not been for the presence of the moon. But we allege the following arguments as decisive of the occurrence of the meteoric shower, on the morning of the 13th November.

1. The number of meteors actually seen on that night, in the two eastern quarters of the heavens, was in fact greater than on the corresponding hours of any other night before or since, notwithstanding the unusual brightness of the moon.

2. Still, at the lowest estimate made by any of the observers, *two thirds* of the whole number must have been lost in the moonlight, and therefore, we may safely estimate the entire number that would have been visible had the moon been away, at three times two hundred and twenty six, that is, at six hundred and seventy eight,—a number far greater than ordinary. The greatest number of shooting stars seen by any observer during the present season, were counted by Mr. Fitch on the 28th of November, from 4h. 10m. to 5h. 15m., in which time he saw 36, being at the rate of 33 per hour. Yet on the morning of the 13th, I counted in the same quarter of the heavens, between the hours of half past four and half past five, 32 meteors, which multiplied as before by 3, gives for the number that would have been seen in the absence of the moon 96,—a number almost three times as great as the greatest number observed at any corresponding hour of other nights. We do not deem it fair to make the comparison with other seasons of the year, especially when the number with which the comparison is made was unusually large,—such, for example, as the number seen on the 9th or 10th of August, since there is reason to believe that

* See the Report for 1836, in the 31st volume of this Journal, p. 386.

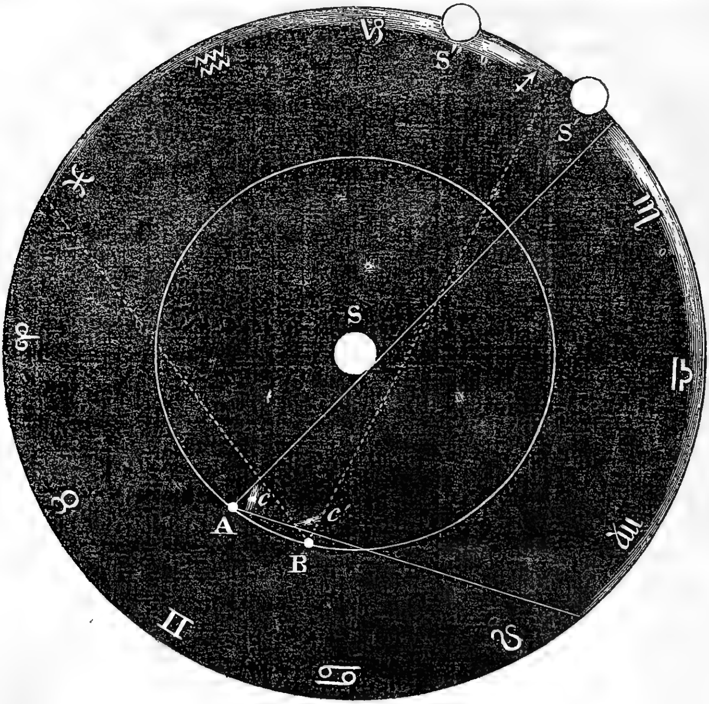
that time constitutes one of the periods of the recurrence of the phenomenon.

3. As in preceding years, nearly all the meteors moved in lines which radiated from the same centre; and the point of radiation was as heretofore in the constellation Leo, and almost precisely in the same part of Leo as the "radiant" of last year.

The fact noticed by Mr. Fitch, that, on the 16th of October, the radiant was in Gemini, and moved successively forward in the direction of the earth's motion in its orbit, keeping nearly or exactly in the line of its tangent, is an observation of great interest and importance, and plainly indicates a connexion between the phenomenon and the revolution of the earth around the sun, a connexion which has been recognized from many other independent sources of evidence. It is also a fact of similar interest, that the radiant point of the shooting stars was always in the region occupied by the extreme visible portions of the *Zodiacal Light*, or rather a little westward of the *visible* parts of that light. This light has been very conspicuous in the east the present autumn. As early as October 5th, it became distinctly visible in the east before the dawn of day, reaching as high at least as the Nebula of Cancer. It travelled eastward nearly at the same pace with the sun, and, on the 2d of November terminated near Regulus, and had sensibly increased in brightness. On the morning of November 8th (the last time I saw it before the 13th) it was still brighter, and advancing at nearly the same rate as before. The western sky had for some time been unfavorable for observations on this light, on account of the moon; but on the 29th of October I searched for it diligently in the western sky, after twilight, but could not detect the least trace of it. As soon after the 13th, as the absence of the moon and the state of the weather would permit, I began to renew the search in the west. Although very soon after the 13th, that part of the milky way where the Zodiacal Light usually crosses it, appeared more luminous than common, yet the illumination was ambiguous from the presence of Venus, and I could not feel certain of seeing the Zodiacal Light until the evening of the 21st, when, in company with three of my astronomical associates, I observed it under very favorable circumstances. At 7 o'clock in the evening, (Venus being near the horizon, and hidden behind a cloud,) we were severally able to define the boundaries of the Zodiacal Light. By fixing the right eye on the milky way near the Eagle, and the left eye near the head of Capricornus, we could discern a luminous pyramid less bright than the milky way, but still sufficiently distinct to say it was there, its upper edge grazing Alpha Capricorni, and the vertex reaching to the right shoulder of Aquarius. Its light was very feeble and diffuse, but the triangular space between it and the milky way, embracing the Dolphin, was perceptibly darker.

On the 26th of November, the moon being away, I looked for the Zodiacal Light again in the morning sky, and was surprised to see it so bright,—much brighter I think than it has appeared for the several preceding years when I have watched it after the 13th of November. It was now, therefore, visible on both sides of the sun, having an elongation from that luminary, in the region of the ecliptic, of 60° in the morning and 90° in the evening sky. From this time I could hardly discern any change of place in it in the morning, reaching uniformly to near γ Virginis, nor any perceptible diminution of brightness until December 5th, when the brightness evidently began to decline, and on the 9th (the last time I saw it in the east) the light was comparatively feeble, until just before day, although its visible dimensions were nearly as great as for some days before.

In the evening sky, meanwhile, the Zodiacal Light increased rapidly in brightness, and advanced along the ecliptic faster than the sun. On the 2d of December, after the moon was set, it could be seen, rising to the meridian, at an elongation from the sun of not less than 120°, while its elongation on the other side of the sun was nearly 60°. Its entire dimensions had therefore expanded since November 26th, being now 180° in length, while it was then only 150°. At the present time (December 12th) the moon prevents observations both morning and evening. Were it not for Venus, (now of a dazzling splendor,) my previous observations would lead me to expect to see it become shortly very conspicuous in the west, while in a few days it would cease entirely to be seen in the east. *Does not this great and sudden expansion, covering at the same time both sides of the sun, indicate something of the nature of an inferior conjunction?* And would not such a position result, from the change of position which the earth would take with respect to a nebulous body of great extent, lying over the earth's orbit, through the *skirts* of which the earth passed on the 13th of November, but, moving more rapidly than that body, throwing the sun behind it, as seen in perspective? My meaning, perhaps, will be better comprehended by a diagram.

