TRANSACTIONS

OF THE

AMERICAN

PHILOSOPHICAL SOCIETY,

HELD AT

PHILADELPHIA,

FOR PROMOTING

USEFUL KNOWLEDGE.

VOLUME VI.—PART I.

PHILADELPHIA:

FROM THE PRESS OF THE LATE R. AITKEN.

BY JANE AITKEN, No. 20, NORTH THIRD STREET.

1804.

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Conditions of the Magellanic Premium.

M. JOHN Hyacinth De Magellan, in London, having fometime ago offered as a donation, to the American Philofophical Society held at Philadelphia for promoting ufeful knowledge, the fum of two hundred guineas, to be by them vefted in a fecure and permanent fund, to the end that the intereft arifing therefrom fhould be annually difpofed of in premiums, to be adjudged by the fociety, to the author of the beft difcovery, or moft ufeful invention, relating to navigation, aftronomy, or natural philofophy (mere natural hiftory only excepted) and the fociety having accepted of the above donation, hereby publifh the conditions, prefcribed by the donor, and agreed to by the fociety, upon which the faid annual premiums will be awarded.

1. The candidate fhall fend his difcovery, invention, or improvement, addreffed to the Prefident, or one of the Vice-Prefidents of the fociety, free of poftage or other charges; and fhall diftinguifh his performance by fome motto device or other fignature, at his pleafure. Together with his difcovery, invention, or improvement, he fhall alfo fend a fealed letter, containing the fame motto device or fignature, and fubfcribed with the real name, and place of refidence of the author.

2. Perfons of any nation, fect, or denomination whatever, fhall be admitted as candidates for this premium.

3. No difcovery, invention, or improvement fhall be entitled to this premium, which hath been already publifhed, or for which the author hath been publicly rewarded elfe where.

4 The candidate fhall communicate his difcovery, invention, or improvement, either in the Englifh, French, German, or Latin language.

5. All fuch communications fhall be publickly read, or exhibited to the fociety, at fome ftated meeting, not lefs than one month previous to the day of adjudication; and fhall at all times be open to the infpection of fuch members as fhall defire it. But no member fhall carry home with him the communication, defcription, or model, except the officer to whom it fhall be intrufted; nor fhall fuch officer part with the fame out of his cuftody, without a fpecial order of the fociety for that purpofe.

6. The fociety having previoufly referred the feveral communications. from candidates for the premium then depending, to the confideration of the twelve councellors and other officers of the fociety, and having re-

ceived their report thereon, ſhall, at one of their ſtated meetings in the month of December, annually, after the expiration of this current year, (of the time and place, together with the particular occaſion of which meeting, due notice ſhall be previouſly given, by public advertiſement) proceed to the final adjudication of the ſaid premium: and after due conſideration had, a vote ſhall firſt be taken on this queſtion, viz. Whether any of the communications then under inſpection be worthy of the propoſed premium? If this queſtion be determined in the negative, the whole buſineſs ſhall be deferred till another year: but if in the affirmative, the ſociety ſhall proceed to determine by ballot, given by the members at large, the diſcovery, invention, or improvement, moſt uſeful and worthy; and that diſcovery, invention, or improvement, which ſhall be found to have a majority of concurring votes in its favour ſhall be ſucceſsful; and then, and not till then, the ſealed letter accompanying the crowned performance ſhall be opened, and the name of the author announced as the perſon entitled to the ſaid premium.

7. No member of the ſociety who is a candidate for the premium then depending, or who hath not previouſly declared to the ſociety, either by word or writing, that he has conſidered and weighed, according to the beſt of his judgment, the comparative merits of the ſeveral claims then under conſideration, ſhall ſit in judgment, or give his vote in awarding the ſaid premium.

8. A full account of the crowned ſubject ſhall be publiſhed by the ſociety, as ſoon as may be after the adjudication, either in a ſeparate publication, or in the next ſucceeding volume of their tranſactions, or in both.

9. The unſucceſsful performances ſhall remain under conſideration, and their authors be conſidered as candidates for the premium, for five years next ſucceeding the time of their preſentment; except ſuch performances as their authors may, in the mean time, think fit to withdraw. And the ſociety ſhall, annually, publiſh an abſtract of the titles, object or ſubject matter of the communications ſo under conſideration; ſuch only excepted as the ſociety ſhall think not worthy of public notice.

10. The letters containing the names of authors whoſe performances ſhall be rejected, or which ſhall be found unſucceſsful after a tryal of five years, ſhall be burnt before the ſociety, without breaking the ſeals.

11. In caſe there ſhould be a failure, in any year, of any communication worthy of the propoſed premium, there will then be two premiums to be awarded in the next year. But no accumulation of premiums ſhall entitle an author to more than one premium for any one diſcovery, invention, or improvement.

12. The premium ſhall conſiſt of an oval plate of ſolid ſtandard gold, of the value of ten guineas; on one ſide thereof ſhall be neatly engraved a ſhort Latin motto, ſuited to the occaſion, together with the words ——The premium of John Hyacinth de Magellan, of London, eſtabliſhed in the year 1786. And on the other ſide of the plate ſhall be engraved theſe words. Awarded by the A. P. S.———for the diſcovery of——— A. D.—

And the ſeal of the ſociety ſhall be annexed to the medal, by a ribbon paſſing through a ſmall hole at the lower edge thereof.

DONATIONS

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FROM THE RESPECTIVE SOCIETIES.

NOVA Acta Acad. Scient. Imp. Petrop. Tom. 12. 1801, 4to.

Nouveaux Memoires de L'Academie Royale des Sciences et Belles Lettres, pour les Années, 1786—1798, Tom. 1—9. Berlin. 4to.

Memorias de la Real Academia de la Historia, Tom. 1—3. 1796, 1796, 1799. Madrid, 4to.

——Catalogo de los individuos actuales. Madrid, 1803.

——Oracion funebre por El Exc°. el Conde de Campomanes, por Don J. Traggia. Madrid, 1802.

——Dos Oraciones al Rey, 1785, 1788.

——Nuevos Estatutos de la Real Academia. Madrid, 1792.

Juntas publicas de la Real Sociedad Economica de Amigos del Pays, de Valencia, celebradas 1799, 1800. 2 Tom. 4to.

Verhandelingen van het Bataafsch Genootschap, der proefondervindelyke Wysbegeerte te Rotterdam, Deel. 7, 8, 10—12, 1793—1798, 4to.

——Nieuwe Verhandelingen, &c. Deel. 1, 2. Te Amsterdam, 1800, 1801, 4to.

Memoires de L'Institut National des Sciences et des Arts, 3me et 4me, Tomes, pour les Années, 9, 11. Paris, 4to. The 1st & 2d vol. were sent, but have miscarried.

——Memoire sur les Collections de Voyages des de Bry et de Thevenot. Par A. G. Camus, membre de l'Inst. L'an. 11, Paris, 4to. Printed at the expence of the Institute.

Gottingensis Reg. Soc. Scien. Novi Commentarii. Tom. 5—8. 1774—1777, 4to.

———— Commentationes. Tom. 1—14, 1778—1799, 4to.

Transactions of the Society of Arts, Manufactures and Commerce, 1—20 Vol. Lond. 1783—1802, 8vo.

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Transactions of the Literary and Philosophical Society of Manchester, Vols. 4th & 5th, 2 parts each, 1793—1802, 8vo.

Transactions of the Historical Society of Massachusetts, 1—8 Vols. Boston, 1792—1795 & 1798—1802, 8vo. Also a catalogue of their Library.

Prospectus, Charter, Ordinances, &c. of the Royal Institution of G. Britain; with lists of Proprietors, &c. Lond. 1800, 4to.

Communication from the Pennsylvania Society for the encouragement of manufactures and the useful arts. Philad. 1804, 8vo.

The Transactions, of the Royal Irish Academy, 2—8 Vols. 4to. and of the Haarlem Society, 1—42 Vols. 8vo, are on their way, but are not yet received.

Batavian Republic; By the Council of the Interior.

The Flora Batava. Drawings by J. C. Sepp & Son, Description by J. Kops. Numbers 1—12. Amsterdam. Commenced 1800.

FROM INDIVIDUALS.

Adams (John—L. L. D.). The 2d & 3d, vols. of his Defence of the American Constitutions; to complete the work. London. 1787, 1788, 8vo.

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——Vicente de Salazar's Historia de la Prov. de Philipinas, China, y Tunking. 3a parte. Manilla, 1742, fol.

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Bradford (S. F). Sir William Jones's Asiatic Researches 1—6 vol. Lond. 1801, 8vo

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Belknap's (Jeremiah, by his widow) 2d vol. of American Biography. Boston. 1798. 8vo.

Birch (W. Y.) & Small (A.). Russel's (W.) History of Ancient Europe. 2 vols. Philad 1801, 8vo.

——Russel's (W.) History of Modern Europe. 1—5 vols. Philad. phia 1801, 8vo.

——Willich's (A. F. M.) Domestic Encyclopedia, Edited by James Mease, M. D. 5 Vols. Philad. 1803-4, 8vo.

Brown (S—M. D.) A plan of the Muscle shoals in Tenessee river.

Buchan (Earl of——Dryburg Abbey, Scotland). The Plan of the City of Washington presented to him by Gen. Washington.

Byrne (Patrick). Kirwan's (R.) Essay on Manures, Dublin, 1801, 8vo.

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Carey (M). Arrowsmith's Map of the discoveries in North America. Lond. 1795.

——Priestley's (Joseph, L. L. D—F. R. S.) Biographical Charts to the present time 4to. Description, 8vo. Philad. 1803.

Campbell (Rose). Quinologia ò tratado del arbol de la quina &c. por Don Hipolito Ruiz, primer Botanico del Expedicion del Perù. Madrid, 1792, 4to.

——Unanue's (Don J. H.) Disertacion sobre el cultivo, &c. dela planta *Coca* del Perù, with a specimen of the leaves. Lima, 1794, 4to.

Chauncey (Charles). The Transactions of the Agricultural Society of the State of Connecticut. 4to.

Collin (Nicholas, D. D). Prosperin's (Erico) "Dissertatio de Cognitione Probabili, Uplandi, 1767, 4to.

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——On Vaccination; several small publications from England; with an account of the Royal Jennerian Institution established for the extermination of the small pox. London. 1803.

Dana (Francis). Catalogus Bibliothecæ Harvardianæ Cantabrigiæ Nov. Anglorum. Bostoniæ, 1790.

Dalton (J). His Meteorological Observations & Essays. Lond. 1793, 8vo.

Drayton (John). His View of South Carolina as respects natural and civil concerns. Charleston, 1802, 8vo.

Dobson (Thomas). Smith's (Carmichael) Essay on nitrous fumigation. Philadelphia 1799 8vo.

Foronda (Le Chev. Don Valentin de) Cons. Gen. from Spain to the U. S. The following works of which he is the Author or Translator.

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——Traduccion (con muchas notas) de las Instituciones Politicas de Bielfield, tratando delos Reynos de Portugal y Espana. Burdeos. 1781.
——La Logica de Condillac puesta en Dialogo; 2d Ed. Madrid. 1800, 12mo.
Fahlburg (Samuel, M. D). An additional map of St. Bartholomews, shewing a dangerous Shoal in its vicinity.
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——Printed specimen of a Table of Logarithms. Idem 1803.
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Groff (J). Aikin's (C. R.) Concise view &c. of facts concerning the Vaccine or Cow-Pock. Philad. Ed. with a new Appendix 1801. 12mo.
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Haygarth (John, M. D.). His Medical Transactions, 1—4 Vol. Bath, 1801, 8vo.
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——Proposal to exchange objects of Natural History &c. Cologne 1802.

——" Tablettes Synoptiques et Systèmatiques de son Cabinet des Curiosités Naturelles." première partie. Regne Mineral. Cologne, 1797, 8vo.

——Brion's (C. L. I. de) Relation du Cabinet et de la Biblioteque, consacrés a l'usage public, par M. Le Baron de Hupsch. Cologne, 1792, 8vo.

——Idem—Historischer und pragmatischer Beweis der grossen und vielfachen Verdienste des Freyh Von Hupsch. Cologne, 1799, 8vo

Humphreys (J). Parke's (Mungo) Travels in the interior of Africa 1795—7 with Major Rennel's Geographical Illustrations. Philad. Ed. 1800, 8vo.

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Knox (Rev. S.). An Essay on the means of improving public Education. Fredericktown, 1803, 8vo.

Laforgue (L.). "l'Art du Dentiste" Paris, l'an. 10, 8vo.

Latimer (J.). Mercurio Peruano de Historia, Literatura &c. por una Sociedad Academica de Amantes del Pays, 2 Tomos, Lima, 1791, Enero à Agosto, 4to.

Leslie (R). Wm. Tatham's Political Oeconomy of Inland Navigation. Philad. 1799, 4to.

——Repertory of Arts 1—12 Vol. to the year 1800, Lond. 8vo.

Lettsom (John Coakley, M. D.). His Essay on the Cow Pox. Lond. 1801, 4to.

——Hints to promote Beneficence, Temperance, &c. 1—3 Vols. Lond. 1801, 8vo.

——Haygarth's (John M. D.). Enquiry how to prevent the Small-Pox. Bath, 1801, 8vo.

Levingston (R. R.—Am. Minis. in France). Exposition Publique des produits de l'industrie Françoise. Paris l'an. 10, 12mo.

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Pugh (S). Six copies of his "Observations sur les moyens de perfectionner les Barometres." Rouen, l'an. 8, 4tô.

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——Historieal disquisition on the Mammoth. Lond. 1803, 8vo.

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——Remarks on Wakefield & Evanson, in letters to a young man. Lond. 1st part, 1792, 2d part 1793.

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——Sermon on a Fast day, April 1793, at Hackney. Lon. 1793.

——Doctrine of Phlogiston established, 8vo. Northd. 1803.

——Collins on Human Liberty, re-published with a preface by J. P. 1790, 8vo.

Spalding (Lyman, M. B). Bills of Mortality for Portsmouth, New-Hampshire, for 1801-2-3, collected and arranged by him.

Smith (Richard, of Huntingdon). Dobb's (Arthur). Account of of the country adjacent to Hudson's Bay, Lond. 1744, 4to.

——Maupertuis on the figure of the Earth, and measurement of a degree of Longitude. Translation. London, 1788, 8vo.

——Ustaritz (Don G. de). On the Theory and Practice of Commerce. Dublin, 1752, 8vo.

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——Account of the Establishment of Washington College Maryland. Phila. 1784, 8vo.

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——Smith (Wm. L. L. D.), Dickinson (John). Their Essay on the Constitutional Power of G. Britain over America. Philad. 1774, 8vo.

Smith (Chas. Lancaster). Pitisci Lexicon Antiquitatum Romanorum. Tomi. 2, Leovardiæ, 1713, fol.

——Murray's (S. Alexr) True Interest of Great Britain and Ireland and the Plantations; and proposals for an union. London, 1740 fol.

——Widow and Children's fund, of the Church of England in Scotland. Edinb. 1748 fol.

——Æliani Sophistae Variæ Historiæ, cum versione Justi Vulteji, et Jacobi Perizonii commentario, Lugduni, Batav. 2 Tom. 1701, 8vo.

——Limborch (Philip. a) de veritate religionis Christianæ. Godæ, 1687, 4to.

——Kersey's (John) Elements of Algebra. London, 1673, fol.

——Fry (Joseph and Son's), specimens of printing Types. Lond. 1785, 8vo.

——Parker's (Richard) History and Antiquities of the University of Cambridge G. B. London, 1622, 8vo.

——Starrat's (William) Doctrine of projectiles applied to Gunnery. Dublin 1733, 8vo.

——Grew's (Theophilus) Tables of the sun and moon fitted to the meridian of Philadelphia. Manuscript, 1746, 4to.

——Ali Ben. Ali Taleb Carmina Arabicè et Latinè edidit et notis illustravit Gerardus Kuypers. Lugduni Batav. 1745, 8vo.

Smith (Charles). Sullivan's (Thomas) Journal of the American War from 1775 to 1778, Manuscript, 8vo.

Smith (Jon. B.) White's (John). Surgeon Gen. to the Settlement. Journal of a Voyage to New South Wales, with 65 plates of natural productions. London, 1790. 4to.

Tracy (Destut). "Project D'Elements d'Idiologie" (2 copies) Paris, l'an 9, 8vo.

Vaughan (Sam. Jun.) Dictionare, Orient. D'Herbelot. Mastricht, 1776, folio.

——Supplement, par Visdelou and Galand, 1780.

——Pere Duhalde's description of China and Chinese Tartary Korea and Thibet, 2 Vols. with the Charts bound separate. London, 1738, 1748, folio.

——Aikin's (John, M. D). Description of Manchester and its environs. London, 1795, 4to.

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——A skeleton head of the Maryland marmot, or arctomys-monax of Linnæus, found in a cave, in Virginia.
Kinloch (Cleland) Marine shells from the high hills of Santee, S. C.
Latimer (James) Gold and silver ore from South America.
Lewis (Capt. M.) Specimens of plants, earths, seeds, and minerals, collected by him in his expedition from St. Louis up the Missouri to the Western Ocean, and back, 1804, 5, 6.
Livingston (Robert R.) Volcanic minerals from Italy.
Maclure (Wm.) A col. of minerals made in Europe & the U. States.

Mease (James, M. D.) Specimens of lead ore from Perkiomen and of minerals from Ireland, collected by Donald Stuart, who collects for the Dublin Society.

Mugford (Capt. Wm.) A model of his rudder, described in page 208 of this volume.

Newell (Capt. Andrew) Some rare shells and corals from Sumatra

Partridge (Wm.) Specimens of copper ore from Perkiomen.

Peyrouse (M.) An Indian earthen vase from Upper Louisiana.

Pichon (L. A.) Disinfecting apparatus of Guyton de Morveau.

Rogers (Maurice) Specimen of crude platina.

Ross (Charles) Lava from the Isle of Ascension.

Rivardi (Major) An Indian hatchet.

Rose (Robert, M. D.) Minerals, coralines &c. from Niagara &c. and coal from seven counties of Pennsylvania.

Sansom (Joseph) Two silver medals of Washington, one as Pres. of the U. States, one as Commander in Chief. Engraved by Reich.

Smith (J. R.) A marble bust of Franklin, executed at Florence.

Smith (R. Sec. of the Navy of the U. S.) A bronze medal of Comm. Preble. The die engraved by Reich, by order of Government.

Traquair (A.) Two large specimens of slate from the Penn. quarry.

Tanner (Benj.) An engraved portrait of the R. R. Bishop White.

Tarascon (L. A.) The lower jaw bone of the Mammoth.

Vaughan (John) Specimens of native gold from Cabarrus county, North Carolina, purer than the standard of the United States.

——Specimens of gypsum from Nova Scotia and France.

Woodhouse (James, M. D. Late Professor of Chem. in the Univ. of Penn.) By Will,—His collection of minerals.

Worthington (Thomas) Vitrified substance from an ancient Indian fort.—Chilicothe.

WEIGHTS AND MEASURES.

There are deposited in the Cabinet of the Society, by Mr. John Vaughan, and by him purchased from Mr. F. R. Hassler (Mathematical Professor at the U. S. Military College, West Point, and a member of the Society.)

1. Exact copies of two French toises, made of small bars of iron. They have been compared with those sent by M. Lalande to Mr. Bird of London, on the occasion of the measurement of a degree in Maryland, by Mason and Dixon.

2. A toise of Canivet bearing the inscription "Toise de France étalonée le 26 Oct. 1768 a 16° de thermometre de Reaumur. On the back of this toise is marked the double length of a pendulum near the equator.

3. An exact French Mètre. It bears the general mark of the Committee of Weights and Measures; being examined by them.

4. A French Kylogramme, also examined by the Committee.

5. A Standard Troy pound, carefully compared &c.

These deposits are accompanied by a memoir, stating in detail the result of a number of comparative experiments, to ascertain their accuracy, together with the following books relative to the same subjects, also deposited by M. Vaughan in the Library of the Society.

La figure de la terre déterminée par des observations faites au Cercle Polaire, par M. de Maupertuis, Paris, 1738, 8vo.

Idem, par des observations de M. M. Bouger & de la Condamine aux environs de l'equateur, par M. Bouger, Paris 1749, 4to.

Degré du méridien entre Paris & Amiens, determiné par la mesure de M. Picard, &c. Paris, 1740, 8vo.

Mesure des trois premiers degrés du méridien dans l'hemisphere austral, par M. de la Condamine, Paris, 1751, 4to.

La méridienne de l'Observ. Roy. de Paris, verifiée par M. Cassini de Thiery, Paris, 1744, 4to.

Observations astronomiques & physiques faites, pour determiner la figure de la terre, par Don Geo. Juan & Don A. de Ulloa, Amst. 1842, 4to.

Voyage astron. & geograph. dans l'Etat de l'Eglise, par les P. P. Maire & Boscovich, Paris, 1770, 4to.

Journal d'un voyage au Nord. 1736, 7, par M. Outhier: Paris, 1744, 4to.

Relation de deux voyages en Allemagne par rapport a la figure de la terre &c. par M. Cassini de Thiery, Paris, 1763, 4to.

Rapport fait a l'Inst. Nat. de France sur la mesure de la méridienne de France, avec le discours prononcé, lors de la presentation des etalons prototypes du mètre & du Kilogramme, Paris, l'an. 7, 4to.

Method proposed for determining the relative situation of the R. Observ. of Greenwich & Paris, with observations on the magnitude and figure of the earth, by Major General Wm. Roy, London, 1787, 4to.

Translation into French by M. De Prony, of the methods of measuring the Base at Hounslow Heath by Major General Wm. Roy, Paris 1787, 4to.

An account of the trig. operations employed to determine the difference of the Observ. of Greenwich and Paris, by Maj. Gen. Wm. Roy, 1790, 4to.

Operations faites en France, 1787, pour la jonction des observatoires de Paris & de Greenwich, par Cassini, Mechain, & le Gendre, Paris, 1789, 4to.

Le systéme des nouvelles mesures de la France mis a la portée de tout le monde, par Aubry, 5me ed. Paris, l'an. 7, 8vo.

Beschreibung der Ausmessungs—methode, welche bey den Danischen geographischen Karten angewendet worden, mit Kupfern, von Thomas Bugge, Dresden, 1787, 4to.

Schriften-Maasse und Gewichte betreffend, der Helvetischen Regierung vorgelegt, 1801, 8vo.

Report of Thomas Jefferson, when Secretary of State, to Congress; on the subject of establishing a uniformity in the weights, measures and coins of the United States, New-York, 1790, 8vo.

The above may be considered as valuable data, whenever the Government of our country shall undertake the necessary task of establishing a general standard of weights and measures for the United States.

CONTENTS

OF VOLUME VI.—PART I.

TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY, &c.

No. I.

On the Language of Signs among certain North American Indians. By William Dunbar, Esq. of the Mississippi Territory, communicated by Thomas Jefferson, President of the Society.

NATCHEZ, June 30, 1800.

Read 16th January, 1801.

SIR,

MR. NOLAN'S man of signs has been here, but was so occupied that a long time elapsed ere I could have an opportunity of conversing with him, and afterwards falling sick was seized with such an invincible desire of returning to his own country, that I had little hopes of gaining much upon his impatience.

A commencement however we have made, and although little has been done, it is sufficient to convince me, that this language by signs has been artfully and systematically framed. In my last I took notice of some analogy which I conceived to subsist between the Chinese written language and our Western language by signs; I had not then read Sir George Staunton's account of the British Embassy to China. I will here beg your permission to transcribe a paragraph or two from that work, which appear to strengthen my ideas of the probability of their common origin. "Almost all the countries border-

"ing on the Chinese sea or Eastern Asia, understand and use "the written Chinese, though not the oral language. About "200 characters mark the principal objects of nature; these "may be considered as roots of language, in which every other "word or species in a systematic sense is referred to its proper "genus or root. The heart is a genus represented by a curve "line, somewhat of the form of the object, and the species "referable to it, include all the sentiments, passions, and af-"fections, that agitate the human breast, each species being "accompanied by some mark denoting the genus or heart." Now Sir if the commencement of this extract was altered and we were to say "Almost all the Indian nations living between the Mississippi, and the Western American ocean, understand and use the same language by signs, although their respective oral tongues are frequently unknown to each other," the remainder of the paragraph would be perfectly descriptive of the organization of this language by signs, and would convey to an adept a full and complete idea of the systêmatic order which has been observed in its formation. Permit me to refer you to the short and very imperfect list of signs enclosed, where you will find water to be a genus, and rain, snow, ice, hail, hoar-frost, dew, &c. are species represented by signs more or less complex, retaining always the root or genus as the basis of the compound sign.

We are also informed that "if any uncertainty remains as "to the meaning of a particular expression, recourse is had to "the ultimate criterion of tracing with the finger in the air or "otherwise, the form of the character and thus ascertaining at "once which was meant to be expressed:" here also is a strong analogy between the language and practice of those countries so far separated from each other, for those Western Indians are so habituated to their signs that they never make use of their oral language, without instinctively at the same time tracing in the air all the corresponding signs, which they perform with the rapidity of ordinary conversation. I cannot avoid concluding that the custom of the Chinese of sometimes tracing the characters in the air, is a proof that this language by signs was at early periods of time universally used by them and by all the nations of the east coast of Asia; and perhaps if enquiry be made it may be found that the usage of this universal language is not yet totally neglected. In the above-mentioned account of the embassy, we are told only, I think, of three Chinese characters, the sun represented by a circle, the moon by a crescent, and man by two lines forming an angle representing the lower extremities; those three signs are precisely the same which are used by the Western people: in order to represent the two first mentioned, the thumb and fore-finger of the right hand are formed either into a Circle or Crescent, and the sign of man is expressed by extending the fore-finger of the right hand and bringing it down, until it rests a moment between the lower extremities.

It is probable that Chinese Sailors or others, may be found in your maritime towns, who might give some useful information, and it cannot I suppose be difficult to procure a collection of Chinese characters with English explanations, which would afford an opportunity of making farther comparisons upon a future investigation of this curious subject. I think Captain Cook says, some where, that in some of the Islands of the Western pacific he found persons who possessed a great facility of communicating their ideas by signs and made much use of gesticulations: this was probably no other than the language by signs; and if it is found that the Chinese actually use at this day upon some occasions a language by signs, actual experiment alone will convince me that it is not the same which is used by our Western Indians. Hence would spring forth an analogy and connection between the Continents of the New and Old World which would go directly to the decision of your question, without being involved in the ambiguity arising from the imperfect resemblance of words.

WILLIAM DUNBAR.

THOMAS JEFFERSON, *President* A. P. S.

Signs made use of by the Indian Nations to the West of the Mississippi, refered to in the foregoing letter.

White, with the under side of the fingers of the right hand, rub gently upon that part of the left hand which corresponds with the knitting of the bones of the fore-finger and thumb.

Egg. The right hand held up with the fingers and thumb extended and approaching each other as if holding an Egg within.

Stone. The right hand shut give several small blows on the left.

The same or similar to what went before, Place the two fore-fingers parallel to each other and push them forward a little.

Water. The hand formed into a bowl and brought up to the mouth passing a little upwards without touching the mouth.

Rain. Begin with the sign of water, then raise the hands even with the forehead, extending the fingers outwards and give a shaking motion as if to represent the dripping of water.

Snow. Begin with the sign of rain, then the sign of air or cold and conclude with the sign of white.

Ice. Begin with the sign of water then of cold, then the earth and lastly a stone with the sign of sameness or similarity.

Hail. Begin with the sign of water, then the sign of cold, next the sign of a stone, then the same, then the sign of white and lastly conclude with the sign of an Egg; all which combined gives the idea of hail.

Frost. Begin with the sign of water, then the sign of night or darkness, then the sign of cold, then the sign of white, and lastly the earth.

Cloud. Begin with the sign of water, then raise the two hands as high as the forehead and placing them with an inclination of 15° let them gently cross one another.

Fire. The two hands brought near the breast touching or approaching each other and half shut, then moved outwards moderately quick, the fingers being extended and the hands a little separated at the same time, as if to imitate the appearance of flame.

Bring, fetch or give me. The hand half shut with the thumbs pressing against the fore-finger, being first moderately extended either to the right or left, is brought with a moderate jerk to the opposite side, as if something was pulled along by the hand. Consequently the sign of water preceding this sign would convey the expression "give me water."

Earth. The two hands open and extended, brought horizontally near each other opposite to either knee, then carried to the opposite side and raised in a curve movement until brought round and opposite to the face.

Air. The right hand held perpendicularly upwards and brought forwards with a tremulous or vibratory motion until it passes beyond the face.

Big, great or large. The two hands open placed wide apart on each side the body and moved forwards.

Fear, to be afraid, to cause fear. The two hands with the fingers turned inwards opposite to the lower ribs, then brought upwards with a tremulous movement as if to represent the common idea of the heart rising up to the throat, the three last signs placed in the order given, would convey the idea of a violent hurricane.

Sun. The thumb and finger forming a circle elevated in front towards the face.

Moon. The thumb and finger open are elevated towards the right ear; this last sign is generally preceded by sign of the night or darkness which

Night is the two hands open and extended crossing one another horizontally.

Heat. The two hands raised as high as the head and bending forwards horizontally with the points of the fingers curving a little downwards.

Cold. The same sign as for air, but when applied to a person the right hand is shut and held up nearly opposite the shoulder and put into a tremulous motion.

I. The fingers of the right hand laid against the breast. This last sign with that preceding placed after it would signify I am cold.

Smoak. Begin with the sign of fire then raise the hand upward with the fingers open as if to represent smoak.

Clear, The hands are uplifted and spread both ways from the head.

Bow The left hand being a little extended, the right hand touches it and makes the motion of drawing the cord of the bow.

Thunder. The sign of rain accompanied by the voice imitating the rumbling sound of thunder.

Lightning. First the sign of thunder, then open or separate the hands and lastly bring the right hand down towards the earth in the center of the opening just made.

Cow. The two fore-fingers brought up to the side of the head and extended outwards so as to represent the position of the horns.

Male and Female. Note, to distinguish between the Male and Female in all cases add for the male a fillip with the fore-finger of the right hand on the cheek and for the female, bring the two hands open towards the breast, the fingers approaching and then move them outwards.

Gelt. Bring the fingers and thumb of the left hand together as if something was held by them, then approach the right hand and make the motion of cutting across what is supposed to be held in the left hand, and then draw off the right hand as if pulling away what has been cut.

Dunghill fowl. Bring the thumb and fingers of the right hand together, and holding the hand moderately elevated, move it across imitating the motion of the head of a cock in walking.

Turkey. The open hands brought up opposite to the shoulders and imitating slowly the motion of the wings of a bird, to which add the last sign.

Duck. The last sign, then the sign of water, and lastly the sign of swimming which last is performed by the fore-finger of the right hand extended outwards and moved to and fro.

Horse. The right hand with the edge downwards, the fingers joined, the thumb recumbent, extended forwards.

Deer. The right hand extended upwards by the right ear, with a quick puff from the mouth.

Man with the fore-finger of the right hand extended and the hand shut describe a line beginning at the pit of the stomach and passing down the middle of the body as far as the hand conveniently reaches holding the hand a moment between the lower extremities.

Woman. The finger and thumb of the right hand partly open, and placed as if laying hold of the breast.

Child. Bring the fingers and thumb of the right hand and place them against the lips, then draw them away and bring the right hand against the fore arm of the left as if holding an infant. Should the child be male, prefix the sign of a man before the last sign, and if a female, do so by the sign of the woman.

Boy. Bring the fingers and thumb of the right hand to touch the lips, then extend the hands and make the sign of man, then raise the hand with the fingers upwards and placed at the height of a boy.

Girl. Begin with the above sign and make the sign of woman, and then raise the hand to the height of the girl.

You. The hand open held upwards obliquely and pointing forward.

He, or another. The fore-fingers extended and hands shut, and fingers brought over one another, or nearly touching and then separated moderately quick.

Many or much. The flat of the right hand patting on the back of the left hand ; which is repeated in proportion to the greater or lesser quantity.

Know. The fore-finger of the right hand held up nearly opposite to the nose, and brought with a half turn to the right and carried a little outwards. Place any of the articles before the last sign; which will then signify, I know, you know, he knows;—both hands being made use of in the manner described, implies to know much.

Now, or at present. The two hands forming each an hollow and brought near other and put into a tremulous motion upwards and downwards.

Come here. The hand stretched outwards with the palm under, and brought back with a curve motion downwards and inclining to the body.

Go. The back of the hand stretched out and upwards.

What say you. The palm of the hand upwards and carried circularly outwards and depressed.

No, nothing, I have none. The hand held up before the face, with the palm outwards, and vibrated to and fro.

From whence come you, say. First the sign of you, then the hand extended open and drawn to the breast and lastly, the sign of, what say you?

Come. The fore-finger moved from right to left with an interrupted motion as if imitating the alternate movement of stepping.

Mine. The hand shut and held up to the view.

House. The hand half open and the fore-finger extended and separated, then raising the hand upwards and give it a half turn, as if screwing something.

Done or Finished. The hands placed edge up and down parallel to each other, the right hand without, which latter is drawn back as if cutting something.

Spring Season. The sign of cold, to which add the last sign of being done or finished.

Body. The hands with the fingers pointed to the lower part of the body and then drawn upwards.

Hair. The movement of combing.

	HOURS. 5. 3. 9.		WINDS.		RAIN.	APRIL.		HOURS. 5. 3. 9.		WINDS.		RAIN.	1799.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.	DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	63	29 54	S	1		Rain.		69	29 51				Cloudy.
Mon.	75	29 54	N W	3	0.50	Rain and hail.	Tues.	73	29 51	S	1	0.26	Rain.
1	64	29 53	W			Clearing up.	16	68	29 51	S S W			Clouds thinner.
	50	29 80	N W	1		Very clear		68	29 63	S S W	1		Clds. disp. almost clr.
Tues.	68	29 80	N	1		Very clear.	Wed.	84	29 68	S S W	1		Clear.
2	57	29 80					17	64	29 74				Clear.
	47	29 80						61	29 83	N			Very clear.
Wed.	72	29 82	S			Clear.	Thurs.	78	29 85	N W	1		Very clear.
3	61	29 82				Grey clouds.	18	70	29 87	N W			Very clear.
	55	29 86	N E	1		Rain.		56	29 87	N W			Very clear.
Thurs.	68	29 86	E N E	1	0.13	Rain.	Friday	76	29 91	N W	1		Clear.
4	50	29 88	E			Cloudy.	19	68	29 96	N W			Clear.
	41	29 90				Cloudy.		51	29 94	N W	2		Clr. with thin we. vap.
Friday	55	29 94	W			Clear.	Satur.	72	29 94	E	1		More clouds.
5	44	29 94	N			Star light.	20	64	29 85	S	1		Rain commences.
	35	29 94	N W			Very clear.		64	29 61	S	1	1.140	Rain.
Satur.	64	29 94	N E			Clear.	Sunday	78	29 58	S	1		Cloudy.
6	50	29 94				Clear.	21	72	29 58	S	1		Cloudy.
	37	29 94	S W	1		Very clear.		72	29 55	S W	1		Cloudy.
Sunday	71	29 84	S W	1		Clear.	Mon.	83	29 51	S W	2		Cloudy.
7	60	29 84	W			Clear.	22	79	29 51	S W			Cloudy.
	56	29 84	W	1		Clear.		62	29 70	N W	1		Very clear.
Mon.	73	29 76	W	2		Cloudy.	Tues.	76	29 76	N W			Clear.
8	68	29 76				Stars give dim light.	23	68	29 82	N W	2		Very clear.
	55	30 00	S E	2		Clear.		58	29 82				Very clear.
Tues.	66	29 97	W	2		Clear.	Wed.	83	29 82	S	1		Clear.
9	50	29 97				Clear.	24	78	29 82	S			Clear.
	44	29 97	W			Clear.		63	29 82	S W	1		Clear.
Wed.	63	29 84	W	1		White clouds.	Thurs.	81	29 82	S	2		Thin white clouds.
10	62	29 82				Cloudy.	25	74	29 82	S	1		Cloudy.
	55	29 72				A few clouds.		68	29 67	S E	1	0,795	Rain.
Thurs.	70	29 70	W	1		Cloudy.	Friday	78	29 54	S	2	0.125	Rain.
11	66	29 68			0.02	Rain.	26	75	29 60				Cloudy.
	64	29 70	E			Cloudy.		65	29 67	S W	1		Clearing up.
Friday	76	29 74				Cloudy.	Satur.	81½	29 67	S W	1		Clear.
12	72	29 74				Cloudy.	27	71	29 70				Very clear.
	68	29 74				Cloudy.		58	29 77	S S W	2		Very clear.
Satur.	81	29 74	S W			Cloudy.	Sunday	86	29 77	S	1		Clear.
13	76	29 83				Cloudy.	28	77	29 77	S	1		Clear.
	71	29 88	W			Fine rain.		74	29 84	S	1		Thin grey clouds.
Sunday	78	29 88	S E			Fine rain.	Mon.	87	29 84	S			Clear.
14	71	29 86				Cloudy.	29	78	29 79	S			Clear.
	68	29 80	S E	1		Cloudy.		80	29 63	S	1		Grey clouds.
Mon.	78	29 72	S E	2		Cloudy.	Tues.	77	29 73				Some drops of rain.
15	73	29 64				Cloudy.	30	64	29 80	S	2		Rain.

REMARKS.

1st. The hail was of a spheroidal form $\frac{3}{8}$ inch in its equatorial diameter, and $\frac{1}{4}$ inch in its axis, very transparent and fell with a N W wind. 10th. Strawberry redens. 12th. Walnut and hickory trees begin to bud, also Linn. Grass pastures begin to furnish abundance of food in the wood lands. 13th. Young artichokes formed and shooting up. 16th, Strawberry ripe. 20th, Green peas and artichokes ripe. 22d, Grubs and caterpillars devour the young cotton, corn and Irish potatoes, &c, the cotton shoots from many of the old stalks. 28th, Windsor beans fit to gather.

Days.	Hours. 5. 3. 9. Th.	Bar.	Winds. Pts.	Str.	Rain. In.	May. State of the weather.
Wed. 1	64	29 90	N W	1		Clear.
	70	29 95	N W	2		Clear.
	60	30 00	N W	1		Very clear.
Thurs. 2	54	30 00	N W			Very clear.
	77	30 00	N W	2		Very clear.
	64	30 00	N W	1		Very clear.
Friday 3	56	30 00	N W	1		Very clear.
	74	30 00	N W	2		Very clear.
	64	30 00	N W			Very clear.
Satur. 4	55	30 04	N W			Very clear.
	74	30 00	N W			Very clear.
	60	30 00				Very clear.
Sunday 5	56	30 00	N W	1		Very clear.
	74	30 00				Very clear.
	68	29 96	N W			Very clear.
Mon. 6	61	29 97				Very clear
	82½	29 99	W	1		Very clear.
	71	29 99	S	1		Very clear.
Tues. 7	65	29 99	S	1		Very thin we. clouds.
	83	29 98	S			Thin white clouds.
	71	29 98	S	1		Thin clouds.
Wed. 8	65	29 98	S			Clear.
	83½	29 98	S	1		White clouds.
	71	29 98				Clear.
Thurs. 9	61	29 99	S S W	1		Clear.
	84	29 99	S S W	1		Clear.
	71	29 99				Clear.
Friday 10	67	29 96	W N W			Clear.
	85	29 93	W N W	1		White clds. at the hor.
	74	29 87	W			Clear
Satur. 11	64	29 90	W			Foggy.
	84	29 90	W	1		Clear.
	72	29 85	S W	1		Clear.
Sunday 12	65	29 90	S S W			Slightly hazy
	86	29 88	S S W			Thin veil of white cls.
	73	29 87				Stars shine dimly.
Mon. 13	65	29 90				Grey morning.
	84	29 88	E	2		Grey clouds.
	73	29 85				Cloudy.
Tues. 14	69	29 81	S S E	1		Grey clouds.
	80	29 67	W & S E	1		Cloudy.
	75	29 67	S E	1		Cloudy.
Wed. 15	73	29 67				Thin clouds.
	83	29 67	W	1		Thin white clouds.
	78	29 64	W			Fine veil of white clds
Thur. 16	76	29 71	S W	1		Dark clouds, rain.
	83	29 68			0.21	Cloudy & rain.
	72	29 83				Clouds disperse.

Days.	Hours. 5. 3. 9. Th.	Bar.	Winds. Pts.	Str.	Rain. In.	1799. State of the weather.
Friday 17	67	29 70	W	1		Thin white clouds.
	82	29 74	W	1		Clear.
	73	29 77				Clear.
Satur. 18	62	29 88	N W	1		Very clear.
	80	29 88	N W	2		Very clear.
	69	29 88	N W			Very clear.
Sunday 19	58	29 90	N			Very clear.
	83	29 90	N	1		Very clear.
	72	29 90	S W			Very clear.
Mon. 20	60	29 92	S W			Clear.
	80	29 90	W	1		Clear.
	73	29 88				Clear.
Tues. 21	68	29 94	S W	1		Grey clouds.
	81½	29 92	S			A few white clouds.
	76	29 89				Clear.
Wed. 22	72	29 89	S	1		Grey clouds.
	86	29 8	S W	2		White clouds.
	76½	29 83	W	1		Clear.
Thur 23	71	29 80	S W	2		Some white clouds.
	87	29 81	S W	2		Clr, with some wh. c.
	76	29 80				Clear.
Friday 24	67	29 78	W	1		Some Grey clouds.
	86½	29 75	W	1		Clear.
	77	29 73				Clear.
Satur. 25	77	29 74				Foggy.
	86	29 77	N W	2	0.58	Rain.
	68	29 70				Stars shine dim.
Sunday 26	63	29 75	W N W			Some white clouds.
	82	29 76	W N W	1		Grey clouds.
	72	29 76				Star light.
Mon. 27	64	29 85	W			Clear.
	85	29 85	S W	1		Clear.
	72	29 85	W S W	1		Clear.
Tues. 28	66	29 88				Clear.
	86	29 91	W			White clouds.
	72	29 93			0.02	Cloudy small rain.
Wed. 29	69	29 88	S E	1		Cloudy.
	84	29 87	E	1		Thin clouds.
	75	29 86				Thin clouds.
Thurs. 30	69	29 86				Thin clouds.
	85	29 82	S S E			Thin white clouds.
	74	29 79				Stars shine dimly.
Friday 31	76	29 81	E			Clear, some clouds.
	87	29 81	E	1		Clear.
	72	29 79				Clear.

REMARKS.

5th, Poppies in flower. 10th, Black mulberry ripe; gathered ripe turnip seed and cabbage seed; grubs and caterpillars disappear in our field. 12th, French beans fit to eat. 18th, Rye and wheat fit to reap.

	HOURS. 5. 3. 9.		WINDS.		RAIN.	JUNE.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	65	29 79				Clear.
Satur.	87	29 82	W	1		Clear.
1	78	29 85	W	1		Clear.
	69	29 85				Clear.
Sunday	87	29 85				Clear.
2	79	29 85				Clear.
	74	29 85				Clear.
Mon.	87	29 84	S E			Clear.
3	72	29 83				Clear.
	76	29 83				Clear.
Tues.	89½	29 83	N E	1		Clear.
4	67	29 82	N E	1		Clear.
	69	29 83				Clear.
Wed.	92	29 83	E	1		Clear.
5	82	29 82				Clear.
	72	29 83				Clear.
Thur	92	29 82	W	1		Clear.
6	80	29 80				Clear.
	72	29 81				Clear.
Friday	88	29 81	N	2		Clr. some drops of rain
7	79	29 81				Clear.
	70	29 81	N	2		Clear.
Satur.	87	29 81	N	2		Clear.
8	76	29 81	W			Very clear.
	73	29 80				Very clear.
Sunday	87	29 80	S W			Very clear.
9	70	29 80	W			Very clear.
	70	29 80				Very clear.
Mon.	89	29 90	S W	1		Very clear.
10	73	29 94	W	1		Very clear.
	68	29 96				Light clouds.
Tues.	84	30 02	S		0.10	Light rain.
11	79	30 00				Clouds.
	73	30 00	S E	1		Cloudy.
Wed.	90	29 96	S E	2		Cloudy.
12	76	29 94				Clear.
	72	29 94				Light grey clouds.
Thurs.	91	29 90	S E			Light grey clouds.
13	76	29 87	S W			Clear.
	69	29 86				Clear.
Friday	88	29 83	S E			Grey clouds.
14	79	29 80	N E			Clear.
	72	29 82				Rain.
Satur.	92	29 85	E	3	0.12	Rain.
15	77	29 88				Clear.

	HOURS. 5. 3. 9.		WINDS.		RAIN.	1799.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	71	29 88				Clear.
Sun.	91	29 88	S E	1		Clear.
16	78	29 88				Clear.
	72	29 89				Clear.
Mon.	91	29 90	S E	1		Clear.
17	80	29 89				Clear.
	71	29 91				Hazy.
Tues.	92	29 90	S W	1		Light clouds.
18	78	29 89	S W	1		Light clouds.
	73	29 92				Hazy.
Wed.	91	29 91	S E	1		Light clouds.
19	79	29 90	S W	1		Clear.
	70	29 93				Hazy.
Thurs.	92	29 92	S E			Light clouds.
20	79	29 91	S W	1		Dull star light.
	69	29 94				Light clouds.
Friday	92	29 94				Cloudy and rain.
21	65	29 93	S E	3	0.82	Rain, thundergust.
	70	29 97				Light clouds.
Satur.	92	29 97				Light clouds.
22	75	29 97	S E	1	0.10	Rain.
	71	29 98	S E			Cloudy.
Sun.	89	29 98	S E	1		Cloudy.
23	65	29 98	S E			Cloudy.
	73	29 98	S E			Cloudy.
Mon.	87	29 98	S E	1		Clouds & sunshine.
24	89	29 97	S E			Cloudy.
	76	29 96	S E	2		Clouds.
Tues.	90	29 96	S E	2		Flying clouds.
25	77	29 96	S E			Cloudy.
	73	29 98	S			Clear.
Wed.	80	29 97	S	2		Drizzly.
26	77	29 96	S	1		Clear.
	77	29 98	S			Clear.
Thurs.	87	29 97	S	1		Clouds & fine rain.
27	76	29 96	S W			Clear.
	79	29 98	S W	1		Clear.
Friday	85	29 97	S W	2		Rain.
28	74	29 96	S W		0.71	Rain.
	73	29 98	S W			Clear.
Satur.	86	29 97	S	1		Rain.
29	76	29 96	S	1	0.21	Rain.
	76	29 98	S E			Clear.
Sunday	86	29 97	S E	2		Rain.
30	75	29 96	S E			Rain.