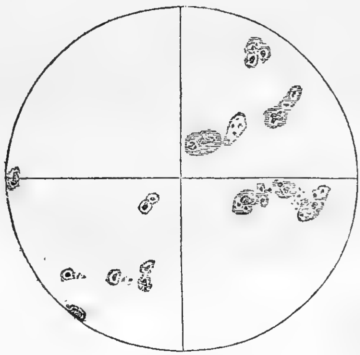


Let ♈ ♉ ♊, &c. represent the zodiac, and let A be the place of the earth in its orbit on the 13th of November. Let *c* represent a nebulous body so situated with respect to the earth that the extreme portions nearest to the earth shall lie across the earth's path. The sun being seen among the stars at S′, the body *c*, supposed to consist of light nebulous matter, would be projected over a great space, rising to the westward of the sun towards Leo as represented in the figure. Let B be the place of the earth after it has passed by the nebulous body, (the sun being at S″) and let the body be at *c*′; it would be seen in the heavens on both sides of the sun, rising after sunset towards the constellations Aquarius and Pisces.

The existence of such a nebulous body, which afforded the meteoric shower of 1833, was inferred without the least reference to the Zodiacal Light.* The inquiry now is, does that light answer to the conditions of the supposed body? if so, we infer that it is in fact the body itself, and its successive appearances will lend important aid to the theory suggested, as a source of evidence entirely independent of those from which the existence of the nebulous body was inferred.

* See Vol. xxvi of this Journal, p. 162.

Whether (as some have supposed) the *Spots on the Sun* have any connexion with the Zodiacal Light or not, it may not be improper to record the fact, that these spots have, for a few weeks past, been very remarkable for their number, magnitude and frequent changes. On the 13th of November, there were on the sun's disk, *eight* distinct groups visible in the finder of Clarke's Telescope, which, with a power of 55, were resolved into more than *sixty* distinct spots. By the 20th of November, some of the larger groups had moved off the disk, and the remaining spots were less remarkable than before. To-day, however, (Dec. 13th,) they are as numerous and striking as ever, presenting at 10 o'clock, A. M. an appearance like the following, the comparative dimensions of the spots being increased a little for the sake of distinctness.*



On the night of the meteoric shower, the *Magnetic Needle* was carefully observed, at this place, by Mr. Herrick; at St. John's College in Maryland by President Humphreys; and at Mt. St. Mary's College in the same state, by Mr. L. Obermeyer. At none of these places was any peculiar change in the needle detected.

The *Barometer* and *Thermometer* were attentively watched by Mr. Charles Rich, but no remarkable changes either of pressure or of temperature were observed; and such is the testimony on this point of observers in other places.

The night of the 14th of November, as already remarked, was signalized by an *Aurora Borealis* of the most magnificent description. Through the kindness of my friends and correspondents, I am in possession of numerous papers relating to this phenomenon, which I had purposed to collate in a separate article; but my limits do not permit its publication in the present number of this Journal.

Yale College, December 13th, 1837.

* I am indebted for this diagram to Mr. A. B. Haile, who has examined the sun daily since the 13th of November.

2. *Extraordinary case of electrical excitement, with preliminary remarks by the Editor.*—The facts stated below, were, by my request, kindly communicated for this Journal by Dr. Willard Hosford, a respectable physician of Orford, New Hampshire, the place where the occurrence happened. Being in that place in September, and finding the belief in the facts to be universal, particularly on the part of persons of judgment and science, (as at the neighboring University, Dartmouth, at Hanover, eighteen miles south,) I became desirous of preserving a record of them.

Dr. Hosford remarks in the letter accompanying his communication, that abundant evidence from the most intelligent persons is at hand for the support of every point in the case. He observes also, that the appearance of the aurora during which the electrical excitement of the lady took place, "was precisely the same as that described by some gentlemen at New Haven."

Speaking of it Dr. Hosford adds, that "the heavens were lighted with a crimson aurora of such uncommon splendor, as to excite no ordinary emotions in every observer, and we had, he observes, in addition, an electrical exhibition much less dazzling, but more singular and to the parties concerned more interesting."

A lady of great respectability, during the evening of the 25th of January, 1837, the time when the aurora occurred, became suddenly and unconsciously charged with electricity, and she gave the first exhibition of this power in passing her hand over the face of her brother, when, to the astonishment of both, vivid electrical sparks passed to it from the end of each finger.

The fact was immediately mentioned, but the company were so sceptical that each in succession required for conviction, both to see and feel the spark. On entering the room soon afterward, the combined testimony of the company was insufficient to convince me of the fact until a spark, three fourths of an inch long, passed from the lady's knuckle to my nose causing an involuntary recoil. This power continued with augmented force from the 25th of January to the last of February, when it began to decline, and became extinct by the middle of May.

The quantity of electricity manifested during some days was much more than on others, and different hours were often marked by a like variableness; but it is believed, that under favorable circumstances, from the 25th of January to the first of the following April, there was no time when the lady was incapable of yielding electrical sparks.

The most prominent circumstances which appeared to add to her electrical power, were an atmosphere of about 80° Fah., moderate exercise, tranquillity of mind, and social enjoyment; these, severally or combined, added to her productive power, while the reverse diminished it precisely in the same ratio. Of these, a high temperature evidently had the greatest effect, while the excitement diminished as the mercury sunk, and disappeared before it reached zero. The lady thinks fear alone would produce the same effect by its check on the vital action.

We had no evidence that the barometrical condition of the atmosphere exerted any influence, and the result was precisely the same whether it were humid or arid.

It is not strange that the lady suffered a severe mental perturbation from the visitation of a power so unexpected and undesired, in addition to the vexation arising from her involuntarily giving sparks to every conducting body that came within the sphere of her electrical influence; for whatever of the iron stove or its appurtenances, or the metallic utensils of her work box, such as needles, scissors, knife, pencil, &c. &c. she had occasion to lay her hands upon, first received a spark, producing a consequent twinge at the point of contact.