REMARKS.

10th, Tender Indian corn fit for use; also, earliest peaches just beginning to ripen. 12th, Cotton in blossom.

Days.	Hours 4½. 3. 9. Th.	Bar.	Winds. Pts.	Str.	Rain. In.	July. State of the weather.
Mon. 1	70	29 98	S	1		Cloudy.
	86	29 97	S E	1		Cloudy.
	77	29 96			0.22	Rain.
Tues. 2	73	29 96	S E			Clouds.
	89	29 95	S E	1	0.02	Rain.
	74	29 95	S W			Clouds.
Wed. 3	73	29 95				Clouds.
	89	29 94	S	1		Clouds.
	74	29 93				Clouds.
Thur. 4	74	29 94				Clouds.
	90	29 93	S E	1		Clouds.
	73	29 92				Clouds.
Friday 5	70	29 90				Clouds.
	84	29 87	S E	1	1.05	Rain.
	70	29 86				Cloudy.
Satur. 6	73	29 85				Cloudy.
	87	29 84	S E	1		Cloudy.
	80	29 83			0.01	Rain.
Sun. 7	70	29 82				Cloudy.
	88	29 81				Small rain.
	78	29 81				Cloudy.
Mon. 8	75	29 80				Cloudy.
	89	29 80	E	1		Cloudy.
	80	29 79			0.10	Clear.
Tues. 9	73	29 79	E		0.25	Cloudy.
	86	29 80	E			Cloudy.
	77	29 82				Cloudy.
Wed. 10	74	29 83				Cloudy.
	90	29 83	E		0.10	Cloudy.
	76	29 84	E			Clear.
Thur. 11	73	29 85				Clear.
	89	29 86	E			Cloudy.
	77	29 86				Cloudy.
Friday 12	73	29 86	E			Clear.
	90½	29 87	N E	1		Cloudy.
	83	29 86	S W	1		Clear.
Satur. 13	75	29 86				Cloudy.
	89	29 85	S E		0.10	Cloudy & rain.
	73	29 84	S W			Clear.
Sun. 14	76	29 86				Clear.
	89½	29 85	S E	1		Clouds & sunshine.
	72	29 84	S W			Clear.
Mon. 15	75	29 85				Fine.
	90	29 84	S E	1		Clouds & sunshine.
	73	29 83	S W			Very clear.
Tues. 16	74	29 84				Clear & fine.
	87	29 83	S E	1	0.15	A shower.
	75	29 82	S W			Fine.

Days.	Hours 4½. 3. 9. Th.	Bar.	Winds. Pts.	Str.	Rain. In.	1799. State of the weather.
Wed. 17	73	29 84				Clear.
	89	29 83	S E	1		Clouds & sunshine.
	74	29 8[illegible]	S W			Clear & fine.
Thurs. 18	72	29 84				Fine.
	89	29 83	S E	1		Clear.
	73	29 82	S W			Fine.
Friday 19	70	29 83				Fine.
	90	29 82	S W	1		Some clouds.
	72	29 81				Clear & fine.
Satur. 20	72	29 81	S W			Clear & fine.
	91	29 80	S W	1		Some clouds.
	80	29 80	S W	1		Very fine.
Sunday 21	73	29 83	S W	1		Very fine.
	90	29 82	S W	1		Very fine.
	77	29 80				Very fine.
Mon. 22	71	29 81				Very fine.
	92	29 82	W			Very fine.
	83	29 83	S			Very fine.
Tues. 23	70	29 83				Clear.
	91½	29 78	N W			Clear.
	78½	29 78	N W	1		Clear.
Wed. 24	71	29 79	E			Clear.
	89	29 80	N E	1		Cloudy.
	80	29 81				Cloudy.
Thurs. 25	72	29 84				Cloudy.
	90	29 88	N E	1		Clear.
	80	29 90				Clear.
Friday 26	70	29 94	S			Clear.
	91½	29 97	S	1		Fine.
	98	29 91	S W			Fine.
Satur. 27	76	29 93				Clear.
	92	29 92	S W	1		Clear.
	82	29 91	S W	1		Clear.
Sunday 28	75	29 92				Clear
	91½	29 91	S W	1		Clear.
	82	29 91	S W			Clear.
Mon. 29	75	29 93				Some clouds.
	91½	29 92	S E			Cloudy.
	73	29 91				Clear.
Tues. 30	74	29 93				Cloudy.
	92	29 92	S E	1	0.12	Rain.
	73	29 92	S W			Clear.
Wed. 31	74	29 94				Clear.
	89	29 92	S E			Clear.
	73	29 90				Fine.

REMARKS.

Cotton pods as large as a walnut, on the 15th.

	HOURS. 5. 3. 9.		WINDS.		RAIN.	APRIL.		HOURS. 5. 3. 9.		WINDS.		RAIN.	1799.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.	DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	63	29 54	S	1		Rain.		69	29 51				Cloudy.
Mon.	75	29 54	N W	3	0.50	Rain and hail.	Tues.	73	29 51	S	1	0.26	Rain.
1	64	29 53	W			Clearing up.	16	68	29 51	S S W			Clouds thinner.
	50	29 80	N W	1		Very clear		68	29 63	S S W	1		Clds. disp. almost clr.
Tues.	68	29 80	N	1		Very clear.	Wed.	84	29 68	S S W	1		Clear.
2	57	29 80					17	64	29 74				Clear.
	47	29 80						61	29 83	N			Very clear.
Wed.	72	29 82	S			Clear.	Thurs.	78	29 85	N W	1		Very clear.
3	61	29 82				Grey clouds.	18	70	29 87	N W			Very clear.
	55	29 86	N E	1		Rain.		56	29 87	N W			Very clear.
Thurs.	68	29 86	E N E	1	0.13	Rain.	Friday	76	29 91	N W	1		Clear.
4	50	29 88	E			Cloudy.	19	68	29 96	N W			Clear.
	41	29 90				Cloudy.		51	29 94	N W	2		Clr. with thin we. vap.
Friday	55	29 94	W			Clear.	Satur.	72	29 94	E	1		More clouds.
5	44	29 94	N			Star light.	20	64	29 85	S	1		Rain commences.
	35	29 94	N W			Very clear.		64	29 61	S	1	1.140	Rain.
Satur.	64	29 94	N E			Clear.	Sunday	78	29 58	S	1		Cloudy.
6	50	29 94				Clear.	21	72	29 58	S	1		Cloudy.
	37	29 94	S W	1		Very clear.		72	29 55	S W	1		Cloudy.
Sunday	71	29 84	S W	1		Clear.	Mon.	83	29 51	S W	2		Cloudy.
7	60	29 84	W			Clear.	22	79	29 51	S W			Cloudy.
	56	29 84	W	1		Clear.		62	29 70	N W	1		Very clear.
Mon.	73	29 76	W	2		Cloudy.	Tues.	76	29 76	N W			Clear.
8	68	29·76				Stars give dim light.	23	68	29 82	N W	2		Very clear.
	55	30 00	S E	2		Clear.		58	29 82				Very clear.
Tues.	66	29 97	W	2		Clear.	Wed.	83	29 82	S	1		Clear.
9	50	29 97				Clear.	24	78	29 82	S			Clear.
	44	29 97	W			Clear.		63	29 82	S W	1		Clear.
Wed.	63	29 84	W	1		White clouds.	Thurs.	81	29 82	S	2		Thin white clouds.
10	62	29 82				Cloudy,	25	74	29 82	S	1		Cloudy.
	55	29 72				A few clouds.		68	29 67	S E	1	0,795	Rain.
Thurs.	70	29 70	W	1		Cloudy.	Friday	78	29 54	S	2	0.125	Rain.
11	66	29 68			0.02	Rain.	26	75	29 60				Cloudy.
	64	29 70	E			Cloudy.		65	29 67	S W	1		Clearing up.
Friday	76	29 74				Cloudy.	Satur.	81½	29 67	S W	1		Clear.
12	72	29 74				Cloudy.	27	71	29 70				Very clear.
	68	29 74				Cloudy.		58	29 77	S S W	2		Very clear.
Satur.	81	29 74	S W			Cloudy.	Sunday	86	29 77	S	1		Clear.
13	76	29 83				Cloudy.	28	77	29 77	S	1		Clear.
	71	29 88	W			Fine rain.		74	29 84	S	1		Thin grey clouds.
Sunday	78	29 88	S E			Fine rain.	Mon.	87	29 84	S			Clear.
14	71	29 86				Cloudy.	29	78	29 79	S			Clear.
	68	29 80	S E	1		Cloudy.		80	29 63	S	1		Grey clouds.
Mon.	78	29 72	S E	2		Cloudy.	Tues.	77	29 73				Some drops of rain.
15	73	29 64				Cloudy.	30	64	29 80	S	2		Rain.

REMARKS.

1st. The hail was of a spheroidal form $\frac{3}{8}$ inch in its equatorial diameter, and $\frac{1}{4}$ inch in its axis, very transparent and fell with a N W wind. 10th. Strawberry redens. 12th. Walnut and hickory trees begin to bud, also Linn. Grass pastures begin to furnish abundance of food in the wood lands. 13th. Young artichokes formed and shooting up. 16th, Strawberry ripe. 20th, Green peas and artichokes ripe. 22d, Grubs and caterpillars devour the young cotton, corn and Irish potatoes, &c, the cotton shoots from many of the old stalks. 28th, Windsor beans fit to gather.

	HOURS. 5. 3. 9.		WINDS.		RAIN.	MAY.		HOURS. 5. 3. 9.		WINDS.		RAIN.	1799.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.	DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	64	29 90	N W	1		Clear.		67	29 70	W	1		Thin white clouds.
Wed.	70	29 95	N W	2		Clear.	Friday	82	29 74	W	1		Clear.
1	60	30 00	N W	1		Very clear.	17	73	29 77				Clear.
	54	30 00	N W			Very clear.		62	29 88	N W	1		Very clear.
Thurs.	77	30 00	N W	2		Very clear.	Satur.	80	29 88	N W	2		Very clear.
2	64	30 00	N W	1		Very clear.	18	69	29 88	N W			Very clear.
	56	30 00	N W	1		Very clear.		58	29 90	N			Very clear.
Friday	74	30 00	N W	2		Very clear.	Sunday	83	29 90	N	1		Very clear.
3	64	30 00	N W			Very clear.	19	72	29 90	S W			Very clear.
	55	30 04	N W			Very clear.		60	29 92	S W			Clear.
Satur.	74	30 00	N W			Very clear.	Mon.	80	29 90	W	1		Clear.
4	60	30 00				Very clear.	20	73	29 88				Clear.
	56	30 00	N W	1		Very clear.		68	29 94	S W	1		Grey clouds.
Sunday	74	30 00				Very clear.	Tues.	81½	29 92	S			A few white clouds.
5	63	29 96	N W			Very clear.	21	76	29 89				Clear.
	61	29 97				Very clear.		72	29 89	S	1		Grey clouds.
Mon.	82½	29 99	W	1		Very clear.	Wed.	86	29 87	S W	2		White clouds.
6	71	29 99	S	1		Very clear.	22	76½	29 83	W	1		Clear.
	65	29 99	S	1		Very thin we. clouds.		71	29 80	S W	2		Some white clouds.
Tues.	83	29 98	S			Thin white clouds.	Thur	87	29 81	S W	2		Clr, with some wh. c.
7	71	29 93	S	1		Thin clouds.	23	76	29 80				Clear.
	65	29 98	S			Clear.		67	29 78	W	1		Some Grey clouds.
Wed.	83½	29 98	S	1		White clouds.	Friday	86½	29 75	W	1		Clear.
8	71	29 98				Clear.	24	77	29 73				Clear.
	61	29 99	S S W	1		Clear.		77	29 74				Foggy.
Thurs.	81	29 99	S S W	1		Clear.	Satur.	86	29 77	N W	2	0.58	Rain.
9	71	29 99				Clear.	25	68	29 70				Stars shine dim.
	67	29 96	W N W			Clear.		63	29 75	W N W			Some white clouds.
Friday	85	29 93	W N W	1		White clds. at the hor.	Sunday	82	29 76	W N W	1		Grey clouds.
10	74	29 87	W			Clear	26	72	29 76				Star light.
	61	29 90	W			Foggy.		64	29 85	W			Clear.
Satur.	84	29 90	W	1		Clear.	Mon.	85	29 85	S W	1		Clear.
11	72	29 85	S W	1		Clear.	27	72	29 85	W S W	1		Clear.
	65	29 90	S S W			Slightly hazy.		66	29 88				Clear.
Sunday	86	29 88	S S W			Thin veil of white cls.	Tues.	86	29 91	W			White clouds.
12	73	29 87				Stars shine dimly.	28	72	29 93			0.02	Cloudy small rain.
	65	29 90				Grey morning.		69	29 88	S E	1		Cloudy.
Mon.	84	29 88	E	2		Grey clouds.	Wed.	84	29 87	E	1		Thin clouds.
13	73	29 85				Cloudy.	29	75	29 86				Thin clouds.
	60	29 81	S S E	1		Grey clouds.		69	29 86				Thin clouds.
Tues.	80	29 67	W & S E	1		Cloudy.	Thurs.	85	29 82	S S E			Thin white clouds.
14	75	29 67	S E	1		Cloudy.	30	74	29 79				Stars shine dimly.
	75	29 67				Thin clouds.		76	29 81	E			Clear, some clouds.
Wed.	83	29 67	W	1		Thin white clouds.	Friday	87	29 81	E	1		Clear.
15	78	29 64	W			Fine veil of white clds	31	72	29 79				Clear.
	76	29 71	S W	1		Dark clouds, rain.							
Thur.	83	29 68			0.21	Cloudy & rain.							
16	72	29 83				Clouds disperse.							

REMARKS.

5th, Poppies in flower. 10th, Black mulberry ripe; gathered ripe turnip seed and cabbage seed; grubs and caterpillars disappear in our field. 12th, French beans fit to eat. 18th, Rye and wheat fit to reap.

	Hours. 5. 3. 9.		Winds.		Rain.	June.
Days.	Th.	Bar.	Pts.	Str.	In.	State of the weather.
	68	29 79				Clear.
Satur.	87	29 82	W	1		Clear.
1	78	29 85	W	1		Clear.
	69	29 85				Clear.
Sunday	87	29 85				Clear.
2	79	29 85				Clear.
	74	29 85				Clear.
Mon.	87	29 84	S E			Clear.
3	72	29 83				Clear.
	76	29 83				Clear.
Tues.	89½	29 83	N E	1		Clear.
4	67	29 82	N E	1		Clear.
	69	29 83				Clear.
Wed.	92	29 83	E	1		Clear.
5	82	29 82				Clear.
	72	29 83				Clear.
Thur.	92	29 82	W	1		Clear.
6	80	29 80				Clear.
	72	29 81				Clear.
Friday	88	29 81	N	2		Clr. some drops of rain
7	79	29 81				Clear.
	70	29 81	N	2		Clear.
Satur.	87	29 81	N	2		Clear.
8	76	29 81	W			Very clear.
	73	29 80				Very clear.
Sunday	87	29 80	S W			Very clear.
9	70	29 80	W			Very clear.
	70	29 80				Very clear.
Mon.	89	29 90	S W	1		Very clear.
10	73	29 94	W	1		Very clear.
	68	29 96				Light clouds.
Tues.	84	30 02	S		0.10	Light rain.
11	79	30 00				Clouds.
	73	30 00	S E	1		Cloudy.
Wed.	90	29 96	S E	2		Cloudy.
12	76	29 94				Clear.
	72	29 94				Light grey clouds.
Thurs.	91	29 90	S E			Light grey clouds.
13	76	29 87	S W			Clear.
	69	29 86				Clear.
Friday	88	29 83	S E			Grey clouds.
14	79	29 80	N E			Clear.
	72	29 82				Rain.
Satur.	92	29 85	E	3	0.12	Rain.
15	77	29 88				Clear.

	Hours. 5. 3. 9.		Winds.		Rain.	1799.
Days.	Th.	Bar.	Pts.	Str.	In.	State of the weather.
	71	29 88				Clear.
Sun.	91	29 88	S E	1		Clear.
16	78	29 88				Clear.
	72	29 89				Clear.
Mon.	91	29 90	S E	1		Clear.
17	80	29 89				Clear.
	71	29 91				Hazy.
Tues.	92	29 90	S W	1		Light clouds.
18	78	29 89	S W	1		Light clouds.
	73	29 92				Hazy.
Wed.	91	29 91	S E	1		Light clouds.
19	79	29 90	S W	1		Clear.
	70	29 93				Hazy.
Thurs.	92	29 92	S E			Light clouds.
20	79	29 91	S W	1		Dull star light.
	69	29 94				Light clouds.
Friday	92	29 94				Cloudy and rain.
21	65	29 93	S E	3	0.82	Rain, thundergust.
	70	29 97				Light clouds.
Satur.	92	29 97				Light clouds.
22	75	29 97	S E	1	0.10	Rain.
	71	29 98	S E			Cloudy.
Sun.	89	29 98	S E	1		Cloudy.
23	65	29 98	S E			Cloudy.
	73	29 98	S E			Cloudy.
Mon.	87	29 98	S E	1		Clouds & sunshine.
24	89	29 97	S E			Cloudy.
	76	29 96	S E	2		Clouds.
Tues.	90	29 96	S E	2		Flying clouds.
25	77	29 96	S E			Cloudy.
	73	29 98	S			Clear.
Wed.	80	29 97	S	2		Drizzly.
26	77	29 96	S	1		Clear.
	77	29 98	S			Clear.
Thurs.	87	29 97	S	1		Clouds & fine rain.
27	76	29 96	S W			Clear.
	79	29 98	S W	1		Clear.
Friday	85	29 97	S W	2		Rain.
28	74	29 96	S W		0.71	Rain.
	73	29 98	S W			Clear.
Satur.	86	29 97	S	1		Rain.
29	76	29 96	S	1	0.21	Rain.
	76	29 98	S E			Clear.
Sunday	86	29 97	S E	2		Rain.
30	75	29 96	S E			Rain.

REMARKS.

10th, Tender Indian corn fit for use; also, earliest peaches just beginning to ripen. 12th, Cotton in blossom.

JULY. 1799.

Days.	Th. (Hours 4½. 3. 9.)	Bar.	Winds. Pts.	Winds. Str.	Rain. In.	State of the weather.
Mon. 1	70	29 98	S	1		Cloudy.
	86	29 97	S E	1		Cloudy.
	77	29 96			0.22	Rain.
Tues. 2	73	29 96	S E			Clouds.
	89	29 95	S E	1	0.02	Rain.
	74	29 95	S W			Clouds.
Wed. 3	73	29 95				Clouds.
	89	29 94	S	1		Clouds.
	74	29 93				Clouds.
Thur. 4	74	29 94				Clouds.
	90	29 93	S E	1		Clouds.
	73	29 92				Clouds.
Friday 5	70	29 90				Clouds.
	84	29 87	S E	1	1.05	Rain.
	70	29 86				Cloudy.
Satur. 6	73	29 85				Cloudy.
	87	29 84	S E	1		Cloudy.
	80	29 83			0.01	Rain.
Sun. 7	70	29 82				Cloudy.
	88	29 81				Small rain.
	78	29 81				Cloudy.
Mon. 8	75	29 80				Cloudy.
	89	29 80	E	1		Cloudy.
	80	29 79			0.10	Clear.
Tues. 9	73	29 79	E		0 25	Cloudy.
	86	29 80	E			Cloudy.
	77	29 82				Cloudy.
Wed. 10	74	29 83				cloudy.
	90	29 83	E		0.10	Cloudy.
	76	29 84	E			Clear.
Thur. 11	73	29 85				Clear.
	89	29 86	E			Cloudy.
	77	29 86				Cloudy.
Friday 12	73	29 86	E			Clear.
	90½	29 87	N E	1		Cloudy.
	83	29 86	S W	1		Clear.
Satur. 13	75	29 86				Cloudy.
	89	29 85	S E		0.10	Cloudy & rain.
	73	29 84	S W			Clear.
Sun. 14	76	29 86				Clear.
	89½	29 85	S E	1		Clouds & sunshine.
	72	29 84	S W			Clear.
Mon. 15	75	29 85				Fine.
	90	29 84	S E	1		Clouds & sunshine.
	73	29 83	S W			Very clear.
Tues. 16	74	29 84				Clear & fine.
	87	29 83	S E	1	0.15	A shower.
	75	29 82	S W			Fine.

Days.	Th. (Hours 4½. 3. 9.)	Bar.	Winds. Pts.	Winds. Str.	Rain. In.	State of the weather.
Wed. 17	73	29 84				Clear.
	89	29 83	S E	1		Clouds & sunshine.
	74	29 82	S W			Clear & fine.
Thurs. 18	72	29 84				Fine.
	89	29 83	S E	1		Clear.
	73	29 82	S W			Fine.
Friday 19	70	29 83				Fine.
	90	29 82	S W	1		Some clouds.
	72	29 81				Clear & fine.
Satur. 20	72	29 81	S W			Clear & fine.
	91	29 80	S W	1		Some clouds.
	80	29 80	S W	1		Very fine.
Sunday 21	73	29 83	S W	1		Very fine.
	90	29 82	S W	1		Very fine.
	77	29 80				Very fine.
Mon. 22	71	29 81				Very fine.
	92	29 82	W			Very fine.
	83	29 83	S			Very fine.
Tues. 23	70	29 83				Clear.
	91½	29 78	N W			Clear.
	78½	29 78	N W	1		Clear.
Wed. 24	71	29 79	E			Clear.
	89	29 80	N E	1		Cloudy.
	80	29 81				Cloudy.
Thurs. 25	72	29 84				Cloudy.
	90	29 88	N E	1		Clear.
	80	29 90				Clear.
Friday 26	70	29 94	S			Clear.
	91½	29 97	S	1		Fine.
	98	29 91	S W			Fine.
Satur. 27	76	29 93				Clear.
	92	29 92	S W	1		Clear.
	82	29 91	S W	1		Clear.
Sunday 28	75	29 92				Clear
	91½	29 91	S W	1		Clear.
	82	29 91	S W			Clear.
Mon. 29	75	29 93				Some clouds.
	91½	29 92	S E			Cloudy.
	73	29 91				Clear.
Tues. 30	74	29 93				Cloudy.
	92	29 92	S E	1	0.12	Rain.
	73	29 92	S W			Clear.
Wed. 31	74	29 94				Clear.
	89	29 92	S E			Clear.
	73	29 90				Fine.

REMARKS.

Cotton pods as large as a walnut, on the 15th.

	HOURS. 4½. 3. 9.		WINDS.		RAIN.	AUGUST.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
Thur. 1	72	29 90				Clear.
	87	29 88	S E	1		Fine.
	78	29 86				Fine.
Friday 2	76	29 86	S W			Light clouds.
	85	29 85	S E	1	0.03	Light shower.
	75	29 85	E			Cloudy.
Satur. 3	70	29 85				
	86	29 85	E	1		
	73	29 86	N E	2	1.77	Rain.
Sun. 4	72	29 86				Clear.
	83	29 86	W			Cloudy.
	75	29 84				Clear.
Mon. 5	71	29 86				Cloudy.
	88	29 86	N W			Clear.
	73	29 87				Clear.
Tues. 6	69	29 89				Clear.
	87½	29 89	N W			Clear.
	73	29 88				Clear.
Wed. 7	68	29 88				Clear.
	90	29 90	N			Clear.
	78	29 91	S W			Clear.
Thur 8	71	29 92				Clear.
	89	29 92	S		0.02	Some clouds & rain.
	72	29 92	S W			Cloudy.
Friday 9	69	29 94	S			Cloudy.
	86	29 93	S	2	0.72	Rain.
	75	29 92	S W			Cloudy.
Satur. 10	70	29 90	S			Cloudy.
	87	29 90	S	1		Cloudy.
	79	29 90	S W			Cloudy.
Sun. 11	72	29 90				Cloudy.
	89	29 89	S	1	0.05	Cloudy & rain.
	82	29 89	S W			Cloudy.
Mon. 12	75	29 89				Cloudy.
	85	29 89	S W	1		Cloudy.
	80	29 89	S W			Cloudy.
Tues. 13	76	29 89				Cloudy.
	88	29 88	S W		0.01	Fine rain.
	76	29 88	S W			Clear.
Wed. 14	70	29 86				Cloudy.
	90	29 85	S E			Clear.
	79½	29 85				Clear.
Thur. 15	73	29 84				Clear.
	89	29 83	S W			Some clouds.
	79	29 82				Clear.
Friday 16	76	29 82				Thin clouds.
	89	29 81				Thin clouds.
	82	29 81				Clear.

	HOURS. 4½. 3. 9.		WINDS.		RAIN.	1799.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
Satur. 17	75	29 81				Clear.
	84	29 80	W			Thin clouds.
	73	29 79	N	1		Clear.
Sunday 18	69	29 79				Cloudy.
	84	29 78				Cloudy.
	72½	29 77				Clear.
Mon. 19	65	29 78	N E			Very fine.
	81½	29 78	N E	3	0.05	Thundergust & rain.
	69	29 78				Clear.
Tues. 20	65	29 78	E			Rain.
	79	29 77	E	1		Rain.
	68	29 77	E		0.40	Rain.
Wed. 21	65	29 82	E			Cloudy.
	75	29 80	E	1		Cloudy.
	72	29 79	E			Cloudy.
Thurs. 22	66	29 80	E			Cloudy.
	82	29 82	S E	1		Cloudy, drops of rain.
	72	29 83				Cloudy.
Friday 23	68	29 85				Cloudy.
	83	29 87	S E	1		Cloudy, drops of rain.
	74	29 88				Cloudy.
Satur. 24	72	29 99	S	1		Cl. a st. wth heav. ra.
	86	29 96	S	1	0.77	Clear.
	72	29 98				Clear.
Sunday 25	68	29 97	S			Clear.
	86	29 96	N W			Some clouds.
	76	29 95				Clear.
Mon. 26	69	29 91	N E			Clear.
	87	29 88	E	1		Clear.
	79	29 87	S	1		Clear.
Tues. 27	72	29 88	E			Clear.
	89	29 87	S E		0.01	A small shower.
	79	29 86				Clear.
Wed. 28	79	29 87	E		0.03	Rain.
	84	29 88	E	1		Cloudy.
	79	29 89	S			Cloudy.
Thurs. 29	75	29 91	E			Foggy.
	87	29 91	E	1		Cloudy.
	7	29 91	S			Cloudy.
Friday 30	75	29 91	E			Cloudy.
	87	29 92	E	1		Cloudy.
	78	29 91	E			Cloudy.
Satur. 31	73	29 90	E			Cloudy.
	87	29 90	E			Cloudy
	80	29 90				Cloudy.

REMARKS.

31st. Picked cotton.

	HOURS. 4½. 3. 9.		WINDS.		RAIN.	SEPTEMBER.		HOURS. 4½. 3. 9.		WINDS.		RAIN.	1799.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.	DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	73	29 95	E	1		Thin white clouds.		72	29 85	E			Cloudy, drops of rain.
Sunday	90	29 94	S E	1		Some white clouds.	Mon.	78	29 79	E		0.53	Rain.
1	81	29 92	S	1		Clear.	16	75	29 78				Cloudy.
	75	29 91	E			Cloudy.		75	29 77	E			Cloudy.
Mon.	87	29 90	E			Cloudy.	Tues.	80	29 76	E	1		Cloudy & rain.
2	79	29 90	S			Clear.	17	74	29 75	E		0.20	Rain.
	75	29 88				Some clouds.		72	29 75	E			Rain.
Tues.	86	29 87	S E		0.53	Rain.	Wed.	70	29 75	N W	2		Clear.
3	77	29 86	S			Cloudy.	18	65	29 78	N W			Clear.
	75	29 85	S			Cloudy & fog.		55	29 84	N W	1		Clear.
Wed.	87	29 80	S E	1		Cloudy & thunder.	Thurs.	71½	29 84	N W	1		Clear.
4	78	29 79	S			Clear.	19	66	29 84	N			Cloudy & damp.
	76	29 79	E			Clear.		62	29 83	N E			Cloudy.
Thurs.	83	29 78	S E	1		Some clouds.	Friday	84	29 83	N W	1		Clear.
5	76	29 78	S W			Some clouds.	20	66	29 82				Clear.
	73	29 78	N W			Some clouds,		60	29 80	N W			Clear.
Friday	87	29 78	N W	1		Clear.	Satur.	81	29 83	W	1		Clear.
6	79	29 77	N W			Clear.	21	74	29 85	N W			Clear.
	72	29 77	N W	·		Clear.		70	29 85	W			Clear.
Satur.	86	29 77	S W	1		Cloudy.	Sunday	83	29 84	W	1		Clear.
7	79	29 77	N W			Clear.	22	75	29 82				Cloudy.
	72	29 80				Clear.		72	29 80	E			Cloudy & dark.
Sunday	86	29 81	W			Clear.	Mon.	76	29 74	E	2		Rain.
8	77	29 82				Clear.	23	75	29 70	W		1.31	Rain.
	70	29 83				Clear.		70	29 63	W		1 33	Rain during the night
Mon.	90	29 85	S W			Clear.	Tues.	79	29 65	W	1		Cloudy.
9	78	29 87				Clear.	24	70	29 66				Cloudy & sunshine.
	72	29 87				Clear.		69	29 68	E			Cloudy & sunshine.
Tues.	90	29 88	S W	1		Clear.	Wed.	78	29 70	S	1		Cloudy.
10	79	29 89				Clear.	25	70	29 72	S W			Cloudy. sunshine.
	72½	29 87	E			Clear.		69	29 74	W			Cloudy.
Wed.	87	29 85	S E	1	0.16	A little rain.	Thurs.	75	29 76	W	1		Cloudy.
11	79	29 83	N			Clear.	26	72	29 80	W			Cloudy.
	75	29 86	E			Thin clouds.		66	29 85	N			Very clear.
Thurs.	85	29 87	E	1		Cloudy.	Friday	83	29 89	N	1		Very fine.
12	77	29 87	E			Cloudy.	27	72	29 88	N			Very clear.
	73	29 85	E	1		Cloudy,		61	29 93	N			Very fine.
Friday	84	29 84	E	1		Cloudy.	Satur.	81	29 92	N	1		Very fine.
13	75	29 83	E		0.33	Rain.	28	71	29 90	N			Very fine.
	73	29 84	E			Cloudy.		62	29 90	N			Very fine.
Satur.	82	29 84	E	1		Cloudy.	Sunday	83	29 90	N	1		Very fine.
14	73	29 84	E		0.42	Rain.	29	72	29 89	N			Very fine.
	70	29 85	E		0.03	Rain last night, cl up.		64	29 88	N			Very fine.
Sunday	83	29 85	E	1	0.015	Cloudy, some rain.	Mon.	84	29 87	N E	1		Very fine.
15	74½	29 85	E			Cloudy.	30	73	29 86	E			Very fine.

REMARKS.

2d. Cotton harvest commences.

	HOURS. 4½. 3. 9.		WINDS.		RAIN.	OCTOBER.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
Tues. 1	69	29 86	S : E	1		Clear, some white cl.
	85	29 85	S	1		Many white clouds.
	73	29 81				A little hazy.
Wed. 2	69	29 80	W	1		Grey clouds.
	83	29 80	S E			Grey clouds.
	74	29 77	S E	1	0.50	Rain.
Thurs. 3	71	29 78	S			Cloudy.
	82	29 80	S	2		Cloudy.
	75	29 82	S			Cloudy.
Friday 4	71	29 87	N E	1		Cloudy.
	81	29 67	N E	1		Clear.
	74½	29 86	N	1		Clear.
Satur. 5	62	29 88	N			Clear.
	81	29 89	N	1		Cloudy.
	69	29 93	N	2		Cloudy.
Sunday 6	68	29 90	N E			Cloudy.
	82	29 88	N E	1		Cloudy.
	69	29 77				Cloudy.
Mon. 7	68	29 85	E	1		Cloudy.
	82	00 00	E	2		Cloudy.
	69	00 00				Cloudy.
Tues. 8	68	29 82	E			Cloudy.
	82	29 79	S	1		Cloudy, a litt. shower.
	69	29 76	S E	1	1.11	Rain.
Wed. 9	67	29 77	E			Cloudy.
	60	29 78	N	2	0.10	Rain.
	52	29 79	N			Cloudy.
Thurs. 10	44	29 80	N			Cloudy.
	52	29 81	N E	2		Cloudy.
	50	29 82	N E			Cloudy.
Friday 11	46	29 83	N N E			Cloudy.
	62	29 83	N N E	1		Clearing up.
	54	29 83	E			Cloudy.
Satur. 12	51	29 80	S			Overcast.
	77	29 80	S	1		Lt. clds. with sunsh.
	70	29 79	S			Hazy.
Sunday 13	63	29 79	S W			Cloudy.
	75	29 78	S W	1		Cloudy.
	70	29 78	S W			Clouds with moonsh.
Mon. 14	60	29 79	W			Cloudy, damp & cold.
	67	29 80	W			Cloudy.
	56	29 85	N W			Clearing up.
Tues. 15	65	29 88	N W			Clear.
	77	29 88	N W	1		Clear.
	60	29 90	N W			Clear.
Wed. 16	54	29 90	N W			Clear.
	75	29 90	N W	1		Clear.
	65	29 90	N W			Serene.

	HOURS 4½. 3. 9.		WINDS.		RAIN.	1799.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
Thurs. 17	40	29 92	N W			Clear.
	72	29 89	N	1		Clear.
	56	29 87	N			Light clouds.
Friday 18	47	29 85	N			Light clouds.
	70	29 85	N W	1		Light clouds.
	62	29 84	N W			Clear.
Satur. 19	60	29 82	W			Light clouds.
	76	29 82	W	1		Clear.
	69	29 83	S			Light clouds.
Sunday 20	66	29 84	S	1		Foggy.
	75	29 84	W	1		Clear.
	64	29 85	N W			Clear.
Mon. 21	55	29 94	N W	1		Clear.
	80	29 94	N W			Fine.
	65	29 94	N			Fine.
Tues. 22	60	29 94	E	1		Fine.
	82	29 94	E	2		Fine.
	65	29 94	E			Fine.
Wed. 23	55	29 94	E			Fine.
	82	29 94	S	2		Clear.
	65	29 96	S			Clear.
Thurs 24	68	29 99	S	1		A little cloudy,
	81	29 99	S E	1		Cloudy.
	73	30 00	S W			Cloudy.
Friday 25	66	30 01				Cloudy, sun at interv.
	80	29 95	N W : E	1		Dim star light.
	71	29 94				Clear.
Satur. 26	61	29 90	N W			Clear.
	76	29 86	N E			Some light clouds.
	63	29 85	N E	1		Dim star light.
Sunday 27	47	29 84				Blue fog.
	66	29 83	N E	2		Clear & dry.
	56	29 82				Blue fog, dry.
Mon. 28	45	29 88	N E	1		Clear.
	67	29 85	N E			Clear.
	52	29 86				Fine.
Tues. 29	45	29 99	N E			Fine.
	71	29 99	N E	1		Clear.
	56	30 05	N E			Blue fog.
Wed. 30	49	30 11	N E			Clear.
	68	30 08	N E	1		Clear.
	50	30 07	N E			Clear.
Thurs. 31	45	30 06	N E			Clear.
	67	30 00	N E	1		A few clouds.
	50	29 98	N E			Clear.

REMARKS.

10th. Cabbages begin to head; and green peas in season.

	Hours. 5. 3. 9.		Winds.		Rain.	November.		Hours. 5. 3. 9.		Winds.		Rain.	1799.
Days.	Th.	Bar.	Pts.	Str.	In.	State of the weather.	Days.	Th.	Bar.	Pts.	Str.	In.	State of the weather.
Friday 1	45	29 97	N E			Grey clouds.	Satur. 16	56	30 03				Clear.
	66	29 96	E	1		Sunshine.		78	30 01	S W	1		Some clouds.
	69	29 95	E			Duskish.		67	30 00				Some clouds.
Satur. 2	66	29 94	S E			Cloudy.	Sun. 17	65	29 98	S			Some clouds.
	74	29 93	S E	1		Dull heavy atmosph.		76	29 86	S	2		Cloudy.
	66	29 92	E			Duskish.		71	29 86	S		0.01	Rain.
Sunday 3	60	29 96	N			Foggy, drops of rain.	Mon. 18	45	30 07	S W : N	2		Driving grey clouds.
	63	29 97	N	2		Cloudy foggy & damp		53	30 07	N			Clearing up.
	56	29 93				Duskish.		45	30 07	N			Clear.
Mon. 4	45	29 82				Clear.	Tues. 19	35	30 12	N W			Very fine.
	63	29 82	N W	1		Some clouds.		57	30 10	N W	1		Fine.
	57	29 83	N W			Duskish.		41	30 08	W			Fine.
Tues. 5	54	29 84	N W	1		Cloudy.	Wed. 20	31	30 07	W			Fine.
	73	29 86	N W			Cloudy.		57	30 07	W	1		Some clouds.
	52	29 87	N W			Cloudy.		34	30 09	W			Cloudy.
Wed. 6	64	29 89	N E		0.02	Cloudy, some rain.	Thurs. 21	37	30 09	W			Clear.
	65	29 90	N E	1		Sunshine.		65	30 09	W	1		Light clouds.
	63	29 90	N E			Dark.		53	30 09	W			Clear.
Thurs. 7	61	29 90	N W			Clear.	Friday 22	42	30 07	W			Light clouds.
	65	29 91	N W	1		Clear.		68	30 04	W			Light clouds.
	63	29 92	N W			Clear.		40	30 05				Clear.
Friday 8	61	29 90	N W			Clear.	Satur. 23	40	30 00	W			Light clouds.
	64	29 89	N W			Clear.		78	29 95	W	1		Light clouds.
	51	29 89	N W			Clear.		65	29 90	E			Light grey clouds.
Satur. 9	46	29 89	N W			Clear.	Sun. 24	65	29 76	E	1	0.12	Light rain.
	67	29 88	N W	1		Clear.		69	29 76	E	1		Cloudy.
	58	29 88	N			Clear.		56	29 78	S E		0.40	Rain.
Sunday 10	45	29 88	N W			Clear.	Mon. 25	42	30 00	N E			Clear.
	67	29 87	N W	1		Clear.		54	30 00	N E			Clear.
	47	29 87	N W			Clear.		48	30 05				Some clouds.
Mon. 11	54	29 88	N E			Clear.	Tues. 26	41	30 05	W N W			Cloudy.
	65	29 88	N E	1		Blue fog.		55	30 00	W			Clear.
	54	29 90				Fog.		41	29 99				Clear.
Tues. 12	41	30 13	N	1		Clear.	Wed. 27	41	29 99	W			Clear.
	54	30 07	N	1		Fine.		51	29 99	W	1		Clear.
	40	30 07				Clear.		49	29 99				Clear.
Wed. 13	31	30 00	N W			Very clear.	Thurs. 28	49	30 00				Clear.
	60	29 98	S E	1		Clear.		60	30 00	N W			Clear.
	51	29 94	S E	1		Clear.		38	30 00	N W			Clear.
Thurs. 14	46	29 99	S W	1		Clear.	Friday 29	28	30 01	N W			Clear.
	71	29 99	S W			Clear.		50	30 02	N W	1		Clear.
	62	29 99				Clear.		34	30 03	N W			Clear.
Friday 15	46	30 06				Very clear.	Satur. 30	26	30 05	N W			Clear.
	72	30 06	S W	1		Very clear.		44	30 00	N E	1		Cloudy.
	59	30 05				Very clear.		50	29 80	E			Cloudy.

	HOURS. 5. 3. 9.		WINDS.		RAIN.	DECEMBER.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	50	29 70	E	1	0.12	Fine rain.
Sun.	61	29 66	E	1		Rain.
1	60	29 63	E		1.72	Rain.
	60	29 63	E		0.02	Small rain.
Mon.	56	29 78	N			Cloudy.
2	55	29 78	N			Cloudy.
	51	29 85	N E			Cloudy.
Tues.	63	29 .85	N E	1		Cloudy.
3	50	29 82	N E			Cloudy.
	57	29 71				Cloudy.
Wed.	65	29 71	N E			Clouds & sunshine.
4	56	29 71	E			Cloudy.
	64	29 71	E			Cloudy.
Thur.	71	29 68	E	1		Cloudy.
5	55	29 64	E	1	0.61	Rain.
	49	29 74	N W	1		Clear.
Friday	50	30 00	N W	1		Clear.
6	42	30 00	N W			Clear.
	32	30 12	N W	1		Clear.
Satur.	59	30 00	N W	1		Clear.
7	45	30 00	N W			Clear.
	35	30 00	N			Clear.
Sun.	55	29 88	N E	1		Cloudy.
8	49	29 80	N E			Clear.
	38	29 76	E			Some clouds.
Mon.	68	29 76	E			Cloudy.
9	63	29 75	S E			Cloudy.
	64	29 74	S			Cloudy.
Tues.	74	29 73	S	1		Cloudy.
10	71	29 72	S E			Moon shine.
	43	29 72	S E			Cloudy.
Wed.	40	29 80	S E			Rain.
11	37	29 80	S		1.24	Rain.
	33	29 60	N W	1		Snow diss. on the gr
Thur.	37	29 70	N W	1		Cloudy.
12	32	29 80	N W			Clear.
	26	29 85	N W			Clear.
Friday	51	29 87	N W	1		Clear.
13	42	29 88	N W			Fine.
	29	30 03	N W			Very fine.
Satur.	58	30 03	N W	1		Fine.
14	63	30 97				Fine.
	41	30 .05				Clear.
Sun.	55	30 02	N			Cloudy.
15	45	30 00				Cloudy.
	46	29 95	N			Cloudy.
Mon.	66	29 93	N	2		Cloudy.
16	65	29 92	N			Rain.

	HOURS. 5. 3. 9.		WINDS.		RAIN.	1799.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	50	29 93	N	1	0.72	Rain.
Tues.	44	29 93	N E	1		Rain.
17	37	29 92	E			Rain.
	37	29 83	S E	1	0.63	Rain.
Wed.	42	29 84	S E	1		Cloudy.
18	42	29 84	S E			Cloudy.
	39	29 85	S E	1		Cloudy.
Thurs.	43	29 86	S E			Cloudy.
19	42	29 88	N			Cloudy.
	39	29 88	N			Cloudy & drizzly.
Friday	40	29 88	N	1	0.11	Cloudy & rain.
20	39	29 88	N			Clearing up.
	37	30 00	N W			Cloudy.
Satur.	42	30 00	N W	1		Clearing up.
21	33	29 99				Some clouds.
	29	29 96	N W			Light clouds.
Sunday	50	29 95	S E			Clouds & sun.
22	40	29 93	S E	1		Clear.
	31	29 96	N			Clear.
Mon.	44	30 00	N	1		Clear.
23	35	30 00	N			Clear.
	26	30 00	N W			Clear.
Tues.	53	30 00	N W	1		Clear.
24	38	30 00	N W	1		Clear.
	25½	30 16	N W			Clear.
Wed.	55	30 00	N W	1		Clear.
25	37	29 95	E	1		Clear.
	47	29 90	S E			Cloudy.
Thurs.	55	29 90	S E	1		Some clouds.
26	47	29 90	N E			Duskish.
	48	29 86	E			Clouds & sunshine.
Friday	58	29 81	E	1		Cloudy.
27	54	29 80	E			Rain.
	59	29 84	S E		0.61	Clearing up.
Satur.	49	29 90	S E	1		Clear.
28	45	29 95	S E			Clear.
	37	29 97	N W			Clear.
Sunday	40	29 98	N W	1		Clear.
29	35	30 00	N W			Clear.
	24	30 11	N W	1		Clear.
Mon.	45	30 12	N W			Clear.
30	28	30 12	N W	1		Clear.
	26	30 10	N			Clear.
Tues.	52	30 00	N E	1		Clear.
31	42	29 .69	E			Cloudy.

REMARKS.

27th. Observed the Missletoe in fruit.

	HOURS. 6. 3. 9.		WINDS.		RAIN.	JANUARY.		HOURS. 6. 3. 9.		WINDS.		RAIN.	1800.
DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.	DAYS.	TH.	BAR.	PTS.	STR.	IN.	State of the weather.
	44	29 60	E	1		Rain.		35	29 80	N W			Clearing up.
Wed.	48	29 70	E	2		Rain.	Friday	46	29 85	N W	1		Clear.
1	35	29 87	E	1	0.30	Rain.	17	35	29 87	N W			Clear.
	26	29 84	N			Clear.		23	29 93	N W			Clear.
Thurs.	38	29 83	N E	1		Clear.	Satur.	53	29 93	N W			Clear.
2	31	29 81	S E			Hazy.	18	39	29 93	N			Clear.
	21½	29 81	N W			Clear.		28	29 94	N W			Clear.
Friday	46	29 83	N W	1		Clear.	Sunday	61	29 95	N W	1		Clear.
3	36	29 84				Clear.	19	51	29 96	N			Clear.
	30	29 90	N W	1		Clear.		34	29 96				Clear.
Satur.	55	29 95	N W	1		Clear.	Mon.	64	29 96	N E	1		Some clouds.
4	39	30 00	N W			Clear.	20	54	29 96	N E			Clear.
	32	29 97	N W			Clear.		34	29 96	E			Some clouds.
Sunday	55	29 94	N W	1		Clear.	Tues.	57	29 95	E	1		Cloudy.
5	44	29 91				Clear.	21	46	29 94	E			Star light.
	33	29 90	N			Some clouds.		35	29 84	E		0.05	Rain.
Mon.	66	29 80	S E	1		Clouds & sun.	Wed.	60	29 80	E	1		Cloudy.
6	53	29 74	S W			Clear.	22	57	29 80	E			Cloudy.
	42	29 80				Clear.		36	29 74	E		0.05	Rain.
Tues.	55	29 83	S W	1		A little cloudy.	Thurs	58	29 74	E	1		Cloudy & light rain.
7	36	29 85				Cloudy.	23	55	29 74	E		0.20	Rain.
	45	30 05	W	1		Clearing up.		45	29 80	N E		0.10	Rain.
Wed.	55	30 05				Clouds & sunshine.	Friday	46	29 82	N	1		Cloudy.
8	44	30 05				Clouds & sunshine.	24	40	29 84	N	1		Cloudy.
	40	30 05	N			Clouds & sunshine.		30	29 86	N	1		Cloudy.
Thurs.	45	30 05	N	1		Clear.	Satur.	47	29 86	N E			Cloudy.
9	34	30 04	N			Clear.	25	47	29 86	N E			Cloudy.
	30	30 05	N W			Clear.		40	29 87	N E	1		Cloudy.
Friday	40	30 04	N W	1		Very fine.	Sunday	54	29 88	N E	1		Drizzly.
10	29	29 94	N			Clear.	26	49	29 88	N E	1		Drizzly.
	23	29 95	N W			Clear.		45	29 92	N	1		Cloudy.
Satur.	47	29 96	N W	1		Clear.	Mon.	48	29 99	N	1		Cloudy.
11	41	29 96	N W			Clear.	27	48	30 07	N	1		Clearing up.
	33	29 96	N W	1		Clear.		36	30 08	N			Clear.
Sunday	49	29 96	N W	1		Clear.	Tues.	52	30 10	N	1		Small clouds.
12	42	29 96	N			Clear.	28	42	30 10	N	1		Clear.
	32	29 97	N W			Clear.		33	30 12	N W	1		Clear.
Mon.	63	29 98	N E	1		Clear.	Wed.	53	30 12	N	1		Some clouds.
13	46	29 99	N			Clear.	29	45	30 13	N	2		Cloudy & dark.
	36	29 99	E			Clear.		35	29 95	N E			Clear.
Tues.	66	29 95	E			Clear.	Thurs.	47	29 95	N E	2		Clear.
14	47	29 91	E			Clear.	30	41	29 95	E	1		Cloudy & dark.
	35	29 88	E			Clear.		29	29 95	N	1		Snow.
Wed.	68	29 80	E			Clear.	Friday	32¼	29 95	N E	2		Snow.
15	56	29 74	E			Clear.	31	32	29 95	N E	1		Rain.
	54	29 74	E			Cloudy.							
Thurs.	60	29 74	E			Rain.							
16	45	29 74	E		0.62	Rain.							

REMARKS.

31st. As the rain fell it froze, adhering to the branches of the trees in beautiful icicles, resembling some trees in blossom: Many large limbs were broken down in the night and following day, by the weight of the ice.

RECAPITULATION.

	THERMOMETER.			BAROMETER.			RAIN.
	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	
	DEG.	DEG.	DEG.	INCHES.	INCHES.	INCHES.	INCHES.
February.	75	19¼	47¾	30 25	29 53	29 759	9 125
March.	76	29	51¾	30 24	29 53	29 928	3 84
April.	86	37	67¼	30 00	29 51	29 772	2 970
May.	87	54	73	30 04	29 63	29 871	0 81
June.	92	65	79	30 02	29 79	29 888	2 84
July.	92	70	79¾	29 98	29 78	29 862	2 13
August.	90	65	73¼	29 99	29 77	29 857	3 86
September.	90	62	75½	29 95	29 63	29 712	4 855
October.	85	44	65½	30 11	29 76	29 510	1 71
November.	78	26	54½	30 13	29 76	29 966	0 55
December.	68	24	46½	30 16	29 63	29 970	5 78
1800, January.	66	21½	43½	30 13	29 60	29 900	1 30
Whole year.	92	19¼	63⅛	30 25	29 51	29 833	39 770

No. III.

Description of a singular Phenomenon seen at Baton Rouge, by William Dunbar, Esq. communicated by Thomas Jefferson, President A. P. S.

NATCHEZ, June 30th, 1800.

Read 16th January 1801

A PHENOMENON was seen to pass Baton Rouge on the night of the 5th April 1800, of which the following is the best description I have been able to obtain.

It was first seen in the South West, and moved so rapidly, passing over the heads of the spectators, as to disappear in the North East in about a quarter of a minute.

It appeared to be of the size of a large house, 70 or 80 feet long and of a form nearly resembling Fig. 5. in Plate, IV.

It appeared to be about 200 yards above the surface of the earth, wholly luminous, but not emitting sparks; of a colour resembling the sun near the horizon in a cold frosty evening, which may be called a crimson red. When passing right over the heads of the spectators, the light on the surface of the earth, was little short of the effect of sun-beams, though at the same time, looking another way, the stars were visible, which appears to be a confirmation of the opinion formed of its moderate elevation. In passing, a considerable degree of heat was felt but no electric sensation. Immediately after it disappeared in the North East, a violent rushing noise was heard, as if the phenomenon was bearing down the forest before it, and in a few seconds a tremendous crash was heard similar to that of the largest piece of ordnance, causing a very sensible earthquake.

I have been informed, that search has been made in the place where the burning body fell, and that a considerable portion of the surface of the earth was found broken up, and every vegetable body burned or greatly scorched. I have not yet received answers to a number of queries I have sent on, which may perhaps bring to light more particulars.

NOTE. The above communication was accompanied by an account of the first invention of the Telegraphe extracted from the works of Dr Hook.

Mr. Dunbar was induced to forward this extract to the Society, as he supposed it had been less noticed than it deserved to be. But it was deemed unnecessary to print the Paper, as it may be seen in the works above mentioned, and is referred to by Dr. Birch in his history of the Royal Society. Vol. 4th, page 299.

No. IV.

A short and easy rule for finding the equation for the change of the sun's declination when equal altitudes are used to regulate a clock or other time keeper. Communicated by Andrew Ellicott Esq.

Read January 16th, 1801.

FOR THE FIRST PART.

FIND the Sun's longitude, declination, and the change of declination for 24^h at the time of the observation, likewise find the proportional part of the change of declination for the half interval between the forenoon and afternoon observations, then take the proportional logarithm answering to the change of declination for the half interval, (increasing the index by 10,) from which take the log. cosecant of the horary angle; to the remainder add the log. cotangent of the latitude of the place of observation, and take out the minute and second from the P. Ls. answering to the sum (10 being deducted from the index) which converted into time will give the first part of the correction and will be deductive in North latitudes, when the sun's longitude is 0, 1, 2, 9, 10, or 11, signs, and additive in the others; but the contrary in South latitudes.

FOR THE SECOND PART.

TO the P. L. of the change of the sun's declination during the half interval, add the log. cotangent of the sun's declination, from that sum deduct the log. cotangent of the horay angle.—Take out the minute and second from P. Ls. answering to the remainder, which turned into time will give the second part of the correction; this is common to all latitudes, and will be additive when the sun's longitude is 0, 1, 2, 6, 7, or 8, signs, and deductive in the others.

EXAMPLE.

Suppose the following equal altitudes were taken in latitude 39°.56′. N. when the sun's longitude was 4ˢ. 15°.

A. M. 8h. 32′ 20″—P. M.	3h	32′	24″
Add	12	0	0
	15	32	24
Deduct forenoon's observation	8	32	20
2)	7	0	4
half interval	3	30	2
Add forenoon's observation	8	32	20
Sun's center on the meridian nearly	12	2	22

FOR THE CORRECTION.

The sun's declination answering to 4ˢ 15° of his longitude is nearly 16° 21′, and the change of declination at the same time about 16′ 55″ in 24 hours, or 2′ 28″ during the half interval.

THEN BY THE RULE.

Change of declination during half interval 2′ 28″ P. L.		11. 8631.
Horary angle 52° 30′ log. cosec.	—	10. 1005
		1. 7626
Latitude 39° 56′ log. cotan.	+	10. 0772
P. L.		1. 8398=2′ 36″=10″ 24‴ in

time, being the first part of the equation, and additive by the rule.

FOR THE SECOND PART.

Change of declination during the half interval 2′ 28″ P. L.	1. 8631
Sun's declination 16° 21′ log cotan. +	10. 5326
	12. 3957
Horary angle 52′ 30′ log. cotan.—	9. 8850
P. L.—	2. 5107=0′ 33″=2″ 12‴in

time, being the second part of the equation, and deductive by the rule.

APPLICATION.

Apparent time of the sun's center on the meridian by equal altitudes nearly		12h 2′ 22″ 0‴
First part of the equation	+10″ 24‴	
Second do........................—	2. 12	+8. 12
Sun's centre on the meridian		12. 2. 30. 12.

No. V.

Account of an extraordinary flight of meteors (commonly called shooting of stars) communicated by Andrew Ellicot, Esq. as extracted from his Journal in a voyage from New-Orleans to Philadelphia.

Read 16th January, 1801

" NOVEMBER 12th 1799, about three o'clock, A. M. I was called up to see the shooting of the stars (as it is commonly called.) The phenomenon was grand and awful, the whole heavens appeared as if illuminated with sky-rockets, which disappeared only by the light of the sun after day break. The meteors, which at any one instant of time appeared as numerous as the stars, flew in all possible directions, except from the earth, toward which they all inclined more or less; and some of them descended perpendicularly over the vessel we were in, so that I was in constant expectation of their falling among us. My thermometer which had been at 86° of Farenheits scale for four days, fell to 56° about 4 o'clock A. M. and nearly at the same time the wind shifted from the South to the N. W. from whence it blew with great violence for three days without intermission. We were in latitude 25° N. and S. E. from Kay Largo, near the edge of the Gulph Stream."

I have since been informed that the above phenomenon extended over a large portion of the West India islands and as far North as Mary's in latitude 30° 42′ where it appeared as brilliant as with us off Cape Florida.

No. VI.

Improved method of projecting and measuring plane Angles by Mr. Robert Patterson communicated by Mr. Andrew Ellicott.

Read 6th March, 1801.

SIR,

THE laying down, and measuring of plane angles, constitute so great a part of practical geometry, that any attempt to render this operation more easy and acurate than by the line of chords, or any other method now in common use, will not, I presume, be deemed altogether unimportant.

The lines of chords on our common scales are in general very inaccurately divided, and even if we suppose the divisions ever so exact it will still be impracticable to take off the measure of an angle to greater accuracy then a half or third of a degree at most; as it is impossible to apply either the nonius or diagonal method of subdivision to a line of unequal parts.

But in the method that I am about to propose a line of equal parts only is used, and therefore the divisions and subdivisions may, by either of the above modes, be made as minute and accurate as can be desired.

The radius of a circle of which the chord of any given arch shall contain just as many equal parts of the radius as the arch contains degrees, is easily calculated. The one I have chosen is that of a circle of which the chord of an arch of 25 degrees shall equal 25 parts. This radius is $57\frac{3}{4}$ very nearly. Now it will be found that of this circle the chord of any arch under 30 degrees will never vary more than $\frac{1}{12}$ part of a unit from the number of degrees in that arch.

Hence to lay down an angle of any given number of degrees and parts you have only to take, with a pair of compasses, from any line of equal parts, $57\frac{3}{4}$, and with this radius describing an arch, apply thereon, from the same line, the chord of the angles required, if not exceeding 30 degrees; (calling each part or equal division of the line a degree) and the two radii drawn from the center to the points of application on the arch, will contain the angle required. If the given angle exceeds 30 degrees, first apply the radius (which equals the chord of 60 degrees) and then taking from the line of equal parts the chord of the difference between 60 degrees and the given angle, apply it on the arch from 60 either forwards or backwards according as the given angle is greater or less than 60 degrees.

The measuring of an angle being only the reverse of the former will consist in describing an arch round the angular point as a center with a radius equal $57\frac{3}{4}$, and then applying the chord of this arch comprehended between the two lines including the angle, if not exceeding 30 degrees, to the same line of equal parts from which the radius was taken. But if the angle exceeds 30 degrees you must first apply the radius, and then measure the arch of excess or defect above or below 60 as above.

Though the above method of projecting and measuring angles will never be liable to an error of more than five or six minutes of a degree, which in practice may be safely neglected, yet even these small errors may, when thought necessary, be allowed for as follows—

From 6 degrees to 21 } call the angle 5 minutes { more }
From 28 —— to 30 } { less }

than it measures and if this allowance be made the error will scarce ever exceed one minute.

The diagonal scale of 20 parts to an inch will be of a very convenient size for the above purpose—On this the half inch is divided into 100 equal parts, each of which will correspond to 6 minutes.

But this method of subdividing lines of equal parts, though no doubt susceptible of great accuracy, is yet attended with inconveniencies which it would be desirable to obviate—such lines occupy so much room on the scale, that but few of them can be inserted, and among such a multiplicity of crossing lines, the eye is liable to mistake one for another.

The following method which is only an application of the nonius division, is susceptible of even greater accuracy and minuteness than the diagonal method, and yet free from all its inconveniencies.—Let each of the larger divisions of the line be subdivided into 10 equal parts, as the line of inches on the common scale; then if you would farther subdivide these, say each into 10 equal parts, you must set off before the beginning of the line, a space equal to 11 of the smaller divisions, which divide into 10 equal parts, numbering them backwards 1, 2, 3, &c. and then each of these divisions on the nonius will exceed one of the smaller divisions on the scale just $\frac{1}{10}$ part of the latter.

The manner of using this nonius in laying down or measuring lines is sufficiently obvious—Thus if you would take off with a pair of compasses $27\frac{6}{10}$ you must extend from 6 on the nonius to 21 (27-6) on the scale, if you would take off $57\frac{7}{10}$ extend from 7 on the nonius to 50 on the scale &c. But a still more minute subdivision may be easily made by combining the nonius and diagonal methods together—thus if each of the lesser divisions, both on the scale and nonius were, by diagonals, subdivided into 10 equal parts, then each of the larger divisions would in fact be subdivided into 1000 equal parts, and yet none of the lines, even on the scale of 20 to an inch, would be less than $\frac{1}{20}$ of an inch assunder. Such a degree of minuteness can however seldom if ever be necessary, and therefore the use of the diagonal scale may be entirely dispensed with.

In Plate III. Fig. 7. the nonius occupies a space equal to 13 of the smaller divisions on the scale, and is divided into 12 equal parts; and therefore, if this line be used as a line of chords, the nonius will divide the degree into 12 parts or 5 minutes.

I am, with sincere respect,
your obliged friend
R. PATTERSON.

ANDREW ELLICOTT Esq.

No. VII.

Sur La Théorie des Vents. Par M. Dupont de Nemours.

Read July 17, 1801.

Le Vent a trois causes: la *dilatation* de l'air par la chaleur, qui le chasse de l'endroit où cette chaleur est éprouvée: la *Condensation* de l'air par le froid, qui le rappelle vers le lieu où le refroidissement se fait sentir; et la *revulsion* qui, lorsqu'un courant d'air s'est établi par une des deux causes précédentes, attire des parties environnantes une nouvelle colonne d'air à la place de celle qui a été mise en mouvement.

La rotation diurne de la terre produit toujours une *dilatation* de l'air, qui est successive dans tous les points du Glôbe où le soleil paroît se lever et où il passe jusqu'à son midi: dilatation que l'echauffement des terres entretient plus ou moins longtemps au delà de midi, selon la nature de ces terres. Et cette dilatation est toujours suivie d'une *condensation* que le soir et la nuit ramènent en chaque lieu jusqu'à la renaissance du nouveau jour.

C'est ce qui produit le Vent *d'Est* général, qui est plus sensible dans la Zône où la chaleur est plus développée.

La ligne de la plus grande chaleur se maintient depuis deux jusqu'à quatre degrés de latitude au nord de celle que trace le cours du soleil, en passant d'un Tropique à l'autre et sur l'Equateur, parceque le Pôle et l'Hémisphere austral, entourés de Mers, ne sont pas si susceptibles d'échauffement que l'hémisphere boréal où il y a moins de mer que de terre.

Pendant l'Eté de l'hémisphère boréal, le vent d'Est alizé s'étend depuis sept jusqu'à douze degrés au nord de son Tropique; Et durant l'Eté de l'hémisphère austral, le même vent n'excéde son Tropique, que d'environ quatre degrés; mais dans les deux hémisphères la rive du vent alizé varie toujours de l'Eté à l'hiver.

Ainsi, au solstice d'Eté de l'hémisphère Septentrional, le vent alizé s'étend jusqu' au trente cinquième ou au trente sixième degré; tandis qu'au solstice d'hiver il atteint à peine le Tropique, et que c'est vers l'hémisphère austral qu'il s'élève alors au vingt huitième degré.

Dans les Equinoxes, le vent alizé ne passe guère le Tropique du Cancer que de quatre degrés, et se tient en général au niveau de l'autre.

Le coup de vent de l'Equinoxe qui n'est violent qu'au delà des Tropiques, est l'effet de la dilatation de l'air sur l'hémisphère où le soleil passe, & de sa condensation sur celui qu'il abandonne.

Le vent alizé, partant dans les Equinoxes de l'Equateur, dans les Solstices d'un Tropique ou de l'autre, & dans leur intervalle de la transversale courbée que le cours du Soleil décrit de l'Equateur aux Tropiques, prend dans toutes ces directions un développement spiral, lequel tient principalement au plan incliné, & toujours diminuant, que chaque hémisphere lui présente.

Sur les terres, le vent alizé se trouve contrarié dans sa course par mille obstacles qui l'intervertissent & paroissent quelque fois la dénaturer. Il reprend un point de départ lorsqu'il quitte chaque continent; et c'est de ce point qu'il s'étale en éventail spiral jusqu'à ce qu'il arrive au Continent opposé.—C'est ce qui le rend plus resserré vers la côte occidentale de l'Afrique qu'à la côte Orientale de l'Amérique, et ce qui le restreint encore à la côte Occidentale de l'Amérique pour l'éployer du Japon à la nouvelle Caledonie et au dessus.

Tous ces Vents généraux ont des Remoux qui deviennent également géneraux. Aucun fluide ne peut perdre un courant sans que ce courant ne presse les parties avoisinantes de sa rive & ne les oblige de former, pour lui céder la place, un contre courant en sens opposé.

Dans le vent général à l'Est, le Refroidissement causé par le retour de la nuit aide beaucoup au Remou, en appellant sans cesse l'air de sa rive à remplacer celui que la chaleur du jour a raréfié et poussé en avant. Et même quand il n'y auroit pas de refroidissement antérieur, le simple déplacement du fluide ameneroit la *révulsion* qui, prise sur un air moins échauffé, causeroit elle même aux lieux que le vent chaud a occupés un refroidissement postérieur; mais les deux causes, la *condensation* & la révulsion se combinent & se fortifient réciproquement.

Ce sont elles qui, dans la Zône même des Tropiques produisent *la Brise du Soir*. Elle est Nord Est au Nord du centre de la chaleur, et Sud-Est à son Sud; et ne pourroit avoir un autre cours. Elle est l'émanation du vent de Remou nord Ouest & sud-Ouest, et la voie naturelle de la *révulsion* par laquelle une partie de l'air de ce vent de remou s'en détache et se remet à la suite du vent alizé.

Vers le quarante cinquième degré sud, au delà de l'influence du vent de Remou, commence à regner un vent de sud Est, appellé vers le nord par la douceur des climats tempérés & vers l'Ouest par la rotation terrestre. Ce vent, dont l'inverse, qui existe certainement sur l'autre hémisphere, ne peut s'y manifester aux navigateurs pour des raisons qu'on appercevra plus bas, ce *vent polaire* du Sud se fait sentir plus loin lorsque le soleil est sur le Tropique du Cancer. Il est repoussé de plusieurs degrés pendant l'Eté austral. On voit de là comment la ligne *calorisée* qui serpente d'un Tropique à l'autre doit deplacer, et deplace avec le *Vent alizé*, les vents de *remou* & ceux de *révulsion* qui en dérivent et même les *vents polaires*.

C'est cette ondulation, ce retrait alternatif du vent alizé, du vent de remou, du vent polaire, qui les substitue l'un à l'autre & qui produit les *Moussons*. Elles en suivent régulierement la marche dans l'Atlantique, dans le grand Océan, dans la mer des Indes, entre la nouvelle Hollande, Madagascar et la pointe de l'Afrique au sud de Madagascar, comme aussi dans celle qui forme le golphe de Bengale, le golphe Arabique, et qui s'étend jusqu'à deux degrés de latitude sud près de Sumatra, et de trois degrés de la même latitude près de la côte de Mélinde.

Il est bien singulier qu'entre ces deux parties de la mer des Indes où la théorie générale est, ainsi que dans tout le reste du monde; confirmée par le fait, il se trouve *une bande*, d'environ dix degrés en latitude et soixante et dix en longitude, où la mousson totalement différente paroisse déterminée par le Solstice, au lieu de l'être comme à ses deux rives par l'équinoxe, et que ce soit précisement dans les mois où le soleil agit sur *cette bande* avec plus de force, que le vent y quitte son cours naturel et devient *Nord-Ouest*.

La cause de cette unique anomalie dans le cours des vents sur toute la surface du glôbe est encore ignorée. On pourroit présumer qu'elle tient à quelque chaîne de montagnes extrêmement hautes et très escarpée en Afrique, qui presque perpendiculairement frappée en cette Saison sur la plus part de ses plans par des vents fort élevés, tels qu'ils le sont naturellement dans cette partie du monde, les repousse à peu près contre leur propre direction.

C'est bien en Afrique que doivent être les plus hautes montagnes de la terre. Elles y sont indispensables pour nourrir dans ce pays brûlant les énormes fleuves qui en arrosent une partie: le Nil, le Niger, la Zaïre et les autres. Et si ces montagnes sont assez éloignées de la Côte pour que l'échauffement des terres et des sables ajoûtant à l'ardeur de la Zône, y ait élévé le Vent alizé à une grande hauteur, et à une plus grande intensité, ce vent recontrant une muraille de glaciers ne peut qu'y tourbillonner avec une fureur qui vraisemblablement en lance une partie jusqu'aux Moluques dans cette extraordinaire mousson. Tout effet particulier et local, doit avoir une cause locale et particulière.

Nous verrons dans un autre mémoire comment celle que nous supposons ici doit, outre la fonte d'une énorme quantité de glaces, produire d'effroyables pluies qui contribuent beaucoup aux débordements de tous les grands fleuves Africains.

Jusqu'à ce que cette mousson *Africo-Indique* eût arrêté nos regards, nous n'avions considéré les vents que tels que les mouvements diurne et annuel de la terre les produisent sur les mers libres, et les produiroient sur les terres même si la surface en étoit aussi unie que celle des mers. Mais nous voici conduits à observer l'effet des montagnes qui repercutant le vent, des montagnes très élevées et en grandes chaînes qui lui opposent une vaste resistance, et celui des vallons où il s'engouffre, qui dirigent son cours et en augmentent l'impetuosité comme des tuyaux de soufflet; Effets quelquefois affoiblis par celui des antiques Forêts qui parfilent le vent et amortissent son courroux. Le rebondissement est toujours en raison du choc. Il est terrible dans les pays montueux: dans ceux surtout dont les augustes Pyramides s'élèvent au dessus de la température où les arbres peuvent croître. Il prend une multitude de directions suivant les diverses faces que lui presentent la position et la configuration extrêmement variées de ces montagnes, qui toutes renvoient la portion qu'elles ont recue du vent géneral d'Est et des vents de Remou d'Ouest, ou même du vent polaire, par un angle de réflexion égal à l'angle d'incidence. Dans l'hémisphère boréal presque entierement terrestre, ces corps solides brisent sans cesse le vent général de Remou, et encore plus le vent polaire.

Le vent est quelque fois renvoyé d'un plan de montagne à un autre; il y a des ricochets. Et chacun de ces vents de reflet a, comme les vents généraux, son remou plus ou moins sensible.

Cette repercussion derecte ou *bricollée*, des vents généraux par les montagnes, et les remoux aux quels elle donne lieu, produisent presque tous les vents particuliers, on en connoît fort peu qui aient d'autres causes.

En voici cependant une espece très digne de remarque, et qui est due à la *révulsion*, à cette même cause qui parmi les vents généraux fait naître la brise du soir, et entretient constamment le vent polaire.

Ce vent local de révulsion a lieu dans les pays très sabloneux et où les rayons du Soleil dardent perpendiculairement.—Le sable de ces pays brûlés contracte durant le jour une chaleur si grande et si durable que la nuit ne peut y rétablir l'équilibre.—Cette chaleur conservée ajoute le lendemain à celle que le jour ramène. L'air y est donc perpétuellement dans un état de dilatation et le vent ne pouvant prendre, qu'à une distance assez éloignée de ces sortes de foyers, sa direction horizontale, y pointe en élévation.—Cela forme pour ainsi dire des cheminées où l'air des mers environnantes est continuellement aspiré.

C'est de là que resultent le petit vent qui, tout près de la côte Occidentale de l'Afrique, porte à terre, et les *Calmes* que l'on trouve ensuite jusqu'à cent lieues et plus de cette même Côte entre les Isles du Cap Verd et le Tropique du Capricorne.

Le vent diurne ne replonge sur la mer, et n'y repousse l'air de l'Est à l'Ouest qu'à cette distance du rivage.—Or, entre un vent qui conduit une portion de l'air dans une certaine direction et la raréfaction qui en fait *revulser* une autre portion en sens inverse, il s'établit absence de vent: il y a *calme*.—Deux vents opposés qui se heurtent ou qui se croisent font *tempête*. Deux vents opposés dont la direction est parallele comme celle des vents de remou avec leur vent primitif, forment dans la ligne de leur collision des *Tourbillons* et des *Trombes*.—deux vents opposés qui se fuient, laissent dans leur intervalle *l'immobilité*.

Celle ci n'a que des inconvéniens pour les lieux et pour les hommes qui ont à pâtir sous son Sceptre de plomb, heureusement qu'elle est rare dans le monde et n'y est jamais complette, les vents sont des bienfaits, les Tempêtes qu'ils occasionnent sont très utiles. Elles reversent et distribuent sur la terre la matiere électrique dont le mouvement de rotation du glôbe avoit chargé les nuages. Elles enrichissent les continens de celle que les vents généraux ont recueillie sur les mers. La réaction perpetuelle des vents particuliers contre les vents généraux et leurs combats entre eux mêmes étoient le meilleur moyen de répandre sur les lieux habités ce fluide vivifiant qui fait si fortement pousser les plantes* et qui donne aux animaux, à l'homme, l'énergie de l'âme et du corps.

Aucun des vents particuliers n'est uniforme, jamais ils ne soufflent ni exactement aux mêmes places, ni avec la même intensité. Il en cesse à chaque moment quelques uns. Il en renaît à chaque moment quelques autres. Deux grandes causes produisent cet effet.

Les variations qu'on a reconnues dans l'obliquité de l'Ecliptique déplacent chaque année la ligne de la plus grande chaleur.

Et chaque jour les points de départ de la chaleur, de même que ceux de sa plus grande activité sont changés dans tous les

* C'est une expérience commune qu'un seul coup de tonnerre fait monter de trois ou quatre pouces toutes les laitues d'un jardin, Et il n'est personne qui ne soit à portée d'observer sur soi même combien on éprouve de fatigue et de malaise dans le moment qui précéde un Orage, Combien on recouvre de forces et de vie quand l'orage a reversé surla terre l'air électrique et oxigéné,

lieux du glôbe par une autre Loi non moins admirable et plus accélerée de la généreuse nature. Cette belle et simple loi que les anciens avoient entrevue, dont NEWTON a découvert et calculé le principe, et de laquelle d'Alembert a développé l'enchaînement et les conséquences, fait que le temps qui s'écoule, depuis un Equinoxe de printemps ou d'Automne jusqu'à l'Equinoxe suivant de la même saison, est de *vingt minutes, vingt deux secondes* plus court que le temps employé par la Terre à faire sa révolution dans son orbite. C'est ce qu'on appelle la *Précession des Equinoxes.* On a cru autrefois qu'elle embrassoit un Période de vingt six mille années pour ramener l'Equinoxe au même point de l'Equateur. C'etoit une très belle observation dans le temps où elle a été faite, avec les mauvais instruments qu'on avoit alors. Et son exactitude doit étonner, quand on voit que sur un si long espace de temps, l'erreur n'étoit que d'un *cent quatrieme.* Les meilleures machines et les observations plus sures des modernes ont conduit à savoir que ce Période n'est que d'environ *Vingt cinq mille Sept cent cinquante ans.*

Mais il n'en résulte pas moins de ce beau et curieux phénomine que durant *vingt cinq mille Sept cent cinquante ans* le Soleil n'a jamais son *lever* ni son *midi* à la même place, et qu'il ne se trouve jamais dans le même lieu à la même heure d'un bon *Chronomètre.* Il y a tous les jours pour chaque lieu une petite avance.

Ainsi l'ondulation de l'Ecliptique et la Précession des Equinoxes, combinant leur influence, font que c'est perpétuellement sur des lieux différents, à des heures différentes, que le Soleil fait éprouver à l'air atmosphérique dela Terre l'impulsion donnée par son lever et par son midi; qu'il lance sa chaleur croissante; et sa plus grande chaleur; qu'il pousse avec elle le vent alizé, et que la spirale de celui ci détermine son Remou.

Le point de départ du vent alizé variant ainsi en chaque lieu chaque matin, et sa plus grande vivacité chaque midi, les faces immobiles des montagnes en sont nécessairement frappées chaque jour sous un angle différent. Tous les vents particuliers de reflet direct, de ricochet, et de remou, changent donc inévitablement chaque jour leurs angles, leurs directious, leurs croisemens. Il n'y a pas un point de la Terre qui n'ait successivement et diversement part à la distribution et au renouvellement des différentes espèces d'airs et de tous les météores qui en resultent.

Il n'y a par conséquent pas une espece d'animal ou de plante qui n'en profite au moins alternativement.

Quelques Savants ont paru écrire, ont dit plus ou moins sérieusement, qu'on pourroit prévoir les variétés de ces vents, et celles des températures qui s'y trouvent liées, si l'on avoit pour chaque lieu une suite d'observations météorologiques qui embrassât tous les jours compris dans le Période de la Précession des Equiuoxes, et qu'alors, d'après l'expérience de ce qui se seroit passé à pareil jour dans le période précédent, il deviendroit possible d'annoncer le temps qu'il feroit & le vent qui souffleroit chaque jour semblable du Période suivant en chaque lieu. Mais pour réaliser une telle hypothèse, il faudroit d'abord que les variations dans l'obliquité de l'Ecliptique accomplissent leur revolution pendant le même temps que la précession des Equinoxes; or cela n'est pas: leur marche est beaucoup plus lente. Et il faudroit encore que durant ce période de *vingt cinq mille sept cent cinquante ans*, il n'y eût aucune montagne abimée, aucun Volcan fermé, ni éteint, aucun rivage de la mer avancé, ni reculé, aucune grande forêt abattue.

Cependant nous savons que suivant des loix qui nous sont encore inconnues, la mer ne garde pas constamment le même lit. Il nous est démontre par les couches de la moyenne et de la nouvelle terre, tantôt *littorales*, tantôt formées au sein des eaux profondes, et se recouvrant l'une l'autre à plusieurs reprises, qu'elle a dêjà fait un grand nombre de fois le tour du glôbe. Nous connoissons beaucoup d'autres mutations, les unes dûës au travail de la nature, les autres à celui de l'homme,nous pouvons doue être sûrs qu'en raison même des régles trés constantes qui dirigent sa course, le Vent, ses ravages, et ses avantages, qui sont infiniment plus grands, varieront toujours.

Il ne faut point inférer de là que les observations météorologiques soient inutiles, ni diminuer le mérite des hommes estimables qui s'y livrent avec un zèle, une activité, une patience dignes d'éloges, elles servent à indiquer les rapports de l'atmosphere avec les maladies régnantes, et quelque fois avec l'abondance ou la pénurie des récoltes. Elles éclairent la physiologie, l'economie domestique, et même l'économie politique. Mais elles doivent laisser à l'almanach de Liège les prédictions sur la pluie, le beau temps, et les vents de l'année prochaine.

No. VIII.

Extracts from a letter, from William Dunbar Esq. of the Natchez, to Thomas Jefferson, President of the Society.

Natchez, Aug, 22, 1801.

Read December 18th, 1801.

BY the present occasion I have the honor of transmitting you a monthly recapitulation of meteorological observations for the year 1800; to which I have subjoined remarks calculated to convey some idea of the nature of our climate.—I have also attended to a hint dropt in one of your letters respecting the Mississippi, by preparing a short account of that river, but my copyist having fallen sick, I am obliged to defer transmitting it until next post.

I have some time since received notices of fossil bones discovered to the west of the Mississippi, and lately an intelligent French gentleman, Commandant of the Apelousas, informs me, that at three different places of that country, bones have been found which are supposed to resemble those of the big-bone-lick near the Ohio, and at another place that he is well assured that in digging a well, a set of human teeth (la denture d'un homme) have been found at the depth of 30 or 35 feet. I have recommended to that gentleman to set on foot a diligent investigation of those objects and if practicable to transmit me specimens of the bones, particularly a jawbone with its included teeth as little mutilated as possible. Should I prove so fortunate as to acquire the possession of any object worthy the attention of the society I shall take an early opportunity of presenting it. Mr. Nolan has formerly given me some intimation of fossil bones of great magnitude being found in various parts of New Mexico.

Your observation of a lunar rain-bow is entirely new to me, but I have often observed a Phenomenon which seems to have been overlooked by Philosophers; it is slightly noticed in Brydone's tour through Sicily and Malta Vol. 1. p. 356. 2d.

Edit. London. This curious and beautiful phenomenon may be seen every fine summer's evening in this and perhaps in all other countries, where serenity is united to a cloudless sky. It is caused by the prismatic effect of the atmosphere upon the sun's departing rays. Soon after sun-set a belt of a yellowish orange colour is seen to extend itself along the eastern horizon, this belt ascends in the same proportion as the sun descends, being about one degree in breadth; in contact with the first, appears a second belt below, of a dark blue colour, and about the same breadth as the first, both belts being tolerably well defined and of a uniform colour throughout: when the double belt has risen a little above the horison, the azure sky may be seen below, and as the belts continue to ascend they become fainter, until at length the prismatic rays meeting with no vapors sufficiently dense to reflect their colours, the whole phenomenon dissolves into pale celestial light; the belts disappear at about 6 or 7°. of altitude. This phenomenon merits some attention; it exhibits as upon a skreen that species of light, which after a greater angular dispersion, arriving at the moon's orbit, faintly illumines her disk during the time of a total eclipse.

It would seem to result from the above appearances, that if a prism were formed of atmospheric air, the solar ray would be separated thereby into two colours only, a yellow orange, and a blue: it is known to opticians that the compound colour of orange and yellow, and the colour which Newton calls indigo, comprise within themselves the seven primitive colours, that is, united they ought to form white; we ought not therefore to reject this effect of atmospheric air, because dissimilar to the prismatic powers of such diaphanous bodies as are best known to us; modern experiments have shewn that refracting bodies possess very different dispersive powers; and when we reflect upon the heterogeneous nature of our atmosphere, composed of at least three permanently elastic fluids, with the adventitious mixture of perhaps a hundred others, subject from chemical affinity to perpetual resolution and composition, disolving at all times a great proportion of aqueous fluid, and the whole pervaded by the electric fluid; shall we presume to doubt, that nature has it in her power to compose a refracting body, whose dispersive powers are equal with respect to the red, orange, yellow, and green making rays, and though greater with regard to the three remaining primitive colours yet perfectly equal among themselves.

WILLIAM DUNBAR.

THOMAS JEFFERSON, PRESIDENT, A. P. S.

No. IX.

METEOROLOGICAL OBSERVATIONS,

MADE by William Dunbar, Esq, at the Forest, four miles east of the River Mississippi, in Lat. 31° 28′ North, and in Long. 91° 30′ west of Greenwich, for the year 1800; with remarks on the state of the winds, weather, vegetation, &c. calculated to give some idea of the climate of that country.

NATCHEZ, Aug, 22, 1801.

Read December 18th, 1801.

MONTHLY RECAPITULATION.

YEAR, 1800.	THERMOMETER.			BAROMETER.			RAIN.
	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	Total.
	DEG.	DEG.	DEG.	INCHES.	INCHES.	INCHES.	INCHES.
January.	68	21½	43½	30 05	29 60	29 90	1 32
February.	72	25	42½	30 10	29 52	30 02	3 11
March.	78	28	58½	30 00	29 38	29 79	1 53
April.	85	44	66¼	30 07	29 65	29 84	6 92
May.	90½	61	72	29 95	29 62	29 76	3 94
June.	96	61	79½	29 99	29 61	29 80	1 26
July.	96	63	81½	29 99	29 78	29 90	4 83
August.	96	70	82	29 99	29 71	29 86	0 35
September.	90	59	76½	29 99	29 71	29 83	4 40
October.	87	36	66	30 29	29 78	30 19	0 40
November.	79	22	56	30 43	29 91	30 13	0 03
December.	75	12	47¼	30 30	29 74	30 05	3 00
Whole Year.	96	12	64¼	30 43	29 38	29 92	31 09

REMARKS transcribed from the general daily Journal.

JANUARY.

THIS month has been attended with more regular continued cold than is usual in this climate, with a smaller proportion of rain, which fell in moderate quantities on 7 or 8 different days; on the 31st. we were presented with a beautiful appearance. As the rain and sleet fell, the branches of trees were enveloped in a thin sheet of ice, and from every minute protuberance or angle depended an elegant christalization, which altogether produced an enchanting effect, giving to the trees the appearance of the most resplendent blossoms. Many large limbs were broken down with the weight of the ice.

FEBRUARY.

2d. This morning the ground is covered with snow, and the trees beautifully spangled with ice. At 10 o'clock the snow begins to melt away, although the sun is yet veiled in clouds. The snow to the depth of two inches is speedily thawed, in exposed situations; but remains all day on dry grass, chips and other bad conductors of heat, to the north of buildings, trees &c. but no where on the bare ground.

3d. This morning the ground is white with snow, and the trees compleatly glazed. One would suppose himself rather in Canada than in lat. 31°.—The sun peeps out, and a moment is granted to admire the most enchanting of pictures—The eye is dazzled with the prospect of myriads of gems, beautiful beyond imagination, with which the whole forest is decked, reflecting a combination of the most vivid colours from the facets of the icy chrystalizations—but another moment, and all is dissolved. From the dreary depth of winter we emerge at once to the enjoyment of the delicious softness of a morning in May.

MARCH.

5th. Elm, Buckeye (horse-chesnut) and spice-wood begin to bud.

10th. Planted corn and rice.

12th. Dogwood displays its beautiful blossoms, as also the red-bud.

18th. Trees in general begin to shew their buds and blossoms, excepting the nut-bearing kinds, linden &c.—Planted cotton the 22d.

APRIL.

Continue to plant cotton daily. 7th. Good pasturage in the wood-land.

10th. Peas ripen—Hickory, Walnut and Chinquepin begin to bud.—11th. Abundance of pasture in the wood-land. 13th. Garden-peas gathered to eat. 15th. Roses blow. 25th. Windsor-beans and Artichokes ripe.—Strawberries ripe since the 12th.

MAY.

5th. Irish potatoes begin to be fit to gather. 10th. Black Mulberry ripe. Gathered ripe turnip and cabbage seed. 12th. French beans fit for use.—17th. Rye and wheat fit to reap—The present is one of the most delightful months of the year, being free from sudden storms, and agreeably temperate; it is generally one of the driest months, but the present is an exception to that rule.

JUNE.

12th. Cotton begins to blossom and the weather becomes hotter than usual at this season. When the Thermometer is at 96°. under a gallery compleatly shaded, though exposed in some degree to the influence of reflection from the bare surface of the earth, if in such circumstances it be removed into a deep shade, under lofty trees, at 3 hours P. M. it will fall to 91 or 92°. If suspended to a tree exposed to the full influence of the sun-beams it rises quickly to 121°.—it perhaps might have risen higher, but being unwilling to risk the bursting of the Thermometer, as it is graduated only to 125°, I removed it without farther trial. In a cellar under the house, dug 4½ feet into the ground, the Thermometer stood at 72°.—15th. Tender Indian corn fit to use.

JULY.

This month yields a good deal of rain,—it begins to be showery about the commencement of the month, sometimes before; had not the course of providence thus ordered it, the present and succeeding months would have become intolerable from heat, and a period would have been put to vegetation; but refreshing and cooling showers, which are almost periodical at this season, falling daily in some one part or more of an extent of 20 or 30 square miles, render the mean temperature of these two months much less than might have been expected from that of the preceeding month of June, which is not unfrequently the hottest month of the year, though in the present it is inferior to both the succeeding months; but it is remarkable that much less rain fell than usual during the month of August, the natural consequence of which is an increase of temperature. I have anticipated the last observation respecting the succeeding month as having an immediate connection with the foregoing remarks.

AUGUST.

From the unusual heat of the season, the cotton harvest is found advanced ten days earlier than in former years, and a commencement was made on the 18th. to collect our valuable staple commodity. In the beginning of the season while the cotton is not yet abundant, a good labourer collects from 50 to 80 pounds in the seed, but as the crop advances to greater maturity and abundance, the task of able men and women may be estimated from 80 to 140lb. which yields one quarter clean cotton fit to be packed for market, when passed through the ginning mill. The harvesting season may continue from 3 to 4 months; from which may be formed some estimate of this very productive branch of agriculture.

SEPTEMBER.

This month is attended with a good deal of rain and introduces the powerful influence of a second spring season upon all vegetating bodies; the two grand agents, heat and moisture, being now found in that due degree most favourable to rapid vegetation. Seeds and grain which have been committed to the soil, during the last and present month, start into life and their organic parts are developed with a vigour unknown to other climes. This is the propitious season for preparing and perfecting the productions of the kitchen-garden, which are to supply us with culinary herbs and roots, during the winter and spring season.

OCTOBER.

The present is the most agreeable month of the year; its temperature is mild and refreshing, occupying the due medium between the extremes of heat and cold. It generally sets in fair during the first week or 10 days of the month, which continues for 6, 7 or more weeks—Nothing can be more favourable than this enchanting season for the restoration of the health of the valetudinarian, who may have suffered from the autumnal intermittent, which generally attacks strangers, soon after the river retires within its banks, about the end of June or beginning of July, and which by the way does not extend its influence beyond 4, 5 or 6 miles from the river swamps, tho' probably when our forests, shall be cut down, this annual visitant of our (otherwise) salubrious climate, will penetrate farther into the interior. The cotton planter too has cause to admire the dispensations of Providence, which facilitate the collecting a most valuable crop, which by an opposite order of the seasons must be totally lost.

NOVEMBER.

The first half and sometimes the whole of this month continues remarkably fine; the present has been particularly so, a few drops of rain having fallen only the first day: about the 22d. and 23d. a north-west wind caused the thermometer to sink below the freezing point, but it presently ascended again and the weather continued mild to the end of the month, the thermometer standing at mid-day from 60 to 70°.—The ewes begin to drop their lambs about the commencement of the month, and continue for three months.

DECEMBER.

The winter now being set in, the weather becomes variable, and a considerable quantity of rain generally falls in the course of the month. This year upon the whole has yielded less rain than the year 1799 and the present month has produced less than the same month of the last year by 2.78 inches. This month has been particularly remarkable for a degree of cold hitherto unexampled in the history of this country—on the morning of the 12th. the thermometer was found sunken to +12°; on that day it did not rise above the freezing point, and next morning was at 17°—on that day it rose to 49°; and both before and after was up to 72°—Cows begin to calve about the commencement of the month and continue calving for 3 or 4 months. Mares are generally a month later in bringing their young.

GENERAL REMARKS respecting the winds, weather, &c.

IT is with us a general remark, that of late years the summers have become hotter and the winters colder than formerly. Orange trees and other tender exotics have suffered much more in the neighbourhood of New Orleans within these 4 or 5 years than before that period; the sugar cane also has been so much injured by the severity of the frosts of the two last winters, as greatly to discourage the planters, whose crops, in many instances, have fallen to one third or less of their expectations. In former years I have observed the mercury of the thermometer not to fall lower than 26 or 27°, but for a few years past, it has generally once or twice in the winter fallen as low as from 17 to 20°. and on the 12th. of December 1800 as above noticed it was found sunken to 12°. which has hitherto no parrallel in this climate, indicating a degree of cold which in any country would be considered considerable, and probably may never be again produced by natural means in lat. $31\frac{1}{2}$°.

As this apparent alteration of climate has been remarked only for a few years and cannot be traced up to any visible natural or artificial change of sufficient magnitude, it would be in vain to search for its physical cause. Doctor Williamson and others have endeavoured to show that clearing, draining and cultivation, extended over the face of a continent, must produce the double effect of a relaxation of the rigours of winter, and an abatement of the heats of summer; the former is probably more evident than the latter, but admitting the demonstration to be conclusive, I would enquire whether a partial clearing extending 30 or 40 miles square, may not be expected to produce a contrary effect by admitting with full liberty, the sunbeams upon the discovered surface of the earth in summer, and promoting during winter a free circulation of cold northern air.

The winds of this country are extremely variable in the winter season, seldom blowing above three days successively from the same point; the north-west wind brings us the severest cold. It may be considered as a general rule during winter, that all winds blowing from the east of the meridian bring rain, and those from the west dry weather; the east and south east winds are most abundantly charged with moisture, as the opposite points are always the driest; the north-east wind during this season is moist chilly and disagreeable, but seldom prevails for any length of time: the north-wind brings (though rarely) sleet or snow.—After 2, 3 or 4 days of damp cloudy or rainy weather, it suddenly clears up with a cold north-west wind, which blows frequently with great force during the first and sometimes part of the second day of the change, the nights being generally calm; after a like period of fair weather, of which the two first days are clear and freezing, and the other two fine mild and agreeable with a morning's hoar frost, it revolves again into the same circle of damp and rainy weather. This may be considered as the general revolution of the winter season, but with many exceptions. The frequent and rapid changes in the state of the weather, during the winter in this climate furnish an excellent opportunity of verifying the vulgar opinion of the moon's pretended influence at her conjunctions, oppositions and quadratures; but truth compels me to say (what probably may be said of many similar persuasions) that after a continued and scrupulous attention to this object, I have not discovered any such regularity of coincidence, which might justify the reverence with which those traditional maxims are at this day received by all these whose minds are not expanded by the lights of philosophy.