The imperfection of her insulator is to be regretted, as it was only the common Turkey carpet of her parlor, and it could sustain an electrical intensity only equal to giving sparks one and a half inch long; these were, however, amply sufficient to satisfy the most sceptical observer, of the existence in or about her system, of an active power that furnished an uninterrupted flow of the electrical fluid, of the amount of which, perhaps the reader may obtain a very definite idea by reflecting upon the following experiments. When her finger was brought within one sixteenth of an inch of a metallic body, a spark that was heard, seen, and felt, passed every second. When she was seated with her feet on the stove-hearth (of iron) engaged with her books, with no motion but that of breathing and the turning of leaves, then three or more sparks per minute would pass to the stove, notwithstanding the insulation of her shoes and silk hosiery. Indeed, her easy chair was no protection from these inconveniences, for this subtle agent would often find its way through the stuffing and covering of its arms to its steel frame work. In a few moments she could charge other persons insulated like herself, thus enabling the first individual to pass it on to a second, and the second to a third.

When most favorably circumstanced, four sparks per minute, of one inch and a half, would pass from the end of her finger to a brass ball on the stove; these were quite brilliant, distinctly seen and heard in any part of a large room, and sharply felt when they passed to another person. In order further to test the strength of this measure, it was passed to the balls by four persons forming a line; this, however, evidently diminished its intensity, yet the spark was bright.*

The foregoing experiments, and others of a similar kind, were indefinitely repeated, we safely say hundreds of times, and to those who witnessed the exhibitions they were perfectly satisfactory, as much so as if they had been produced by an electrical machine and the electricity accumulated in a battery.

The lady had no internal evidence of this faculty, a faculty sui generis; it was manifest to her only in the phenomena of its leaving her by sparks, and its dissipation was imperceptible, while walking her room or seated in a common chair, even after the intensity had previously arrived at the point, of affording one and a half inch sparks.

Neither the lady's hair or silk, so far as was noticed, was ever in a state of divergence; but without doubt this was owing to her dress being thick and heavy, and to her hair having been laid smooth at her toilet and firmly fixed before she appeared upon her insulator.

As this case advanced, and supposing the electricity to have resulted from the friction of her silk, I directed (after a few days) an entire change of my patient's apparel, believing that the substitution of one of cotton, flannel, &c. would relieve her from her electrical inconveniences,† and at the same time a sister, then staying with her, by my request, assumed her dress or a precisely similar one; but in both instances the experiment was an entire failure, for it neither abated the intensity of the electrical excitement in the former instance, or produced it in the latter.

My next conjecture was, that the electricity resulted from the friction of her flannels on the surface, but this suggestion was soon

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* It is greatly to be regretted that the spark had not been received into a Leyden bottle until it would accumulate no longer, and then transferred to a line of persons to receive the shock.—*Ed.*

† This could hardly have been expected from non-conductors; we are informed that the lady was relieved of the electricity by a free communication with the earth by a good conductor, in the manner of a lightning rod, as by touching the stove and its connection with the earth through the medium of the chimney.—*Ed.*

destroyed when at my next visit I found my patient, although in a free perspiration, still highly charged with the electrical excitement. And now if it is difficult to believe that this is a product of the animal system, it is hoped that the sceptics will tell us from whence it came.*

In addition to the ordinary appurtenances of a parlor, it may be proper to add, that the lady's apartment contained a beautiful cabinet of shells, minerals, and foreign curiosities.

This lady is the wife of a very respectable gentleman of this place; she is aged about thirty, of a delicate constitution, nervous temperament, sedentary habits, usually engaged with her books or needlework, and generally enjoying a fine flow of spirits.

She has, however, never been in sound health, but has seldom been confined to her bed by sickness even for a day.

During the past two years she has suffered several attacks of acute rheumatism, of only a few days' continuance, but during the autumn, and the part of winter preceding her electrical development, she suffered much from unseated neuralgia in the various parts of her system, and was particularly affected in the cutis vera, in isolated patches; the sensation produced being precisely like that caused by the application of water heated to the point a little short of producing vesication; in no instance, however, did it produce an apparent hyperæmia, but about the last of December a retrocession took place of this peculiar irritation, to the mucous membranes of the fauces, œsophagus, and stomach, there producing a very apparent hyperæmia, and attended, during the exacerbations, with burning sensations that were torturing indeed; and it was for the relief of these symptoms that medical means were used, but it was found no easy matter to overcome this train of morbid action.

It was nearly immaterial what medicines were used; no permanent relief was obtained, and no advantage resulted from the use of the alkalies, or their varied combinations. In a few instances, a dose of the acetate of morphine was given to secure a night's rest, but she seldom made use of an anodyne.

The effervescing soda draught being very acceptable was freely given—from which, in addition to a rigid system of dietetics, the

* It appears to be Dr. Hosford's opinion, that the electricity was not caused by the aurora that was coincident with its first appearance, but that it was, in some way, an appendage of the animal system.—*Ed.*

influence of the opening spring, and the vis medicatrix naturæ, relief came of her electrical vexations, of most of her neuralgia, and other corporeal infirmities, and to this time, a much better state of health has been enjoyed than for many years.

Orford, N. H., Nov. 16, 1837.

3. *Impressions of feet in rocks.*—Those who are acquainted with the earlier volumes of this work, may remember that in Vol V. at p. 223, there is a full account, with a drawing, of the famous copies of human feet found in limestone near St. Louis. In a letter to the editor, recently received from an eminent English geologist, dated September 9, 1837, are the following striking remarks:

"Lest I should again neglect to call your attention to a subject to which I have long since intended to claim your particular regard, I will in this brief space allude to it. In the 5th volume of your Journal, (1822,) there are remarks on the prints of human feet observed in the secondary limestone of the valley of the Mississippi, by Mr. Schoolcraft and Mr. Benton, with a plate representing the impressions of two feet. Ever since my researches on the rippled sandstones, (published in Jameson's Edinburgh Journal,) I felt persuaded the prints alluded to were the genuine impressions of human feet, made in the limestone when wet. I cannot now go on with the arguments that may be urged in proof of my opinion; but rely upon it, those prints are certain evidence that man existed at the epoch of the deposition of that limestone, as that birds lived when the new red sandstone was formed. Pray get all the evidence on this head you can—rely upon it most important results will be the consequence. I am prepared to find man and the cotemporary animals much lower down in the series than is generally supposed. My friend Sir Woodbine Parish, (the discoverer of the Megatherium,) tells me that similar impressions have been seen in South America; and there was a dispute among the catholics whether they were the feet of the apostles! But truth often lies hid beneath such strange conceits. I can remember the time when my explanation of the rippled sandstones was ridiculed, now no one doubts it."

To these remarks of our respected correspondent, we add the following fragment, dated Baltimore, Oct. 14, 1836, and addressed to the editor.