With the month of February our spring season may be said to commence and southerly winds prevail, as if propitious nature was inclined to facilitate the operations of the husbandman, by carrying off the superabundant moisture with which the surface of the earth is drenched after the winter rains. This salutary effect is much more apparent on the flat lands of lower Louisiana than with us. Those regular gales are also peculiarly favourable in facilitating the ascent of the commercial boats, which at this season, with commencement of the annual inundation, perform their yearly voyage to the Spanish settlements in the higher parts of Louisiana.

As the spring and summer advance, the winds blow chiefly from between S. E. and S. W. with variations from all parts of the compass. During the hot season, the winds are frequently remarked to follow the progress of the sun, being found at N. E. or East in the morning and shifting round, die away in the evening at S. S. W.—The summer evenings are generally still until between 8 and 9 o'clock when a fine cool zephyr sets in from the West or S. W.—It has been said that in the lower parts of the territory near the Mississippi this refreshing nocturnal breeze blows from the East: hitherto correct observations have not been sufficiently multiplied in various parts of the territory to furnish a satisfactory account of this object. The month of June and about one half of July compose the hottest season of the year. Daily refreshing showers of rain commence in July and continue through August, which diminish the excessive degree of heat that otherwise must prevail at this season. The weather continues showery through September, but in October it settles fine, and there is yearly almost without exception 6 or 7 weeks of the most delightful season imaginable, the mean temperature being from 65 to 70°. with variable winds from all points of the compass.

Before the close of November we are reminded of the approach of winter by a few cold mornings and evenings and sometimes nipping frosts, which exhibit their destructive power, first, in the vallies by killing tender plants, while those on the adjoining hills retain sometime longer their bloom and verdure. This effect is to be accounted for by the greater specific gravity of the condensed freezing air, which runs off on all sides from elevated situations into the nearest vallies, there forming a mass of great extent, while the hills are supplied with air less dense and warmer from a superior stratum of the atmosphere. The influence of this cause is so great at the first approaches of winter that a difference of 10°. of Farenheit's scale has been noted at the short interval of 3 miles in the direction of East and West; one position overlooking the great valley of the Mississippi 30 miles wide, while the other was in the interior, environed by forests. On the morning of the 13th, November 1799 the thermometer stood in the first situation at 42°. and in the latter at 32°.

We are told that at Benares in the East Indies lat. $23\frac{1}{2}$°. ice is produced by natural agents artificially brought together, sufficient for the purposes of luxury. Large excavations are dug in an extensive plain, into which the condensed freezing air is collected in a considerable mass, but which probably might have formed upon the plain a stratum of a few inches only, and consequently must have been speedily mollified by the transpiration of the earth, without producing any effect; but being thus accumulated into a body of considerable magnitude it is found that in the stillness of a fine night, water contained in shallow unglazed vessels, placed upon a stratum of about a foot in thickness of some imperfect conductor of heat, such as the stalks of Maize &c. on the bottom of those excavations, is partially or totally converted into ice, according to the degree of temperature of the atmosphere, while perhaps the slightest hoar-frost is not perceptible on the natural surface—perfect calmness is essential to the success of this curious experiment: a moderate circulation of air counteracts the laws of specific gravity, and restores the equilibrium of the caloric in the adjacent strata of the atmosphere.

The North and N. W. wind blows often with some severity before the close of the month of November, shifting to the East of the meridian with fogs and some rain: the fogs being more remarkable in lower Louisiana and adjoining to the great valley of the Mississippi. The winter now sets in with the month of December and its duration may be estimated at two months, although during its whole course, when the wind continues for some time at S. and S. W. we enjoy a very agreeable mild and some times warm temperature, the thermometer often rising to 75°. or more. Hence it follows that our winter climate depends altogether upon the course of the winds. South and S. W. winds involve us within a tropical atmosphere corrected however by the accessions of cold which we have received already from the North, and which produces a most agreeable spring or mild summer temperature; the productions of the garden now vegetate with vigour and if long enough continued the fields assume a verdant hue—a mild fall and moderate winter some times permit us to gather from our gardens at Christmas, green peas and other summer productions. But when on the other hand the winds blow from the N. W. and North we are at once plunged into the rigors of a Northern winter; hence it is that tender shrubs and plants are frequently destroyed here which might be expected to withstand a more Northern clime. The human body also is extremely susceptible of the sudden transitions which naturally suggests the idea, that frequent pleuritic and inflammatory diseases must be the natural attendants of our variable winter climate, but experience demonstrates the contrary. Probably the relaxation which the body undergoes during the extreme heats of summer diminishes the oxygenation of the blood and consequently renders it less susceptible of inflammation.

August and September are called the hurricane months, and I believe there never happens a hurricane of great extent and duration at any other season, and this seldom reaches much higher than New Orleans, sweeping along the sea coast. Storms, hurricanes, whirlwinds or tornados of small extent and very short duration, happen at any season and from all points of the compass. We ought perhaps to except the months of May and October, least of all subject to sudden changes and which upon the whole are the most agreeable months of the year. Sudden gusts or storms of wind and rain generally proceed from N. or N. N. E. and their violence is only of a few minutes duration, although in that short time, it frequently happens that trees are torn up by the roots or snapt short off, houses stript of their covering, fences thrown down and crops greatly damaged and blown about in the air.—Since I have resided in this country, two or three hurricanes only, of great magnitude, have ravaged New Orleans and its vicinity. Two of them burst forth in the months of August of the years 1779 and 1780; I was at New Orleans during the first of those two. More than half of the town was stript of its covering, many houses thrown down in town and country, no ship or vessel of any kind was to be seen on the river next morning. The river which at this season is low was forced over its banks, and the crops which were not yet collected, disappeared from the face of the earth. The forests for some leagues above and below New Orleans assumed the dreary appearance of winter, the woods over large tracts were laid flat with the ground, and it became impossible to traverse the forests, but with immense labour on account of the multitude of logs, limbs and branches with which the earth was every were strewed within the extent of the hurricane; which might be estimated at about 12 miles due North and South, New Orleans being in the centre of its passage. The partial hurricanes which frequently traverse this territory do not merit the name and ought rather be called whirlwinds, which seldom last above 5 to 10 minutes, occupying a narrow vein from 50 to 500 feet in width; whereas that which I witnessed at New Orleans was of some hours duration; it continued blowing from the East or S. E. for two or three hours with undescribable impetuosity, after which succeeded all at once a most profound and awful calm, so inconceivably terrific that the stoutest heart stood appaled and could not look upon it without feeling a secret horror, as if nature were preparing to resolve herself again into chaos. The body became totally unelastic and a disposition was felt to abandon one'self prostrate upon the ground as if despair alone at that moment, could find abode in the human mind, entirely divested of all energy. How is this extraordinary effect to be accounted for? It is generally believed by philosophers, that hurricanes and perhaps the gentlest zephyrs are connected with electrical phænomina, may we then be permitted to suppose that by the violent operation of natural agents (of which we can form no conception) the electric fluid has been in a manner abstracted from the central parts of the hurricane (which we may consider as a vortex) and a species of vacuum formed with respect to the electric fluid—hence that otherwise unaccountable relaxation and dejection of spirits, similar to (though infinitely exceeding) what has been observed of the influence of the sirocco wind in Naples and Sicily upon the human body and mind, no perceptible signs of electricity being discoverable in the atmosphere during the time of its blowing.—Happily the wind was arrested but for a short time, by this horrid state of suspence, for in 5 or 6 minutes, perhaps less, the hurricane began to blow from the opposite point of the compass and very speedily regained a degree of fury and impetuosity equal if not superior to what it had before possessed. Floating bodies, which had been driven up the stream with vast rapidity against the natural course of the river, now descended with a velocity of which the astonished eye could form no estimate, it rather resembled the passage of a winged inhabitant of the air than that of a body born upon the more sluggish element of water. Vessels were left upon dry land or dashed in pieces against the shores. An American armed ship being overset was precipitated into the ocean and never more heard of; the officers and men were chiefly saved by leaping ashore, sometimes by the assistance of rafts and logs of timber, watching the opportunity of the vessel impinging against the bank as she darted from side to side of the river, hurled along by the ungovernable fury of the torrent. From every information I could procure, I believe the center of the hurricane passed over the city of New Orleans, the general progress of its course being at that time from about N. E. to S. W. and as its first fury was felt in the direction of S. E. nearly, and ended about N. W. it is evident that the circular course of the vortex followed that of the sun's apparent diurnal motion.—It is probable that if similar observations are made upon all hurricanes, tornados and whirlwinds they will be found universally to consist of a vortex with a central spot in a state of profound calm, which spot will probably be greater or less according to the magnitude of the vortex.

No circumstance occurred to me which might justify the hypothesis of the celebrated Franklin who supposed the center of a whirlwind or waterspout to be a true vacuum capable of elevating water to the height of 30 or more feet. It is by no means decided that those two phænomena are of the same species. Whirlwinds are always perpendicular to the horizon and are, I believe, never stationary: an intelligent friend of mine once saw (what he supposed to be) a waterspout descend from a low cloud into the Mississippi, it made a very considerable angle with the perpendicular and its inferior extremity remained fixed to one spot during the whole time of its appearance, the very gentle progress of the cloud seemed to prolong the spout, so that at length it separated into two parts, the inferior division, which was by much the shortest, falling into the Mississippi, and the superior slowly ascending until it became united to the cloud.

No. X.

Abstract of a communication from Mr. Martin Duralde, relative to fossil bones, &c. of the Country of Apelousas west of the Mississippi to Mr. William Dunbar of the Natchez, and by him transmitted to the Society. Dated April 24th 1802.

Read Morch 4th, 1803.

THE Country of the Apelousas, although favoured by the goodness of the soil and the salubrity of the climate, is subjected to the disadvantage of not being furnished with springs sufficiently permanent to supply the wants of the inhabitants and their cattle; which renders wells necessary at any distance from the rivers. In digging of these wells, which are of considerable depth, bones and other articles have been discovered, some of which are ennumerated as follows.

At the widow Moreau's, a human scull, in a very decayed state, was found at the depth of 30 to 35 feet below the surface of the ground. At Mr. Lewis Fontenot's, other bones were found at the depth of 25 to 27 feet. Also at Mr. James Duprès's at the depth of 18 feet; but in both these cases, they were so much decayed, as to render it impossible to distinguish, to what animal they belonged or even what bones they were. At Mr. James Lafleur's, at the depth of 30 to 35 feet, was found a piece of an Indian bowl, made of burnt shells, and baked after the Indian manner. M. Duralde in sinking a well in his cow-yard found sound oyster shells, lying in an horizontal direction, near to each other, at the depth of 22 feet. It was also said that M. Fuselier of the Alacapas found the horn of a Goat at the depth of 19 feet. Those of the above discoveries which M. Duralde was not witness to, were attested to his satisfaction—and he supposes many others escaped the notice of the workmen and proprietors.

About the year 1760 or a little after, some person was led by chance to the margin of a small bay called Carancro and observed there a large heap of bones; they were sound and of an enormous size. He was struck with the discovery and made mention of it; and as the news of it spread, the public curiosity was very much excited. Their length, their size, and above all one or two teeth, which were amongst them, led the spectators to judge that this had been the entire skeleton of an Elephant. This soon became the generally received opinion. They perfectly distinguished, the ribs, the vertebræ, the scapulæ, the tibiæ, the thigh bone (which was larger than a man's thigh,) and lastly the hip bone, which had a very distinct cavity for the reception of the head of the thigh bone—M. Nerat the proprietor of the spot where they were found, a man of strict varacity and residing near it, declared that there were bones enough to load two, or at least one very large cart; that he had taken, and during ten years had made use of, the hollow of the hip bones, to press his indigo in, that as well as he can remember there was one of the haunch bones wanting, which forms apart of the eminence of the bason, and that notwithstanding, it was so heavy, that it required a very strong man to handle it.

Six years ago during the time of a great drought, Alexander Fontenot perceived, and took up from the bottom of a brook, about five feet deep, an extraordinary tooth standing upright, being part above and part under ground. The great size of this, and a remnant of ivory which was found with it, induced the belief, that it had belonged to an Elephant. It was already much decayed, and has disappeared from his yard, after having been tossed about it, during three or four years. The place was again thoroughly examined by directions of M. Duralde, but without making any further discovery.

Mr. John Teston, a man of integrity, declared that about 15 years ago he found the remains of an enormous jaw-bone in a brook on his plantation, weighing as he judged 25lb. He took it up, and shewed it to several persons, all of them unfortunately of little knowledge or experience in these subjects; but, from a faint recollection of what had been discovered at Carancro, they supposed that it must have belonged to an Elephant. He pointed out to M. Duralde the place from whence it was taken, but there only remained some small pieces of bone much scattered, none exceeding an inch in diameter, and totally insufficient to lead the most intelligent observer to any important conclusion. These two brooks are separated from each other from 750 to 900 Toises, and distant from Carancro about four or five leagues.

M. Duralde accompanies the above facts by the following observations.

These bones, which were supposed to be those of the Elephant, have been discovered, on the borders of brooks passing through Prairies, in a clay soil at the depth of a few feet; except those at Carancro, which were found heaped up on a small point of sand, at the mouth of another brook of the same kind as those mentioned, and which may have been deposited there by the floods.

The inhabitants of this country think that the surface thereof has risen visibly; because these marshes which were impassable to man and beast when they settled there, will at present allow a free passage over them even on horseback at the end of summer and beginning of autumn. This fact is really so, and I believe there are two causes of the diminution of water; the one is the evaporation occasioned by the sun, the other the travelling of the cattle; they wear the road and make a dust, which the rains carry off to these places, by which the bottom becomes insensibly raised, when it dries, and is hardened by the going and coming of these animals. This, if I do not deceive myself, is the solution of the problem; my opinion arises from the inspection of certain low places, which appear most certainly to have been morasses formerly; for although they are now become firm and solid, yet we can still observe the places of all the tufts of reeds, with the intervals which have separated them, such as we find them in muddy marshes. Whatever may be the cause of this elevation, the nature of the soil warrants the opinion, that it has not been caused by alluvions.

There is also an appearance in this range of country, which is very common, but which continues to surprise me every time I observe it; namely, the circular form of certain marshes of different diameters upon the highest grounds. I have not ascertained the fact mathematically, but the eye so well attests their regularity, that it seems as if art could not have rendered them more perfect. These marshes are not deep, and most of them dry up in times of great drought, and the bottom deepens gradually from the circumference to the centre. I have never observed them without endeavouring to ascertain the cause of them; none other, equally satisfactory, has presented itself to my mind, than that they were cavities which have been thus excavated by some whirlpool, at the time the whole surface was covered by water. I cannot help avowing, even at the risk of being accused of temerity, that the existence of these marshes, combined with the circumstance of finding these bones at such extraordinary depths, and also with a tradition of the Alacapas (a neighbouring Indian tribe) has almost convinced my mind that such a state of things existed at some very distant period.

No. XI.

Observations made on a Lunar Eclipse at the Observatory in the City of Philadelphia on the 21st, of September 1801, *by Mess. Patterson, and Ellicott.*

Read Dec. 18th, 1801.

The beginning of the eclipse, that of total darkness, and the end of the eclipse, could not be observed on account of clouds; but the end of total darkness was observed as below.

	h	′	″	
End of total darkness as observed by Mr. Patterson	15	15	7	apparent time

		h	′	″	
☽'s. limb began to emerge by	Mr. Ellicott	at 15	13	33	ap. time
☽'s. limb emerged by	Mr. Ellicott	at 15	15	37	ap. time

The telescopes made use of were both achromatic, and magnified about 70 times.

No. XII.

On the Hybernation of Swallows, by the late Colonel Antes. Communicated by Dr. Barton.

Read May 17th, 1802.

Philadelphia July 9th, 1801.

ABOUT 30 years ago, I was desired by Mr. Stettler, who lived in Frederick Township, (at the time in Philadelphia county,) to lay off a level for the purpose of leading the water of a spring upon a meadow.—The exact year I do not recollect, but am positive it was in the month of February.—I began where the stream entered his ground, and before I had proceeded far I struck a hollow about a rod square which was filled with wet mud and leaves. The labourers followed my level, and dug the trench. On getting into the hollow or pond, I observed that they threw up the body of a swallow. I took it up, muddy as it was, and having washed it in the water, I put it into my pocket. In a few hours I returned to the house of Mr. Stettler, took the swallow and placed it upon the wall of the stove, which was just warm. While we were taking some refreshments, we were surprised by the chirping of the bird, which soon afterwards was flying about the room, catching flies, and alighting from time to time upon the furniture. From the time of laying it on the stove, to the moment of its revival, was not more, I think, than about a quarter of an hour. Mr. Stettler kept the swallow in his house till the weather became warm, and the swallows began generally to appear: he then gave it its liberty.

The stream, which was the object of my business with Mr. Stettler, was dry during the summer; but after a heavy rain during the winter, and often during the summer, it flowed over into the hollow, carrying into it the leaves and mud which I found there, but did not flow through it. It had been a very mild winter;—the swallow was buried perhaps a foot, for the trench was no deeper; but it was certainly buried below the frost. I did not observe in that place any other swallows, the trench was narrow, and was carried near the edge of the pond. I have many times since that period, seen the swallows turned up out of the mud early in the spring; although the particulars of these instances, are not so clearly impressed upon my recollection. I have also often seen swallows, especially martins, creep under the roots of trees on the margin of creeks; I have then sought for them without success, and believe that they were retiring for the winter.

FREDERICK ANTES.

No. XIII.

Astronomical observations made at Lancaster, Pennsylvania, chiefly with a view to ascertain the longitude of that borough, and as a test of the accuracy with which the longitude may be found by lunar observation; in a letter from Andrew Ellicott to Robert Patterson.

Read January 21st, 1803.

Lancaster December 16th, 1802.

DEAR SIR,

IF you think the following astronomical observations of sufficient importance, you have my permission to hand them to the Philosophical Society. In making them I had principally two objects in view; *first,* the determination of the longitude of this borough; and *secondly,* the correction of the theory of the satellites of Jupiter, by increasing the number of observations on their eclipses.—The latitude of the place of observation is about 40° 2′ 39″ north.

Nov. 25th, 1801. The observed times, and distances, between the sun and moon's nearest limbs,

	h ′ ″		° ′ ″	
Apparent time.	22 12 1	. . . .	110 29 0	add 15″ for the error of the sextant.
	22 13 16	. . . .	110 28 20	
	22 14 6	. . . .	110 28 0	
	22 15 14	. . . .	110 27 30	
	22 16 6	. . . .	110 27 20	
	22 16 53	. . . .	110 27 0	
Means.	22 14 36	. . . .	110 27 52	

27th, The observed times, and distances between the sun and moon's nearest limbs.

	h ′ ″		° ′ ″	
Apparent time.	23 19 20	. . . .	88 11 10	add 15″ for the error of the sextant.
	23 20 19	. . . .	88 11 0	
	23 21 10	. . . .	88 10 40	
	23 21 45	. . . .	88 10 20	
	23 22 17	. . . .	88 9 50	
	23 23 0	. . . .	88 9 30	
Means.	23 21 18	. . . .	88 10 25	

28th, The observed times, and distances, between the sun and moon's nearest limbs,

	h ′ ″	° ′ ″	
Apparent time.	21 1 24	77 51 20	add 15″ for the error of the sextant.
	21 2 24	77 50 40	
	21 3 13	77 50 20	
	21 3 51	77 49 40	
	21 4 37	77 49 20	
	21 5 39	77 49 0	
Means.	21 3 31	77 50 3	

December 11th, The observed times, and distances, between the sun and moon's nearest limbs.

	h ′ ″	° ′ ″	
Apparent time.	2 42 39	80 29 20	add 15″ for the error of the sextant.
	2 43 24	80 30 0	
	2 44 11	80 30 40	
	2 44 55	80 30 50	
	2 45 34	80 31 0	
	2 46 23	80 31 10	
	2 47 31	80 31 30	
Means.	2 44 57	80 30 39	

12th, The observed times, and distances, between the sun and moon's nearest limbs.

	h ′ ″	° ′ ″	
Apparent time,	1 28 36	92 48 20	add 15″ for the error of the sextant.
	1 29 37	92 48 40	
	1 30 22	92 49 20	
	1 31 19	92 49 40	
	1 32 10	92 50 20	
	1 32 49	92 50 50	
	1 33 42	92 51 30	
	1 34 34	92 52 0	
Means,	1 31 39	92 50 5	

The observed times, and distances, between the moon's western limb, and Aldebaran (α Tauri,) east of her.

	h ′ ″	° ′ ″	
Apparent time,	6 27 3	71 22 30	add 15″ for the error of the sextant.
	6 28 14	71 22 0	
	6 29 14	71 22 0	
	6 29 56	71 21 30	
	6 31 15	71 21 10	
	6 32 16	71 20 50	
	6 33 5	71 20 20	
Means.	6 30 9	71 21 29	

24th, Immersion of the 1st satellite of Jupiter, observed at $12^h\ 34'\ 27''$ mean time, or $12^h\ 34'\ 13''$ apparent time.—The planet and satellites well defined:—magnifying power of the telescope 100.

Jan. 5th, 1802. Immersion of the 2d satellite of Jupiter, observed at $10^h\ 15'\ 6''$ mean time, or $10^h\ 9'\ 10''$ apparent time.—The night fine and clear,—the belts and satellites well defined:—magnifying power 100.

25th, Immersion of the 1st satellite of Jupiter, observed at $9^h\ 5'\ 7''$ mean time, or $8^h\ 52'\ 19''$ apparent time.

Emersion of the 4th satellite of Jupiter, observed at $11^h\ 32'\ 42''$ mean time, or $11^h\ 19'\ 53''$ apparent time. The night was remarkably fine,—the belts and satellites perfectly defined:—magnifying power 100.

February 6th, Immersion of the 2d satellite of Jupiter, observed at $9^h\ 51'\ 46''$ mean time, or $9^h\ 37'\ 15''$ apparent time:—The night a little hazy:—magnifying power 100.

9th, The moon occulted a number of stars in the northern part of that cluster called the Pleiades: the occultations of the three largest were particularly attended to.—The immersons were all instantaneous; but the emersions could not be observed on account of the houses on the west side of the street. Not having either the places, or characters of the stars observed, I have in Fig. 3d, Plate III, laid down the relative positions of the principal ones in the cluster, as nearly as I could do it without the aid of any other instrument than my telescope, and numbered those that were occulted.

	h ′ ″		h ′ ″	
No. 1 immersed at	10 23 54	mean time, or at	10 9 16	apparent time.
2 - - do. - -	10 31 38		10 17 0	
3 - - do. - -	10 53 2		10 38 24	

In the diagram, A B C E represents the dark part of the moon's disk, and A E C D the enlightened part. When the enlightened part was kept out of the field of the telescope, the limb of the dark part was sufficiently visible, and well defined; by which I was enabled, without fatiguing my eye, to trace the approach of the moon to the stars, and pay that close attention so very necessary at the instant of the occultation. The star No. 1 is very small, and seldom visible without the aid of a glass. In each case the star appeared for a few seconds well defined on the edge of the moon's disk.—Various theories have been devised to account for this singular phenomenon, but I am inclined to believe with La Lande, that it is merely an optical illusion*.

* Il arrive souvent dans les éclipses d' étoiles ou de planettes par la lune, que l'astre éclipsé paroît tout entier pendant quelques secondes sur le disque eclairé de la lune; on a attribué ce phénomene á l'atmosphere de la lune, et M. Euler enterprend de prouver son existence par les éclipses de soleil

17th, About $9^h\ 14'\ 9''$ mean time, or $8^h\ 59'\ 47''$ apparent time, the 1st satellite of Jupiter disappeared behind the body of the planet: Jupiter being too near the opposition for the eclipse to be visible.—Observations of this kind cannot be made with great accuracy.

March 10th, Emersion of the 2d satellite of Jupiter, observed at $12^h\ 26'\ 10''$ mean time, or $12^h\ 15'\ 41''$ apparent time: —night remarkably fine, magnifying power of the telescope 100.

16th, Immersion of the 4th satellite of Jupiter, observed at $12^h\ 50'\ 1''$ mean time, or $12^h\ 41'\ 13''$ apparent time:—the night clear, but the moon was so near to the planet that her superior light rendered the satellites less distinct; on which account I suspect that at least $10''$ ought to be added to the time of the immersion, and which I have used in deducing the longitude from this observation: magnifying power 100.

21st, Emersion of the 1st satellite of Jupiter, observed at $8^h\ 2'\ 53''$ mean time, or $7^h\ 55'\ 32''$ apparent time:—the night fine,—magnifying power of the telescope 100.

28th, Emersion of the 2d satellite of Jupiter, observed at $6^h\ 57'\ 57''$ mean time, or $6^h\ 52'\ 45''$ apparent time.

Emersion of the 1st satellite of Jupiter, observed at $9^h\ 57'\ 21''$ mean time, or $9^h\ 52'\ 12''$ apparent time:—night remarkably fine: magnifying power 100.

April 4th, Emersion of the 2d satellite of Jupiter, observed at $9^h\ 34'\ 57''$ mean time, or $9^h\ 31'\ 50''$ apparent time.

Emersion of the 1st satellite of Jupiter observed at $11^h\ 51'\ 36''$ mean time, or $11^h\ 48'\ 36''$ apparent time.—Night uncommonly clear: magnifying power 100.

20th, Emersion of the 1st satellite of Jupiter, observed at $10^h\ 9'\ 28''$ mean time, or $10^h\ 10'\ 40''$ apparent time:—night a little hazy, belts badly defined, magnifying power 100.

May 6th, Emersion of the 1st satellite of Jupiter, observed at $8^h\ 27'\ 56''$ mean time, or $8^h\ 31'\ 33''$ apparent time:—very

(*Mém de Berlin* 1748 *p.* 103.) M. de l'Isle l'attribuoit á la diffraction ou á l'inflection des rayons qui rasent les bords de la lune (Mem. pour servir a l'hist. de l'astron 1738, p 249.) Ce phenomene, observe par Grimaldi et par Newton (Opt. parte 3d) servoit sur-tout a M de l'Isle pour expliquer les anneaux que l on voit autour du soleil dans les eclipses totales; pour moi, je pense que c'est une simple illusion optique occasionée par l'irradiation ou le debordement de lumiere.

Astron. par La Lande Tom. 2d. art. 1991.

hazy, on which account I have deducted 20″ from the observed time of the observation in deducing the longitude from it:—magnifying power 100.

The 2d satellite was expected to emerge about 56 minutes after the 1st: after looking for it at least 4 minutes beyond the calculated time, I discovered that it had emerged in contact with the 1st.

15th. Emersion of the 3d satellite of Jupiter, observed at $9^h\ 45'\ 8''$ mean time, or $9^h\ 49'\ 7''$ apparent time: night clear, —magnifying power of the telescope 100.

29th. Emersion of the 1st satellite of Jupiter, observed at $8^h\ 40'\ 4''$ mean time, or $8^h\ 43'\ 7''$ apparent time:—night clear, magnifying power 100.

June 4th. In the evening, the moon occulted two small stars in (♋) Cancer.

	h	′	″			h	′	″	
Immersion of the 1st, at	8	46	0	mean time, or	at	8	48	11	apparent time.
do. of the 2d, at	9	11	12		at	9	13	23	

The last immersion took place so near to the extremity of the moon's southern limb, that it did not appear probable the moon's disk would extend 30″ south of the star.—In each of these occultations, the stars appeared plainly defined on the edge of the moon's disk some seconds before the occultations took place:—in the last case, the star, by being so near to the southern extremity of the moon, appeared to be in contact with her limb for nearly 10 seconds, and for an equal space of time defined on the edge of the disk.

5th. Emersion of the 1st satellite of Jupiter, observed at $10^h\ 34'\ 55''$ mean time, or $10^h\ 36'\ 53''$ apparent time. The night clear, but the belts were scarcely visible, and the limb of the planet uncommonly tremulous: magnifying power 100.

21st. Emersion of the 1st satellite of Jupiter, observed at $8^h\ 52'\ 41''$ mean time, or $8^h\ 51'\ 26''$ apparent time: the planet and satellites well defined, magnifying power 100.

July 14th. Emersion of the 1st satellite of Jupiter, observed at $9^h\ 5'\ 22''$ mean time, or $9^h\ 0'\ 0''$ apparent time. The planet was so low and tremulous that the belts were not discernible:—magnifying power 100. This observation, as well as those of May 6th, and June 5th, are not to be considered as so accurate as some of the others.

Sep. 11th. Observation on the end of a lunar eclipse.

	h ′ ″		h ′ ″	
☽ began to leave the earth's shadow at	6 54 47	mean time, or	6 58 16	apparent time.
☽ clear of the penumbra at	6 57 15	mean time, or	7 0 44	apparent time.

Longitude by the lunar distances.

	h ′ ″	
Nov. 25th, 1801. The ☽ from the ☉ long.	5 4 54	West from Greenwich.
27th, ... do. . . . . . do.	5 4 28	
28th, ... do. . . . . . do.	5 4 14	
Dec. 11th, ... do. . . . . . do.	5 5 29	
12th, ... do. . . . . . do.	5 4 7	
—The ☽ from Aldebaran (α Tauri) do.	5 4 58	
Mean,	5 4 42	

Longitude west from Greenwich by the eclipses of the satellites of Jupiter, as deduced from the tables of Mr. Delambre, and the British nautical almanac.

	Longitude by Delambre's Tables. h ′ ″	Longitude by the nautical almanac. h ′ ″
Dec. 24th, 1801. Immersion of the 1st satellite	5 5 2	5 5 39
Jan. 5th, 1802. . . . do. . . . . . 2d sat.	5 4 12	5 4 48
25th, ... do. . . . . . 1st sat.	5 5 9	5 5 40
Emersion. . . . 4th sat.	5 5 45	5 2 11
Feb. 6th, ... Immersion . . . 2d sat.	5 4 29	5 5 48
ar. 19th, ... Emersion. . . . 2d sat.	5 5 17	5 4 48
16th, ... Immersion . . . 4th sat.	5 5 22	5 1 6
21st, ... Emersion. . . . 1st sat.	5 5 17	5 6 0
28th, ... do. . . . . . 2d sat.	5 5 12	5 5 15
do. . . . . . 1st sat.	5 5 9	5 5 52
April 4th, ... Emersion of the 2d sat.	5 5 21	5 5 32
do. . . . . . 1st sat.	5 5 17	5 6 2
20th, ... do. . . . . . 1st sat.	5 5 5	5 5 49
May 6th, ... do. . . . . . 1st sat.	5 4 48	5 5 20
15th, ... do. . . . . . 3d sat.	5 5 5	5 11 7
29th, ... do. . . . . 1st sat.	5 4 59	5 5 18
June 5th, ... do. . . . . . 1st sat.	5 4 47	5 5 9
21st, ... do. . . . . . 1st sat.	5 5 1	5 5 8
July 14th, ... do. . . . . . 1st sat.	5 4 43	5 4 39

Note. The observations made on the eclipses of the 1st satellite on May the 6th, June 5th, and July 14th, are to be considered as doubtful:—see the entries in the preceding journal on those days.

Longitude deduced from the lunar eclipse of Sept. 11th.

	h ′ ″	
If the time when the moon began to leave the earth's shadow be taken for the end of the eclipse, the longitude will be	5 6 44	West from Greenwich.
If the time of the moon's leaving the penumbra be taken for the end of the eclipse, the longitude will be	5 4 16	
Mean,	5 3 50	

By our maps, the borough of Lancaster appears to be about 4′ 29″ in time, west from the city of Philadelphia, which added to 5^h 0′ 37″, the longitude of the latter west from Greenwich, will give 5^h 5′ 6″ for the difference of meridians between the borough of Lancaster and the observatory of Greenwich; which differs but 24″ in time from the mean of the six lunar observations, and only 59″ in time from the widest of them. From this it is manifest, that very great dependance may be placed in the lunar observations, for the determination of the longitude.

In determining the longitude from lunar observations, we have the advantage of increasing the number almost at pleasure, and rendering them so numerous, that the mean of all the results shall be nearly as accurate as the lunar theory itself, which seldom errs so much as 30″ of a degree, and generally much less.

By looking over the longitudes as deduced from the eclipses of Jupiter's satellites, it will be seen that the results from Delambre's tables are much more uniform than those from the nautical almanac, particularly of the 1st, 3d, and 4th satellites; with respect to the 2d, the nautical almanac appears to have the advantage; but it is to be remembered, that the observations made at this place have been too few, and the period too short, to decide on a subject of such nicety: it is nevertheless probable, that when the period is extended, and the number of observations increased on the eclipses of the 2d satellite, that Delambre's tables will be found to be the most accurate.

If a mean of the longitudes deduced from the lunar observations, the eclipses of Jupiter's satellites agreeably to Delambre's tables, and the lunar eclipse be taken collectively, the longitude of Lancaster will appear to be 5^h 5′ 0″.6; and if a mean of the eight good observations on the eclipses of the 1st satellite of Jupiter be taken, the longitude will be $5^h\ 5'\ 7''.3$ which exceeds the longitude as taken from our maps but $1''.3$ and that of a mean of the whole collectively but $6''.7$. From which it appears, that the longitude may be considered to lie between $5^h\ 5'\ 0.''6$, and $5^h\ 5'\ 7''.3$ west from Greenwich, without the possibility of a material error: I shall therefore for the present call it $5^h\ 5'\ 4''$.

Observation on the going of the Clock.

The pendulum-rod of the clock is made of wood, as being the most convenient for transportation, and not so liable to accidents as the gridiron-rod in removing the clock from one place to another, in which way it has heretofore generally been used.

It was formerly supposed that wood neither expanded, nor contracted, in the direction of the grain, with heat and cold; but this is not strictly true, though the alteration appears much less than from wet and dry. When the atmosphere continues for some time equally saturated with moisture, the clock has always been found to go very regularly, notwithstanding the great and sudden changes we experience in the United States, from hot to cold, and from cold to hot. But the atmosphere being charged at different times, with different degrees of moisture, has a considerable effect, provided those changes from wet to dry, and the contrary, are of sufficient duration: for it requires several days' continuance of a damp, or dry atmosphere, to produce any sensible effect. I have observed for several seasons, that when the weather became warm in the spring, the motion of the clock was accelerated; the contrary would have been the case, had the pendulum-rod consisted of one single bar of metal, because it would have expanded or lengthened, as the weather became warm; but from the motion of the clock being accelerated, it is evident that the pendulum-rod must have contracted, and this was probably occasioned by the dry atmosphere, and drying winds, so prevalent at that season of the year, in this country.

It does not appear from the experience of several years, that the clock would vary more than 12 seconds per diem, with the extreme changes of winter and summer, and wet and dry in our climate; when a single rod of iron would produce a change of 22 seconds per diem, and one of brass 34. Hence a conclusion may be drawn, that wood (though far from being perfect) is preferable to a single rod, either of iron, or of brass.

I am, with great esteem,

your sincere friend,

and humble servant,

ANDREW ELLICOTT.

No. XIV.

Notices of the Natural History of the northerly parts of Louisiana, in a letter from Dr. John Watkins to Dr. Barton.

Read Jan. 1st, 1803.

St. Louis, Ilinois. Octobr. 20th, 1802.
Supposed latitude between 39° and 40°.

DEAR SIR,

In the note which you gave me some time ago, relative to some of the animals, larger trees and shrubs, that are to be found on the west side of the Mississippi; you requested me, that as the questions were made without much regard to order, to trouble myself as little as possible about the arrangement of my answers. I shall therefore proceed, in the spirit of that request, and in the plainest manner, without regard to any particular arrangement, mention such of those animals, trees, and shrubs, as are here to be met with; and state to you as nearly as I can the part of the country where they most abound.

The red fox (canis vulpes) is not known in this part of the country, or any where on this side the Mississippi, immediately in our latitude. North of 44 degrees however, and at the distance of seven or eight hundred miles west of the Mississippi, this animal is very common. The beaver (castor fiber) is very common here, and has been observed in great numbers as far west as the whites have penetrated; and agreeably to the accounts of the savages, this animal is found in great abundance in the mountains that divide the waters of the southern from those of the Atlantic ocean.

The buffaloe (bos americanus) is common in all this country, and is found in great abundance as far west as the country has been penetrated. During the winter they change their range, and ramble to a great distance in the south, returning again in the spring to their more northern residence. In these rambles they go together in immense droves, and the savages, by watching them in proper passages, destroy great numbers with little trouble and expense.

The elk (cervus* wapiti), the common deer (cervus virginianus), the raccoon (ursus lotor), the panther (felis concolor), the ground hog (arctomys monax), the grey fox (canis virginianus), the mink†, the flying squirrel (sciurus volucella), the ground squirrel (sciurus striatus), the grey squirrel (sciurus cinereus), and the black squirrel (sciurus niger), are all found in this country, and are common for many hundred miles to the west.

The opossum (didelphis opossum) is common here; and agreeably to the information of Mr. Choteau, a sensible well-informed man, this animal is to be met with as far west as three hundred and fifty leagues from hence, that is, following the course of the Missouri, which is west one quarter of a degree to the north; and that after passing a large river, called *la Riviere qui coule*, the opossum disappears, and the Porcupine (hystrix dorsata), which is not to be seen about here, becomes common.

In mounting the Missouri, after passing the river *qui coule*, that is 350 leagues west of the Mississippi, the country assumes a different aspect. The river washes for several hundred miles a barren ungrateful soil, destitute of timber. Nothing is to be

* Unknown to Linnæus. I call it C. Wapiti. B. S. B. † Mustela Winingus *mihi*. B. S. B.

seen but extensive plains of what is called natural meadow, and here and there, upon the borders of the rivers and creeks, a few cotton wood (populus deltoide), hickory (juglans), and shrub oak (quercus). Here it is that the white bear (ursus arctos?) is found; to give you a just description of this animal would require more knowledge of natural history than I possess. I shall therefore only repeat to you, in general, what the most intelligent and best informed traders and hunters have informed me upon this subject. The white bear, as it is here called, is found of all colours from a brown to almost a perfect white; and, to use the hunters expression, differs as much in its colour as the different varieties of dogs. It is much taller and longer than the common bear; the belly is more lank, and the abdomen drawn up like that of a horse kept for the course. It runs much swifter, and its head and claws are much larger, and longer in proportion than the common bear. It feeds principally upon animal food, and is considered by the savages as their most dangerous enemy. It attacks universally; kills, and devours human flesh. It is not in the above mentioned country alone that this animal is found; it is common much farther to the north and west, and occupies a wide and extensive range, upon all the waters that form the sources of the Missouri.

I can verify, in part, the truth of the above account of the white bear, particularly as to its size and external appearance. My friend the Lieutenant Governor of the upper Louisiana and commandant of Saint Louis, Mr. Dehault Delassus, has now in his possession one of these bears of about six months old. Its colour is that of a pale orange approaching to white, with a streak of dark brown along the back, and on the outside of the thighs. It is taller and longer than common bears of its age, notwithstanding the manner in which it has been raised, and its head and claws are much larger. It has been constantly fed upon boiled indian corn, and pains have been taken to render it as docile and good natured as possible. It has not as yet shewn any symptoms of ferocity, but suffers its keeper to beat and handle it as he pleases. In general it exhibits, in its manners, nearly the same character with that of the common bear. This cub, with another of a different family and colour, was caught, when very young, by the Chayenne Indians and presented to the Governor through some of their traders. These Indians inhabit the country upon the head waters of one of the principal branches of the Missouri, called *la Fourche,* and their residence cannot be less than 450, or 500 leagues west of the Mississippi. Mr. Delassus made a present not long sinse of one of these cubs, the smallest and darkest coloured, to my friend Mr. Wm. Harrison Governor of the Indiana territory, who informed me that he intended to present it to the President of the Philosophical Society of Philadelphia. There you will no doubt have an opportunity of seeing it, and will be prepared to form a much more correct opinion, as to its proper place among the different tribes of bears, than can possibly be done from the imperfect account given by hunters.

The buck eye (Æsculus flava), the pacan tree (juglans pecan), black walnut (juglans nigra), our common species of hickory, the sugar maple (acer saccharum), the persimmon (diospyros virginiana), and the coffee tree (guilandina dioica), as it is called in Kentucky, are all common in this country, and are to be found as far west as 350 leagues from hence; that is until you arrive at *la Riviere qui coule.* The beech (fagus ferruginea), the chinquapin (fagus pumila), the chesnut (fagus castanea?) and the poplar with a tulip flower (liriodendron tulipifera), are none of them to be found in this part of the country or to the west of this, agreeably to the information of the best-informed traders and hunters. The poplar with a tulip flower however is found in abundance about one hundred miles to the south of this, and on the west side of the Mississippi.

JOHN WATKINS.

No. XV.

On two species of Sphex, inhabiting Virginia and Pennsylvania, and probably extending through the United States. By B. Henry Latrobe.

Read January 21st, 1803.

Philadelphia January, 21st, 1803.

The two species of Sphex to which this memoir is confined, are well known under the names, blue wasp, mason, and dirt-dauber. Among all the remarkable insects belonging to the order of hymenoptera of Linnæus, they appear to be most distinguished by their singular and cruel mode of providing for their young.

The two species are distinguished from each other in their manner of building, and in the form of their bodies; but agree exactly in their mode of life, in the materials of which they build their cells, and the food provided by them for their offspring.

The first, No. I. Plate I. is probably the Sphex coerulea of Linnæus, of which the following is the description:

Coerulea, alis fuscis: habitat in America septentrionali.

This sphex, is by far the most common of the two species: the antennae are pointed and stand up when he is at work. His nose is furnished with a strong beak, with which he works sideways, leaving ridges on his cells which make them appear to be plaited; his thorax is thick, the abdomen petiolated. From the scutum attached to the petiole, is extended a strong hook, which is very serviceable to him in securing his prey. His sting is not very painful, and soon ceases to be troublesome. The wings which Linnæus describes as brown, play between a beautiful green, brown, and blue. The joints of the feet are yellow, the whole of the head, body, and legs are blue.

I have however seen some individuals which had yellow spots on the thorax, in front of the wings.

The other sphex, No. II. Plate I. (probably the Pennsylvanica of Linnæus) differs from the former in many particulars of form and colour. Linnæus's description runs thus:

Nigra, abdomine petiolato atro, alis subviolaceis. Habitat in Pennsylvania.

The specific differences are as follows:

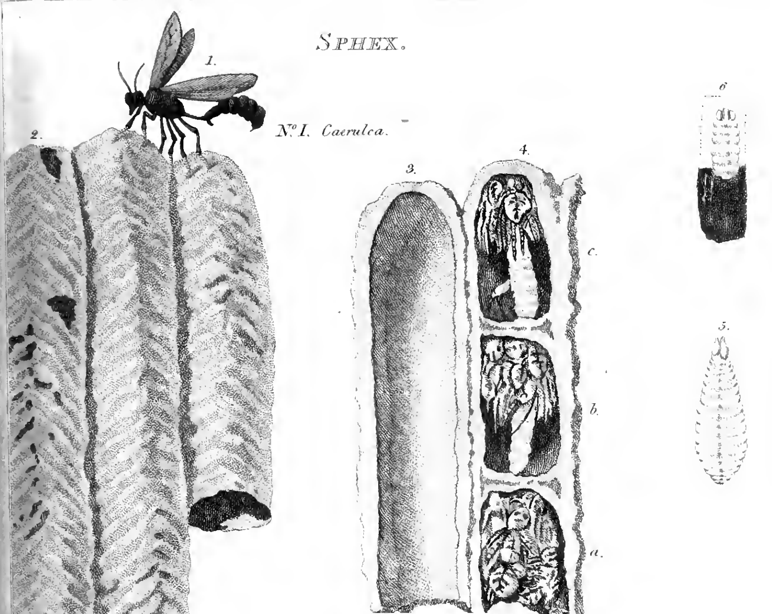
The head is broad, the nose blunt and emarginate, his thorax is longer in proportion, the petiole of the abdomen very long, the hook is wanting, the abdomen conical and elegantly formed. The general colour is a dark blue approaching to black, but on the thorax are many yellow spots, and the legs, thighs, and feet are also spotted with yellow. His antennae are longer than in No. I. and he carries them less upright, and often curls them. No. II. Fig. 2. is an enlarged view of his head.

The figures both of the coerulea and Pennsylvanica are exactly the size of the live insects, and an attempt is made to imitate accurately their manner when alighting on their cells.

The cells both of the S. coerulea and Pennsylvanica are built of clay collected in moist places; but their appearance, and mode of contruction is very different.

The S. coerulea chuses, in the open air, the south side of a rock, or of the trunk of a tree for his structure. He then seeks by the side of a stream for his materials. He scrapes the clay together with his feet, and working it into as large a round ball as he can well carry off, he begins by plaistering the stone or wood with a thin coat. He spreads the clay with his head, uttering a shrill sound during his work. He then flies off for another lump, and by degrees forms the upper ridge of his cell. He afterwards adapts a second ridge to the first, working alternately on each side, frequently going into the tube thus formed, and making it perfectly smooth in the inside. In this manner he compleats a tube of 3 or 4 inches long, before any attempt is made to carry in provisions for the young brood.

Plate I.



was for at least half an hour.