"Having lately read in your Journal the communication of Prof. Hitchcock concerning the impressions of birds' feet on the sandstone in the Connecticut valley, I was reminded of having read something of an analogous kind many years ago concerning a locality in Tennessee, which I would beg leave to lay before you under the hope that some of your intelligent readers in that neighborhood may examine into this subject more particularly.

"Extract from the American Encyclopedia, published by Dobson at Philadelphia, 1778 to 1803—Supplement, vol. 3, p. 344. From a meagre account of Tennessee, I extract the following: 'The enchanted mountain, about two miles south of Brass town, is famed for the curiosities on its rocks. There are on several rocks a number of impressions resembling the tracks of turkeys, bears, horses, and human beings, as visible and perfect as if they were made on snow or sand,' &c. There are other particulars stated which seem to be loose guesses of ignorant people, &c."

We are not aware whether Dr. Troost, the learned and able geologist of Tennessee, has investigated these facts, or whether they have fallen under his observation. If the alledged facts are real, we should be glad to know his opinion of them, and we should be greatly obliged, if in compliance with our English correspondent and with our own, any facts may be communicated relating to impressions on rocks.—Ed.

November 18, 1837.

4. *New locality of Iolite, with other minerals associated.*—About two years ago, I discovered a locality of *iolite* in this place. I have subsequently revisited it, and take this opportunity of communicating to you the result of my observations.

The *iolite* is found about one mile and a half N. E. of the village of Brimfield, on the road leading to Warren, and near the residence of Samuel Patrick. It is of a violet blue color, sometimes with a shade of brown: fracture uneven: translucent: structure foliated. I have obtained no specimens which show the crystalline form. Externally, it differs very little from that found at Haddam, Conn., except that the hues are more vivid, and the tabular masses are not as large. I am not aware that other localities have been discovered in this country. The accompanying rock is well characterized granite.

In connexion with the *iolite*, occurs *adularia* of a wine yellow and sometimes greenish tint. Some of the specimens possess the chatoyant appearance. They display a strong pearly lustre, and are often nearly transparent. In some specimens the minute foliæ are perceptible, giving them a striated appearance. Few localities afford better specimens.

Sulphuret of molybdenum,—in imperfect hexahedral prisms: structure lamellar. Abundant, though disseminated in dots throughout the mass.

Mica,–black: in six-sided tables. Good specimens can be obtained.

Garnet,–occurs abundantly: crystallized imperfectly, and massive.

This locality, as yet, has been but partially explored.

J. W. Foster, *of Zanesville, Ohio.*

Brimfield, Mass., Dec. 7th, 1837.

5. *Caoutchouc.*—Much attention has been bestowed upon this article, with a view of discovering some solvent or mode of reducing it to a consistence capable of receiving any desirable form, or of being applied to the surface of cloth in the form of varnish, in order to render it water proof; but believing that no method has yet been made public by which it could be used with economy and facility, I am induced to offer the following, with the hope that it will be found both useful and interesting.

I wish to premise, that all hitherto known solvents of *caoutchouc* are liable to objections. In a trial which I once made, I found that oil of turpentine dissolved *raw* caoutchouc tardily; and on having been spread on calico and exposed to the atmosphere, it remained glutinous at the end of a year.

About two years ago, I was induced to perform some experiments with caoutchouc, and I accidentally ascertained, that if it be previously cut fine and immersed in common sul. ether or a solution of (some alkali? I used) carb. soda, 2 oz. to a pint of water, for a week, and then put into *good new* oil of turpentine, it dissolved with facility; and when spread on cloth and exposed to a dry atmosphere, it *speedily dries and assumes its original properties*, usually in twenty four hours.

Calico, linen, or articles of clothing, may receive a coating with this solution, sufficient to render them water proof without materially altering their general appearance or injuring their pliability.

When less elasticity and more body is required, I hazard a conjecture, that this solution may economically be diluted or mixed with asphaltum, Venice turpentine, or some other articles soluble in oil of turpentine. Arza Andrews, M. D.

Meriden, Ct., Nov. 29th, 1837.

6. *On meteoric showers in August; supplementary to Art. XX.*—The facts below given, came to hand too late for insertion in their proper place. For those marked *a.* and *b.* I am indebted to the kind attention of my friend, Mr. Geo. C. Schaeffer, of New York.

a. The following is the entire statement concerning the meteors seen in England, Aug. 10, 1833, an imperfect account of which was given at pp. 178, 179 of this volume.

"A very remarkable flight of falling stars was seen between 10 P. M. and midnight, on the evening of Aug. 10, (1833,) about midway between Worcester and Great Malvern. They resembled the almost incessant discharge of sky-rockets in the upper regions of the atmosphere, and the trailing light they left upon the sky was particularly curious and beautiful. This appearance continued for a considerable time; the velocity with which the meteors appeared to move was very great. Some of them were nearly in the zenith, but none approached the horizon. The general direction of their course was from Northwest to Southeast."—Lees: Analyst, Aug. 1834.

b. In a register of the weather, kept at Edmonton, near London, by Mr. C. H. Adams, published in the London Literary Gazette, in the report for the week Aug. 2–8, 1834, it is stated, "the innumerable meteors which are nightly seen, shooting in all directions, are worthy of notice, as were those especially from 9 to 11 on the evening of the 9th inst."—Compare (5), p. 136.

c. By No. 218 of *L'Institut*, received here on the 11th Dec., it appears that M. Quetelet, at the session of the Royal Academy of Brussels, Dec. 3, 1836, stated his belief that shooting stars were unusually frequent about the middle of August, and more particularly on the 10th. In order to find facts in relation to this subject, he examined the Register of the Observatory of Brussels. The only observations there recorded of extraordinary appearances of these meteors, refer to Aug. 10, 1834, and Aug. 10, 1835. No special attention had, however, been given in the Register to observations of these phenomena.—L'Institut, *fol. Paris, No.* 218, *p.* 256. *Aout*, 1837.

At the time when the last number of this Journal was published, I was not aware that any person in Europe or elsewhere, had ever advanced the idea of a meteoric shower in August.

The statement on p. 359 concerning the *tangential region*, is inaccurate in the unrestricted form there given. In our latitude, it is true only about the times of the solstices, but in the intertropical latitudes it would, without much variation, hold true, during the year. The general propriety of the conclusion there stated, viz. that the showers would have been found more abundant after midnight, remains however unaffected. If we assume the radiant of August 9 to be in the ecliptic, and 90° West from the sun's place, it will be found to rise about 10*h*. 40*m*. P. M. This may account for the fact that about that time of the year, meteors have been seen so abundantly before midnight.