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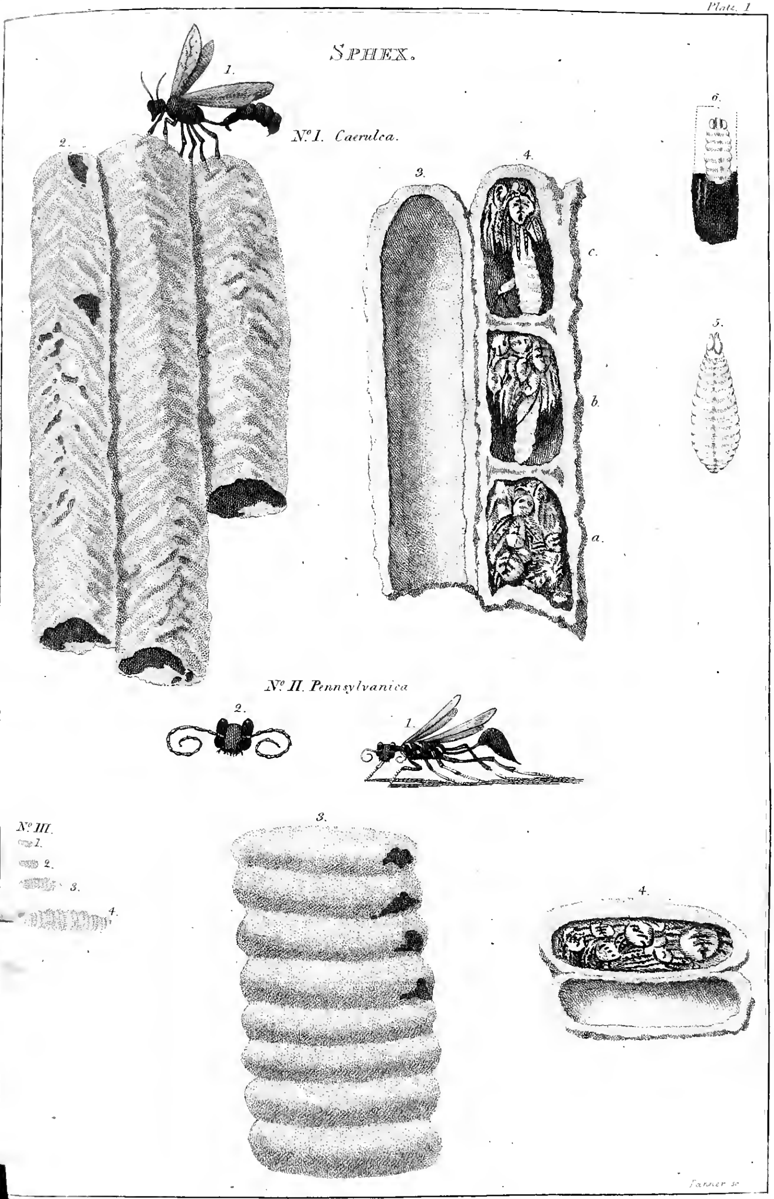

SPHEX.
1.
Nº I. Caerulea.
2.
3.
4.
c.
b.
a.
6.
5.
Nº II. Pennsylvanica
2.
1.
Nº III.
1.
2.
3.
4.
3.
4.
Farmer sc

In the inside of houses, nothing furnishes both these species of sphex with a more convenient situation for their cells than the backs of picture frames; for they are fond of building in places which have a very moderate degree of light, and the back of a picture frame hanging against the wall has also the advantage of furnishing two sides of the cell. A hollow moulding of a pannel has also its strong temptations, or the internal angle of the frame of a table. In the wooden houses of Virginia they occupy all these situations in great numbers. I have seen the hollow space in the front of the books in a library occupied by a whole tribe of the sphex coerulea, which thereby saved themselves much trouble, as they had only to close the space between the edges of the binding.

The sphex Pennsylvanica differs exceedingly from the coerulea in the construction of his cells. Instead of a series of long tubes divided into separate cells, the former builds separate horizontal apartments close to each other. They are perfectly smooth internally, but roughly finished on the outside. See No. II. Fig. 3 & 4: of both these species of cells the figures give an exact representation, both as to size and form.

The food provided by both species for their offspring is however exactly the same, namely *spiders* of every genus and species, chiefly however of those who do not fortify themselves by extensive webs. There is a common yellow spider which they collect in the greatest numbers. I have however observed both the Pennsylvanica and coerulea attack large spiders, in the midst of their webs and of the dead bodies of other insects which had fallen victims to them; especially in a remarkable instance: the sphex flew nimbly at the spider and stung him. He then retired to clean himself from the cobwebs. This he did in the manner of a fly, using his hind legs to wipe his wings, and his fore legs to his head. After several attacks the spider at last attempted to escape by letting himself down to the floor, by a thread. He then ran away, but his enemy followed him, and frequently stinging him attempted to carry him off: but the spider was too large and heavy; and though the sphex endeavoured to lighten his load by biting off the spider's legs, he could not succeed while I observed him, which was for at least half an hour.

The spiders thus collected are not killed; life enough seems to be still left to preserve them from putrefaction or drying. In all the cells which I have opened, they were in a languid state capable of motion, but not of crawling along. Nothing more cruel than their condition can well be conceived. They are closely and indiscriminately packed together, waiting to be devoured piecemeal by the young worm, for whose support they are destined. See No. I 4, & No. II. 4.

Each of the cells of the sphex, Pennsylvanica being separately contrived to enclose a sufficient number of spiders, they are separately made. But the sphex coerulea, having formed a long tube, crams into it as many spiders as he judges sufficient, and encloses them, together with an egg, by a cross partition of clay. He then puts a new head to the next cell and having filled it, encloses it as the first. Thus he proceeds to the amount sometimes of 4 or 5 cells in one tube.

The egg appears to be soon hatched after deposition, though I found it impossible to ascertain the time between the closing of the cell and the escape of the young sphex.

No. I. Fig. 3 & 4, exhibit the exact state in which I found two ranges of cells at Ripponlodge in Virginia. The cells were made at the back of a picture frame, from which I cut them carefully with a table knife. The figure shows the side next to the frame. Fig. 3, is an empty tube, ready to be divided into cells. Fig. 4 a, is the last filled cell of the other range. It is full of spiders, the worm having been just hatched, and eaten nothing. b. contains a worm more advanced which has consumed half his store. c. contains another in a still greater progress to maturity, which has but little provision left. Fig. 5, exhibits the worm, which after consuming all the stock of spiders, is prepared to spin its involucrum. Fig. 6, represents the chrysalis, broken. The dots exhibit its full size.

In the first range of the cells, No. I. Fig. 2; and in No. II. Fig. 3, are seen the holes by which the young sphex escapes. No. II. Fig. 4, shews the inside of two cells, carefully separated from the board on which they were built.

As I had always found the number of spiders in each cell unequal, but apparently regulated by their size, I opened a range of cells of the sphex Pennsylvanica, and having weighing the contents I found the result as follows. See No. III.

	grains.
The lowest contained 19 spiders and a small worm, which seemed lately hatched, and had eaten nothing. See Fig. I.—The spiders weighed	$7\frac{1}{2}$
The next contained 17 spiders and one empty skin, the worm, Fig. 2, weighed $\frac{1}{4}$ of a grain, the spiders	$6\frac{1}{4}$
The third contained 19 very small spiders and a few empty skins, weighing	$5\frac{3}{4}$
The worm, Fig. 3, weighed	$\frac{1}{2}$
The fourth contained only the empty skins of the spiders. The worm, Fig. 4, seemed lean and weak, he was just beginning to spin. I think he must have had a short allowance provided for him, or have been sick: he weighed	$3\frac{1}{4}$
The fifth contained an involucrum in which was a large grub not yet changed to a chrysalis. The involucrum and worm being heavier than the last, weighed	$3\frac{1}{2}$

The 6th and 7th cells were open at the point, the young sphex having escaped.

This examination proves that the sphex exercises a nice degree of judgment in the quantity of provision he lays up. For the cell No. 3. must have contained 22 or 23 spiders, and I have often counted only 6 or 7 in one, but they were of a large size. It also appears that the full-grown worm weighs about half as much as the food that reared him.

If it be further necessary to break the line which has formerly been drawn between reason and instinct, the economy of the whole class of hymenoptera, and especially of the sphex, will contribute towards it, I will relate a singular instance of conduct in which instinct appears to be out of the question.

In order to examine one of these insects (the Pennsylvanica) at work, I raised a picture frame a little from the wall. In doing this, I injured several of his cells, for the dirt sticking to the wall was torn off, and left holes in them, through which the spiders and young worms were visible. I kept the frame about an inch from the wall so as to see plainly behind it. In a few moments the sphex returned, bringing with him a round lump of clay. He had just begun a new cell, but seeing his former work disturbed, he ran rapidly over the cells, in apparent doubt what to do. At last he put down the clay on the margin of one of the holes, and began to spread it with his nose, pushing it out before him with the action of a hog which is rooting. While he did this he made a shrill buzzing noise. Having plaistered up the hole very perfectly and neatly, he flew away. In 4 minutes he returned with another lump of clay. He put it down at once by the next hole, and stopped it in the same manner. He repeated this four times, and having finished his repairs, and satisfied himself by ranging over the cells several times, he flew for another lump, with which he proceeded to compleat his new cell.

If reason be exhibited in the modification of conduct to unexpected circumstances, this surely was an instance of reasoning. The sphex saw the unexpected dilapidation of his work: it had happened in his absence: the clay he brought was for the new cell: seeing however, the injury done to his work, he thoroughly repaired the old cells, instead of building new ones.

For some insteresting notices concerning the insects which are the subject of the preceeding paper, see a communication by Mr. John Bartram, a member of this Society, in the Transactions of the Royal Society of London, vol. 43. No. 476, for the year 1745.

No. XVI.

Memorandum concerning a new Vegetable Muscipula. By Dr. Barton.

Read February 18th, 1803.

February, 16th, 1803.

The existence of an irritable principle in vegetables was denied by Haller, by Gaubius, and by Wolf, but has been completely demonstrated by the researches of many of the botanists. This principle is now found to pervade almost every part of the organized plant. It is particularly conspicuous in the stamens and pistils, or male and female organs of generation, in vegetables. With respect to these organs, it would indeed seem, that the irritability which they possess is almost entirely subservient to the function of generation.

In many vegetables, the irritable power is very remarkable, and some facts would lead us to believe, that it is accompanied by the sense of perception. The wonderful faculty of the Dionæa muscipula, one of the native plants of our country, is now pretty well known to every person who is studious of the interesting subject of vegetable physiology. Each leaf of the Dionæa is terminated by a glandular-like apparatus, which immediately closes upon, and retains, the insect that alights upon it. Something of the same kind has been discovered in different species of Drosera, or Sundew.

We are by no means acquainted with the extent of the irritable principle in vegetables. It will, doubtless, be found to pervade the vegetable structure much more generally than is now supposed. In particular, we may expect to discover instances of irritability in many vegetables, in which this attribute has not, hitherto, been observed. In the summer of 1801, I discovered a vegetable muscipula in the vicinity of Philadelphia. Having collected some branches, in flower, of the Asclepias syriaca, or Syrian Swallow-wort, well known in the United States by the names of Wild-cotton, cotton-plant, &c*; with the view of making some experiments with the milky juice of this plant, I was not a little surprized to find, in the course of a few hours, a number of the common house-flies strongly attached to the flowers; being secured, some by their proboscis, and others by their legs: the greater number, however, by their legs. I, at first, imagined, that the flies were merely retained by the viscous juice of the flowers of this Asclepias: but I soon found, that this was not the case They were detained by the small valves of the flower, and I observed, that the irritability of the valves seemed to reside exclusively in one particular spot, not larger than the point of a common sized pin. Neither in this spot nor in any other part of the valve, could I observe the least vestige of a glutinous or viscous quality. I think it sufficiently evident, that the valve is endued with the irritable principle.

In the genus Asclepias, the valves which I have noticed, are ten in number, being situated in pairs, so as to form five little *foveæ*, the structure and uses of which are not sufficiently known to the botanists.

A considerable number of flies, not less perhaps than sixty or seventy, which alighted upon the flowers of my Asclepias, were detained in the manner I have mentioned, a few by their proboscis, the greater number, however, by their legs; and a very few by their proboscis, and one or more of the legs. Many of the flies, particularly the larger ones, were enabled, after some time, to disengage themselves from their prison, without the loss of any of their limbs or organs, or any perceptible injury whatever. Many others effected their escape, not however, without the loss of one or more of their legs, or their proboscis. Not a few, after making long and repeated efforts to regain their liberty, perished in their vegetable prisons.

* This is a very common plant in every part of the United States, that I have visited; viz. from the latitude of 43 to that of 38. It is a vegetable of considerable importance; and, accordingly, it is cultivated, with much attention, in some parts of Europe. Paper, cloth, and other useful articles are made out of its stems, the silk-like matter in the follicles, &c. In Canada, a good brown sugar is procured from the nectar of the flowers. In the vicinity of Philadelphia, the plant flowers in June and July.

I cannot find, in any of the authors whom I have consulted, any mention of the curious property of the Asclepias syriaca, which I have described: and yet this is a very common vegetable, not only in America, but likewise in the old world. It is evident, however, from a passage in the *Genera Plantarum* of Mr. De Jussieu, that the fly-catching property of some species of Asclepias has been noticed, before me. In describing the *organa sexualia* of this family of plants, the learned French botanist has the following words: "An potiùs circumscripto sexu, non pro polline tantùm, sed pro antheris etiam habenda corpuscula quorum valvulas contrahunt distrahuntve cornua, vectium elasticorum more sæpé muscicapa, non aliis nata laboribus." I may add, that the flowers of the Apocinum androsæmifolium, a North-American vegetable, very nearly allied to the genus Asclepias, have been shown, by Dr. Darwin and other writers, to be endued with the property of catching insects.

It is a curious fact, which may be worth mentioning, in this place, that several of the *Contortæ*, or Contorted plants, to which the genera Asclepias and Apocinum belong, prove destructive to insects, in various ways. I shall not repeat what I have already said, concerning the two genera, just mentioned. It is a well-ascertained fact, that flies, mistaking it would seem (for instinct often errs) the peculiarly fetid flowers of the Stapelia variegata for putrid flesh, deposit their eggs upon the petals of this plant. As this is not a proper nidus for the eggs, the young ones, when hatched, soon perish. The common Rosebay, or Oleander (Nerium Oleander) is another of the Contorted plants. It has long been known, that this is a poisonous plant. But I do not know, that any person than myself has observed, that this fine vegetable proves very destructive to the common house-flies. These insects visit the Oleander, in order to drink the fluid secreted in the tube of its flowers. The liquor soon intoxicates them, and very few of those which have gained admittance into the blossom, ever return from it. So great is the number of flies destroyed, in the course of one season, by a single Oleander, that I have often thought it would be worth our while to pay more attention, than we yet do, to the cultivation of this vegetable; as, independently on its beauty, it is so well calculated to lessen the numbers of a most common and troublesome insect.

No. XVII.

On the Process of claying Sugar. By Jonathan Williams. Esq.

Read March 4th, 1803.

The art of refining sugar consists of three operations; the first is *clarification*, so well known in Pharmacy, by the addition of a coagulable substance, and a gentle application of heat. The second is *chrystalisation*, that is, evaporating the superabundant water by a strong application of heat; the third is merely washing away the colouring mucus from the chrystalised mass, by a gradual supply, and minute distribution of water. The last operation being alone the subject of this paper, it is needless to enter into a detail of the preceding ones, which are totally distinct from it.

The mould in common use is made in the shape of a cone, and perforated at its apex. It is placed in the fill-house in an inverted position, and filled from the coolers with the sugar partially granulated, but not sufficiently to separate the grains from the mucus; a great proportion being still held in solution by heat. In this state the mould remains all night, and in the morning is hauled up from the fill-house into a room above, where it is placed upon a pot, the apex of the cone entering the mouth of the pot. The sugar is now become cool, and forms a mass of grains and mucus; but care is taken to keep the room warm enough to prevent the too great inspissation of the mucus. The surface of the sugar at the base of the cone is made level, and having shrunk in consequence of the first running of the mucus, there is sufficient space within the mould to hold a quantity of clay, made, by a proper mixture of water, into a semifluid state, resembling thin paste. Part of the water, no doubt, will escape from the superior surface of the clay by evaporation; but by far the greater part will be distributed over the surface, and gradually descend through an immense number of interstices, forming little currents all over the mass of sugar; thus increasing the fluidity of the mucus, and favouring its descent towards the apex, where it issues in a single stream into the pot on which the mould stands. To give a more ready issue to the mucus at the apex, a perforation is previously made in the mass by a small spear, called a pricker.

At the end of several days this clay becomes a dry cake, being deprived of its water, in the manner above described: it is then removed, and fresh diluted clay being put into its place, the operation of washing the mucus from the chrystals recommences. This is repeated, till the loaf becomes sufficiently white, when it is taken from the mould, by gently striking its edge against a block which causes the loaf to fall into the hand; being then dried in the stove, it becomes ready for consumption.

It is evident that the water contained in the clay on the base of the cone must, in descending to its apex, go on relatively increasing, in proportion to the diminishing surfaces (that is, inversely as the squares of the diameters) through which it passes, till at last it all assembles at a point and is discharged through one hole. It is also evident, that these repeated operations of washing the mucus from the grains or chrystals of the sugar, dissolve and carry off a part of the sugar itself; it is accordingly found in practice, that by evaporating the water of the fluid that had filtred through the mass, more sugar may be obtained, but the mucus will of course bear a large proportion to the grains; these sirups therefore are generally mixed with the next boiling, and so on, till they at last run from loaves of the lowest quality (called *bastards*) and finally become treacle or molasses, which will no longer granulate.

The mould which was at first full, will now contain a loaf of white sugar, the solid contents of which is not more than half of what it was originally.

Let Fig. 4. Plate III, represent the section of a mould, in the shape of those at present in use, filled with sugar; it is evident, by inspection, that only so much of the mucus of the of the mass as does not exceed in diameter that of the hole at the apex, can descend in a right line, yet every drop in the whole mass must issue from the same aperture.

Let us suppose this mass to be divided into any number of strata;—it is evident that each stratum not only suffers the washing and consequent waste incident to itself, but must also be washed by the fluid issuing from all the strata above it. If then the water from the clay be just sufficient to wash the first stratum white, a further quantity must be added to whiten the second stratum, which has now beside its own, the colouring mucus of the first stratum increased in quantity by all the water that had been added; but this second supply of water must pass through the first stratum where it is not wanted, and here it must do the mischief of dissolving a part of the whitened sugar. The third stratum again has three times its own quantity, and thus the quantity of mucus accumulates in a series of proportionals, till the last stratum receives the colouring mucus of the whole mass, and all the water that had been added, if it be not before entirely dissolved. It must too be considered, that as the currents of mucus are descending along the sides of the cone, the loaf will constantly sink, endeavouring by its gravity always to keep in contact with the mould; and thus will be still more liable it to be dissolved by these currents.

If at the end of the operation, the loaf should be found only two thirds of its original height, one third of the number of strata must have been entirely dissolved; and as the vacant part of the mould will be at the base of the cone, the defficient strata will be those of the largest diameter; which shows a real deficiency of mass, much greater than at first sight might be imagined. It must be considered also, that the sugar thus returned to its former liquid state, will require to be evaporated by the application of great heat (no evaporation going on in the pot, its mouth being closed by the mould) which will inevitably deepen its colour; so that every operation of this sort makes the mucus darker and darker, till it becomes almost black, the known colour of molasses or treacle.

If proof of the latter fact were requisite, we need only look at the juice of the cane, which is nearly colourless, and would doubtless yield white sugar in the first instance, if the necessary operation of boiling did not make it brown.

Let Fig. 5 represent a cylindrical mould of the same base, and one third of the altitude of the conical one, Fig. 4; we know that the solid contents of these masses would be equal. It is evident then that the same quantity of sugar in the cylindrical mould would contain but one third the number of horizontal strata with that in the conical one, and consequently that the proportional series of accumulating mucus would extend to only one third the number of terms in the latter, that it did in the former case. It is evident also that every descending current would describe a right line, save only the little variations in passing round the chrystals; all the horizontal strata therefore being equal in diameter, none could receive any fluid laterally, but all would be able to support an equal quantity of water without any additional cause of dissolution, except the proportional series of the descending fluid, which, as before mentioned, would only extend to one third the number oft erms, and be unaffected with any increase from a constantly diminishing surface, as in the cone.

The plain consequence of this difference in the two masses is, that a greater quantity of undissolved sugar must be retained in the cylinder than in the cone, while the operation of whitening, that is of washing away the colouring mucus from the chrystals, is equally effected in both.

No attention is paid to the mere form of the loaf, because, as it is always broken into pieces before it can be used, the consumers would soon accommodate themselves to any one generally adopted: and for all purposes of packing, the cylindrical shape would be most convenient. But as it might be difficult to "knock out" from the mould a cylindrical mass without breaking it, so much deviation from this shape might be adopted in practice, as would favour this operation; the frustum of a cone therefore as Fig. 6, Plate III, nearly resembling the shape of a common flower pot, is recommended. Let the smaller diameter of this mould be its bottom, to be perforated with as many holes as the matter of which the mould is made will admit without breaking. Let a piece of leather or other flexible substance be prepared, somewhat larger than the bottom of the mould; let there be as many points or small spikes through this leather as there are holes in the mould, and so fixed that each point being within its corresponding hole when the mould is set, may be withdrawn when it is ready to be hauled up in the morning, by merely lifting the mould from it; the operator's feet being on the edges of the leather to keep it down. The mass then would be ready pricked, and this operation would be saved.

Instead of a pot, let this mould be placed over a deep dish like the bottom of a flower pot; 3 or 4 small knobs at the bottom of the mould, near the edge, would be sufficient to keep it above the mucus that would run into the dish, and leave a free circulation of air over the surface: by this means the evaporation of water from the mucus would be spontaneously going on while it is collecting, and instead of thin sirup to be boiled over again, a thick mass would be found already in part granulated.

To ascertain the reality of the improvement here proposed, the following experiment has been made.

Two moulds were prepared; one such as is in common use, with but one issue for the sirup, the other with many issues as above described. Equal quantities of sugar from the coolers were put into each, and both went through a like process in every respect. After being under clay the usual time the sugar was taken out and weighed.

The loaf of the first mould weighed six pounds two ounces, that of the second weighed seven pounds fourteen ounces, making a difference of twenty eight ounces in ninety eight; that is a saving (without any additional labour) of nearly twenty eight per cent. To this saving add the spontaneous evaporation from the surface of an open dish, which it is presumed would lessen the quantity of fluid, that would require another boiling, at least one half. The latter part of the experiment was not tried for want of convenient apparatus.

As the quantities of sugar in the moulds were determined by equal dips of a ladle only, there may have been some inaccuracy; but if the result in practice should give a saving of twenty per cent. or even less, the manufacturer will be amply repaid for changing the form of his moulds; especially as the decrease by breakage might be supplied by the new form, and thus eventually occasion very little additional expense.

No. XVIII.

An Account of some newly discovered Islands and Shoals, in the Indian Seas. By Mr. Thomas, an Officer on board the American Ship Ganges.

Read April 1st, 1803.

SHIP GANGES, Feb. 15, 1802.

AT 6 P. M. passed between two islands, lying W b N and E b S, per compass, which we supposed to be Egmont and Edgecomb islands, as seen by captain Carteret in the Swallow.

After running 25 leagues N b E $\frac{1}{2}$ E, passed by nine small islands entirely covered with wood, lying in a N W and S E direction; in length about 15 leagues. These islands were not seen by captain Carteret, nor are they laid down in the charts which we had, either of Robertson or Dalrymple, nor in any chart I have since seen. Being abreast of the northermost at noon, had a very good meridian altitude;—which made us in latitude 9° 44′ S. From distances of moon and stars east and west of her, taken 14 hours after leaving the land, I should lay them down in longitude 166° 43′ E. They are of a middling height, may be seen at the distance of 8 or 10 leagues, and have no dangerous rocks or shoals in their vicinity: having run so close in with the shore as to see the natives on the beech, and their huts, with the naked eye.

Egmont Island is very erroneously laid down by captain Carteret, in 11° 00′ S. & 164° 50′ E. From my observations, which I had a good opportunity of making, and which may I presume be considered as tolerably correct, I should lay it down in 10° 50′ S. and 166° 10′ E.

MARCH 3d, 1802.

At 8 A. M. made several small low islands, distant about 6 or 7 miles: they are very dangerously situate, being level with the water, and if it were not for a few cocoa-nut trees growing on them, it would be impossible to see them 3 leagues off, on the clearest day. They lie in a N W and S E direction, about 7 leagues long; and are entirely surrounded with rocks. A reef extends from the N W part into the sea about 6 miles, over which the sea breaks very high: there are but very few dry spots on the whole of them; they consist of white sand and coral. I make the northern extreme to lie in 9° 55′ N. and the southern in 9° 38′ N. Longitude of the middle of the shoal, from observations of sun and moon, 161° 26′ E.

SEPTEMBER 7th, 1802.

At midnight made a shoal not twice the ship's length off, and steering right for it; immediately wore, and stood to the N W till day light; then stood to the S E, in order to survey the shoal. At 9 A. M. made the S W part, distant about 3 miles, and run along the N E part of it at the distance of one mile, or a mile and a half: it runs about N E and S W 16 or 18 miles in length, and about 1½ in breadth; the N E part is the broadest, and on this part was the only dry spot I could see from the mast head. Some large drift-wood lying on it, had much the appearance of black rocks.

It is a very dangerous shoal, and can not be seen until you are very near it. From good observed distances of the sun and moon, which I had the same afternoon, and good meridian altitudes that day and the day after, when in sight of the shoal, I have been able to ascertain its situation with tolerable correctness viz:

	° ′	° ′
The S W. extreme,	Lat. 2 52 N.	Long. 131 07 E.
The N N. extreme,	Lat. 3 06 N.	Long. 131 23 E.

These are all in the usual course to and from China, of ships going round New Holland, and returning by the eastern passage.

No. XIX.

FIRST Report of Benjamin Henry Latrobe, to the American Philosophical Society, held at Philadelphia; in answer to the enquiry of the Society of Rotterdam, "Whether any, and what "improvements have been made in the construction of Steam-"Engines in America?"

Philadelphia, 20th May, 1803.

Gentlemen,

THE Report due from me to the Society, in consequence of the enquiry made by the Society of Rotterdam, as to the improvements made in America, in the construction of steam-engines, would have been laid before you at a much earlier period, had it not been my wish to submit several American alterations in the construction of steam-engines, which promised to be very valuable improvements, to the test of experience: and this delay has not been without its use; for it has been discovered that some of our innovations, the theory of which appeared to be very perfect, have proved extremely deficient in practical utility.

In this first report I will therefore confine myself to such improvements as have had a fair trial, in engines actually at work.

Steam-engines, on the old construction, were introduced in America above 40 years ago. Two, I believe, were put up in New-England before the revolutionary war; and one, (which I have seen) at the copper-mine on the river Passaick, in New-Jersey, known by the name of the Schuyler-mine. All the principal parts of these engines were imported from England. With the Schuyler-mine engine, Mr. Hornblower, the uncle of the younger Hornblower, who is well known as a skillful and scientific engine-builder, and whose calculations on the power of steam are extremely useful, came to America. He put up the engine, which at different times has been at work during the last thirty years, and which, notwithstanding its imperfect construction, and the faulty boring of its cylinder, effectually drained the mine.

During the general lassitude of mechanical exertion which succeeded the American revolution, the utility of steam-engines appears to have been forgotten; but the subject afterwards started into very general notice, in a form in which it could not possibly be attended with much success. A sort of mania began to prevail, which indeed has not yet entirely subsided, for impelling boats by steam-engines.—Dr. Franklin proposed to force forward the boat by the immediate action of steam upon the water. (See his Works). Many attempts to simplify the working of the engine, and more to employ a means of dispensing with the beam, in converting the Libratory into a rotatory motion, were made. For a short time a passage-boat, rowed by a steam-engine, was established between Bordentown and Philadelphia: but it was soon laid aside. The best and most powerful steam-engine which has been employed for this purpose, excepting perhaps one constructed by Dr. Kinsey, with the performance of which I am not sufficiently acquainted, belonged to a few gentlemen of New-York. It was made to act, by way of experiment, upon oars, upon paddles, and upon flutter wheels. Nothing in the success of any of these experiments appeared to be a sufficient compensation for the expense, and the extreme inconvenience of the steam-engine in the vessel.

There are indeed general objections to the use of the steam-engine for impelling boats, from which no particular mode of application can be free. These are: 1st, The weight of the engine and of the fewel. 2d, The large space it occupies. 3d, The tendency of its action to rack the vessel and render it leaky. 4th, The expense of maintenance. 5th, The irregularity of its motion, and the motion of the water in the boiler and cistern, and of the fuel-vessel in rough water. 6th, The difficulty arising from the liability of the paddles or oars to break, if light; and from the weight, if made strong. Nor have I ever heard of an instance, verified by other testimony than that of the inventor, of a speedy and agreeable voyage having been performed in a steam-boat of any construction. I am well aware, that there are still many very respectable and ingenious men, who consider the application of the steam-engine to the purpose of navigation, as highly important, and as very practicable, especially on the rapid waters of the Mississippi; and who would feel themselves almost offended at the expression of an opposite opinion. And perhaps some of the objections against it may be obviated. That founded on the expense and weight of the fuel may not, for some years, exist on the Mississippi, where there is a redundance of wood on the banks: but the cutting and loading will be almost as great an evil.

I have said thus much on the engines which have been constructed among us for the purpose of navigating boats, because many modes of working and constructing them have been adopted which are not used in Europe. Not one of them, however, appears to have sufficient merit to render it worthy of description and imitation; nor will I, unless by your further desire, occupy your attention with them.

The only engines of any considerable powers which, as far as I know, are now at work in America, are the following. 1st, At New-York, belonging to the Manhattan Water-Company, for the supply of the city with water. 2d, One at New-York, belonging to Mr. Roosevelt, employed to saw timber. 3d, Two at Philadelphia, belonging to the corporation of the city, for the supply of the city with water; one of which also drives a rolling and slitting mill. 4th, One at Boston, of which I have been only generally informed, employed in some manufacture. In my second report, I will notice the improvements made by the very ingenious Dr. Kinsey, who has erected, at New-York, an engine upon a new principle which is intended to be used in the supply of that city with water; should it on experiment, be found to answer the intended purpose. He has made other improvements in the construction of steam-engines, of which I shall also give you some account. Nor ought I to omit the mention of a small engine, erected by Mr. Oliver Evans, as an experiment, with which he grinds Plaister of Paris; nor of the steam-wheel of Mr. Briggs.

1st. The Manhattan company's engine at New-York, is upon the principle of Bolton and Watt's double engines, without any variation. It has two boilers; one a wooden one, upon the construction of those first put up in Philadelphia, the other of sheet iron, on Bolton & Watt's construction. The fly-wheel is driven by a sun and planet motion, and the shaft works three small pumps with common cranks.

2d. Mr. Roosevelt's engine has all the improvements which have been made by the joint ingenuity of Messrs. Smallman & Staudinger, with the assistance of the capital and intelligence of Mr. Roosevelt; and which have also been adopted to the engines, belonging to the water-works at Philadelphia.

3d. The engines at Philadelphia, independently of these improvements, act also upon a pump, the principal of which, though not new, has never before, I believe, been used upon a large scale; and which is worthy of being particularly described.

I shall now proceed to describe these *innovations*, for experience does not permit me as yet to call them all *improvements*, although I have no doubt, but that they will furnish hints of use to bring the steam-engine to greater perfection.

1st. THE WOODEN BOILER.

Wooden boilers have been applied in America to the purpose of distilling for many years. Mr. Anderson, whose improvements in that art are well known, appears to have first introduced them in America. But it was found that the mash had a very injurious effect upon the solidity of the wood: for while the outside retained the appearance of soundness, and the inside that of a burnt, but hard surface, the body of the plank was entirely decayed. It was however still to be tried,

Fig. 1.

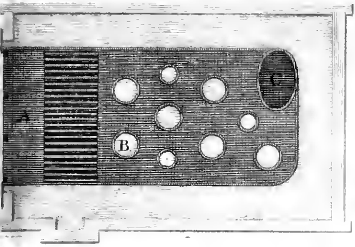
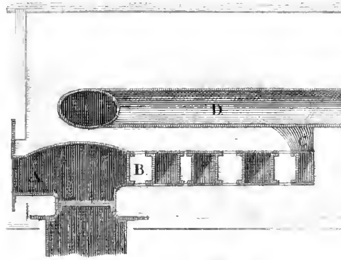


Fig 2.



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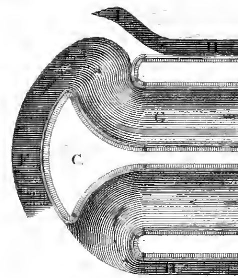


Fig. 4.

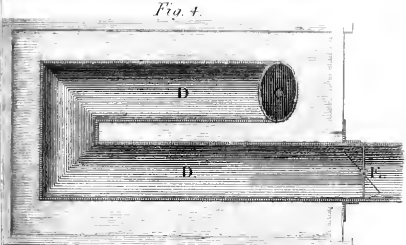
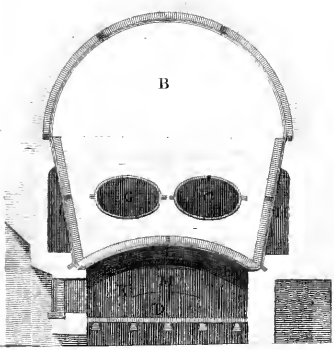
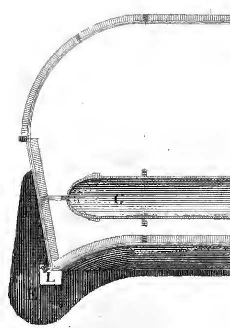


Fig. 6.



Fig



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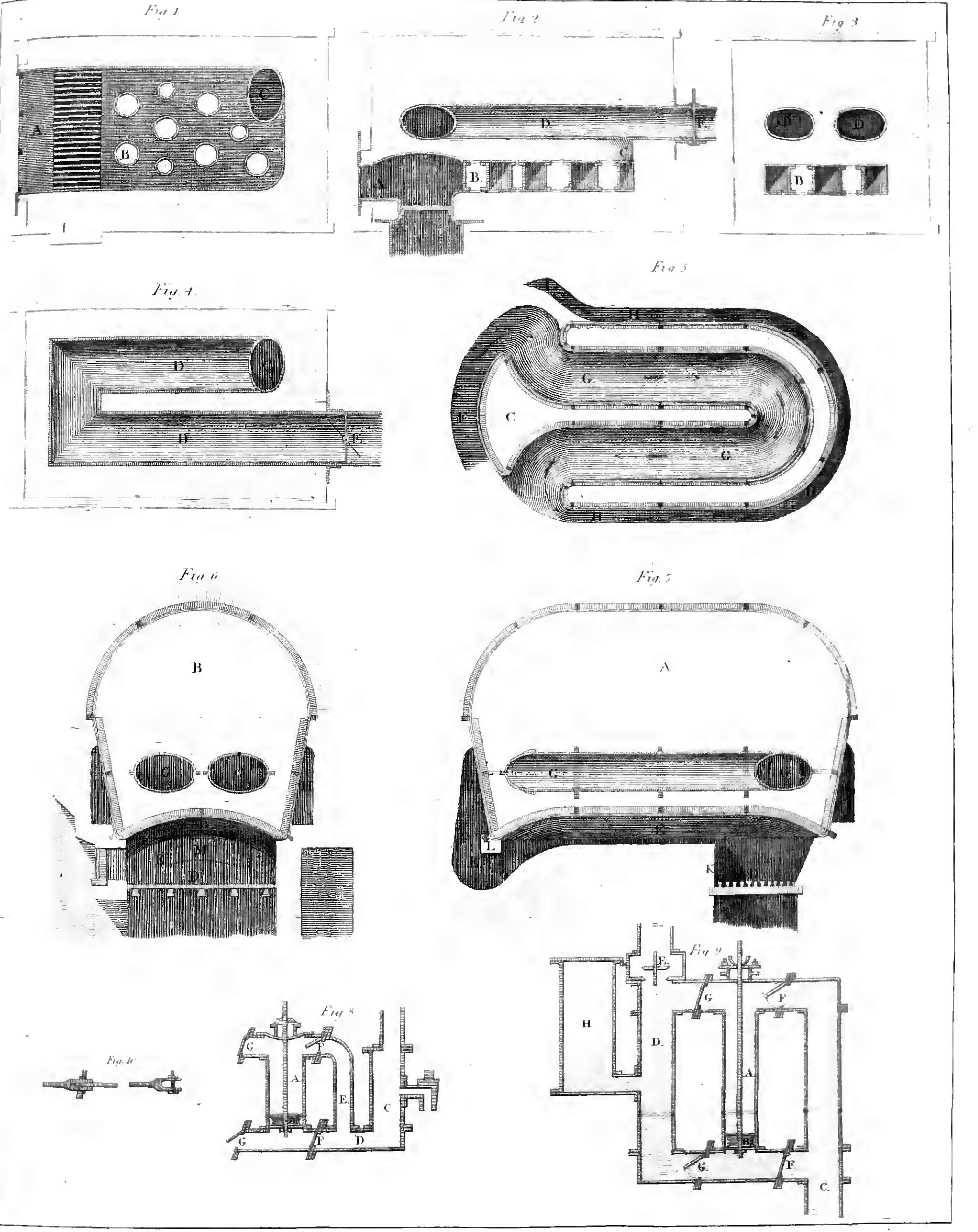
Wooden boilers have been applied in America to the purpose of distilling for many years. Mr. Anderson, whose improvements in that art are well known, appears to have first introduced them in America. But it was found that the mash had a very injurious effect upon the solidity of the wood: for while the outside retained the appearance of soundness, and the inside that of a burnt, but hard surface, the body of the plank was entirely decayed. It was however still to be tried,

Plate 2.



whether simple water and steam, would have the same effect; and upon the hint of Chancellor Livingston, our present Ambassador in France, Messrs. Roosevelt Smallman and Haudinger contrived the wooden boiler, which has been used for all the engines in New York and Philadelphia; and not without its great, though only temporary, advantages. The construction of the wooden boiler, will be best understood, by reference to the plan and section of the new boiler of the engine in Center-square, Philadelphia, which is by far the best of those which have been made. It is in fact only a wooden chest containing the water, in which a furnace is contrived, of which the flues wind several times through the water, before they discharge themselves into the chimney.

In the plan and section, Plate II, Fig. 1, 2, 3, 4, A is the furnace, B B B, are upright cylinders, called heaters, among which the fire passes, heating the water within them, and which, at the same time, support the roof of the fire-bed, or lower passage of the flame to the flues. C, is the take-up, or passage from the fire-bed to the flues. D the upper flue through which the fire passes from the take-up to the register E, when it enters into the chimney.

This boiler differs from the others, in the addition of the upright cylinders of the fire-bed, and in the elliptical form of its flues. The merits of this boiler are—that as the wood, in which the water is contained, is a very slow conductor of heat, a great saving of fuel is thereby effected; especially, as an opportunity is afforded, by means of the cylindrical heaters and of the length of the flue, to expose a very large surface of iron containing water to the action of the fire. An idea of of this saving may be formed, by the quantity of coal consumed by the engine in the Center-square, which is a double steam-engine, the diameter of whose cylinder is 32 inches. The power of this engine is calculated to answer the future, as well as to supply the present wants of the city; it is therefore kept irregularly at work, filling, alternately, the elevated reservoir, and stopping during the time which is occupied by the discharge of the water into the city. It may, however, be fairly rated to go at the rate of 12 strokes, of 6 feet, per minute, for 16 hours in 24, during which time it consumes from 25 to 33 bushels of Virginia coals of the best sort. Of the amount of the saving, I cannot venture to make an estimate; on account of the great variety of coal with which we are supplied, much of which is of a very indifferent quality. That there is a great saving is certain; and while the wooden boilers continue stream-tight, (for that part which contains the water gives no trouble) they are certainly equal, if not superior, to every other. The wood, however, which is above the water, and is acted upon by the steam, seems to loose its solidity in the course of time; and steam-leaks arise in the joints, and wherever a bolt passes through. The joint-leaks may for a considerable time, be easily stopped, by screwing up the bolts that hold the planks together; but it is not so easy to cure the bolt-leaks; for the bolt, when screwed up, bends the top or the sides inwards, and forces new leaks, either along the corners, or at some other bolt-hole. I do not, however, believe, that every thing has as yet been done, which could be done, to obviate these defects. A conical wooden boiler hooped would not be subject to some of them: such a one has been applied by Mr. Oliver Evans to his small steam-engine. During two years, which have elapsed since the boilers of the public engines have been erected, much has been done to improve them. Whether the last boiler will prove as perfect in its wood-work, as it is in its furnaces and flues, is still to be ascertained by experience. At present nothing can work better.

I will only mention one other circumstance, the knowledge of which may prevent similar mischief.—In the first boiler erected in Philadelphia, oak timber was used to support the sides, bottom, and top of the boilers, the plank of which was white pine, 4 inches thick. In less than a year it was discovered, that the substance of the pine plank, to the depth of an inch, was entirely destroyed by the acid of the oak. Means were then used to prevent its further action, by the intervention of putty and pasteboard; and in most cases by substituting pine timbers in the room of those of oak.

CAST-IRON BOILER.

Within the last few months, a cast-iron boiler has been put up, at the lower engine, which hitherto exceeds the expection, I had formed of the facility with which steam is raised and supported by it. The engine is a double steam-engine, of 40 inches cylinder, and 6 feet stroke. The boiler has straight sides, and semicircular ends; it is 17 feet long, and 8 feet wide at the bottom; and nineteen feet long, and 10 feet wide at the height of 5 feet 7 inches. At this height, it is covered by a vault; which, in its transverse section, is semicircular; and in its longitudinal section exhibits half of its plan. The bottom is concave every way; rising one foot in the center. The fire-place is 6 feet long, and at an average 4 feet wide; and is under one extreme end of the bottom. The fire-bed is arched, parallel with the bottom, leaving a space of one foot high, for the passage of the flame. At the end opposite to the fire-place, the flame descends along the bottom of the boiler, and, passing under an arch of fire-bricks, which protects the flanch of the bottom, strikes the side of the boiler at its extreme end. Here it enters a flat elliptical flue, which, passing into the boiler, follows its form, returning again and coming out near the place at which it entered. The entering part of the flue is separated from the returning flue, by a partition of fire-bricks. The flue, on coming out of the boiler, turns short round, and is carried round the whole boiler until it enters the chimney; as will be more clearly shewn by referring to Plate II. Fig. 5,6, 7; the same letters on each figure referring to the same things. Fig. 5. C, a horizontal section of the boiler, through the center of the flues. Fig. 6. B, a transverse section of boiler at the fire-grate. Fig. 7. A, a longitudinal section. Fig. 6, 7. D, the fire-bed. K, a bridge-wall nine inches thick, over which the fire passes to the passage E, under the bottom of the boiler, being parallel both ways with the same. Fig. 7. L an arch of fire-bricks to support and protect the flanch from being melted by the heat. Fig. 6, 7. The fire passes from D, through the passage E, under the arch L, Fig. 7, to the take-up E, Fig. 5, 7, where it enters the upper flue G, Fig. 5, 6, 7, which passes through the boiler. H, the flue round the outside of the boiler, wherein the fire is carried until it enters the chimney at I, Fig. 5. The whole boiler is tied together internally by numerous braces, Fig. 10, which are forked and bolted together upon the flanches, and are indispensable to prevent the boiler from bursting. The flanches and joints of the castings are represented Fig. 6, 7.

The boiler is composed of 70 plates of iron, cast with flanches, and bolted together, so that the flanch and bolts are within the water of the boiler wherever the flame touches it; otherwise they would be burned off in a few days. The pieces are so contrived as to be of only 12 different patterns. This boiler consumed 50 bushels of coal, and ½ a cord of wood, while rolling iron 12 hours, at 20 strokes per minute, and pumping water 6 hours, at 12 strokes per minute.

I will only further observe, that this boiler requires a very active fire-man; and it is my opinion, that if it were 3 feet longer, a more moderate fire would raise the same steam and consume less fuel. The permanence of this boiler renders it very superior to the wooden one; and the difference of the consumption of fuel in each, in proportion to the size of the engine, is not great.

The further improvement of the engine itself consists in a new application of an improved construction of the air-pump. I will first remark, that by the air-pump of Bolton and Watt, the condenser is only once emptied, of its water of condensation and of the air produced, in every stroke. The superiority of our air-pump consists in its evacuating the condenser twice at every stroke, thereby creating a much better vacuum, and of course adding considerably to the power of our engine in proportion to the diameter of its cylinder without encreasing friction. The drawing, Plate II, Fig. 8, will best explain the construction of this pump.

A, is the pump-barrel. B, the piston which is solid. C, the condenser. D, a pipe of connection between the condenser and the lower chamber of the air-pump. E, a pipe of connection with the upper chamber of the air-pump. F, valves opening towards the air-pump. G, discharging-valves into two hot-wells. The head of hot-water suffered to remain on these valves must be moderate, or they will refuse to open; for it must be remarked, that great part of the contents of the air-pump is an elastic gaz, which suffers compression and is not expelled, if the weight on the valve be too great. The action of this air-pump is evident from the drawing. The expulsion of the contents of each chamber creates a vacuum in the other, which draws in the contents of the condenser; and thus they act equally and alternately, agreeing in their operation with the alternate condensation of the steam in the opposite chambers of the cylinder. Experience proves this to be a real improvement.

The principle which has been applied to the construction of the air-pump, is that upon which the main pump of our water-works is constructed. A section of this pump is annexed which perfectly explains it.

This pump has so many advantages that, had the corporation of 1800 permitted its disadvantages, (of which I shall presently speak,) to be remedied by the means then proposed, I have no doubt, but that I might now recommend its general adoption, wherever a double steam-engine is used for pumping. The drawing in Plate II, Fig. 9, will explain its construction; A the working barrel. B the piston. C the feed-pipe. D the rising main pipe. F the valves which supply the working barrel. G discharging valves in the ascending pipe. H the air-vessel—The valve E, in the rising pipe, and the air-vessel H, are not added to our pumps. The want of one or other of them, has these disadvantages: as long as the engine makes only 11 or 12 strokes per minute, no inconvenience whatever is perceived in the working of the pumps. But in the engine in the center-square, which raises the water in an 18 inch pipe 51 feet, and which has less redundant power than that on Schuylkill, the attempt to work faster than 12 strokes per minute is vain; and, as it appears to me, from two causes: 1st, whenever the piston is at its utmost ascent or descent, and makes a momentary stop, the whole column of water follows the shutting valve, acquiring momentum as it falls. The range of our valves is 16 inches, the column therefore descends at an average 8 inches. It weighs near 3 tons, and to open the opposite valve against the momentum of such a column, gives the engine a shock that seems to endanger every part of it. In endeavouring to work with its full power at a speed of 20 strokes a minute, this shock is so severe, as to occasion a very perceptible stop in the return of the stroke, during which the water of condensation mounts into the cylinder. Two methods were proposed to remedy this inconvenience, which amounts to a perfect uselessness of more than $\frac{1}{3}$ of our power. 1st, to place a large plug-valve E, Fig. 9, in the rising pipe close to the pump, having as much water-way through its seat at a very small rise, as the whole pipe. This valve would shut instantaneously at the end of the stroke, catching the falling column of water, and nothing would oppose its immediate return. 2d, to place an air-vessel so as to act on the whole column. By this means the fall of the water would be entirely prevented.