We have now an August meteoric shower, in five successive years, (1833 to 1837 inclusive,) and there seems to be little risk in predicting its recurrence on or about the 9th of next August. For several reasons, and especially on account of our early dawn at that season, it is extremely important that persons who live near the equator, in all quarters of the globe, should make careful observations on this interesting phenomenon. E. C. Herrick.

New Haven, Dec. 15, 1837.

7. *Brilliant Meteor seen in the day time.*—On Saturday, August 20, 1836, being in the state of Illinois, on the road between Winchester and Jacksonville, and about eight miles southwest from the latter place, (which is near N. lat. 39° 45′, and W. long. 89° 40′,) a brilliant meteor or globe of fire was seen both by myself and companion. Its true bearing was about N. 15° E., nearly. Its apparent size was about fifteen minutes of a degree; or, the apparent disc was about one fourth that of the moon. When first seen it had an altitude of about 60°; it moved rapidly in a line nearly vertical, and became invisible at an altitude of about 40°. It would doubtless have been seen at a greater elevation had the eye at first been properly directed. The sky at the time was entirely clear, and the sun shining bright; it being about four o'clock in the afternoon. The meteor left behind a distinct train of smoke, which appeared like a small cloud and was visible for at least fifteen minutes. An explosion was noticed by several persons in the vicinity, which I failed to hear on account of the noise made by the wagon in which I was traveling. R. Gaylord.

8. *A Synopsis of the family of Naïades*; by Isaac Lea, Philadelphia, 1836.—This work deserved a notice at our hands long since, but it has been mislaid and overlooked. Mr. Lea's reputation is too well and too extensively known to need any encomium from us: his name is identified with American conchology, and no student sees the word *Unio*, without being reminded of our author and his distinguished services. In this synopsis are enumerated three hundred and fifty four species, recent and fossil.

In his introduction, Mr. Lea justly remarks on the difficulty experienced in attempting any correct and unobjectionable division of a family, in which the distinctive characters of species are so blended and run into each other, as scarcely to be separated by the most minute care. In doing this he has certainly succeeded better than his predecessors, and the number of new species brought forward is quite remarkable. He divides the family into two genera, *Margarita and Iridina,* and the first into the sub-genera Unio, Margaritana, Dipsas, Anodonta and Pleiodon. A writer in the Zoological and Botanical Journal some time since, called in question several species of the genus *Unio* which Mr. Lea had described as his own, attributing them to other zoologists; these species, we observe, Mr. Lea still sees proper to retain, for which he doubtless has satisfactory reasons.—B. S., Jr.

9. *Temperature of Lake Ontario.*—This lake is so large and deep that it never freezes in winter to any great extent. The ice formed along the shores in still weather is dashed to pieces, and in part thrown upon the banks by the first wind that raises its waves. The ice is formed too in much greater quantity late in winter, when the water has had time to cool. In the severe winter of 1835–6, the steam boat Traveler ran through the winter from Niagara to Toronto, in Canada, a distance of about thirty six miles. In March, of that winter, the ice once covered the water for the whole distance and was broken through, as it was not thick, by the boat. The wind soon dashed the ice in pieces. The ice then extended several miles from the westward of the lake. But so much ice is a rare occurrence on this lake, and takes place only in a severe winter, and late too in the season, when the waters have been unruffled by winds for some days, or, as the engineer of the boat remarked, *during a long calm.*

The surface of Lake Ontario is about two hundred and forty feet above tide water. It is said to have been *sounded* to the depth of *three hundred* feet, which would place its bottom below the level of the sea. It is doubtful whether the statements on the depth of the great lakes can be relied upon. It is quite certain that some are given far too large. Lake Erie freezes to a great extent, if not entirely over its surface; but Lake Ontario is so deep that even with the discharge of the cooled water of Lake Erie into it, the waters are rarely lowered to the point of congelation.

The climate of this part of the state must be affected by such great bodies of water. As the water is cooled in winter, it must take a considerable time for the temperature to rise to that of he air, and hence the winter must be prolonged a little, and the spring be retarded, and in autumn, the water must be throwing off its caloric to the atmosphere, and retard to some extent the approach of winter. The frequent direction of the wind towards the lake, while the upper air is moving in a different direction and often in a nearly opposite course, shows the influence of the cooler waters of the lake in summer.

At my request Mr. William McAnslan, the engineer of the steamboat Traveler, made the following observations upon the temperature of the lake. The observations began May 5th, 1837.

		May 15.	May 22.	June 19.	July 15.	Aug. 7.	Sept. 4.	Oct. 16	Nov. 13.
1.	Water,	60°	68°	63°	68°	73°	63°	47°	44°
	Air,	63	66	64	67	73	65	50	45
2.	Water,	45	46	60	65	70	63	52	46
	Air,	63	77	65	67	72	64	54	38
3.	Water,	39	39	58	63	69	60	54	46
	Air,	44	44	54	64	74	63	54	36
4.	Water,	37½	38	55	63	68	58	53	44
	Air,	52	40	58	65	72	63	53	38
5.	Water,	37½	38	42	53	64	57	54	45
	Air,	48½	41	55	63	71	60	56	38
6.	Water,	38	38	40	52	64	58	54	45
	Air,	54	39½	54	63	72	59	59	36
7.	Water,	39½	38	40	52	65	59	53	46
	Air,	55	40	50	62	73	59	59	36
8.	Water,	40	39	42	54	66	62	52	47
	Air,	54	44	55	64	73	63	57	33
9.	Water,	42	40	50	58	66	64	52	46
	Air,	55	45	62	67	73	65	56	32
10.	Water,	44	42	53	59	66	64	51	47
	Air,	55	49	63	68	73	65	54	33
11.	Water,	52	51	56	59	63	64	52	45
	Air,	54	54	64	68	72	63	54	40
	Wind,	S.	N. W.	S.	N. W.	S. W.	N. W.	N. W.	N.
	Mean temp. of the day,	70	59	62.3	68.3	74.3	56.3	46	38.6
	Mean temp. of two preced. days,	71.6	57.2	59.6	74.8	62.5	56.5	46.6	46.5

The observations began at the mouth of Genesee River, and were continued to Coburg, on the Canada side. The distance to Coburg is about sixty miles, and the place lies a little W. of N. from this city. The *first* observation was made just in the mouth of the Genesee; the *second* observation, about half a mile from the mouth of the Genesee, where its waters are well mingled with those of the lakes; the *nine* succeeding were made about every six or seven miles, the last being at the landing at Coburg. They were made upon water drawn from about one foot below the surface. It was found however by repeated trials, that the temperature for three feet deep was not sensibly different from that at the surface. At the bottom of the table is given the course of the wind on the day of observation and the mean temperature of that day at Rochester, and also the mean temperature of the two preceding days.

The gradual diminution of temperature from the shore towards the middle of the lake, from spring to September, is an interesting fact. Mr. McAnslan,* who is an engineer of considerable knowledge of chemistry and mechanics, remarks too, that the direction and strength of wind carries the colder portion nearer the shore in the direction of the wind. In August and September, the temperature of the water was nearly uniform from shore to shore. In October and November, the water in the middle of the lake was warmer than nearer to the shores. In spring and down to July, the air on the lake is peculiarly cool from the coolness of the water. In October the temperature of the atmosphere and lake was nearly the same, while the difference was considerable in the preceding month. Finally, it is probable that the current of Niagara River is pretty direct through the lake, and that the accumulation of ice on Lake Erie and its being heaped up and continued on the eastern part of the lake, often till into May, must be in part the cause of the low temperature of the water of Lake Ontario, as shown in the table for the months of May and June. C. D.

10. *Encrinite, Tufa, &c.*—For the benefit of the numerous readers of your Journal, who may or may not be interested in the collection and examination of the organic remains of this country, I beg

* Some alteration in the position of the floatboards of the *wheels* of the Traveller has been made by Mr. McAnslan, by which they seem to move with more efficiency through water.

leave to state, that a few days since I obtained a petrifacation from the surface of a fragment of limestone from Becraft's mountain, which, after cleaning, proved to be a perfect specimen of the second variety of encrinite, called by Parkinson the cap encrinite. This is the first and only specimen of this family of fossils which has been found in this vicinity. The fossil vertebral remains of this animal constitute the principal part of the rocks of this mountain. Having no figures of the above named fossil in my possession, I cannot conclusively determine whether this be the cap or the pear encrinite; I am however inclined to the opinion of its being the former. I would also state, that I have recently discovered an excellent locality of calcareous tufa about a mile from this city. It is mostly stalactical and very compact, some being susceptible of a beautiful polish. Impressions of fern I lately discovered on shale overlying a narrow vein of coal, about a mile and a half south of this place. I mention the above as being altogether new in this neighborhood.

Hudson, May 22d, 1837. S. A. ROWLEY.

11. *Description of a New Trilobite ;* by JACOB GREEN, M. D. Prof. of Chem. in Jefferson Med. Coll.

CALYMENE ROWII. *Green.*

The outline of this fossil as it lies upon the rock presents a very regular oval figure. The buckler and the body are a good deal elevated, and measure longitudinally nearly an inch and two thirds.

The *buckler* is lunate, and is edged round its whole border with a little groove or channel. Its *front* or middle lobe is elevated above the cheeks, is rounded at its anterior part and gradually enlarges as it approaches the middle lobe of the abdomen. There are no tubercles or folds upon it, but its posterior angles are so truncated as to form a subtriangular protuberance on each side of the commencement of the vertebral column. The *cheeks* are shaped like spherical triangles, and seem from our specimen, to have projected on each side to the fourth articulation of the abdomen. The *oculiferous tubercles* are large and lunate; they are placed close to the front and seem almost to form a part of it; they are situated just before the protuberances above mentioned.

The *abdomen* and *tail* can readily be distinguished. There are twenty three articulations in both. The middle lobe is very prominent, is separated from the lateral ones on each side by a deep channel, and gradually and regularly tapers to its termination, which is near the end of the body. The *lateral lobes* are rounded. The *costal arches* of the abdomen have a furrow scooped out of their upper surface, and their outward extremities terminate in obtuse points, between which there is a raised line. The *caudal arches* are not grooved, but there is a faint impressed line running along their upper surface, which is slightly bifurcated at their termination.

This beautiful and highly interesting trilobite was found by Mr. George L. Le Row, of Poughkeepsie, N. Y., to whose kindness I owe this opportunity of describing it. The specific name is given in compliment to the discoverer. There is a strong analogy in some leading particulars between this species and our *C. Diops.* Professor Dalman's C. Concinna represented on his first plate, fig. 5, *a b* and *c*, comes very near it, but there are many marked differences between them. Mr. Le Row in a letter to me states, "the locality of this trilobite is just out of the village of Fly creek, three miles from Cooperstown, in Otsego town and county, N. Y., on the land of a Mr. Williams. No other specimen has been found there. I possess the body of one of the same species obtained about half a mile from the above locality." In the *Poughkeepsie Telegraph*, Nov. 22d, 1837, Mr. Le Row has given a figure of our trilobite, accompanied by the following remarks: "The above specimen of a trilobite was obtained during the past summer, about three miles south of the head waters of the Susquehannah river; it is peculiarly perfect, and the engraving exhibits the outlines of the fossil in a remarkably distinct manner."* It was found imbedded in a layer of soft argillite, slightly ferruginous, and of such is the fossil composed. The strata in which it was found was filled with orthoceræ and numerous other fossils. Immediately under this layer is another of argillite, of harder texture and darker color, and free from petrifactions.

12. *Difference between the English Porcelain and that of Germany and of the continent.*—From an eminent individual perfectly acquainted with both the science and practice of making porcelain, and familiar with the principal establishments in Europe, we learn the following facts:—

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* The figure alluded to is beatifully executed, but the representation of the *front* of the buckler is by no means exact.

"The English porcelain is made upon principles entirely different from those which govern the manufacture of the French and German porcelain. The paste or biscuit, contains alkaline materials, phosphate of lime derived from bones, &c., and is baked at a higher temperature than that which is necessary for the enamel, which contains lead and not feldspar. The German porcelain is composed essentially of kaolin and feldspar; it is baked at the same time with the enamel or glaze, which never contains lead, and is composed essentially of feldspar." These two kinds of pottery so very different, are usually confounded by professors of chemistry.

13. *Mathematical, Philosophical, and Chemical Instruments.*—We have received the lithograph circular of Louis and André Breton, pupils of the celebrated Lenoir & Fortin. Their establishment is Rue Servandoni, No. 4, pres St. Sulpice, Paris.

They pledge themselves to furnish to institutions and individuals, all or any of the instruments necessary to science, in all its branches; manufactured with accuracy and despatch, and at reasonable prices.

We invite the attention of the American scientific public to this establishment.

Our miscellany has been unavoidably abridged in the present No. to make room for articles, and especially for the abstract from the doings of the British Association, which being indeed in themselves miscellaneous, in that way it happens that this department is in fact more extensive than usual, and we may find it necessary to take the same course in the succeeding No.

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APPENDIX

TO THE

AMERICAN JOURNAL OF SCIENCE AND ARTS, VOL. XXXiii, NO. 2.