I regret that though this apparatus was provided, and could easily have been put up, in the course of a few days, circumstances prohibited the trial of them, and that I can only submit them as projects.—Could this pump be used with the same speed as the single pump, one half of the power of every double pumping engine, which works a single pump, would be saved; for the beam would need no counterpoise, and all the expense and friction of a second pump, where two are employed to balance each other, would be avoided.

I hope shortly to deliver you a second report on this subject,—and am with true respect yours.

Read May 20th, 1803. B. HENRY LATROBE.

Since the above was read in the Society I have constructed another and much larger iron boiler on this plan, the former having fully answered my expectation. In the new boiler I have passed the fire through a second flue above the other, which is immersed in the steam only, from which I promise myself great advantage. B. H. L.

The wooden boiler above described was planned and the erection of it commenced in July, 1801. The cast-iron boiler was projected in the latter end of January 1803.

No. XX.

Account of the fusion of Strontites, and volatilization of Platinum, and also of a new arrangement of apparatus. Communicated by Robert Hare, junr. member of the Society.

Read June 17th, 1803.

IT is known, I believe, to some of the members of the Philosophical Society, that a memoir on the supply and application of the blowpipe, which I had presented to the Chemical Society, was published in the commencement of last summer*. This memoir contains a description of a machine, termed an *hydrostatic blowpipe,* calculated to confine or propel the gases, for the production of heat, or other purposes; also an account of some experiments, in which by a concentration of caloric, till then unattained, substances were fused, which had been before deemed infusible. It was mentioned that alumine, silex, and barytes, were found susceptible of rapid fusion, and that the fusion of lime and magnesia, though extremely difficult, was yet, in a few instances partially attained. Platinum was described, as not only susceptible of fusion, but even of volatilization.

Being induced, last winter, to reinstate the apparatus, by which these experiments were performed, I was enabled to confirm my judgment of the volatilization of platinum, by the observation of Drs. Woodhouse and Seybert; for in the presence of these skilful Chemists, I completely dissipated some small globules of this metal, of about the tenth of an inch in diameter. In fact, I found platinum to be equally susceptible of rapid volatilization, whether exposed in its native granular form, or in that of globules, obtained from the orange coloured precipitate of the nitro-muriatic solution, by the muriate of ammoniac.

* Republished in the 14th volume of Tillock's Philosophical Magazine, and also in the annales de Chimie vol. 45.

About the same time, I discovered Strontites to be a fusible substance; for, having obtained a portion of this earth pure, from a specimen of the carbonat of strontites of Argyleshire in Scotland, I exposed it on charcoal to the flame of the compound blowpipe, after the manner described in my memoir above alluded to*. It became fused into a blackish semivitrious mass, in shape somewhat semiglobular.

In the performance of these and other experiments, I was associated with Mr. Benjamin Silliman, a gentleman of science and ingenuity, who had a short time before been elected Professor of Chemistry and Natural History, in Yale College, Connecticut.

In the course of our operations, having occasion for large quantities of the gases, we became desirous of avoiding the inconvenience of lading water in and out of the pneumatic tub, as this fluid rose or fell, in consequence of the filling or emptying of large air-holders and jars. This induced us to design an apparatus wherein this evil was avoided, and in which the pneumatic tub and hydrostatic blowpipe were united. This apparatus has since been executed by Mr. Silliman, in the laboratory of Yale College: and, as it proves to be convenient in operations requiring large quantities of the gases, I think it not improper to lay a drawing and description of it before the society. The drawing differs a little from the original, in the arrangement of parts, where alteration is obviously advantageous.

As the apparatus to be described, is little else than an union of the hydrostatic blowpipe, and pneumatic tub, it will of

* In that memoir I ventured to distinguish this flame by the word gaseous. This appellation has been objected to, as not sufficiently distinctive—an objection since rendered valid, by the discovery of the gaseous oxide of carbon, which had been confounded with hydrogen; and also by the consideration, that it does not distinguish between the flame of the hydrogen and oxygen gases when perfectly pure, and when contaminated by other substances held in a state of solution or mixture.

Certainly the term gaseous is equally applicable to the flame of the gaseous oxide, and to that of hydrogen gas; but it is equally certain that it was in direct opposition to the theory now almost universally received, that the editors of the New-York Medical Repository, declared all flame to be essentially gaseous: for it is well known that, with an exception for the combustion of the permanently elastic fluids mentioned above, flame is not ignited gas, but ignited vapour. However, as the term was badly chosen, I have written in the place of it, flame of the compound blowpipe, the propriety of which will appear from an inspection of the instrument by means of which the flame is supported, (See plate III. Fig. 2) course be easily understood by every one, who is acquainted with those machines. The pneumatic tub is necessarily familiar to every chemist; and for an explanation of the hydrostatic blowpipe, I beg leave to refer to my memoir before mentioned.

There is a transparent representation of the apparatus at Fig. 1, Plate, III. It consists of an oblong tub A, containing two chests B, C, which are open at bottom, and completely air-tight every where else. One of these chests B, is double the size of the other; and is divided by the air-tight partition K K, into two compartments. Thus three air-cells are formed, one by the smaller chest C, and two by the larger one B. These last mentioned cells communicate with the open air by means of cocks and pipes a, b, The other cell communicates with the air by means of the cock c.—At D, E, F, three circular bellows may be observed, each furnished with a suction-pipe, and pipe of emission. The suction-pipes may be observed at d e, f g, h i, severally entering their respective bellows; and the pipes of emission may be seen at k l, m n, o p, each issuing from the bottom of the bellows to which it appertains. The orifices of the pipes of emission k, m, p, under the air-cells, and those of the suction-pipes within the bellows, at e, g, i, are furnished with valves opening upwards. The bodies of the bellows consist of hose-leather sewed water-tight, and distended by iron rings. They are nailed to the bottom of the tub, and to circular pieces of wood, which constitute the tops of the bellows. These tops are loaded with several pounds of lead, which keeps them depressed, when they are not elevated by means of the handles and rods. The table is affixed to the tub, by means of hooks and staples, so that it may be removed at pleasure.

At G H I, H I, pipes of delivery may be observed. These are furnished with cocks at H H, and conical mouths at I I. which last, are calculated for the insertion of an adjutage, for the purposes of an ordinary blow-pipe; or for the reception of the compound blowpipe at Fig. 2.

In order to prepare this apparatus for use, let the cock of the air-cell behind the partition K K, be closed, and let all the rest be open. Then let as much water be poured into the tub, as will rise half an inch above the surface of the chests, and fill all the jars of the apparatus. The two air-cells whose cocks remained open, will now be filled with water, because the air had liberty to pass out of them: but the air-cell behind the partition K K, will remain empty of water, because, as its cock was closed, the air was confined, and the entrance of the water thereby prevented. The air-cell thus unoccupied by water, for the sake of distinction, I term the *regulator;* the propriety of which will be seen presently.

In operating with the common pneumatic tub, as the large jars and air-holders become filled with gas, it is necessary to lade out of the tub, the water displaced from them, as it would otherwise rise so high, as to overflow; and to float, and overturn the jars, no longer holding water. But in this new apparatus, this inconvenience is avoided, by allowing an escape of air from the regulator, adequate to the descent of water from the jars. For as this air, is necessarily subjected to hydrostatic pressure; it will escape if the cock a be opened, and a proportionate quantity of water, will subside into the regulator. When the jars and air-holders, are again filled with water, there would be a deficiency of this fluid, were not that which had been allowed to subside into the regulator, again expelled therefrom, by the action of the bellows at D. By the extension of these bellows, which is effected by means of their handle and rod, the valve of the pipe of emission at k, shuts; that of the suction-pipe at e, opens, and the air enters the bellows. The hand being removed from the handle, the lead on the top of the bellows depresses them; and the air within being compressed, shuts the valve of the suction-pipe, opens that of the pipe of emission at k, and enters the regulator, from which it expels a quantity of water equal to the bulk which the bellows gained by extension: and as all this is repeated at every stroke of the handle, it follows, that the water which had been allowed to subside into the regulator, may be quickly expelled therefrom.

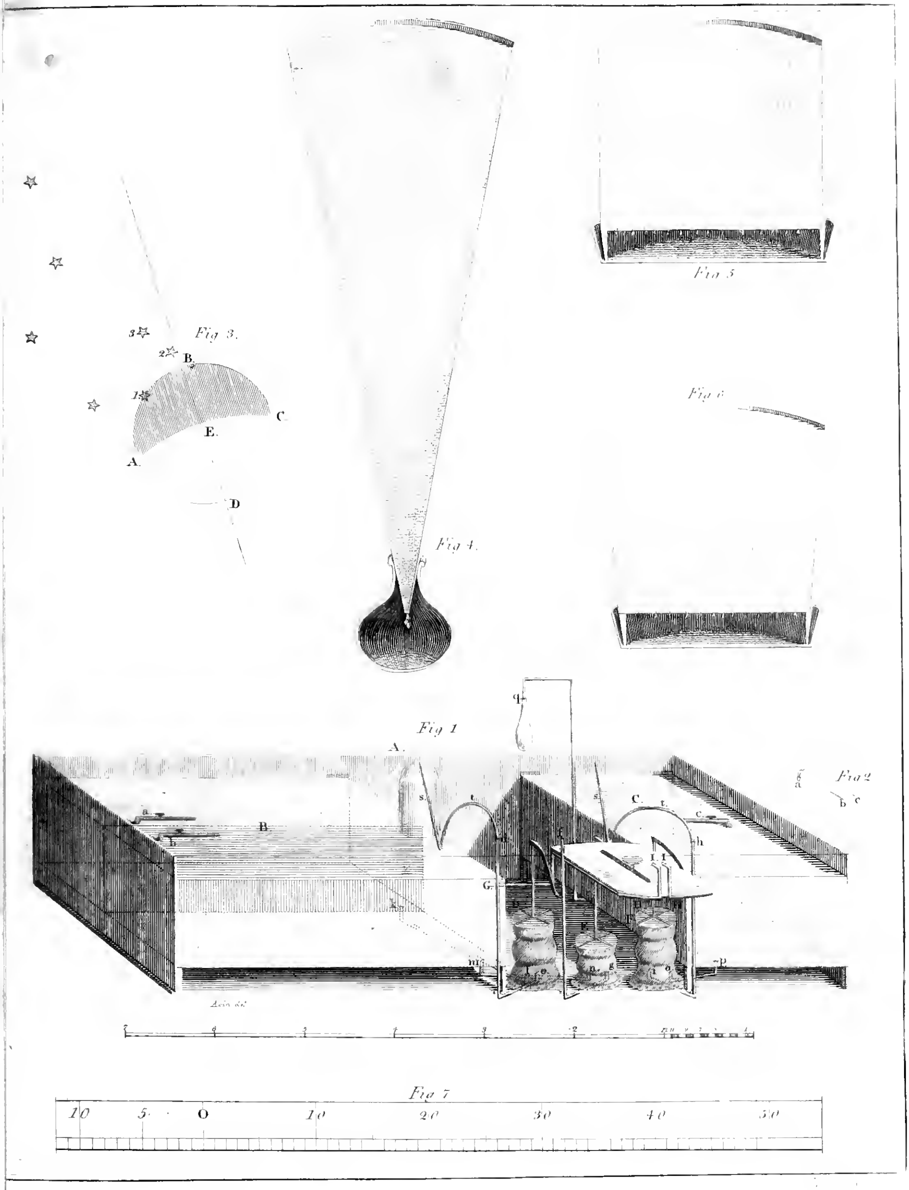


Fig 3.
3
2
1
B.
C
E.
A.
D
Fig 4.
Fig 5
Fig 6
Fig 1
A.
B.
a
b
s.
t
C.
t.
c.
h
G.
I. I
q
m
p
Fig 2
a
b
c
Fig 7
10
5
O
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20
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40
50

The air-cell formed in front of the partition K K, and that constituted by the smaller chest C, are used to contain factitious air; especially to confine sufficient quantities of the hydrogen and oxygen gases, for the production of intense heat, or the composition of water. As the contamination of hydrogen gas with atmospheric or pure air, might be attended with dangerous consequences, the air-cell constituted by the chest C, should be employed for this gas; as its separate situation, renders it secure from this danger. In order to prepare these cells for the reception of the gases, all the atmospheric air should be allowed to pass out, so that they may be completely filled with water. When they are to be filled with gas, the syphons s s, annexed to the hoses t t, inserted into the suction-pipes at d h, must be passed into the jars; and the bellows E, F, must be extended. The air of the jars will be drawn into the bellows, and from thence be expelled into the air-cells, from which it will displace an equal bulk of water. But, lest the expulsion of the water from the cells should cause it to rise too high in the tub, and to overflow; a correspondent depression should be effected in the mean-time, by the escape of air from the regulator.

Gas may also be made to pass into the cells immediately from the retort, bottle, or matrass made use of in obtaining it without the intervention of the bellows, for if an elastic fluid be generated in the matrass at q, it must of necessity pass thro' the syphon inserted therein, and enter the air-cell at r.

It must be obvious, that as long as the chests are covered with water, any gases contained in the air-cells, will be subjected to hydrostatic pressure, and that of course when the cocks H H, are open, they will be propelled through the pipes of delivery, and pass out through any adjutages, inserted into their conical mouths at I, I.

If the upper parts of the chests C, D, E, F, be made of thick plank, they may be used as shelves to support the jars; as the thickness of the plank, will alone depress the aëriform fluid contained in the cells, sufficiently below the surface of the water, to afford the necessary pressure. But if from any cause, the pressure be not great enough, the chests should be depressed until it becomes so; and the tub should be furnished with shelves at the usual height, to support the jars. Having subjected the gas in the cells to sufficient pressure, the velocity of efflux must be regulated by opening the cocks more or less. For this purpose, the perforations in the keys should be narrow and oblong; so as to admit of a gradual increase, or diminution, of the quantity of gas emitted.

The compound blowpipe represented by Fig. 2, consists of two common brass blowpipes whose points are made to meet in a perforation in the conical frustum of silver a. Now if the orifices b, c, of these pipes, be inserted into themouths I, I, of the pipes of delivery, it is obvious, that on opening the cocks H, H, any gases contained in the cells from whence these pipes issue, will be forced through them by the pressure of the water in the tub, and will meet in a point within the frustum. When the hydrogen and oxygen gases are thus made to meet, and are ignited, that intense heat is produced, by means of which I was enabled to accomplish the fusions, mentioned in a former part of this paper. But all this is fully explained in my memoir, to which I have so frequently referred, in the course of this communication.

It seems not improper to subjoin, that when the frustum of the compound blowpipe a, Fig. 2, is inserted into a receiver, and a supply of the hydrogen and oxygen gases is supported by means of the hydrostatic blowpipe, or the apparatus described in this paper, very convenient means are afforded of recomposing water—an operation of so much importance to modern chemical theory, that it can never become obsolete, or uninteresting to the cultivators of science. The advantage of the method consists in this, that the gases mix in the frustum before they become ignited, and must enter into the receiver in a state of combustion. This therefore is not dependent on the quantity of azot, or other noxious gas collected in the vessel; and as the burning gases may be made to enter under the pressure of a considerable column of water, the impure air, collected during the process, may be forced out through a tube into a mercurial apparatus; the operation may continue as long as desired, and the proceeds may be examin-

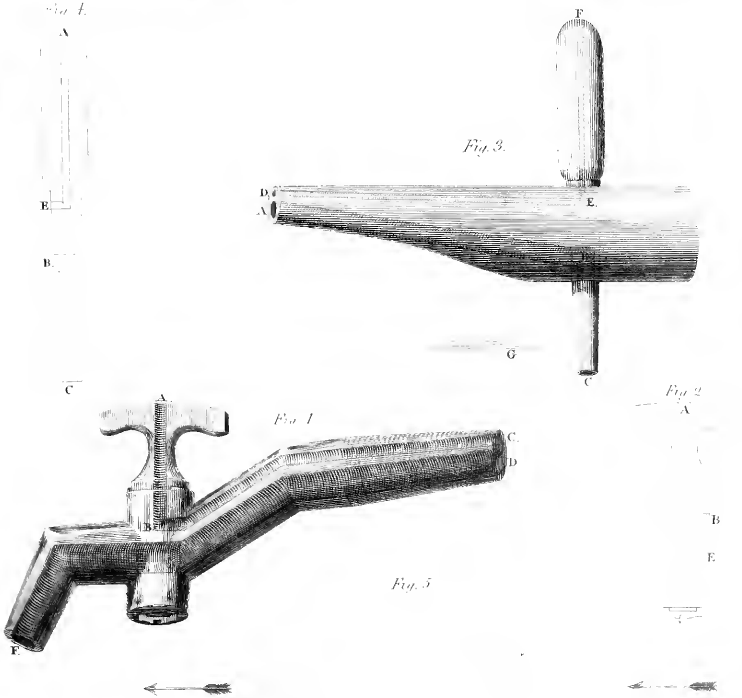
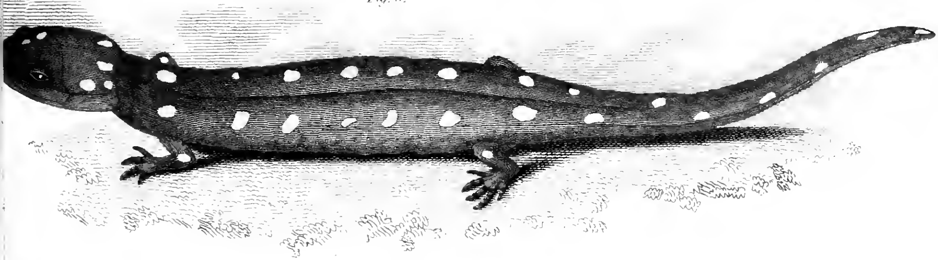


Fig. 6.



ed with the greatest accuracy. Mr. Silliman in recomposing water by means of this instrument, in a manner nearly similar to that which I have pointed out, found it extremely convenient and satisfactory.

No. XXI.

AN account of a Cock with two perforations, contrived to obviate the necessity of a vent-peg, in tapping air-tight casks. By Robert Hare, jun.

GENTLEMEN,

CONSIDERED merely as an item added to the list of philosophical contrivances the subject of the present communication would without doubt, be too unimportant to merit a place in a volume of your transactions: but I submit it with deference to the judgment of the society, whether as an addition, though a small one, to the comfort and convenience of society at large, it may not obtain a place, to which in any other light it can have no pretensions.

It is well known that an air-tight cask is usually tapped by means of two apertures, one in the upper part for the admission of air, the other below for the emission of the fluid; or, in other words, by means of a vent-peg and cock. This method would not be very objectionable, were the vent-peg always firmly replaced as soon as the admission of air becomes no longer necessary; but this is seldom attended to, and the consequence is the frequent sourness or vapidity of vinous liquors. The quantity of liquor annually spoiled by the omission of vent-pegs must be immense; and must be particularly great in those families where tapsters are too numerous to be responsible for neglect.

To obviate these evils, arising from the necessity of a vent-peg, I have contrived a cock. Fig. 1. Plate IV. with two perforations, A B C. D E F. which are opened or shut by turning the key, in the same manner as the single perforation of the common cock. When this newly invented instrument, which for the sake of distinction may be termed a *pneumatic cock*, is inserted into an air-tight cask containing a fluid, and the key properly adjusted, the air enters at the upper perforation, and the fluid passes out at the lower one, with a velocity proportionate to the depth of the delivering orifice of the cock at F, below the point C, at which the air enters the cask. It may be worthy of observation, that as long as there is a sufficient quantity of fluid in the cask, to cover the orifices C, D, of the pneumatic cock, the velocity of its efflux will be always equable, not being dependent on the height of the fluid in the cask, but invariably proportionate to the depth of the point F, at which the fluid is emitted from the cock, below the point C, at which the air enters the cask. Hence if it be desired to augment the velocity of efflux, it may be effected by encreasing the length of the nozzle F.—For if a line be supposed to be drawn from the orifice C of the upper perforation, to the surface G of the fluid in the cask, and another be imagined to be let fall from the surface of the fluid, to D the orifice of the lower perforation, and from thence to be extended through the lower perforation to the nozzle of the cock at F, these lines may be considered as marking out the courses of two unequal columns of the fluid acting on each other as if contained within the legs of a syphon. Consequently the shorter column will be displaced by the longer one, with a velocity proportionate to the excess of the perpendicular depth of the latter, which is obviously the same with the perpendicular depth of the nozzle F, below C, the point at which the air enters the cask. But the velocity with which the longer column G, D, E, F, displaces the shorter column C, G, or with which it enables the air to displace it, and with which it is itself thereby enabled to descend through the lower perforation to the point of emission, must evidently be the same with the velocity of efflux. Of course this last must be in proportion, to the excess of the perpendicular depth of the longer column, which is the same with the depth of F, below C.

The cock is of a bended form, that the key may be situated below the receiving orifice D, so that on opening the cock, the fluid may run into the nozzle with sufficient rapidity to fill its full bore; which is essential to the principle of the instrument. For the same reason the bore of the nozzle tapers a little from the key at E, towards the orifice at F.

As the fixed air generated within air-tight casks containing vinous liquors; sometimes more than counteracts the pressure of the atmosphere, and forces these fluids through every aperture which may be made for them; it is in such cases necessary while the cock remains open, to close the orifice A, of the upper perforation with the thumb, which may be done with great facility, while the fingers are employed in holding the key.

That the structure of the cock may be compleatly understood, Fig. 2, affords a separate view of the key, and of those parts of the upper and lower perforations, which lie within it.

Fig. 3, is a representation of a cock executed in wood, on the same principle with that above described. The dotted lines A B C, D E F, represents the tracks of the upper and lower perforations, of which the latter comes out through the key. This is made unusually long in order to depress the delivering orifice, and thereby increase the velocity of efflux. The lower perforation is considerably inclined below the horizontal line, in order that on opening the cock the fluid may run into the key with rapidity sufficient to fill the bore full.

This as before observed being essential to the action of the pneumatic cock, Fig. 4, is a separate view of the wooden key, with the parts of the perforations which lie within it.

No. XXII.

Some account of a New Species of North American Lizard. By Dr. Barton.

Read, April 15th, 1803.

THE species of Lizard of which I propose to give the Philosophical Society some account, and of which I have the satisfaction of showing them not only a good drawing but also a living specimen, was found at the distance of a few miles from the city of Philadelphia, about eight weeks ago. It is six inches and eight tenths of an inch in length from the end of the nose to the extremity of the tail. The nose is very blunt, the head forming nearly an oval. The whole body is remarkably smooth, somewhat glutinous to the touch, and of a dirty purplish colour, a good deal similar to that of our fox-grape. The whole under side of the body, the legs, the tail, &c. is of a livid purplish colour, and very abundantly besprinkled over with bluish white spots of different sizes, but all of them very minute. The upper part of the body is beautifully marked with a number of spots of a fine yellow colour. These spots are very irregularly distributed over the animal. The most anterior of them are adjacent to the right eye. There are no corresponding spots in the immediate vicinity of the left eye. Some of the spots are nearly round, others are irregularly oval. They are entirely confined to the upper part and to the sides of the body of the animal, including the legs. The largest of these spots is about the eighth of an inch in diameter.

A very minute description of the animal does not seem necessary, as the drawing in Plate IV. Fig. 6. will convey a much better idea of it than the most finished description. In addition to what I have already said, I shall therefore only observe, that the mouth is very large, being more than half the length of the head; that the legs and feet are very small for the bulk of the animal; that the fore-feet are furnished with four toes, and the hind feet with five toes; all of which are unarmed or destitute of nails. The toes are marked transversely with blackish lines. The tail is not round, but considerably compressed sideways.

This species of lizard is unnoticed by Linnæus, Gmelin, La Cépede, Shaw, or any other of the later writers (so far as I know) on the class of amphibia. It may, from merely attending to the description, be mistaken for the Lacerta punctata of Linnæus, from which, however, it differs in several essential respects. The general ground colour of the two animals is very different: that of the punctata is brown *(corpus fuscum,)* while that of this lacerta is a dirty purple or violet. The throat, the sides and the belly of the punctata are of a dull yellow, while the underside of this lacerta are a livid purplish. If these were the only differences, I should not urge the difference of species, for colour is known to be a very variable feature of animals, though I believe not remarkably so in the tribe of lizards. The two animals are spotted, but the spots of the lacerta punctata are white: those of this species a fine yellow. It would appear from Catesby's figure and description of the lacerta punctata, that the spots of this species are confined to the back and tail; there being a double row upon the back and a single one upon the tail. In my lacerta, the yellow spots are found upon the head and legs as well as upon the back and tail, and they are very irregularly distributed. Catesby makes no mention of any small ash-coloured spots, of which there is a great number upon the belly and sides of my lacerta. Lastly, the tail of the lacerta punctata is round *(cauda teres)*, whereas the tail of the animal which I describe is manifestly compressed. Upon the whole, I do not hesitate to conclude, that the lacerta punctata and my lacerta are two distinct species. Believing this to be the case, I should be glad to be able to give an appropriate specific name to the new species. I cannot, at present, think of a better than one derived from the prevailing colour of the animal, a colour inclining to violet or purplish. I beg leave, therefore, to name it Lacerta subviolacea, and would thus describe it for the benefit of systematic writers, who often prefer a short description (ever liable, where the species of a family are numerous, to mislead) to one more minute and extensive;

Lacerta subviolacea: cauda compressa, mediocri; corpore subviolaceo, glabro, viscido, poroso; maculis flavis cinereisque vario; palmis tetradactylis, plantis pentadactylis, omnibus muticis.

The Lacerta subviolacea belongs to that section of the family of lizards, which are designated by the name of Salamanders *(Salamandræ*.)* Its natural position in the system will be near to the Lacerta Salamandra, to which, in several respects, it is closely allied. Like that species, it emits from different parts of its body, but particularly from the upper part of its tail, a milk-like fluid, which escapes from the animal in globules or drops of different sizes. This fluid is extremely glutinous, or adhesive. It does not seem to be of a gummous nature, for it is insoluble in water, but appears to be rapidly dissolved by alcohol. The emission of this fluid seems to be a voluntary act; for when it is irritated, the animal discharges it in large quantities.

I was desirous of knowing the effects of this fluid upon the system. With this view, I have made a few experiments, which are as yet too incomplete to be fully depended upon. The following experiments, however, have been made with care. Having pressed out from the tail of the animal, a small portion of the white fluid, I applied it to my tongue. It communicated almost instantaneously, the impression of a powerful astringent, but was succeeded, in a very short time, by a sense of causticity, and a taste very similar to that of the muriate of mercury, or corrosive sublimate. This last impression, notwithstanding repeated washings of the mouth, remained upon the tongue the greater part of a day. It occasioned a plentiful discharge of saliva from the mouth. Some of my pupils and other gentlemen repeated the experiment, and with similar effects.

The peculiar taste, and particularly the salivation, occasioned by this North-American lizard, induce me to believe, that there is more foundation than many physicians have imagined, for the reports of the Spanish and other physicians, concerning

* "Salamandræ, corpore nudo, pedibus muticis, palmis tetradactylis." Gmelin.

the salivating property of certain species of lizards, and for believing, that such lizards, eaten raw, as they are directed to be, may have been found really useful, in the treatment of siphylis, and other diseases. On this curious subject, in addition to what is to be met with in different foreign publications, I received some interesting information from my learned and amiable friend, the late Mr. Julius Von Rohr, when he was in Philadelphia, in the year 1793. The facts communicated to me by that gentleman, have left me no room to doubt, that the uncooked flesh of some species of lizards in South-America and in the West-Indies, induce a genuine salivation, of some continuance, and which has been found beneficial in lepra, and other diseases, particularly those of a cutaneous nature.

I am sorry, that my account of this species of lizard is thus necessarily defective. Though the animal has been in my possession for several weeks, I have not been able to make many observations of consequence concerning it. It appears to be an harmless animal, unless, which is highly probable, it may sometimes prove injurious by emitting the white fluid which I have mentioned. Though it has been much irritated by me, it has never shown a disposition to bite. It seems extremely unwilling to meet the light or heat of the day. When it is removed from the wet moss, in which I have kept it, it soon betakes itself to the same habitation, and nearly conceals itself by drawing the moss about it. I am not certain, that it has eaten any thing since it came into my possession. I have, however, repeatedly given it worms and other animals. I believe it to be a water lizard, as it is so fond of affecting the wet moss. Besides, when I put it into a bason of water, it swarm with great rapidity and ease.

I weighed this animal at different times. On the 24th of March, I found the weight to be 342 grains. In somewhat less than an hour after, it weighed only 324 grains, having lost eighteen grains. It had been recently taken out of the water. Its greatest weight was that which I have first montioned*. It is a well-ascertained fact, however, that the weight of many

* Or five drams, and forty-two grains,

of the amphibia, particularly the frogs and lizards, is very various at different times, even in the course of the same day or hour. This difference of weight is often entirely independent on any aliment, whether solid or fluid, being taken into the stomach, and must be ascribed to the absorption of water.

Philadelphia, April 15th, 1803.

POSTSCRIPT.

I believe all the smaller species of lizards, as well those which have a rougher, as those with a smoother skin, shed their coats annually. I think every species sheds its skin at least *once* every year. Perhaps, some species cast their coats twice a year, and some facts lead me to believe, that different individuals of the same species vary not a little in this respect. The same irregularity is observable in the rattle-snake (Crotalus horridus), as I know from my own observations.

After the preceeding paper was read to the Society, I had an opportunity of marking the progress of the desquamation or shedding of the skin of the lacerta subviolacea. On the 27th of April, it was first observed, that this process had commenced. The first appearance of the change was on the tail. At 12 o'clock, the skin began to loosen on the side of the thorax. At 4 o'clock it extended from the thorax to the tail, where it had commenced.

28th. This morning, the skin entirely peeled off the tail and the abdomen, and was scattered about in shrivelled portions. At 4 o'clock in the afternoon, the skin of the feet was drawn off entire, having the appearance of a glove.

29th. This morning, the animal had entirely lost its skin.

I have now reason to believe, that the lizard never ate any thing during the whole of the time it continued in my possession.

No. XXIII

Continuation of Astronomical Observations, made at Lancaster, Pennsylvania. In a letter from Andrew Ellicott, Esq. to R. Patterson.

Read Oct. 7th, 1803.

Lancaster Oct. 1st, 1803.

DEAR SIR,

I now forward a continuation of my astronomical observations, made at this place: they would have been more numerous had the weather permitted. The season has been remarkably unfavourable for such pursuits.

The results of the observations on the solar eclipse of the 21st of February, the occultations the 30th of March, 27th of May, and 23d of September last, I have not as yet had time to make out:—the duties of my office admitting of but little leisure for scientific enquiries.—But to the observations.

Feb. 21st, 1803. Observations on the beginning of a solar eclipse.

The day was cloudy till about half an hour before the beginning of the eclipse; on which account I had made no preparations to observe it.—A few minutes before the time calculated for the beginning, I directed the telescope to the sun; the lower limb was very tremulous, and indented in many places by a waving, serpentine motion, which will frequently be observed when the sun is near the horizon:—these indents, combined with other causes, produced an uncertainty of a few seconds, (though probably not more than 10 or 12) in the beginning, which I observed at $5^h\ 4'\ 57''$ mean time, or $4^h\ 50'\ 57''$ apparent time.

23d. Took the pendulum with the wooden rod from my clock, and substituted a grid-iron one, which I had that day completed.

March 1st. Immersion of the 1st satellite of Jupiter, observed at $8^h\ 31'\ 13''$ mean time, or $8^h\ 18'\ 31''$ apparent time. The planet tremulous, and the belts indistinct:—magnifying power 100. At 9 o'clock in the evening the thermometer stood at 6°.

11th. Immersion of the 2d satellite of Jupiter, observed at $10^h\ 43'\ 35''$ mean time, or $10^h\ 33'\ 18''$ apparent time:—night remarkably fine:—magnifying power 100.

19th. Immersion of the 3d satellite of Jupiter, observed at $9^h\ 18'\ 39''$ mean time, or $9^h\ 10'\ 38''$ apparent time.—The evening hazy; on which account, I think, that at least 30″ ought to be added to the observed time of the immersion; which I shall therefore do in comparing the result of this observation with those of the other satellites:—magnifying power 100.

29th. Emersion of the 2d satellite of Jupiter, observed at $7^h\ 48'\ 16''$ mean time, or $7^h\ 43'\ 18''$ apparent time:—the planet and satellites well defined, and very steady:—magnifying power 100.

30th. Observations on the occultation of κ ♊ by the moon.

	h	′	″		h	′	″	
Immersion at	8	25	8	mean time, or	8	20	29	apparent time.
Emersion at	9	45	14		9	40	36	

The above time of the emersion may possibly be 5 or 6 seconds too late;—not having my attention directed to the precise spot where the moon's limb left the star; but, when I discovered it, the light of the star and the moon's limb appeared to be nearly in contact. It is however to be observed, that when the emersions happen on the moon's enlightened limb, the observations may generally be considered doubtful, a few seconds*.

* Lorsque la lune a passé l'opposition, sa partie orientale est éclaireé, sa partie occidentale est obscure ; ainsi les immersions se font dans la partie éclaireé, et les émersions se font dans la partie obsure ; c' est-a-dire, à gauche, dans une lunette astronomique—Je crois que ce sont la les seules

April 5th. Emersion of the 2d satellite of Jupiter, observed at $10^h\ 23'\ 29''$ mean time, or $10^h\ 20'\ 41''$ apparent time:—night very clear and the belts distinct:—magnifying power 100.

9th. Emersion of the 1st satellite of Jupiter, observed at $9^h\ 9'\ 59''$ mean time, or $9^h\ 8'\ 20''$ apparent time:—night clear, and belts distinct:—magnifying power 100.

22d. Immersion of the 4th satellite of Jupiter, observed at $12^h\ 41'\ 19''$ mean time, or $12^h\ 42'\ 54''$ apparent time. At the time this observation was made, the night was very serene and clear:—four belts were distinctly defined on the body of the planet:—magnifying power 100.

Emersion of the above satellite was observed at $14^h\ 52'\ 34''$ mean time, or $14^h\ 54'\ 10''$ apparent time.—The night had become a little hazy, and the belts were scarcely discernable.—The satellite appeared for a few seconds, and then became invisible for more than a minute. From the state of the atmosphere, and the slow manner in which the satellite acquired its light, owing to its oblique way through the shadow of Jupiter, it is my opinion, that at least 2 minutes should be deducted from the observed time of the emersion; which deduction I shall accordingly use in making out the result of the observation.

May 2d. Emersion of the 1st satellite of Jupiter, observed at $9^h\ 21'\ 34''$ mean time, or $9^h\ 24'\ 46''$ apparent time:—night clear, and belts distinct:—magnifying power 100.

9th. Emersion of the 4th satellite of Jupiter, observed at $8^h\ 39'\ 28''$ mean time, or $8^h\ 43'\ 17''$ apparent time.—The planet and satellites were well defined, and the observation one of the most satisfactory I have made at this place:—magnifying power 100.

Emersion of the 1st satellite of Jupiter, observed at $11^h\ 15'\ 46''$ mean time, or $11^h\ 19'\ 35''$ apparent time. This evening I began to pay attention to the decrease of Saturn's ring.

émersions dont on puisse être bien assuré; car quand l' etoile sort de la partie é claireé de la lune, sa lumiere, trop foible par rapport á celle de la lune, ne se distingue pas facilement au premier instant de l' émersion.

Astronomie par la Lande art. 1990.

11th. Saturn's ring well defined; the ansæ are evidently diminishing:—two satellites visible.

14th. Emersion of the 2d satellite of Jupiter, observed at $12^h\ 41'\ 54''$ mean time, or $12^h\ 45'\ 52''$ apparent time:—night clear:—magnifying power 100.

16th. Saturn's ring well defined:—the ansæ not perceptibly diminished since the 11th.

27th. Occultation of a star, supposed to be ς Leonis (♌) observed at $8^h\ 17'\ 53''$ mean time, or $8^h\ 21'\ 10''$ apparent time.

Saturn's ring well defined:—the ansæ decreasing, and appear more luminous towards their extremities than near the body of Jupiter: two satellites very distinct.

June 6th. The night very clear and fine; Saturn's ring was particularly attended to: the ansæ appeared more luminous and sparkling toward their extremities, than near the body of the planet:—three satellites were visible.

9th. Saturn's ring yet visible:—the ansæ were distinct during the twilight, but faint afterwards.

13th. Immersion of the 3d satellite of Jupiter, observed at $9^h\ 7'\ 56''$ mean time, or $9^h\ 8'\ 25''$ apparent time:—the planet and satellites tolerably distinct:—magnifying power 100.

15th. Saturn's ring decreasing: the ansæ were scarcely descernable after the end of twilight.

17th. Emersion of the 1st satellite of Jupiter, observed at $9^h\ 45'\ 43''$ mean time, or $9^h\ 45'\ 21''$ apparent time.—The night clear, and the planet and satellites well defined:—magnifying power 100.

Saturn's ring very faint:—the ansæ were invisible after the end of twilight.

18th. Saturn's ring more faint than last evening: the ansæ disappeared before the end of twilight.

21st. Saturn's ring almost invisible:—the ansæ would frequently disappear for whole minutes, and then become visible for a few minutes more.

22d. The ring of Saturn has almost disappeared: the western ansa only visible, and that for but a few seconds at a time.

23d. The ring of Saturn invisible, though I looked for it with both telescopes* during the twilight, and half an hour after. By the theory of Mr. Sejour, the disappearance of the ring ought to have taken place on the 28th†; and, perhaps, with better telescopes, that would have been the case; for much depends upon the goodness of those instruments, and the state of the atmosphere at the time of making the observations.—With Mr. Herschel's large telescope there is no real disappearance. It is likewise possible, that the difference between the disappearance as resulting from the theory, and observation, may, in part, be owing to a small retrogade motion in the nodes of the ring.

Sept. 23d. The moon occulted a star at $8^h\ 43'\ 51''$ mean time, or $8^h\ 51'\ 28''$ apparent time. The star is in the constellation of Sagittarius (♐), and supposed to be the one numbered 712 in Mayer's catalogue:—it is of the 6th magnitude: the star appeared to remain well defined 4 or 5 seconds on the moon's limb, but the disappearance was instantaneous.

I shall now, after a preliminary observation, proceed to state the results of the foregoing observations on the eclipses of Jupiter's satellites, as deduced both from Mr. Delambre's tables, and the British nautical almanac.—As a standard of comparison I shall consider the correct longitude of Lancaster to be $5^h\ 5'\ 4''$ west, from the observatory at Greenwich; and which I am persuaded will not be found many seconds erroneous‡.

	Long. by Delambre's tables.		Long. by the naut. almanac.
	h ′ ″		h ′ ″
1803, March 1st. Immer. 1st sat.	5 5 21		5 5 58
too great.	17	too great.	54
11th. Immer. 2d sat.	5 4 43		5 6 28
too small.	21	too great.	1 24

* One of them a Reflector with a magnifying power of 300.

† Essai sur les phénomènes relatifs aux disparitions périodiques de l' anneau de Saturn. Par *M. Dionis Du Séjour*. Pages 165 & 166.

‡ NOTE, Agreeably to the tables of Mr. Delambre, the longitude of Lancaster, by a mean of the five observations on the eclipses of the 1st satellite of Jupiter, appears to be 5h 5′ 10″ west from Greenwich; which exceeds the assumed standard 6″:—And if a mean of all the determinations, agreeably to the same tables, be taken collectively, the longitude will be 5h 5′ 4″ west from Greenwich, which agrees exactly with the assumed standard.

	h ′ ″		h ′ ″
19th. Immer. 3d sat.	5 5 27		5 13 55
too great.	23	too great.	8 51
29th. Emer. 2d sat.	5 5 20		5 5 42
too great.	16	too great.	38
April 5th. Emer. 2d sat.	5 5 22		5 5 40
too great.	18	too great.	36
9th. Emer. 1st sat.	5 5 4		5 5 40
too great.	0	too great.	36
22d. Immer 4th sat*.	5 3 28		4 44 30
too small.	1 36	too small.	20 34
do. Emer. do.	5 4 16		5 6 55
too small.	48	too great.	1 51
May 2d. Emer. 1st sat.	5 5 1		5 5 38
too small.	3	too great.	34
9th. Emer. 4th sat.	5 6 26		5 11 23
too great.	1 22	too great.	6 19
do. 1st sat.	5 5 16		5 6 4
too great.	12	too great.	1 0
14th. Emer. 2d sat.	5 5 30		5 5 38
too great.	26	too great.	34
June 13th. Immer. 3d sat.	5 4 41		5 13 1
too small.	23	too great.	7 57
17th. Emer. 1st sat.	5 5 9		5 5 58
too great.	5	too great.	54

On the 23d of February the pendulum with a wooden rod was taken from the clock and replaced by a grid-iron one; but, owing to the unfavourable situation of the clock, I did not expect to derive any material advantage from the change; in this however I have been agreeably disappointed; the extreme variations from the mean rate of going for the whole year, will not amount to 2 seconds, notwithstanding the con-

* The theory of the 4th satellite of Jupiter is a subject of peculiar nicety, and has required great labour to bring it to its present degree of perfection; for which we are principally indebted to the genius, and industry of Mr. Delambre. An error so small in the inclination of the orbit of this planet, or in the place of the nodes, as to be scarcely distinguished from the unavoidable errors of observation, when the satellite passes through the center of Jupiter's shadow, will become very considerable as it is leaving it at either pole; because, those errors increase nearly in the ratio of the squares of the satellite's distances from the center of the shadow. From the immersion, and emersion of April 22d, to which this note refers, it appears, that the inclination of the orbit of this satellite, is either stated too small in the theory used by the computers of the British nautical almanac, or is subject to changes not yet introduced into these tables.

stant jaring of the building by the shutting of the doors belonging to it.

I am, Sir, with great esteem,

your friend and humble servant,

ANDREW ELLICOTT.

Mr. Robert Patterson,
V. P. of the A. P. S.

No. XXIV.

Observations and Experiments relating to equivocal, or spontaneous, Generation. By J. Priestley, L. L. D. F. R. S.

Read, Nov. 18th, 1803.

THERE is nothing in modern philosophy that appears to me so extraordinary, as the revival of what has long been considered as the exploded doctrine of *equivocal,* or, as Dr. Darwin calls it, *spontaneous generation**; by which is meant the production of organized bodies from substances that have no organization, as plants and animals from no pre-existing germs of the same kinds, plants without seeds, and animals without sexual intercourse.

The germ of an organized body, the seed of a plant, or the embrio of an animal, in its first discoverable state, is now

* Thus the tall oak, the giant of the wood,
Which bears Britannia's thunders on the flood;
The whale, unmeasured monster of the main,
The lordly lion, monarch of the plain,
The eagle soaring in the realms of air,
Whose eye undazzled drinks the solar glare,
Imperious man, who rules the bestial crowd,
Of language, reason, and reflection proud,
With brow erect who scorns this earthly sod,
And styles himself the image of his God;
Arose from rudiments of form and sense,
An embrion point, or microscopic ens!!!
Temple of Nature.

found to be the future plant or animal in miniature, containing every thing essential to it when full grown, only requiring to have the several organs enlarged, and the interstices filled with extraneous nutritious matter. When the external form undergoes the greatest change, as from an aquatic insect to a flying gnat, a caterpillar to a crysalis, a crysalis to a butterfly, or a tadpole to a frog, there is nothing *new* in the organization; all the parts of the gnat, the butterfly, and the frog, having really existed, though not appearing to the common observer in the forms in which they are first seen. In like manner, every thing essential to the oak is found in the acorn.

It is now, however, maintained that bodies as exquisitely organized as any that we are acquainted with (for this is true of the smallest insect, as well as of the largest animal) arise, without the interposition of a creative power, from substances that have no organization at all, from mere *brute matter*—earth, water, or mucilage, in a certain degree of heat. Sometimes the term *organic particles* is made use of, as the origin of the plants and animals that are said to be produced this way; but as it is without meaning, the germs of those specific plants and animals which are said to come from them, and a great variety of these organized bodies are said to arise from the same organic particles, the case is not materially different. Still, completely organized bodies, of specific kinds, are maintained to be produced from substances that could not have any natural connexion with them, or particular relation to them. And this I assert is nothing less than the production of an effect without any adequate cause. If the organic particle, from which an oak is produced be not precisely an acorn, the production of it from any thing else is as much a miracle, and out of the course of nature, as if it had come from a bean, or a pea, or absolutely from nothing at all; and if miracles be denied, (as they are, I believe, by all the advocates for this doctrine of equivocal generation,) these plants and animals, completely organized as they are found to be, as well adopted to their destined places and uses in the general system as the largest plants and animals, have no *intelligent cause* whatever, which is unquestionably atheism. For if one part of the system of nature does not require an intelligent cause, neither does any other part, or the whole.

As Dr. Darwin presses my observations on the *green matter*, on which I formerly made some experiments, as producing dephlogisticated air by the influence of light, into the service of his hypothesis; I have this last summer given some attention to them, and have diversified them with that view; and from these it will appear that they are far from serving his purpose; since none of this green matter, which he does not doubt to be a vegetable, though of the smallest kind, is produced in any water, though ever so proper for it, unless its surface has been more or less exposed to the atmosphere, from which, consequently, the invisible seeds of this vegetable may come.

He says *(Temple of Nature, notes p. 4.)* " not only mi-" croscopic animals appear to be produced by a spontaneous " vital process, and these quickly improve by solitary genera-" tion, like the buds of trees, or like the polypus and aphis, " but there is one vegetable body which appears to be produ-" ced by a spontaneous vital process, and is believed to be " propagated and enlarged in so short a time by solitary gene-" ration, as to become visible to the naked eye. I mean the " green vegetable matter first attended to by Dr. Priestley, and " called by him *conferva fontinalis*. The proofs that this material " is a vegetable are from its giving up so much oxygen when " exposed to the sun shine, as it grows in water, and from its " green colour."