Davenport's recent Experiments in Electro-Magnetic Machinery.*

(Copy of a letter from Mr. DAVENPORT.)

TO PROF. SILLIMAN.

Dear Sir—Having lately made a number of applications of the power of *large galvanic magnets* in propelling machinery, (being independent of the large machine now constructing by the association,†) I have thought proper to state to you the results, believing they would not be uninteresting to you.

I have constructed a machine, with two revolving magnets, two feet in length, made of iron three and a half inches in diameter, and weighing, after being wound with six coils of No. 10 copper wire, one hundred pounds each. Three stationary magnets of two feet diameter, were placed around the periphery making six poles, and weighing one hundred pounds each.

With this machine I produced one hundred revolutions per minute, with six square feet of sheet zinc exposed to action, surrounded with thin sheet copper.

I then displaced the stationary magnets, and substituted one magnet three inches in diameter, forming a semicircle, with the poles directly opposite each other, and weighing about one hundred pounds. With this magnet I produced one hundred and fifty revolutions per minute, using the same quantity of zinc surface. With one revolving magnet I produced one hundred and seventy-five revolutions per minute, with four square feet of sheet zinc. I next constructed a *hollow* magnet of two feet in length and four inches in diameter, made of boiler iron, five-sixteenths of an inch in thickness, with four

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* Received after the Journal was finished.

† The machine alluded to in the above letter, as now being constructed for the Electro-Magnetic Association, by Messrs. Davenport & Cook, is nearly completed, and is expected to be of about two tons power. It is formed by a combination of small magnets, weighing about four pounds each, and three and a half inches between the poles. These magnets are placed, two hundred thirty four in number, on an iron shaft six feet in length, and a corresponding number in a circle as stationary magnets.

coils of copper wire, with which I succeeded in getting one hundred revolutions per minute. A hollow magnet was then constructed of thin sheet iron, of the thickness of common *stove-pipe iron*, which revolved one hundred and fifty times per minute. *Hollow* magnets I think may be used to great advantage where weight is an objection; but in my experiments I generally make use of *solid* iron.

I also constructed a machine with simply two magnets formed of two inch round iron, of fifteen inches in length, of the stirrup form. The distance between the centres of the poles is five inches, and the magnet revolves four hundred and fifty times per minute, with two square feet of zinc. The stationary magnets being placed with the poles pointing upwards, and the poles of the revolving magnet pointing downwards, the shaft to which the revolving magnet is attached passes through its centre, and rests on the centre of the stationary magnet. Two of these machines (weighing in all fifty pounds) I have attached to small drilling-works, which I find produce sufficient power to do all my drilling of iron and steel, to the size of one-fourth of an inch diameter.

I have adopted this form on the third machine which I have recently put in operation. The magnets are formed of two and three-fourth inch iron, with the centres of their poles nine inches apart and weighing 50 lbs. each, with this I produced three hundred revolutions per minute, and have successfully attached it to turning hard wood of three inches diameter. I find the power increases in full proportion to the increase of weight and without increasing in proportion the size of the battery. The wire must be increased in size in proportion to the size of the iron used, and consequently the difficulty attending long wires will always be avoided.

I find no difficulty in using my machine *twelve hours in succession*, without changing batteries or agitating the solution.

I am erecting conveniences to test the powers of each magnet as they are increased in weight and size, and think I shall be able in season for the April number of your Journal to give the exact increase of power in proportion to weight, of magnets weighing from ten pounds to several tons.

I have also made some very satisfactory trials, while making my machines, respecting the expense for the consumption of zinc and acids, and I think I shall soon be able to give nearly the precise cost of making the largest machinery.

Galvanism is, I trust, destined to produce the greatest results in the most simple form, and I hope not to be considered an enthusiast, when I venture to predict, that soon engines capable of propelling the largest machinery will be produced by the simple action of *two galvanic magnets*, and worked with much less expense than steam.

Yours, respectfully,

THOMAS DAVENPORT.

New York, December 26, 1837.

ACKNOWLEDGMENTS TO CORRESPONDENTS, FRIENDS AND STRANGERS.

Remarks.—This method of acknowledgment has been adopted, because it is not always practicable to write letters, where they might be reasonably expected; and still more difficult is it to prepare and insert in this Journal, notices of all the books and pamphlets which are kindly presented, even in cases, where such notices, critical or commendatory, would be appropriate; for it is often equally impossible to command the time requisite to frame them, or even to read the works; still, judicious remarks, from other hands, would usually find both acceptance and insertion.

In public, it is rarely proper to advert to personal concerns; to excuse, for instance, any apparent neglect of courtesy, by pleading the unintermitting pressure of labor, and the numerous calls of our fellow-men for information, advice, or assistance, in lines of duty, with which they presume us to be acquainted.

The apology, implied in this remark, is drawn from me, that I may not seem inattentive to the civilities of many respectable persons, authors, editors, publishers, and others, both at home and abroad. It is still my endeavor to reply to all letters which appear to require an answer; although, as a substitute, many acknowledgments are made in these pages, which may sometimes be, as now, in part, retrospective.—*Ed.*

Books, Pamphlets, &c.

DOMESTIC.

A Discourse on Temperance and Stimulants in a warm climate, by E. H. Barton, M. D. New Orleans, 1837. From the author.

Familiar View of the Operation and Tendency of Usury Laws. New York, 1837. J. R. Hurd.

Catalogue of Chatham Academy—October, 1837, to January, 1837. Wm. H. Williams, the Principal.

Annual Report of the Common Schools, Academies and Colleges of Pennsylvania, by Th. H. Burrowes, Superintendent. From the Author.

An Act on Common Schools, with explanatory instructions, &c. by Thos. G. Burrowes. Harrisburg, Penn. 1837. The author.

Vindication of General Washington from the stigma of adherence to secret societies, by Joseph Ritner, Gov. of Pennsylvania. From Mr. Burrowes.

Geological Questions relating to the Survey of the state of New York. From W. W. Mather.

Charter of the Portage Canal and Manufacturing Company. Two copies.

Proceedings of the President and Fellows of the Connecticut Medical Society, in convention, May, 1837. From the Convention.

A System of Mineralogy, including a Treatise on Crystallography, &c. &c, by James D. Dana, A. M., Assistant in the department of Chemistry, Mineralogy and Geology in Yale College. The author.

An Essay on Indian Corn. 1837. From the author, Peter A. Browne, Esq.

Discourse before the Alumni of the University of Pennsylvania, July, 1836, by Th. J. Wharton. From the author.

Transactions of the Natural History Society of Hartford, No. 1. 1836.

Catalogue of Phenogamous Plants and Ferns, native or naturalized, near Baltimore. From the author, Wm. E. A. Aikin, M. D.