" D. Ingenhouz asserts that by filling a bottle with well-" water, and inverting it immediately into a bason of well-" water, this green vegetable is formed in great quantity; " and he believes that the water itself, or some substance con-" tained in the water, is converted into this kind of vegetation " which then quickly propagates itself."

" Mr. Girtanner asserts that this green vegetable matter is " not produced by water and heat alone, but requires the sun's " light for this purpose, as he observed by many experiments, " and thinks it arises from decomposing water deprived of " a part of its oxygen; and he laughs at Dr. Priestley for be-" lieving that the seeds of this conferva, and the parents of "microscopic animals, exist universally in the atmosphere, and "penetrate the sides of glass jars." *Philosophical Magazine for May* 1800.

He further says, p. 9, "The green vegetable matter of Dr. "Priestley, which is universally produced in stagnant water, "and the mucor, or mouldiness, which is seen on the surface "of all putrid vegetable and animal matter, have probably "no parents, but a spontaneous origin from the congress of "the decomposing organic articles, and afterwards propagate "themselves."

Let us now compare *this* language with that of *nature* in my experiments. On the first of July I placed in the open air several vessels containing pump-water, two of them covered with olive oil, one in a phial with a ground glass stopper, one with a loose tin cover, and the rest with the surface of the water exposed to the atmosphere; and having found (as may be seen in the account of my former experiments on this green matter) that it was produced with the greatest facility, and in the greatest abundance, when a small quantity of vegetable matter, especially thin slices of raw potatoes, was put into the water, I put equal quantities, viz. twenty grains of potatoe, into each of the larger vessels and ten into each of the smaller. Into two very large decanters, the mouths of which were narrow, I put fifty grains of the same, one of them having oil on its surface, and the other none. At the same time having filled a large phial with the same water, I inverted it in a vessel of mercury.

In about a week the wide mouthed open vessel began to have green matter, and the large decanter with the narrow mouth had the same appearance in three weeks. On the first of August the vessel which had a loose tin cover, coming about half an inch below its edge, had a slight tinge of green, and on the first of September the phial with the ground glass stopper (but which, appeared by some of the water escaping, not to fit exactly) began to have green matter. But none of the vessels that were covered with oil, or that which had its mouth inverted in mercury, had any green matter at all on the 12th of September; when, having waited as I thought long enough, I put an end to the experiment.

Here we see that the wider was the mouth of the vessel, the sooner did the green matter appear in it; but that in time the germ (or whatever it may be called that produced it) found its way through the smallest apertures, and were ascended into the vessel with the tin cover before it could descend into it; but that when all access to the water was precluded by a covering of oil, or a quantity of mercury, no green matter was produced. These experiments, therefore, are far from favouring the doctrine of spontaneous generation, but are perfectly agreeable to the supposition that the seeds of this small vegetable float in the air, and insinuate themselves into water of a kind proper for their growth, through the smallest apertures.

Among the *experimental facts,* as Dr. Darwin calls them, in the support of his hypothesis, he says, p. 3. "that one or "more of four persons, whom he names, put some boiling "veal broth into a phial previously heated in the fire, and "sealing it up hermetically, or with wax, observed it to be "replete with animalcules in three or four days." But he should have said which of these four persons made the experiment, and have referred to the passage in their writings in which it is mentioned. Otherwise no judgment can be formed of its accuracy. And why did not the Doctor repeat the experiment himself, since it is so easily done? Besides, we know that even the heat of boiling water will not destroy some kinds of insects, and probably much less the eggs, or embryo's, of them.

He adds (ib.) that "to suppose the eggs of former micro-"scopic animals to float in the atmosphere, and pass through "the sealed glass phial, is so contrary to apparent nature, as "to be totally incredible." But who does, or would suppose this. That various animalcules, as well as the seeds of various plants, invisible to us, *do* float in the atmosphere, is unquestionable; but that they pass through glass I never heard before, though in a preceeding paragraph it is ascribed to myself. He adds, "as the latter are viviparous, it is equally absurd to sup-"pose that their parents float universally in the atmosphere, to "lay their young in paste, or vinegar." To me, however, this does not appear to be at all *impossible;* and it is observation of *facts,* and not *conjecture,* that must determine the question of *probability.*

"Some other *fungi*" he says p. 9. "as those growing in "close wine vaults, or others which arise from decaying trees, "or rotten timber, may perhaps be owing to a similar sponta- "neous production, and not previously exist as perfect organic "beings in the juices of the wood, as some have supposed. "In the same manner it would seem that the common escu- "lent mushroom is produced from horse dung at any time, "and in any place, as is the common practice of many gar- "deners." This requires no particular answer. Decaying trees &c. may afford a proper *nidus* for the seeds of vegetables that are invisible to us; and that any of them previously exist in the juices of the tree, was I believe, never supposed. The horse dung also may afford a proper nidus for the seeds of the mushroom. Besides these are only random observations, and the facts have never been investigated in an accurate philosophical manner.

It is said by many, that the different kinds of worms which are found in animal bodies have their origin there, and from no worms of the same kinds, but from the unorganized matter of which our food consists. But according to later observations, most of these very worms have been found *out* of the body, and therefore there is nothing improbable in the supposition of the seminal matter from which they came having been conveyed into the body in the food, &c. and if some of them have been found out of the body, the rest may in time be found out of it also. It is, besides, unworthy of philosophers to draw important conclusions from mere ignorance.

Having recited these facts, and *supposed facts,* I shall consider distinctly all that Dr. Darwin has advanced by way of *argument* in defence of the system that he has espoused.

He supposes, what no person will deny, that "dead orga- "nic matter, or that which had contributed to the growth of "vegetable and animal bodies, may by chemical attractions, "in the organs of plants and animals, contribute to the nou- "rishment of other plants and animals." But he adds, p. 6.

" the same particles of organic matter may form spontaneous " microscopic animals, or microscopic vegetables, by chemi- " cal dissolutions, and new combinations of organic matter, " in watery fluids with sufficient moisture."

But these microscopic vegetables and animals, there is every reason to think, have as complete and exquisite an organic structure as the larger plants and animals, and have as evident marks of design in their organization, and therefore could not have been formed by any decomposition or composition of such dead matter, whether called *organic* or not, without the interposition of an intelligent author. Besides, these microscopic vegetables and animals are infinitely various, and therefore could never arise from the same dead materials, in the same circumstances, by the mere application of warmth and moisture. Each of these vegetables and animals must, according to the analogy of nature, have proceeded from an organized germ, containing all the necessary parts of the future plant or animal, as well as the largest trees and animals, though their minuteness elude our search, and though the manner in which their seeds or germs are conveyed from place to place be unknown to us. But the attention that is given to this subject by ingenious naturalists is continually discovering a greater analogy between these microscopic vegetables, and animals and those of the largest kinds. This argument from the production of minute plants and animals has no force but from our ignorance.

" It is as difficult," he says, p. 7. " to understand the at- " traction of the parts of coutchouk, and other kinds of at- " traction, as the spontaneous production of a fibre from de- " composing animal or vegetable substances, which contracts " in a similar manner, and this constitutes the primordia of " life." But admitting that the power by which a fibre contracts to be not more difficult to comprehend than other contractions, and that fibres are the primordia of life, whence comes the regular arrangement of these fibres, and the various system of vessels formed by them, for the purposes of nutrition, the propagation of the species, &c. in the complex structure of these minute animals. There is nothing like that in the coutchouk, or any other substance that is not an animal.

Microscopic vegetables and animals remaining without any visible sign of life months and years is no proof that they were capable of deriving their origin from dead unorganized matter. While their organization is not destroyed, the motions which indicate life may be restored by proper degrees of heat and moisture; but this is not materially different from the case of frogs and other animals, which discover no sign of life, a great part of the winter, and revive with the warmth of spring.

That any thing composing an animal or vegetable should, after affording nutriment to other animals, attain some kind of organization, or even vitality, may be admitted; because the digestive powers of animals may not be able to destroy their organization, or vitality. But if it remain uninjured, and be afterwards revived, it cannot be any thing besides the very same organization that it had before. So birds feed upon seeds, which yet retain so much of their organization, and life, as to be able to produce the plants from which they came, but never any of a different kind. Beyond this no analogy in nature can carry us.

" These microscopic organic bodies," he says, p. 8. " are " multiplied and enlarged by solitary re-production, without " sexual intercourse, till they acquire greater perfection, or " new properties. Liewenhook observed in rain-water which " had stood a few days, the smallest scarcely visible animal- " cules and in a few days more he observed others eight " times as large." But this proves nothing more than an increase in bulk, and no change of a small animal into a larger of a different kind, which the argument requires. If it was the same animal that assumed a new form, in a more advanced state, it is no more than the case of a tadpole and a frog, or a caterpillar and butterfly. That several insects are multiplied without sexual intercourse is no proof of spontaneous generation. Plants are several ways produced without seeds; and according to Dr. Darwin's observations, this mode of animal re-production has its limits. For that after a certain number of such generations the last discover the properties of *sex*, and then produce others by sexual intercourse, so that it is probable, that if at that time they could be kept from sexual intercourse the re-production would cease.

Dr. Darwin, and all other advocates for spontaneous generation, speaks of some animals as *simple* and others as *complete*, some as *imperfect* and others as *perfect;* whereas, as far as we can discover, all animals, even the most minute that have been examined, appear to be as perfect, and to have a structure as wonderfully complicated, as the largest, though on account of their minuteness, we cannot dissect them to so much advantage. Their organs are equally adapted to their situations and occasions; and what is more, they have as great a degree of *intelligence* (which they discover by the methods of seeking their food, avoiding, or contending with their enemies) as the largest animals: besides, it is never pretended that any large species of animals, though called imperfect, as crabs and oysters, &c. are ever produced by spontaneous generation.

The larger kinds of the more perfect animals Dr. Darwin does not pretend to have ever been "produced immediately "in this mode of spontaneous generation;" but he supposes, what is even more improbable, viz. that "vegetables and ani-"mals improve by re-production; so that spontaneous vitality "(p. 1.) is only to be looked for in the simplest organic be-"ings, as in the smallest miscroscopic animalcules, which per-"petually perhaps however enlarge themselves by re-produc-"tion; and that the larger and more complicated animals "have acquired their present perfection by succesive genera-"tions, during an uncounted series of ages."

By this he must have meant to insinuate, for it is not clearly expressed (perhaps to avoid the ridicule of it) that lions, horses, and others, which he considers as more complicated animals, though they are not more so than flies and other insects, may have arisen from animals of different kinds, in the lowest state of organization, in fact, that they were once nothing more than microscopic animalcules.

But this is far from being analogous to any thing that we observe in the course of nature. We see no plants or animals, though ever so simple, growing to more than a certain size, and producing their like, and never any others organized in a different manner. Is it at all probable that lions, horses or elephants, were ever any other than they now are? Were they originally microscopic? And if they come to be what they now are by successive generations, why does not the change and improvement go on? Do we ever see any small animal become a larger of a different kind? Do any mice become rats, rats become dogs, or wolves, wasps become hornets, &c. and yet this is precisely the analogy that the hypothesis requires.

In order to obviate the prejudice against this doctrine of spontaneous production, as favouring *atheism*, Dr. Darwin says of the objectors, p. 1. "They do not recollect that "God created all things which exist, and that these have "been from the beginning in a perpetual state of improvement, which appears from the globe itself, as well as from "the animals and vegetables which possess it. And lastly, "that there is more dignity in our idea of the Supreme "Author of all things, when we conceive Him to be the "cause of causes, than the cause simply of the events "which we see, if there can be any difference in infinity of "power."

The Supreme Being is, no doubt, the cause of all causes; but these causes have a regular connexion, which we are able to trace; and if any thing be produced in any different manner, we say it is not according to the course of nature, but a *miracle*. The world is, no doubt, in a state of improvement; but notwithstanding this, we see no change in the vegetable or animal systems, nor does the history of the most remote times favour the hypothesis. The plants and animals described in the book of Job are the same that they are now, and so are the dogs, asses, and lions &c. of Homer.

Vegetables and animals do not by any improvement, natural or artificial, change into one another, or into vegetables and animals of other species. It is, therefore, contrary to analogy, or the established course of nature, that they should do so. If miracles; which imply an omnipotent and designing power (and which to the generality of mankind are the most striking proofs of the existence of such a power, and a power distinct from the visible parts of nature, the laws of which it counteracts) be denied, all changes that take place contrary to the observed analogy of nature must be *events without a cause;* and if one such event can take place, any others might, and consequently the whole system might have had no superior designing cause; and if there be any such thing as *atheism,* this is certainly it.

Dr. Darwin speaks of his organic particles as possessed of certain *appetencies,* or *powers of attraction.* But whence came these powers, or any others, such as those of electricity, magnetism, &c.? These powers discover as much wisdom, by their adaptation to each other, and their use in the general system, as the organic bodies which he supposes them to form; so that the supposition of these *powers,* which must have been imparted *ab extra,* only removes the difficulty he wishes to get quit of one step farther, and there it is left in as much force as ever. There are still marks of *design,* and therefore the necessity of a *designing cause.*

No. XXV.

Observations on the Discovery of Nitre, in common Salt, which had been frequently mixed with Snow, in a Letter to Dr. Wistar, from J. Priestley, L. L. D. F. R. S.

Read, December 2, 1803.

DEAR SIR,

WHEN I had the pleasure of seeing you at Northumberland, I mentioned a fact which I had just observed, but which appeared to me so extraordinary, that I wished you not to speak of it till I had more completely ascertained it. It was the conversion of a quantity of common salt into nitre. But having seen, in the last *Medical Repository,* an observation of Dr. Mitchell's, which throws some light upon it, I think it best upon the whole to acquaint experimentalists in general with all that I know of the matter; that, as the experiments must be made in the winter, they may take advantage of that which is now approaching.

In the winter of 1799 I made those experiments on the *production of air from the freezing of water*, an account of which is published in the 5th Vol. of the Transactions of the Philosophical Society of Philadelphia, p. 36; And having made use of the same salt, mixed with snow, in every experiment, always evaporating the mixture till the salt was recovered dry, I collected the salt when I had done with it, and put it into a glass bottle, with a label expressing what it was, and what use had been made of it.

This quantity of common salt having been frequently dissolved, and evaporated in an iron vessel, remained till the 26th of last October; when, having occasion to make a large quantity of marine acid, and this salt appearing to be of little value, I put to it an equal weight of acid of vitriol and about twice the quantity of water, and began the distillation in the usual way. But I was soon surprized to observe that *red vapours* rose from it, first filling the retort, and then the adopter, &c. and when the process was finished, returning to the retort, exactly as in the process for making spirit of nitre.

Not doubting, from this appearance, but that the produce was the nitrous acid (though having used much water, the acid was of course weak, and nearly colourless) I immediately dissolved copper in it, and found that it yielded as pure nitrous air as any that I had ever procured in the same way.

Examining the salt separately, I observed that when it was thrown upon hot coals, whether those portions of it that were white, or those that were brown from a mixture of the calx of iron, it burned exactly like nitre; so that from this appearance, I should have concluded that it had been wholly so. But that it contained some marine salt, and that the acid procured from it had a mixture of the marine acid, could not well be doubted; and this appeared to be the case both by the acid becoming turbid by a mixture of the solution of silver in nitrous acid, and by its dissolving gold with the application of heat, so that it was a weak aqua regia.

This conversion of common salt into nitre appeared so extraordinary, that I first thought there must have been some mistake in the *label*, though few persons I believe are more careful in that respect than myself. But I never had any nitre of that appearance, and least of all any that had in it a mixture of common salt; so that I could not doubt but that this was the same salt that I had used before for the purpose above mentioned. That this change must have come from the *snow* with which it had been dissolved, could not be doubted; and therefore I resolved to repeat the experiment with the next that should fall, but seeing that Dr. Mitchell had procured an acid from hail stones, I was instantly determined to excite other persons to repeat the experiment as well as myself, having now more confidence in my own.

What was the acid that Dr. Mitchell procured he did not ascertain, mine was unquestionably the *nitrous*, and it must have displaced that of the common salt by a superior affinity to its base. This acid must be exceedingly volatile; for I could not produce the same effect by repeated solutions and evaporations of the same kind of salt in snow water of long standing, a quantity of which I have always had, to use occasionally instead of distilled water.

The manner in which nitrous acid may be formed in the atmosphere is easily explained on my hypothesis of the composition of that acid; since I have always procured it by the de-composition of dephlogisticated and inflammable air, together with a small mixture of marine acid (which must therefore be formed from some of the same elements) as Mr. Cavendish procured it by the de-composition of dephlogisticated air, both of us using electric sparks.

Now it is probable that, although most kinds of air, even those that have no chemical affinity, will remain diffused through each other, without any sensible separation, after being mixed together, yet in the upper regions of the atmosphere, above that of the winds, there may be a redundancy of inflammable air, which is so much lighter than any other kind of air, as Mr. Kirwan and others suppose, and that there is a proportion of dephlogisticated air, in the same region cannot be doubted. In this region there are many electrical appearances, as the aurora borealis, falling stars, &c. and in the lower parts of it thunder and lightening; and by these means, the two kinds of air may be de-composed, and a highly dephlogisticated nitrous acid, as mine always was, procured.—This, being formed, will, of course attach itself to any snow or hail that may be forming in the same region at the same time, and by this means be brought down to the earth; confirming, in this unexpected manner, the vulgar opinion of nitre being contained in snow. Wishing that a fact of so extraordinary a nature, and which has probably more important consequences that I can foresee, may be farther investigated by your presenting this communication to the Philosophical Society.

I am, Dear Sir,

Your's sincerely, &c.

JOSEPH PRIESTLEY.

Northumberland, Nov. 21st, 1803.

Dr. C. Wistar, one of the V. P. of the A. P. S.

No. XXVI.

A Letter on the supposed Fortifications of the Western Country, from Bishop Madison of Virginia to Dr. Barton.

Read Dec. 16th, 1803.

DEAR SIR,

HAVING lately visited that beautiful river, the Kanhawa, and a considerable part of the country, within its neighbourhood, an opportunity was afforded of examining with attention some of those remarkable phænomena, which there present themselves, and which have been so much the subject of conversation, and of literary discussion. To remove error of whatever kind, is, in effect, to promote the progress of intelligence; with this view, I will endeavour to prove to you, that my journey has enabled me to strike one, at least, from that long catalogue, which so often tortures human ingenuity.

You have often heard of those remarkable fortifications with which the western country abounds; and you know also, how much it has puzzled some of our literati, who supposed themselves, no doubt, most profound in historical, geographical and philosophical lore, to give a satisfactory account of such surprising monuments of military labour and art. Some have called to their aid the bold and indefatigable Ferdinand Soto; others, the fabulous Welch Prince of the 12th, century; and all have made a thousand conjectures, as lifeless as either Soto, or the Prince. Had they first examined into the fact, and endeavoured to settle this most essential pre-requisite, they would soon have seen, that the inquiry might be very easily terminated; and, that what had so greatly excited the *admiration of the curious*, existed only in their own imaginations. No one was more impressed, than myself with the general opinion, that there did exist regular and extensive fortifications, of great antiquity, in many parts of that vast country, which is watered by the various tributary streams of the Ohio, and the Mississippi. The first specimen which I beheld, was examined with an ardent curiosity, and with a full conviction, that it was the work of a people, skilled in the means of military defence. The appearance is imposing; the mind seems to acquiesce in the current opinion, and more disposed to join in a fruitless admiration, than to question the reality of those fortifications. But, as my observations were extended, and new specimens daily presented themselves, the delusion vanished; I became convinced, that those works were not fortifications, and never had the smallest relation to military defence. The reasons upon which this conviction, so contrary to that which has been generally received, was founded, I shall now submit to your consideration. Only, let me first observe, that those supposed fortifications differ as to area and form. Some are found upon the banks of rivers, presenting a semi-ellipse, the greater axis running along the banks: others are nearly circular, remote from water, and small; their diameters seldom exceeding forty or fifty yards. The first of these species is the largest;

their longer axis, at a mean rate, may be estimated at 250 yards; their shorter, at 200 or 220. It is said, and I believe upon good authority, that some have been found large enough to comprehend 50 acres, and even more. Some are also reported to be square; but I did not see any of that form. I shall confine myself to those which I have seen, and which are to be met with in the low grounds of the rivers Kanhawa, Elk, and Guyandot, or their adjacent uplands; though I am persuaded, the conclusion which I undertake to establish will be applicable to all those works, which have been dignified with the appellation of fortifications, in whatever part of the western country they may be found; since, from the information which I have obtained, there are certain striking features in which they all agree, and which indicate one common origin and destination.

1. Those works were not designed for fortifications, because many of them have the ditch within the enclosure, and because, the earth thrown up, or the supposed parapet, wants the elevation necessary for a defensive work. Both these circumstances occur, without exception, so far as my observations went, in all those which present an entire, or nearly a regular circle. The imaginary breast-work induces a belief, that it never exceeded four or five feet in height. At present, the bank seldom rises more than three feet above the plain; and it is well known, that in ground which does not wash, a bank of earth, thrown up in usual way, will lose very little of its height, in a century, or twenty centuries; one fourth for depression would be more than a sufficient allowance. But, we will not rest our argument upon what may, perhaps, be deemed a disputable point. The ditch, even at this day, affords, a certain criterion by which me may judge of the original elevation of the bank. Its width seldom exceeds four feet, at its margin; its depth is little more than two feet. Such a ditch, making every allowance for the operation of those causes, which tend continually to diminish its depth, whilst some of them are at the same time, increasing its width, could not have yeilded more earth, than would form a bank of the elevation mentioned. If the width, now, be not greater than

that ascribed, we may be assured, that, originally it was a very trifling fosse. But you will naturally ask; are there not some found which present a different aspect, and which evidence more laborious efforts? no, on the contrary, it is remarkable, that the kind of which I am now writing have as constant a similarity to each other, as those rude edifices, or cabins, which our first settlers rear. The description of one will answer for all; there is no anomaly, except, now and then, in the diameter of the circle; and here, the variation will only amount to a few yards.

Permit me now to ask, whether the military art does not necessarily require, that the ditch should be *exterior;* and, whether, among any people advanced to such a degree of improvement in the arts, as to attempt defensive works by throwing up earth, a single instance can be adduced in which the ditch has not an exterior position. Again, can we believe, that a work, having a bank or a ditch, not higher or deeper than I have mentioned, could be intended as a fortification? The moment which gave birth to the idea of a defensive work would also shew, that it must, in its execution, be rendered adequate to the end contemplated. It is scarcely worth while to go back to Livy or Polybius, upon this occasion. But they both inform us, "that the Romans, in the early period of their warfare, dug trenches, which were, at least, eight feet broad by six deep; that they were often twelve feet in breadth; sometimes, fifteen or twenty; that, of the earth dug out of the fosse, and thrown up *on the side of the camp,* they formed the parapet, or breast-work; and to make it more firm, mingled with it turf, cut in a certain size and form. Upon the brow of the parapet, palisades were also planted, firmly fixed and closely connected." The form of the fortification was always square. System appears to have been the tutelar Deity of the Romans. They always proceeded upon one plan. As to the form, indeed there appears to be no reason why that should not vary, not only among different nations; but with the same nation, as different situations might require. The Greeks generally preferred the round figure; but with them, the nature of places decided the question as to form. In other respects, the decision must be made according to fixed and unalterable principles. The same reasons which determined every particular as to height, depth, and position of the earth thrown up, among the Romans, would equally determine the conduct of any other nation. What defence required; what would oppose a sufficient obstacle to human agility, was the point to be decided; and this point would be decided in nearly the same manner by every people unacquainted with gun-powder. The decision would not admit of such fosses and parapets as we find dispersed over the western country. Man in this new world, has lost no portion of his former agility.

2dly. Because, near to most of these imaginary fortifications and I think I may say, near to every one, which is formed upon the plan first mentioned, in a direct line with the gateway, you will find a mound, of an easy ascent, and from 10 to 20 feet in height. These mounds effectually command the whole enclosure. There is not a missil weapon, which would not, from the height and distance of the mound, fall within the fortification; nor would they fall in vain. But, to rear a fortification, and then build a castle or mound without, at the distance of 40 or 50 yards, which would give to an enemy the entire command of such a Fortification, would be as little recommended by an Esquimaux, as by a Bonaparte. The truth is, no such blunder has been committed; there is no such discordancy of means to be here found. On the contrary, we may trace a perfect harmony of parts. Those mounds are, universally cemeteries. Wherever they have been opened, we find human bones, and Indian relicks. They have grown up gradually, as death robbed a family of its relatives, or a tribe of its warriors. Alternate strata of bones and earth, mingled with stones and Indian relicks, establish this position. And hence it is, that we find near the summit of those mounds articles of European manufacture, such as the tomahawk and knife; but never are they seen at any depth in the mound. Besides, it is well known, that among many of the Indian tribes, the bones of the deceased are annually collected and deposited in one place; that funeral rites are then solemnized with the warmest expressions of love and friendship; and that this untutored race urged by the feelings of nature, consign to the bosom of the earth, along with the remains of their deceased relatives and friends, food, weapons of war, and often those articles which they possessed and most highly valued, when alive. This custom has reared beyond doubt, those numerous mounds. Thus instead of having any relation to military arrangements, or involving the absurdity before mentioned, they furnish, on the contrary, strong evidence, that the enclosures themselves were not destined for defensive works; because, reared as these mounds have been by small, but successive annual increments, they plainly evince that the enclosures, which are so near to them, have been, not the temporary stations of a retiring or weakened army, but the fixed habitation of a family, and a long line of descendants.

That these mounds, or repositories of the dead, sometimes also, called barrows, were formed by deposition of bones and earth, at different periods, is now rendered certain by the perfect examination to which one of them, situated on the Rivanna, was subjected by the author of the Notes on Virginia. His penetrating genius seldom touches a subject without throwing upon it new light; upon this he has shown all that can be desired. The manner in which the barrow was opened, afforded an opportunity of viewing its interior with accuracy. "Appearances, says he, certainly indicate that it has derived both origin and growth from the accustomary collection of bones, and deposition of them together; that the first collection had been deposited on the common surface of the earth, a few stones put over it and then a covering of earth; that the second had been laid on this, had covered more or less of it in proportion to the number of bones, and was then also covered with earth, and so on. The following are the particular circumstances which give it this aspect. 1. The number of bones. 2. Their confused position. 3. Their being in different strata. 4. The strata in one part having no correspondence with those in another. 5. The different states of decay in these strata, which seem to indicate a difference in the time of inhumation. 6. The existence of infant bones among them." p. 178. First Paris Ed. The number of bones in this barrow, or mound, which was only 40 feet in diameter at the base, and above 12 in height, authorized the conjecture that it contained a thousand skeletons. Now, as all those numerous mounds, or barrows have the most obvious similarity, we may conclude, that what is true of one of them, is, ceteris paribus, applicable to all. The only difference consists in their dimensions. I visited one, situated on the low grounds of the Kanhawa, which might be almost called the pyramid of the west. Its base measured 140 yards in circumference; its altitude is very nearly 40 feet. It resembles a truncated cone; upon the top there is a level of 12 or 13 feet in diameter. A tall oak, of two feet and a half in diameter, which had grown on the top, and had long looked down upon the humbler forresters below, had experienced a revolutionary breeze, which swept it from its majestic station, apparently, above 6 or 7 years before my visit. Within a few miles of this, stands another, which is said to be higher. No marks of excavation, near the mound, are to be seen. On the contrary, it is probable, from the examination which was made, that the earth composing the mound was brought from some distance; it is also highly probable, that this was done at different periods, for we cannot believe, that savages would submit to the patient exertion of labour requisite to accomplish such a work, at any one undertaking. Near to this large one are several upon a much smaller scale. But, if that upon the Rivanna, which was so accurately examined, contained the bones of a thousand persons, this upon the Kanhawa would contain forty times that number, estimating their capacities as cones. But who will believe, that war has ever been glutted with so many Indian victims by any one battle? The probability seems to be, that those mounds, formed upon so large a scale, were national burying places; especially as they are not connected with any particular enclosure; whilst those upon a smaller scale, and which are immediately connected with such a work, were the repositories of those, who had there once enjoyed a fixed habitation. But whether this conjecture be admitted or not, the inference, from what has been said under this head, that those enclosures could not be designed as fortifications, will, I think, be obvious to every one.

3dly. Because those supposed fortifications, not unfrequently lie at the very bottom of a hill, from which stones might be rolled in thousands into every part of them, to the no small annoyance, we may readily conceive, of the besieged.

4thly. Because, in those works which are remote from a river, or a creek, you find no certain indications of a well; and yet that water is a very necessary article to a besieged army, will be acknowledged on all hands.

5thly. Because those works are so numerous, that, supposing them to be fortifications, we must believe every inch of that very extensive country in which they are found had been most valiantly and obstinately disputed. For, upon the Kanhawa, to the extent of 80 or an 100 miles, and also upon many of the rivers which empty their waters into it, there is scarcely a square mile in which you will not meet with several. Indeed they are as thick, and as irregularly dispersed, as you have seen the habitations of farmers, or planters, in a rich and well settled country, but, notwithstanding their frequency, you no where see such advantageous positions selected, as the nature of the ground, and other circumstances would immediately have recommended to the rudest engineer, either for the purpose of opposing inroads, or of giving protection to an army which was too weak to withstand an invading enemy. The union of Elk and Kanhawa rivers affords a point of defence which could not have escaped the attention of any people; and yet we find no fortification at this place, but many dispersed through the low grounds in its vicinity.

I could add many other reasons; I might observe that some are upon so small a scale, whilst others are upon one so large, as equally to oppose the idea of their being places of defence. If one of 40 or 50 yards in diameter should be deemed too small for a defensive work, what shall we say to that whose outline embraces 50, or even an 100 acres? What tribe of Indians would furnish men sufficient to defend such a breastwork in all its points? But I believe the reasons assigned, when collectively taken, will be deemed conclusive; or, as abundantly establishing a perfect conviction, that these western enclosures were not designed for fortifications. This was my object. What was the real design of them may be left to future inquiry. It is true, that we want here a compass to guide us, and are left to find our way through this night of time, in the best manner we can. I have already said, that those enclosures carried along with them strong evidence of their being fixed habitations. If so, then they were designed merely as lines of demarkation, shewing the particular spot, or portion of ground, which a family wished to appropriate; and indeed, they may be considered as exemplars of the manner in which land limits would be ascertained, previous to that period, when geometry begins to point out a mode more worthy of intelligent beings. This rude mode might, in a sequel of years, have introduced a geometry among the Aborigines of America. Though they had not a Nile to obliterate land marks, still the desire of saving labour would produce in one case, what anxiety to preserve property did in the other. If the same mode has not been continued, it has arisen from the means, which European or American art has supplied, of accomplishing the same end with much more facility.

The people inhabiting this country must have been numerous. The frequency of their burying places is a proof. The traveller finds them in every direction, and often, many in every mile. Under a mild climate, a people will always multiply in proportion to the quantity of food, which they can procure. Here, the waters contain fish in considerable abundance, some weighing not less than 60 or 80 pounds. Not far distant are those extensive and fertile plains, which were crowded with wild animals. The mildness of the climate is also remarkable. It appears to equal that of Richmond or Williamsburg; though the huge range of mountains which attend the Allegheny have not yet disappeared, and though the latitude of the place where Elk and Kanhawa rivers meet, according to an observation which I made with an imperfect instrument, is 38° 2′. All these circumstances were highly favorable to population; and also to permanent residence. Another circumstance, the face of the country, or locality, would serve to prevent this increase of population from diffusing itself on every side, and consequently would condense a tribe;

for the Kanhawa and its tributary streams are hemmed in by high and craggy hills, often approaching to mountains, and beyond which, to a considerable extent, the country in general is fit only for the habitation of wild beasts.

It is true, that on the N. W. side of the Ohio, there are works, which seem to claim higher pretensions to the rank assigned them. They present more elevated parapets, deeper ditches, with other indications of military art. Perhaps, however, when more accurately examined, in all their aspects, they will be found to be only the habitation of a chief of some powerful tribe. The love of distinction prevails with no less force in the savage, than the civilized breast. M'Kinzie, in his unadorned narratives, mentions frequently the habitation of the chief or king, as much larger, and even as commodious, when compared with those of inferior rank. In latitudes so high as those which he traversed with heroic perseverance, necessity compelled the savage to contrive more warm and durable habitations; but the same principle which would give marks of distinction to the residence of the chieftain in one climate, would produce the same effect in any other, though they might assume different appearances. Besides, it might not be improper to recollect in an examination of those works, that the French began to build forts in the Miamis, and Illinois country, as early as the year 1680; and that they were afterwards systematically continued until the loss of Canada.

I cannot conclude this letter, already, I fear, too long, without mentioning another curious specimen of Indian labour, and of their progress in one of the arts. This specimen is found within four miles of the place whose latitude I endeavoured to take, and within two of what are improperly called *Burning Springs*, upon a rock of hard freestone, which lies sloping o the south, touching the margin of the river, and presents a flat surface of above 12 feet in length and 9 in breadth, with a plane side to the east of 8 or 9 feet in thickness.

Upon the upper surface of this rock, and also upon the side, we see the outlines of several figures, cut without relief, except in one instance, and somewhat larger than the life. The depth of the outline may be half an inch; its width three quarters, nearly, in some places. In one line ascending from the part of the rock nearest the river, there is a Tortoise; a spread Eagle, executed with great expression, particularly the head, to which is given a shallow relief; and a child, the outline of which is very well drawn. In a parallel line, there are other figures; but among them that of a woman only can be traced. These are very indistinct. Upon the side of the rock, there are two awkward figures, which particularly caught my attention. One is that of a man, with his arms uplifted, and hands spread out, as if engaged in prayer. His head is made to terminate in a point; or rather, he has the appearance of something upon the head, of a triangular or conical form: near to him is another similar figure, suspended by a cord fastened to his heels. I recollected the story, which Father Hennepin relates of one of the missionaries from Canada who was treated in a somewhat similar manner; but whether this piece of seemingly historical sculpture has reference to such an event, can be only matter of conjecture. A Turkey badly executed, with a few other figures may also be seen. The labour and the perseverance requisite to cut those rude figures in a rock so hard, that steel appeared to make but little impression upon it, must have been great; much more so, than making of enclosures in a loose and fertile soil.

Yours, &c.

JAMES MADISON.

B. S. Barton, M. D. one of the V. P. of the A. P. S.

No. XXVII.

Supplement to the account of the Dipus Americanus, in the IV. Vol. of the Transactions of the Society. See No. XII.

Read Dec. 16th, 1803.

IN the 4th volume of the Transactions of the American Philosophical Society, I have given an account of a new species of Dipus, or Jerboa. When that paper was presented to the society, I was not able to say, with absolute confidence, though I thought it highly probable, that the animal which I described was one of the lethargic species of Glires, or those species which pass the winter-season in a torpid state. I have now completely satisfied myself, that the Dipus Americanus does go into the torpid state, in the neighbourhood of Philadelphia.

In the month of August, 1796, one of these little animals was brought to me from the vicinity of this city. It was put into a large glass jar, where I was so fortunate as to preserve it for near four months. Though it made many efforts to escape from its confinement, it seemed, upon the whole, pretty well reconciled to it. It continued active, and both ate and drank abundantly. I fed it upon bread, the grain of Indian corn (Zea Mays), and the berries of the Prinos verticillatus, sometimes called black-alder.

On or about the 22d, of November, it passed into the torpid state. It is curious to observe, that at the time it became torpid, the weather was unusually mild for the season of the year, and moreover the animal was kept in a warm room, in which there was a large fire the greater part of the day and night. I sometimes roused it from its torpid state; at other times it came spontaneously out of it. During the intervals of its waking, it both ate and drank. It was frequently most active, while the weather was extremely cold in December: but when I placed the jar upon a thick cake of ice, in the open air, its movements or activity seemed wholy directed to the making of a comfortable habitation out of the hay with which I supplied it. It was sufficiently evident, however, that the cold was not the only cause of its torpid state. It was finally killed by the application of too great a degree of heat to it, whilst in its torpor.

During its torpor, it commonly laid with its head between its hind legs, with the claws or feet of these closely applied to the head. Its respiration could always be perceived, but was very slow.

The fact of the torpidity of this little animal is known to the gardeners and others near the city. They call it the "seven-sleepers," and assert, that it is frequently found in the earth, at the lower extremity of the horse-radish, and other perpendicular roots. Does it use these as a measure of the distance to which it shall go in the earth, to avoid the influence of the frost?

I have said, that the Dipus Americanus becomes torpid in the neighbourhood of this city. But this, I believe, is not always the case. During the winter-season, this little animal and another species, which I call Dipus mellivorus, take possession of the hives of bees, in which they form for themselves, a warm and comfortable habitation, having ingeniously scooped away some wax. The materials of its nest are fine dry grass, down or feathers, and old rags. It lives upon the honey, and seems to grow very fat upon it. I believe two individuals, a male and a female, commonly inhabit one hive. They sometimes devour the greater part of the honey of a hive.

The circumstance just mentioned is not altogether uninteresting. It plainly proves what I have, long since, asserted, that the torpid state of animals is altogether "an accidental circumstance," and by no means constitutes a specific character. The same species becomes torpid in one country and not in another. Nay, different individuals of the same species become torpid, or continue awake, in the same neighbourhood, and even on the same farm.

BENJAMIN SMITH BARTON.

No. XXVIII.

Hints on the Etymology of certain English words, and on their affinity to words in the languages of different European, Asiatic, and American (Indian) nations, in a letter from Dr. Barton to Dr. Thomas Beddoes.

Read Oct. 21st, 1803.

DEAR SIR,

YOU were pleased to observe, that you take much interest in my inquiries concerning Indian dialects. It is partly on this account, but much more from the attention which it is well known you have devoted to the subject of etymology and language, that I trouble you with this letter.

In the course of my inquiries into the languages of the Americans, I have discovered many instances of affinity between the words of Asiatic and American nations, and those of the English. These affinities are sometimes very striking. Of themselves, they have, I think, some value: but when they are taken in connection with innumerable other facts, they seem to establish this important point, which I have not a doubt will, ultimately, be the opinion of all philosophers, either that all the existing nations of the earth are specifically the same, or (for I do not positively contend, with Blumenbach and Camper, that all mankind constitute but *one species)*, that the ancestors of all the present races of men, were once much more intimately associated together than they are at present.

In adducing the words (or rather a small portion of them) to which I have alluded, I do not deem it necessary to be very methodical. I shall distribute them into three heads, viz. nouns, adjectives, and verbs.

Section I.

1. Tinder. "Any thing eminently inflammable placed to catch fire." Dr. Johnson derives this word from the Saxon.

In the language of the Irish, *Tinne*, and in the Erse of Scotland, *Teine*, is fire. The Welsh, the Cornwallians, and the people of Little-Brittany, call it *Tan*. These are all of the Celtic stock. Other Celts of the old world call it *Tan*, and *Dar*. Several of the North-American tribes unite the two last mentioned words into one. Thus the Delawares, or Lenne-Lennape, call fire, *Tendeu*, *Tindey*, Tindai, *Tanau*, and Twendaigh: the Pampticoughs, *Tindu*, and the Sankikani (as early as 1633) *Tindeywe*.—In the language of the Nanticokes (a North-American tribe), *Tind* is fire. This is precisely the English verb, to kindle, to set on fire.

2. Peat or Turf. Of this well known substance, so common in the northern parts of the old and new world, where it is used as fuel, Johnson has not attempted to give us the derivation. But I find, that the Naudowessies, or Sioux-Indians, of North-America, call fire Peta.

N. B. The language of this great tribe abounds in Finnic words.

3. Morass, a fen, bog, or moor. According to Johnson, from the French *Marais*. Perhaps, however, this word may be better traced to the Permian word for the sea, *Morue*, or to the Gipsey-word *Moros*, the sea.

4. Map, a geographical picture. From *Mappa*, Low-Latin. Johnson. Several of the Asiatic tribes call the earth, *Ma*. Such are the Permians, above mentioned, different tribes of Vogoulitchi, or Vouguls, who inhabit the Oural-mountains. The Gipsey name (or rather one of their names) is *Poo*, or *Pu*. Does it not seem, that the Latin *Mappa* and the English map, are composed of the *Ma* and the *Poo*, which I have mentioned? But what is remarkable, the Chilese of South-America actually call the earth *Mapu*.

5. Valley, a low ground, a hollow between hills. *Vallee*, French; *Vallis*, Latin.—The Kartalini, one of the nations of Mount-Caucasus, call a valley, *Velee*: the Miamis, of North-America, *Walach-kach-ki-kai*.

6. Star. One of the luminous bodies of the heavens. The Persian and Bucharian word is *Stara*: the Aganske, *Staree*. The Osetti call it *Stela*, which is very similar to the Latin.

7. Cascade, a cataract, a water-fall. From the French *Cascade,* and the Italian, *Cascata.*—In the language of the Cheerakee-Indians of North-America, rain is *Kasca.*

8. Storm, a tempest. This word seems properly enough referred to the Welsh, the Saxon, the Dutch, and the Italian. In the language of the Tchiochonski, Finlanders, or Original Finns, inhabiting the borders of the Gulph of Finland, the word is *Storma.*—It may be worth observing in this place, that the Tchiochonski also call a storm, *Sea,* which may have some relation to the English word Sea.

9. Pond, a small pool or lake of water. " Supposed to be the same as pound, Saxon, to shut up." Johnson. *Paane* is water in the language of the people of Bengal and Decan.

10. Cot, Cottage. From the Saxon and the Welsh. In the language of the Carelians and the Olonetzi, two Finnic nations, *Kodee* is a house: in that of the Laplanders, *Kote;* in that of the Esthonians, *Kodda,* and in the dialects of three tribes of Ostiaks, *Kat,* or *Kaut.*

11. Door, the gate of a house. From the Saxon, *Dora,* and the Erse, *Dorris.* Johnson. In the language of the Celts of Little-Britany, and in that of the Welsh, it is *Dor.* In the Persian and Bucharian, *Dar,* or *Daur.*

12. Court, a pallace, hall or chamber, &c. *Cour,* French, *Koert,* Dutch; *Curtis,* Low Latin. Johnson. In the dialects of the Zhiryané and the Permians, it is *Karta.* Both these nations are evidently of the Finnic stock.

13. Kennel, a cot for dogs. *Chenil,* French. Johnson. In the language of the Albanians, residing in Dalmatia, and in some of the islands of the Greek-Archepelago, *Ken* is a dog.

14. Puppy; a whelp. *Poupee,* French. Johnson. In the language of the Kottowi, a nation living on the Jenisea in Siberia, *Pup* is a child. *Papoos* and *Pappooz* are the words for a child, in the dialects of the Piankashaws and Narragansetts of North-America.

15. Cat, a quadruped. *Katz,* Teuton. *Chat,* French. Johnson. Why not the Saxon? *Kat. Kéto,* in a dialect of the Lesghis. *Kate* in that of one of the Vougul tribes. *Katoo* in the Armenian and Immeretian. *Keeta* and *Kata* in the lan-

guage of the Kartalini. *Kot* in that of a tribe of the Toungusians. Other affinities might be pointed out.

16. Cur, a dog. From the Dutch *Korre.* Johnson. The Tchiochonski and the Carelians call a dog, *Kocera,* and the Olonetzi, another Finnic tribe, *Koecero:* the Cheerake-Indians, *Keera.*

17. Nap, slumber, a short sleep. From the Saxon to sleep. Johnson. *Naap* is sleep in the language of the Ingushevtzi and Tooschetti, who dwell on Mount-Caucasus. *Nippa-loo* in the language of the Sawannoo, or Shawnese. In the language of the Nanticokes, another American tribe, *Nip-paan* is to sleep.

18. Mucus, snot, &c. Evidently from the Latin *Mucus.* But in the language of the inhabitants of Tamul, *Mooka,* and in that of the Varugdsians *Mookoo** is the nose. The Malabar word is *Moko.*

19. Pen, a quill, or feather. This is most naturally referred to the Latin, *Penna.* A tribe of Ostiaks call it *Poani.* I cannot help observing, in this place, that a tribe of Koriaks, and the Tchouktchi or Tchuktschi, call a bird *Galla.* I need not remind you of the affinity of this word to the Latin *Gallus,* and *Galla.*

20. Egg. Johnson refers this to the Saxon and the Erse. It is remarkable, that the Lumpocolli, living between the rivers Jenisea and Obe, call an egg, *Eg!*

21. Custard, a kind of sweetmeat. From the Welsh, *Cwstard.* Johnson. The Katahba, or Catauba Indians of North-America, call bread Koostauh and *Coostaw.* It is a fact, that there are many Celtic words in the language of this (now almost extinct) American tribe. They call the earth *Manno* and *Mannowh* (evidently Celtic), which may, perhaps, serve to illustrate a passage in the *Germania* of Tacitus. "Celebrant (Germani) " carminibus antiquis (quod unum apud illos memoriæ " et annalium genus est) *Tuistonem* deum terra editum, et filium *Mannum,* originem gentis conditoresque. Manno tris filios assignant," &c. &c.† *Tuetsch* or *Tuets* is the earth in the dialect of three tribes of Semoyads. *Tue* is the Chilese word.

* This is a Malabar dialect.

† C. Cornelii Taciti de Situ, Moribus, et Populis Germaniæ Libellus.

22. Salt. Gothick, Saxon, Latin, French. This word, with inconsiderable variation, is preserved among many nations of the old world. Thus, the Tchiochonski call it, *Soola, Sola,* and *Suóla:* the Esthonians, *Sool:* the Olonetzi, *Soloo:* the Permians and a tribe of the Ostiaks, *Sol:* the Morduini and the Mokshan, *Sal:* a tribe of the Vouguls, *Sal.* One tribe of the Semoyads call it *See.*

23. Mattock, a kind of toothed instrument to pull up weeds. *Mattuk,* Saxon. Johnson. In the language of the Mahiccans, a North-American tribe, Matook, *Metooque,* and Mahtahhun signify wood. *Mittic,* Metic, *Meteek* are either trees or wood in the dialect of the Chippewas. The Algonkin words are the same.

24. Harrow, an instrument of agriculture. *Charroue,* French, and *Harcke,* a rake, German. Johnson. It is easy to make a much nearer approach to the original of the word than the great English Lexicographer has made. This instrument is called *Hara* in the language of the Tchiochonski, and *Harau* in that of the Cornwallians.