First Annual Report of the Executive Committee of the Young Men's Association, Buffalo, Feb. 8, 1837. From H. R. Wing.

Twenty First Annual Report of the Directors of the American Asylum at Hartford, 1837.

Extracts from the correspondence of the American Bible Society, April, 1837.

Vermont Courier, July 6, 1837, containing a notice of a meteor. The editor.

Kittaning Gazette, June 29, 1837, with a notice of electro-magnetism, by David Alter. The editor.

Address at the Sixth Annual Session of the Western Literary Institute, Cincinnati, 1837, by Albert Picket, Sen. The author.

A Narrative of the Dissolution of the Medical Faculty of Transylvania University. From the author, Prof. L. P. Yandell.

Cleveland Gazette, July 7, 1837, with a notice of an Aurora Borealis.

The Georgian, June 20, 1837—Notice of a Fountain under the Sea off St. Augustine.

New England Farmer, June 16, 1837.

The New Aurora, Vol. I. No. 1, June 17, 1837. Philadelphia.

An Examination of Phrenology, in two lectures, given in the Columbian College; two copies; by Thomas Sewall, M. D. Prof. of Anatomy, &c. From the author.

Introductory Lecture on Acclimation, by E. H. Barton, M. D. New Orleans, 1837. The author.

A Report of the Geological Survey of Connecticut, by C. U. Shepard, M. D. From the author.

Dr. S. H. Tyng's Sermon, Eighth Sunday School Anniversary, May 22, 1837. The author.

Thirteenth Annual Report of American Sunday School Union, May 23, 1837.

Twenty First Annual Report American Bible Society, 1837.

Richmond County Mirror of Science, Literature and News, Vol. I. No. 1. July, 1837.

Address delivered in the Chapel of the University of New York, on the occasion of its dedication, May 28, 1837.

Newark Daily Advertiser, July 28, 1837.

Suggestions on the reformation of the Banking System, by R. Hare, M. D. From the author. 2 copies.

Western Presbyterian Herald, Louisville, Ky. July 27, 1837. Tornadoes.

An Elementary Treatise on Sound, being the second volume of a course of Natural Philosophy, by Benj. Pierce, A. M., University Prof. of Math. and Nat. Philos. Harvard, Cambridge, 1836. From the author.

Catalogue of Officers and Students in Wabash College, 1837.

Report of a Geological Reconnaissance made in 1835, from Washington by Green Bay and the Wisconsin Territory, to the Coteau de Prairie, by G. W. Featherstonhaugh, Esq. From Hon. Gideon Tomlinson.

Mr. Farnham's Letter to the City Council of New Haven in relation to supplying the city with water from the Farmington Canal.

Vermont Chronicle, June 8, 1837, with Meteorological Register for May, 1837. Do. Aug. 16, with Meteor. Register for June, 1837.

New Era, N. York, June 9, 10 and 20, 1837. Sherwood's Discoveries.

Catalogue of Ellington School, 1837.

Monroe Democrat, Aug. 18, 1837. Polished Rocks. C. Dewey.

The People's Friend and Little Falls Gazette, May 27, 1830. From the editor.

Western Presbyterian Herald, Louisville, Ky. July 27, 1827; with account of a terrible Tornado at South Hanover. From Rev. J. Blythe.

The Genesee Farmer, Rochester, Vol. VII. Nos. 20, 21, 25, 26, 27, 29, May 20 to July 22, 1837. Willis Gaylord.

Flora Cestrica—the flowering and filicoid plants of Chester Co. Pa.; pp. 640, with a colored map. From the author, Dr. William Darlington.

Lyell's Geology, 2 vols. 8vo., first American, from fifth London edition. Kay & Brother, Phila. 1837. From the publishers.

D. Appleton & Co.'s Catalogue of English Publications. From the publishers.

Experimental Observations and Improvements in Apparatus, Manipulation, &c., by R. Hare, M. D. Phil. 1836. The author.

Catalogus Collegii Dartmuthensis, 1837. Prof. Hubbard.

Mr. Beach's Answer to Mr. Sigourney. From the author.

Annual Announcement of Lectures, &c. in Jefferson Med. Coll. 1837–8. 2 copies.

The Richmond County Mirror, several Nos. The editor.

Mr. Cozzens' Sermon on the death of the Hon. Wm. Reed.

The North American Spelling Book, by L. W. Leonard. 1836. Keene, N. Hampshire. From the publishers.

A New Grammar of the English Language. Boston, 1834. From the author.

Practical Instruction on Animal Magnetism, by J. P. F. Deleuze. From the translator, Mr. Thos. C. Hartshorn. 1837. Providence.

Catalogue of the Library of the Academy of Natural Sciences of Philadelphia, 1837. The Society.

History of Davenport's Invention of the Application of Electro-Magnetism to Machinery, &c. From Ed. Williams.

Circular Address of the President and Faculty of Louisville Medical College.

General Species and Iconography of Recent Shells, by L. C. Keiner; translated from the French by D. Humphreys Storer, M.D. No. I. From the publisher, Wm. D. Ticknor. Boston, 1837.

Boston Journal of Natural History, containing Papers and Communications read to the Boston Society of Natural History. Part 1. No. 4. The Society.

Rev. H. Winslow's Address before the Boston Nat. Hist. Soc. June 7, 1837. The author.

Rev. H. Winslow's Discourse on the Appropriate Sphere of Woman. Boston, July 9, 1837. The author.

Melanthacearum Americæ Septentrionalis revisio—auctore A. Gray. New York, 1337. The author.

Prospectus of the American Society for the Diffusion of Useful Knowledge—established October 17, 1836. From Gorham D. Abbott.

Circular of the University of the State of New York, Sept. 1837.

First Report of the Universal Lyceum, 1837.

Circular Address of the President and Faculty of the Louisville Medical Institute, 1837.

FOREIGN.

British Annual and Epitome of the Progress of Science, edited by Robert D. Thomson, M. D. London, 1837. The editor.

Select Catalogue of Books by James Kennett, 14 York Street, Covent Garden, London.

New Edinburgh Philosophical Journal, April to July, 1837.

British Annals of Medicine, Nos. 1 to 9, inclusive. In exchange.

London and Edinb. Phil. Mag. &c. Nos. 58, 59, 60. Do.

Loudon's Magazine, Dec. and Jan. 1836–7. Exchange.

London Journal, January and February, 1837. Do.

Mag. of Zoology and Botany, Nos. 1 to 6, inclusive. Exchange.

An Inaugural Lecture on the Study of Botany, by Prof. Daubeny, Univ. Oxford, Eng. 1834. The author.

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