25. Mail, a kind of beater or hammer, a stroke or blow. *Malleus,* Latin. Johnson. *Mal* is one of the words for an axe in the language of the Laplanders.

26. Cade, a barrel. *Cadus,* Latin. Johnson.—Johnson seems not to have known, that the Celtic word is *Kad**. This is also the name in the language of one tribe of the Vouguls; and in Hebrew.

27. Canister, a small basket, &c. *Canistrum,* Latin. Johnson.—The Seneca-Indians of North-America call a cup, *Kanista.*

28. Pear, a fruit. *Poire,* French, *Pyrum,* Latin. Johnson. In the Hebrew, *Peree,* and in the Syrian, *Peero,* is fruit.

29. Oak, a tree. *Ac, Æc,* Saxon.—Johnson. I am quite contented with this; but I must observe that the Lumpocolli (the very tribe who have the English word Egg) call this tree, *Oksi,* or *Oki.* *Oaks* is the name of the Elm among the Tuscaroras and Oneidas.

30. Bark, the rind or covering of a tree. *Barck,* Danish, Johnson.—*Barka* is one of the Gipsey words.

* *Cad* is any kind of liquor in the Cornish language. Borlase.

31. Book, a volume. *Boc*, Saxon, "supposed from *boc*, a beach, because they wrote on *beechen* boards; as liber, in Latin, from the rind of a tree." Johnson. In the language of the Curdi, or people of Curdistan, *Pak*, is the leaf of a tree. We find this word among the Americans. Thus, the Delaware name for a leaf *(folium)* is *Wuni-pak*, or Wunee-pauk: the Mahiccan word, Waunee-pockq. Here there can be no doubt about the affinity of the Asiatic and American words: for a part of the American is *Pak*, which is identically the same as the Curdistan word*. Among the Americans, as well as the Asiatics (and I suppose most other nations), we find numerous instances of the change of P into B, and of B into P. Thus, the Pottawatameh, who speak a dialect of the Delaware, call a leaf Tago-búc. And thus, you see, that the Saxon word, *Boc*, with very little variation, is preserved in America. I am not afraid, that you will deem this a "risible absurdity," or that you will say what Johnson says of Skinner, "how easy it is to "play the fool, under a shew of literature and deep researches." I am of opinion, that etymology (though it has often been abused) is susceptible, in innumerable instances, of the greatest certainty. The very word which I have mentioned above, Wunee-pauk, is a proof of this. About the latter division of the word, we cannot but be satisfied: but what are we to make of the former part, or Wunee? Hitherto, I have not been able to discover that this is the name for a leaf in the language of any tribe or nation of the old world. But, *Vaunoo* is the trunk or stem of a vegetable in the language of a tribe of Semoyads.

32. Cap, the garment that covers the head. *Cap*, Welsh; *Cæppe*, Sax. *Cappe*, Germ. *Cappe*, Fr. *Cappa*, Ital. *Capa*, Span. *Kappe*, Danish and Dutch; *caput*, a head, Latin.—Johnson. To this very satisfactory history of the word, permit me to add, that *Kapa* is a cap in the dialect of the Kubeshanians, who inhabit Mount-Caucasus.

33. Under this first head of nouns, I shall add only one other word: and this is not an English one. In the Scottish dialect, *Bearn* is a child. This word, I think, is Saxon. It is also

* See my New Views of the origin of the tribes and nations of America. Comparative Vocabularies. p. 75, 76. Philadelphia: 1798.

Barn in the language of the Icelanders, in the dialect of the ancient Dacians; and in Swedish. Thus much has been observed by others. It is a curious circumstance, that *Birna* is a pregnant woman in the language of the Jolofs, one of the blackest of all the African nations. I have found Asiatic words in this language, and one or two South-American words*.

SECTION 2.

1. Dank, damp, humid, moist, wet. Skinner derives this from the German *tuncken*, to dip something into water, &c. *Dan* is water in the language of the people of New-Guinea, and *Don* in the languages of the Osetti and Dugori, on Caucasus. The Wyandots, or Hurons of North-America, call a river Yan-Dank-keh, and Yan-Daun-kee-ah. The two Asiatic nations, just mentioned, likewise call a river, *Don*.—The English words, Tank, a large cistern, or bason, and Tankard, a veseel to hold water, are unquestionably of Asiatic original. The word *Tank* is used in India at this very day. There is a river in Pennsylvania, the Indian name of which is Tunkhanna.

2. Naval, belonging to ships. The Kartalini, whom I have already mentioned, and among whom we have found a specimen of an English word, call a ship or vessel, *Navee*.

3. Murky, dark, cloudy, wanting light. From the Danish *Morck*, Johnson. *Merkot* is night in the Susdalien dialect.†

4. Democratical. I think it has escaped the notice of the English Dictionary-makers, that *Demo* is the name for men, or people *(homines, populus)* in the language of the old Persians. I find a great number of English, French, and American (Indian) words in this old language, which Sir William Jones has shown to be Sanscrit. Philosophers will ultimately repose in the belief, that Asia "has been the principal foundery of the human kind;" and Iràn, or Persia, will be considered as

* See New Views, &c. Preliminary Discourse, p. 75.

† "*Susdaliensis* dialectus variis graecis barbarisque verbis a mercaturam in Thracia facientibus "corrupta, ita fere ad Rusicam linguam se habet, uti Iudaeo-Germanica ad Germanicam." Pallas.

one of the cradles from which the species took their departure, to people the various regions of the earth.

5. Peaked, sharp, acuminated. I do not find this word (which is much in use among my countrymen) in Johnson, who, however, gives us the substantive Peak, and the verb to Peak. You will observe, that Johnson is not satisfied with his own account of the verb. " We say (these are his words) a " withered man has a sharp face; Falstaff dying, is said to have " *a nose as sharp as a pen:* from this observation, a sickly man " is said to *peak* or grow acuminated, from *pique.*" We say (in the United-States) of a person whose face is contracted by sickness, he looks *peaked.*

Paká in the language of the Indians of Moultan residing at Astrachan, and *Pukeetoo* in that of the Andieskie residing on Mount-Caucasus, signify sharp.

6. Sharp, keen, piercing, not obtuse, &c. From the Saxon and the Dutch.—Johnson. You may smile, but I will venture to inform you, that *Scharp* is an axe or hatchet, in the language of a tribe of the Vouguls.

7. Tiny; little, small, puny. *Tint, Tynd,* Danish.—Johnson, who says it is a burlesque word. Why so? *Teena,* or *Tina,* signifies small, or little in the dialects of two tribes of the Lesghintzi, or Lesghis, who inhabit Mount-Caucasus. The dialects of the Lesghis are arranged by Professor Pallas immediately before the Tchiochonski and other Finnic languages. There are many Lesghis words, nearly pure, in the languages of the Americans.

8. Big, large, proud, swelling, great in spirit, lofty, brave. " This word (Johnson observes) is of uncertain or unknown etymology." Both Junius and Skinner have endeavoured to arrive at some certainty on the subject. But their researches, in this instance, have been extremely futile. I tread on ticklish ground. In the language of the Toungusians who inhabit the eastern coast of the sea of Baikal, *Biga* is God. In the dialect of other Toungusians, and in the language of the Tschapogirri, who inhabit the eastern bank of the river Jenisea, the word is *Buga.* The word, *Bog,* which signifies God in the language of the Russians, Poles, and other Slavonic nations, is nearly allied

to our English word. Pallas says *Big* is corrupt Russian (malarossica.) It is a fact, that in the languages of many rude nations, the same word not unfrequently signifies both God and large, great, or mighty. This is remarkably the case among the American Indians. In the languages of different tribes, the same word not unfrequently means God, and great. Nay, more than this: it is easy to adduce instances of the same word being used in Asia for God, and in America for great. I shall mention a single instance. Certain tribes inhabiting the peninsula of Kamtschatka call God, *Kootcha:* now, Kutche, and *Kitchi,* are very prevailing words, among the Americans, for great or powerful. And it is remarkable, that they often use it as an epithet for God: thus, *Kitchi-Manitou,* &c. the Great-Spirit, in the language of the Chippewas, &c.

Section 3.

1. To Chirp, to make a chearful noise. "This, says Johnson, seems apparently corrupted from cheer-up." This is certainly a forced derivation. I think he would have been better pleased with the one I am to offer. In the language of the Ostiaks, of Narim, *Churp* is a bird. The Ch is to be sounded like the Chi of the Greeks and the Ch of the Germans. I consider all the Ostiaks as having a Finnic original. Unquestionably, a very great number of English words are Finnic, as are also perhaps a still greater number in the languages of the North-American tribes.

2. To Bouse, to drink lavishly; to tope. *Buysen,* Dutch. Johnson. This word and the adjective Bousy are to be met with among very old English writers. Spencer speaks of the "Bousing can." The word is evidently of Asiatic original. Perhaps, it may be referred to the Asiatic word *Boo,* water, from whence I suppose the American words, Bee, Beeh, *Beh,* water. But I can furnish you with something much less equivocal. According to Mr. Bruce, the Abyssinians make from a species of millet, an intoxicating drink, which they call *Bousa.* Josaphat Barbaro, a Venetian, tells us, as early as 1436, that the Tartars whom he visited, drink a kind of beer

called *Bossa*. And Dr. Forster informs us, that "at this present "ime they have in Russia an inebriating liquor, prepared "from millet, which is called *Busa*, and is very heady."*

3. To Tope, to drink hard; to drink to excess. Toper, a drunkard. "*Topff*, German, an earthen pot; *Toppen*, Dutch, *to be mad*. Skinner prefers the latter etymology." Johnson. I am far from being satisfied with this, and I think something more satisfactory may be offered. In the language of the Gipsies, *Tepaoo* is to drink. You are not ignorant that the language of these vagrants has a most evident and intimate affinity with that of the nations of Hindustàn.

4. To butcher; to kill. The Mandshuri, or Manshour—Tartars, call death *Bootschere*, or *Butchere*. It may not be amiss to observe, in this place, that *Mort* is death in the language of the people of Bengal. How nearly similar is this to the Celtic words, *Mar*, *Mor*, *Mart*; the Latin *Mors*; the Italian *Morte*; the French, *Mor*, &c.!!

5. To Ram, to drive with violence, as with a battering ram. I find nothing satisfactory relative to the etymology of this word, in our English dictionaries. After attending to the following, I hope you will not think I am forcing the subject. In the language of the Tchiokonski, *Ramo*, and in that of the Esthonians (both of whom I have often mentioned) *Ramm* and *Rammo* are the words for our English force and strength (*Vis*, *Robur*). *Rammo* is also the Esthonian word for power (*Potentia*).

As I know not what value you may attach to the preceding mite to extend our knowledge of the original of English words, I shall not, at present, trouble you with any more of a similar kind. Permit me, however, to make a few observations, which seem to arise naturally enough out of this investigation.

Many English words do, unquestionably, exist among certain Asiatic nations, and even among the Indian nations of America. As it is difficult, at first sight, to give a very satisfactory

* History of the Voyages and Discoveries made in the North, &c. p. 172, 173. Dublin Edition, 1786. [illegible] Tartary [illegible] See [illegible] Provinces [illegible] in the years [illegible], and 1794. Vol. I. p. 309, 383, &c. English translation. London: 1803.

explanation of this fact, superficial inquirers (of whom there is always a large number, particularly in the crowd of those who have written upon the origin of mankind) immediately conclude, either that the affinities are entirely *accidental*, or that they are owing to the commercial intercourse which, at present, subsists between the inhabitants of different parts of the earth. That such affinities are accidental, I am sure that no man in his sober senses, will dare to assert. That they are not to be accounted for from the commercial intercourse which at present subsists between different nations is equally certain. The difficulties which encumber this important subject will vanish, when we extend our inquiries beyond the limited horizon of a few hundred years; and when we suffer ourselves to be relieved from the numerous prejudices, which form as it were our pillow in the cradle. The books of Moses inform us, that mankind were created in Asia. Ever since I have busied myself, and I may add, rendered myself happy, with inquiries into the languages of the Americans, I have ceased to entertain any doubts of the accuracy of the scripture story, so far as regards the Asiatic origin of men, and their dispersion from a common centre. These two great facts, which constitute corner-stones in the history of the species, are supported by the more modern history of nations; and I am persuaded will bear the strictest scrutiny of every research of humanity.

The original of nations may, in many instances, be determined solely by an attention to the languages of mankind. Had the books of Moses perished; had no memorials concerning them escaped the numerous revolutions of our globe; had no traditions concerning the origin of the species been transmitted to us, the researches of philosophers, through the medium of language (such is the pure certainty of science!) would have conducted them to the great historical truth, that Asia has been the cradle of the world. But history much more recent than that of the Jewish lawgiver, kindly comes to our assistance. Thus, not to mention other instances, the Saxon chronicle deduces the first inhabitants of Britain from Armenia. Now, it is a fact, that we find some English words in the language of the Armenians, and in the language of the Kartalini and other Caucasian tribes, to which the Armenian is allied. Thus it is easy to conceive, how many Asiatic words (a much greater number than is generally supposed) are still preserved in Britain. They were brought into Britain by the Asiatic colonies; they are still preserved, and will be preserved for a long time, notwithstanding the various admixtures of nations; because languages are the most unperishable of all medals. They are as immortal as the human race.

The Asiatic origin of the Greeks and the Latins has never been called in question. There are many Latin words in the English language. Some of these, I have no doubt, were introduced by the Romans when they conquered and colonized the island. But a much greater number, I suspect, are derived by the ancient inhabitants of Britain from the same tree which supplied the Romans with its fruit. An attention to the following circumstances will render this not a little probable.

We find Latin words among many of the rude and other nations of Asia, who are not known to have had any communication with the Romans. Some instances of this kind I have painted out in a former part of this letter. But we find Latin words among the Indians of America: and I think there in no good foundation for suspecting, that the Romans had ever visited, much less planted colonies in, America. I will give an instance or two. In the language of the Delawares, *Pane* is bread. This is almost pure Latin. It is actually pure Italian, Neapolitan, and Spanish. But whence, it has been asked, did the Americans derive this word? Doubtless, from the same tree which, planted in the soil of Asia, has spread its branches, or diffused its fruit, to every region of the earth. In the language of the Curdes, of Curdistan, *Pan* is bread. This language is nearly allied to the Persian. Thunberg informs us, that the Japanese verb to bake bread is *Pan-jakv.* Now, I have shown, that there are many Curde and Japanese words in the different dialects of America. The same Delawares call a dog, *Me-kanne,* which is nearly Latin, but more nearly still Italian and Neapolitan. In this instance, also, we can trace the word to Asia, for different tribes of Samoyads call a dog, *Kanang, Kanak,* and *Konak;* and the Karassini call it *Kannak.*

It is unnecessary to adduce other instances of this kind.—Many more might be adduced, and will be mentioned in the Second Part of my *New Views*, which is preparing for the press. If those which I have mentioned should be deemed of any importance to you, I shall, in a future letter, communicate another collection. I am well aware, that these inquiries are remote from our immediate professional pursuits; but they are not remote from our inquiries as naturalists. The study of the physical history, that is of the figure, complexion, &c., of mankind, should go hand in hand with a comparison of the languages of the earth. The most finished *Anthropologia*, such an one as Pallas could give us, will be constructed, in a considerable degree, upon the affinities of languages.

I am, Dear Sir,

with much respect,

Your Friend, &c.

BENJAMIN SMITH BARTON.

Thomas Beddoes, M. D. F. R. S.

Philadelphia, October 20th, 1803.

POSTSCRIPT.

You will observe, that the preceding words in the languages of the Americans are written in two different kinds of letters, viz. Roman and Italic. The former, which are fewest in number, were all collected by myself: the latter are either taken from printed books or have been collected for me by my friends, in different parts of the United-States. Most of the words in the Asiatic and other languages, are taken from the *Vocabularia Comparativa* of Professor Pallas. It is much to be regretted, that this very important work has not been completed. I have seen the First and Second parts, which were printed at Petersburgh, in 1786, and 1789. Neither the African nor American languages have any place in these volumes. My own labours have now put me in possession of good specimens of at least one hundred American dialects, and several African ones. These may, at some future period, be offered to the public, as a supplement to the work begun by Catherine and Pallas.

No. XXIX.

Astronomical Observations made by Jose Joaquin de Ferrer, chiefly for the Purpose of determining the Geographical Position of various Places in the United States, and other Parts of North America. Communicated by the Author.

Translated from the Spanish, and read at different times.

GEOGRAPHICAL POSITIONS ON THE ATLANTIC BORDER OF THE UNITED STATES.

		Latitudes.			Longitudes W. of Greenwich.			
		°	′	″	°	′	″	
Cape Hatteras.	†	35	14	30	75	38	15	§
Cape Henlopen light-house.	‡	38	47	16	75	10	03	§
Cape May.	†	38	56	46	74	56	54	§
Germantown market-house.	*	40	02	29				
Coast to the North of Cape-May.	‡	39	39	00	74	16	35	§
Idem.	‡	39	52	40	74	12	15	§
Idem.	‡	40	07	30	74	12	15	§
Highlands.					74	07	24	§
Town of New-Haven.	‡	41	17	07	73	4	53	§
Town of Gilford.	†	41	18	16	72	51	00	§
(Falcon) Falkland-Island.	‡	41	14	50	72	50	15	§
New-London, Light-house.	‡	41	21	08	72	12	15	§
Light-house, on the Easternmost point of Long-Island.	†	41	04	50	71	53	39	§
E. Hampton, in Long-Island.	†	41	00	00	72	15	50	§
Rock-Way in Idem.	†	40	28	00	73	12	55	§
Battery at New-York.	*	40	42	06	74	07	45	

† Latitude observed at sea, at some distance from the parallel, and calculated from a course of 4 or 5 hours from the time of observing.

‡ Latitude observed at sea, upon which dependence may be placed, and not differing ⅕ of a minute from the true lat.

* Longitude determined by astronomical observations; by the emersions of the first satellite of Jupiter compared with the corresponding ones made in Europe, and by the occultation of stars by the moon's disk.

§ Longitude as referred to New-York, by a chronometer of Arnold.

ON THE RIVERS OHIO AND MISSISSIPPI.

THESE Latitudes, which were ascertained in the months of May and June 1801, were observed with a circle of reflection, and an artificial horizon of Mercury; and the Longitudes by the assistance of two chronometers; one made by Arnold No. 396, the other by Earnshaw No. 306 suspended in gimbols. Their going was carefully observed at Pittsburgh and at New-Orleans, and from the regularity observed in their going, reliance is to be placed on the exactness of the difference of meridians.

ON THE OHIO.

	Latitude. °	′	″	Long. (in time) W. of Greenwich. h	′	″
Pittsburgh.	40	26	15	5	19	53
Great Kanhawa.	38	51	54	5	28	32
Galiopolis.	38	49	12	5	28	41
Guiandot.	38	25	00	5	29	16
Sciota River.	38	43	28	5	31	54
Vance Ville.	38	35	00	5	33	00
Manchester.	38	37	00	5	34	05
Cincinnati (Fort Washington).	39	05	54	5	37	50
Louisville.	38	15	48	5	42	39
Falls of Louisville, (2 m. N. W. of L.).	37	17	14			
Blue River.	38	11	00	5	44	53
Green River.	37	52	42	5	49	42
Diamond Island.	38	14	16	5	49	28
Wabash River.	37	49	15	5	52	02
Fort Massac.	37	13	00	5	54	31
Wilkinson Ville.	37	15	00	5	55	40
Confluence of the Rivers Ohio and Mississippi.	37	00	20	5	56	24

ON THE MISSISSIPPI.

	°	′	″	h	′	″
Sand Island (arena).	36	27	28	5	57	40
New-Madrid.	36	34	30	5	58	03
East point of Devil's Island, with a Cliff on the East bank of the River.	35	24	24	5	59	54
Channel between two Islands.	33	58	00	6	4	35
Island.	33	04	30	6	4	57
Island.	32	36	22	6	4	14
Confluence of the Rivers Yazoo and Mississippi.	32	28	00	6	4	12
Walnut Hills.	32	24	37	6	3	49
Grand Goudre.	32	04	30	6	4	27
Natchez.	31	33	48	6	5	54
Spanish Limits.	31	00	00	6	6	43
Red River.	31	01	15	6	7	11
Point Coupee (1st Church)	30	42	00	6	5	36
False River.	30	45	00	6	5	32
The Yellow Cliffs (escapardo)	30	40	00	6	5	24
Northern point of the last Island.	30	06	00	5	6	23
New Orleans.	29	57	30	6	0	38
South West Pass.	28	56	00	5	57	56

Occultation of o in Sagittarius, by the disk of the Moon, observed by J. J. de Ferrer, in Veracruz, August 25, 1795, with an achromatic Telescope of Dolland $2\frac{1}{2}$ feet long.

Immersion in apparent time, 9h 32′ 55″, and in mean time	9h 34′ 31″. 4
Veracruz west of Paris	6 33 42. 8
Immersion in mean time at Paris	16 8 14. 2
	° ′ ″
Right ascension of the sun at the time	154 46 10
o Sagittarius — Right ascension	283 6 21. 2
o Sagittarius — S. declination	22 1 18
Apparent obliquity of the ecliptic	23 27 51
o Sagittarius — Longitude	282 08 9. 5
o Sagittarius — S. latitude	0 53 28. 5
Proportion of equatorial and polar diameters of the earth...334 : 333	
Correct latitude of Veracruz = [19° 11′ 53″—6′ 23″]	19 5 30
Logarithmic radius at Veracruz	9,999 859
Equatorial horizontal parallax of the ☾	55 50. 2
	″
Apparent diameter of the ☾—3″ inflection	30 47. 8
Parallax in longitude	16 56. 5
Parallax in latitude	34 38. 2
S. latitude of the moon by the theory of Laplace	1 30 13. 6

On the 25th & 26th August, the moon was observed in the Royal observatory of Greenwich, and comparing these observations with the theory of Laplace, there results the following error in the theory.

On the 25th, in long: = × 0″. 8 in lat. = × 6″. 5
——— 26th — 1. 6 × 7. 9

It results from these elements, that the true latitude of the moon at the moment of immersion was	1 30 20. 5
Difference of the apparent latitudes between the ☾ & o Sagit.	2 13. 8
	h ′ ″
True conjunction in Paris according to the Greenwich observations in mean time	16 4 58. 9
Conjunction at Veracruz, by the immersion	9 31 16. 1
Longitude of Veracruz, W. of Paris	6 33 42. 8

There was no corresponding observation made in Europe, but as on that and the following day, the transit of the moon over the meridian was observed in the Royal observatory at Greenwich, I was enabled to correct the error in the lunar tables, and found the longitude of Veracruz to be (as above) $6^h\ 33'\ 42''.\ 8$ west of Paris. Citizen Mechain made the longitude, from the same observations, $6^h\ 33'\ 54''.\ 9$. This difference, although very small, might happen, if he was unacquainted with a remark published by the Rev. Nevil Maskelyne: That the transits of the stars were observed by his assistant D. K. and that of the moon by Maskelyne himself, who after comparing the different observations, ascertained that his assistant had contracted the erroneous habit of marking down the transits, half a second after they had happened, from which it became necessary to subtract 0″. 5 of time, from the transits of the stars. If I had omitted this correction, my result would have been similar to that of Citizen Mechàin.

The present observation has this advantage, that the star passed but 2′, 13″ from the apparent centre of the moon, so that if there had been an uncertainty of 10″ in difference of latitude, there could only be one of 3″ in the difference of meridians.

Observations of the Eclipse of the Sun on the 21st February 1803, *made in the City of Havanna and at Lancaster in Pennsylvania, U. S.*

IN the Havanna the beginning of the eclipse could not be observed on account of the clouds; at 4h. 18′. 30″. when the solar disk became clear, the indenture (cuerda) was perceptible. The distance of the horns, was observed alternately, with an excellent Heliometer of Dolland, by Don Antonio de Robredo, and by Don Jose Joaquin de Ferrer.

Apparent times. h ′ ″	Distance of the Horns. ′ ″
4 24 47	15 25
4 26 41	17 06
4 29 12	18 59. 2

Least distance of the Limbs.

h ′ ″	″
5 16 45	0 53. 2

	°	′	″
Latitude of the Havanna by Ferrer.	23	09	07
	h	′	″
Longitude W. of Greenwich by the same.	5	29	16

Beginning of the eclipse *in Lancaster*, as observed by Mr. A. Ellicott.

Apparent time = 4h 50′ 57″

	° ′ ″	
Latitude of Lancaster.	40 02 39	by Mr. Ellicott.
Longitude W. of Greenwich.	5h 05 03	by Mr. Ellicott.

Elements calculated by the theory of Laplace, at. 9 25 mean time in Paris.

	s	°	′	″
Longitude of the ☾ reckoned from the apparent Equinox. .	11	2	19	24. 2
South Latitude of the ☾				30. 5
Horizontal parallax in Paris.			61	03. 2
Horizontal semi-diameter of the ☾			16	41. 5
Relative Horary motion. . . = (37 46 7—2 30 9 =)			35	15. 8
Horary motion in Latitude northerly.			3	29. 4
Longitude of the ⊙ by the tables of Lalambre.	11	02	20	47. 6
Horizontal semi-diameter of the ⊙			16	11. 4
Horizontal parallax of the ⊙				8. 6
Difference of Polar & Equatorial Diameters 1-334th.				

	h	′	″
Conjunction in Paris by the tables, in mean time,	9	27	22
in apparent time	9	13	21

	′	″
Vertical Angles. at Lancaster. = —	10	09
at Havanna.	7	26

From these elements are derived the following results.

	h	′	″
Conjunction at Lancaster, apparent time. . . .	3	59	45
at the Havanna.	3	35	08
Lancaster East of the Havanna.	0	24	37
Havanna west of Greenwich.	5	29	16
Longitude of Lancaster west of Greenwich. . .	5	04	39

If we suppose the eclipse to have commenced at Lancaster 12″ earlier, which Mr. Ellicott suspected, in this case the difference of meridians between the Havanna and Lancaster will be 24′. 25″. and it would result that Lancaster was west of Greenwich 5^h. 04′. 51,″; differing from my result only 12″, which is as near as can be expected; for as this determination depends upon the exactness of the theory of the moon, it cannot be relied on within 30″ of time.

These observations may be very important to compare with others of the same eclipse, which may have been made in other observatories.

GEOGRAPHICAL POSITIONS.

Without the boundary of the United States.

COAST OF CARACAS.

	Latitude North. °	′	″	Long. W. of Greenwich. °	′	″
La Guaira (wharf)*.	10	36	40	67	00	08
Caracas (town-house).	10	30	24	66	57	18
C. Codera.	10	35	36	66	01	44
New-Barcelona (Market-Place).	10	08	14	64	46	23
I. Blanca (S. W. point).	11	51	00	64	40	22

WINDWARD ISLANDS.

	Latitude North.			Long. W. of Greenwich.		
	°	′	″	°	′	″
Saba, highest part.				63	18	36
St. Martins, highest part	18	04	28	63	06	27
Isle of Dogs, the westermost.	18	19	00	63	22	15
St. Thomas the port.	18	20	30	64	57	06
Sta. Cruz, (the capital).	17	44	08	64	42	29

ISLAND OF PORTO-RICO.

	°	′	″	°	′	″
City of St. John, the capital,*.	18	29	10	66	07	48
N. W. point of the island.	18	31	18	67	06	10
Watering place of St. Carlos (town).	18	27	20	67	07	22
Little I. Desecheo.	18	23	48	67	27	48

ISLAND OF ST. DOMINGO.

	°	′	″	°	′	″
C. Samana.	19	16	30	69	08	34
Altavela, rock.	17	28	11			
Navaza I. middle.	18	24	47			

ISLAND OF CUBA.

	°	′	″	°	′	″
C. de Cruz.	19	47	16	77	44	00 ☾
Pico de Tarquino.	19	52	57	76	51	30 ☾
C. Bueno.	20	06	10	74	10	45
C. Mayzi.				74	07	15
Punta de Mulas.	21	04	35	75	33	45
Cayo (Key) Verde.	22	05	06	77	36	45
——— Confites.	22	11	44	77	41	08
——— de Lobos.	22	24	50	77	32	58
——— Guiancho.	22	44	00	78	01	15
Cayo Sta. Maria (the northermost).	23	12	00	78	53	03
Matanzas (city).	23	02	28	81	36	05
Castle St. Severino.	23	02	54	81	35	15
Punta Savanilla.	23	04	30	81	33	15
Punta de Guanos.	23	09	27	81	40	00
Pan de Matanzas.	23	01	39	81	41	41
Moro Castle, Havanna*.	23	09	07	82	19	10
Hill (Cerro) of Guaijabon.	22	47	46	83	21	06

BAHAMA CANAL.

	°	′	″	°	′	″
Cayo Largo. N. E. point.	24	57	30	80	35	26
Cayo Largo. S. E. point.	24	52	00	80	33	36
Coast of Florida.	27	10	00	80	05	45
Double headed Shot, N. W. point. (los roques)	23	59	44	80	23	30
In 10 fathom water on the bank.	24	38	15	79	07	15
The Northermost of fresh water key.	25	43	30	79	08	21
Great Isaac.	26	01	30	79	02	21
Little Isaac (eastermost).	25	57	00	78	46	15
Memory Rock.	26	56	00	79	03	27

BAHAMA ISLANDS.

	Latitude North. °	′	″	Long. W. of Greenwich. °	′	″
I. Abacou, N. E. point.	26	29	52	77	00	21
Rocky point in the same.	26	17	20	77	03	25
Hole in the Wall (or Rock)	25	50	19	77	15	45
New Providence (Nassau).	25	04	33	77	22	06
The Northwestermost of the I. of Berry.	25	50	49	78	01	38
The Eastermost. Idem.	25	22	00	77	41	15
9 fathom water, white sand.	25	44	00	78	14	45
2¼ do.	25	44	00	78	39	45
3 do.	24	53	00	78	51	45
4 do.	24	45	00	78	58	45
10 do.	24	38	00	79	07	15

GULF OF MEXICO.

	°	′	″	°	′	″
Campeche (great Square).	19	50	15	90	30	37
New Veracruz.*	19	11	52	96	04	20
Mount Orizaba (pico)	19	02	17	97	09	20
Bernal Grande.	19	39	42	96	21	05
Gallega Bay, the north part.	19	13	20	96	03	42
Tamiagua (city).	21	15	48			
Barra of New Santander.	23	45	18	98	07	43
Lake of St. Fernando (ó la Carbovera).	24	36	00	97	59	00
Opening, supposed Rio Bravo	25	55	00	97	26	30
Point in the coast.	26	46	00	97	35	00

NOTES.—* Longitude determined by observation.

☾, Longitude determined by lunar distances.

The remainder of the Longitudes are ascertained by chronometers.

The correctness of Latitudes may be fully depended upon.

Height of some Mountains in New Spain, compared with the height of that in Teneriffe.

		French Toises.
New Spain.	Height of the Peak of Orizaba,* above the level of the sea.	2795
	.... of the Cofre de Perote.	2185. 7
	.... of the Town of Xalapa.	698
	....................................Encero.	515. 3

* See Geographical Positions, in this page.

Teneriffe.	Height of the Peak in the Azores according to J. J. De F.	1238
	.... according to Don Vizente Tofino. Brigadier of the Spanish Marine.	1260
	Mean height 1249 Toises.	

JOSE JOAQUIN DE FERRER.

No. XXX.

Description of the river Mississippi and its Delta, with that of the adjacent parts of Louisiana. By William Dunbar, of the Natchez, communicated by the Author, a Member of the Society; through the President.

Read April 6th, 1804.

THE multiplicity of the rivers which are tributary to the Mississippi, extending themselves over an immense tract which comprehends nearly 20°. in lat. and 30°. in long. must render this river, at all seasons, one of the most considerable on the globe. The annual inundation, being supplied from so great a variety of climates, must naturally be expected to be of long duration; and may generally be estimated at nearly half the year; beginning (com. annis) to rise in January, and fall in June; the two extremes being frequently extended by the early autumnal and winter rains in the southern latitudes, and by the protraction of the northern winters, which retards the dissolution of the immense accumulations of snow in those cold regions. At the landing of the Natchez (380 miles from the mouth of the river) the perpendicular ascent of the waters of the Mississippi, from the lowest ebb to the highest inundation, may be estimated at 50 feet. At Baton Rouge (200 miles distant) it was found to be 30 feet; at New-Orleans (80 miles above the mouth) it is about 12 feet; and at the mouth of the river, scarcely any perceptible change is observed, excepting by a stronger current charged with earthy matter rolling into the ocean during the season of the inundation; at which time, all the lakes and communications with the sea are replenished with the waters of the inundation, and the ocean itself is often repelled to such a degree, that fresh water has been drawn up, out of sight of land. This great difference in the perpendicular rise of the waters of the inundation is to be accounted for from the prodigious number of natural canals issuing from the Mississippi, and those immense sheets of water, often unbounded by a single horizon, flowing over the banks never to return, and inundating vast tracts of country which owe their existence to the creative power of this grand river, and which finally discharge themselves into the Mexican Gulph by an infinite number of mouths, many of which are, in apparent magnitude, equal to the Mississippi itself; the space embraced by the Delta of this river on the sea coast being, from information, not less than 3° of longitude.

Table of the mean altitude of the waters of the Mississippi at Natchez, from the lowest ebb to the highest elevation.

	Days.	*Alt. feet.*		*Days.*	*Alt. feet.*
January	1	25	July	1	45
	15	30		15	40
February	1	35	August	1	20
	15	40		15	10
March	1	45	September	1	7
	15	47		15	5
April	1	48	October	1	0
	15	48½		15	0
May	1	49	November	1	5
	15	50		15	10
June	1	50	December	1	15
	15	48		15	20

It is not to be understood that the rise and fall of the Mississippi, in any one year, ever arrives to the extent of the above table; it is found that years of least elevations will generally be those of greatest depressions. The table is calculated only to convey some idea of the extremes which have been noted in a series of years, and of the general progress of the inundation both in its advancement and retreat.

By information from the inhabitants of the island of New-Orleans, about 25 leagues above the capital, in the year 1774, it appears that the Mississippi had overflowed its banks yearly for three years preceding, by which they had lost their crops, and which caused great astonishment, because from the commencement of their settlements, which exceeded 20 years, they had rarely ever seen the Mississippi surmount the level of its banks, and that an embankment, called by the french name of levée, was required only in very few places. Since that period, from year to year, the river has continued to rise higher and higher, which has obliged the inhabitants of Lower Louisiana to prolong and reinforce their levées; in so much that embankments of 5 or 6 feet perpendicular are now required, where as many inches were formerly sufficient. This increasing ascent of the inundation may be naturally accounted for by the gradual extension of the levées on both sides of the river, which became each succeeding year more necessary for the defence of the new settlements against the encroachments of this great river. Those establishments are now extended on either bank to the distance of 60 leagues above the capital; it is not therefore wonderful that high banks in the lower parts of Louisiana should be required to receive and confine a body of water which formerly escaped over a great extent, now occupied by the embankments. In spite of this mode of reasoning, which appears to be sufficiently satisfactory, the Mississippi has ceased to rise to its usual height for these* three years past; the defect at Natchez has not been less than from 8 to 12 feet, and proportionably in the lower country. Many are the conjectures which have been formed to account for this unexpected great change. Some of the old inhabitants say that the Mississippi has returned to its ancient level, while others pretend (ludicrously enough) that the Missouri has found a new passage into the western Pacific Ocean. It does not appear, that we can assign any physical cause why the Mississippi should have certain periods of years in respect to its inundations; nor have observations been made for a sufficient length of time to establish the fact. The late period of great inundations, which have fallen chiefly under my observations, has been about 27 years, not much short of a cycle of the sun; but whether the inundations of this great river are subject to the influence of any regular cause, must be left to the investigation of future philosophers, profoundly skilled in the laws of meteorology.

* This account was commenced in 1800.

The waters of the Mississippi are not, at any time, perfectly transparent: during the absence of the inundation, they are not much troubled, presenting a slight milky appearance, which is attributed to the Missouri; but during the time of the inundation, all the rivers which discharge their superabundant waters into the Mississippi are more or less charged with terrene matter, and during the decline of the inundation, the turbidness is sometimes so great that a glass filled with its water appears to deposit, in a few minutes, a sediment equal to one eighth of its bulk; this extreme impurity is not to be attributed entirely to the immediate effect of the Missouri, but principally to the falling in of the mud banks, either newly formed beneath the influence of the current of the river; or undermined by its rapidity, perpetually changing its bed, by enlarging the concavity of its bends, and projecting its points or head lands: this operation has a natural tendency to lengthen the circuitous course of the river; but the effect is amply compensated by its own progress; for the enlargement of the bends frequently brings them so near each other, that the weight of the waters bursts at once through the solid soil, forming in a few days a new bed capable of conveying the whole waters of this mighty river, and shortening thereby its course many leagues. The disruption which took place at Point Coupée, cut off ten leagues, and within this territory the cut-off at the Homochito has thrown to the east of the Mississippi an island of seven leagues in circuit, and at the Yazooz a similar effect has been produced on the west side by the formation of an island of five leagues in circumference. Those islands are now both converted into peninsulas, by the formation of new land across one of the mouths of the old channel, while the other is partially kept open by the discharge of the (comparatively) small rivers of the Yazooz and Homochito; the former of those, nevertheless, is not inferior in magnitude to that great commercial river the Thames. The consequence of those disruptions, is the formation of lakes, which, in process of time, may be far removed from the actual channel of the river, and in effect are now found to be scattered in all situations over the immense valley of the Mississippi.

When those lakes are first approached, they present so perfect a resemblance of the Mississippi, with regard to breadth, the appearance of the banks, and the natural serpentine form of its course, that many persons have been deceived thereby, and recognized their error only by the discovery of the stagnant state of the water, the appearance on its borders of the Nymphæa Nelumbo, and other aquatic plants; no person therefore doubts that those lakes have all, in their turn, served to convey the waters of this father of rivers, and now during the season of the inundation still flow with a full current, contributing their aid to the evacuation of the waters of a thousand rivers which precipitate themselves into the valley of the Mississippi. When we take a survey of this valley, upwards of 30 miles wide opposite to the Natchez, diverging very obtusely as we approach the sea-coast, where it is perhaps not less than 3° in long. and that in no part of it do we discover any other soil than such as is now daily deposited by the waters of the Mississippi, it is impossible not to believe that this valley has, in the beginning, been a branch or inlet of the ocean, which received into its bosom this great river, similar to the River de-la-Plata, the Gulph of St. Laurence, Delaware bay, and many others not remarkable for the alluvial properties of their rivers. When, on the other hand, we contemplate the effects of the creative power of the Mississippi, which has filled up this prodigious space with soil, more or less solid, and which must at Natchez exceed 100 feet perpendicular above the level of the sea, sloping gradually like an immense glacis to the coast of the bay of Mexico, where nevertheless it does not terminate, but shelving off by continual accumulation frequently embarrasses vessels out of sight of land, along the coast, to the west of the Mississippi; I say when we survey this immense work performed by the hand of nature, we cannot accord with the opinions of certain visionary philosophers, who have been pleased to amuse themselves with the pretended infantile state of our continent, compared to their trans-atlantic world; but, on the contrary, we must grant to it an incalculable antiquity. When the inundation is at its height, the whole valley is replenished with water every where in motion, making its progress towards the ocean; so that at that season the river may be said to be 30 miles or more in breadth at Natchez; the waters which pass over the west bank of the main channel never return; on the east, a chain of high land, which at many points is washed by the river, meandering along its valley, compels its waters to rejoin the primitive stream; but from Baton Rouge, the high land which has hitherto held a southerly course, diverges suddenly to south east, and is no more visited by the grand channel of the Mississippi; all the waters which escape to the eastward between Baton Rouge and Manshac (15 miles) are collected by the Iberville, which, passing through a breach in the high land of about 60 yards wide, delivers its contents to the river Amit, which empties itself into lake Maurepas, communicating with the ocean by the intervention of the more considerable lake Pontchartrain: the high land is continued in a very narrow tongue or promontory, in a south easterly direction, along the island of New-Orleans, which is disruptured in many places, thereby venting the waters of the inundation into the lakes, which otherwise would be collected into an oblong bason, formed by the high land on the one hand, and the bank of the river on the other—one half of the island of New-Orleans would have thereby become so completely inundated as to be uninhabitable.

The perpendicular height of the high lands above the level of the inundation is from 200 to 300 feet at Natchez; at Baton Rouge it does not exceed 25, and on the island of New-Orleans it declines so rapidly as frequently to be lost under the accumulations of soil deposited by the waters of the inundation. In the sides of a canal from New-Orleans to the river St. John's, communicating with lake Pontchartrain, I discovered the continuation of the high land cut through to the breadth of little more than 20 feet.

To a stranger, the first view of the Mississippi conveys not that idea of grandeur, which he may have pictured to himself: his first judgment will rest upon the appearance of its breadth, in which respect it is inferior to many rivers of much less note. Its principal channel is rarely a mile in width any where below the Ohio, unless where its stream is divided by islands or shallows; it is not unfrequently less than half a mile. The magnitude of this river is not to be computed by its width, but by its depth; in which it is perhaps equal to any on the globe; but is so contracted at the place of its entrance into the ocean, as to be there less in width than it is found to be at a thousand miles from its mouth; the cause of this peculiarity is, perhaps, not difficult to develope. The natural effect of rivers is to encrease continually the depth and breadth of their beds, by the perpetual abrasion of their waters; such must be the consequence with regard to all rivers which do not supply by alluvion a sufficient quantity of matter to counteract this effect. Certain rivers, which in the upper part of their course pass through fertile regions, whose rich and tender soil is easily broken down and carried away by the impetuosity of the current, not only supply this deficiency, but discharge such inconceivable quantities of earthy matter, as to fill up, in a great measure, those spacious bays and channels, scooped out by the hand of nature, in order to facilitate the mingling of their waters with those of the ocean; in such circumstances the breadth of the river will always be in proportion to the mean quantity of water discharged during the time it flows within its banks; for it is to be remarked, that during the time of the inundation the common channel of the river is in some measure lost in the immensity of waters, which flow over its banks in all directions; the bottom and sides of the channel, during this time, suffer no abrasion, but, on the contrary, from the diminution of the velocity of the inferior currents, gain rapidly upon the breadth of the river: the moment the current of the river is confined within its proper banks, it begins to exert its dominion over its own channel, and fashions its bed by the momentum of its waters, attacking sometimes one side, sometimes the other, according as the main filament of the stream is deflected from shore to shore; by which means large portions of the newly-created soil are preserved, while in other situations the more compact earth is undermined and borne into the ocean, and thus an equilibrium is restored between the channel and its included waters; hence it comes to pass that rivers which run through alluvial countries are much narrower in proportion to the quantity of their waters, than those whose courses are over rocks, gravel or sand; but on the other hand their depths are great, and they are consequently better fitted for the purposes of navigation. The Mississippi is supposed to be navigable (pursuing the western branch or Missouri) 3000 miles at least from the ocean. Those who have studied the theory of rivers inform us, that the stability of the bed of a river depends upon a due equilibrium between the velocity of the current and the tenacity of those matters which compose its bottom and sides: the velocity of rivers is greatest at the surface, gradually diminishing downwards; hence when the bottom is composed of matter of the most yielding nature, the channel will continue to deepen until the velocity at bottom is almost nothing, and the depth of the water will be regulated by those circumstances: the bottom of the bed of the Mississippi, within the alluvial country, being composed of the finest sand and lightest earth extremely comminuted, it is not surprising that its depth should be comparatively great; its soundings have (it is believed) never been taken with minute attention, but from New-Orleans to the mouth of the river, its depth is said to be from 50 to 70 fathoms, under the thread of the current, which follows the concave shore; diminishing gradually towards the elbows, where there are frequently considerable shallows. The sudden effect of the diminution of the velocity of water is no where more remarkable than at the mouth of this river, for the rolling torrent no sooner arrives at the ocean, than, finding its bed indefinitely enlarged, it spreads on all hands; the thread of the current diverges into an infinite number of filaments like radii from a center; the velocity of the mass of water rapidly diminishes until, no longer able to propel the matter hitherto suspended and swept along by the swiftness of the stream, it is deposited in form of a crescent, opposing to the mouth of the river, a bar with from 12 to 20 feet water. The current being less, immediately to the right and left, than in front, of the mouth of the river, the deposition and accumulation of matter will consequently proceed more rapidly on either side, and the velocity of the current being increased by the contraction of the channel, the bar will be protruded further into the ocean; hence it appears why the mouths of all alluvial rivers terminate in a promontory projecting more or less into the ocean; this last mentioned operation of nature points out the method of improving the navigation of the entrance of the Mississippi, which may be effected at no very considerable expense by carrying out a pier on each side of the principal branch, composed of piles, so far as may be found sufficient to procure the desired depth; the bar will thereby be thrown into deeper water, and in process of time will accumulate and ascend to its former height, which will demand a new prolongation of the piers. Every small rivulet passing through lower Louisiana is a miniature of the Mississippi; what may be performed upon a small scale in respect to the latter, will certainly succeed (by well directed efforts) on the former.—The river St. John's, 60 to 80 feet wide, entering lake Pontchartrain to the north of New-Orleans, was found frequently so choaked up and impeded by a bar across its mouth, that canoes could sometimes with difficulty enter; sloops and batteaux being obliged at such times to remain in the lake exposed to danger; the government directed two very simple piers, each composed of a double row of round rough piles, to be carried from the shore across the bar, and although the piers were pervious to the water, yet so much velocity was acquired, that the bar was very speedily swept off, and the river has always since remained navigable for small sloops and schooners, which proceed up to the city by the river and canal of Carondelet.

The depth of the river diminishes considerably as we advance upwards; probably owing to the increased tenacity of the matter forming its bed; at Natchez, when the waters are low, it is about 12 fathoms, and there are situations below the Ohio, where the ordinary boats have been embarrassed to find a passage both upwards and downwards; a moderate fresh nevertheless renders the Mississippi navigable up to the falls of St. Anthony, about 2000 miles from its mouth. The breadth of the river appears to be upon the increase upwards, in proportion as we get above the alluvial country, as high as the Missouri, notwithstanding the loss of a number of principal rivers which flow in below; in latitude 42°. it is said to be half a mile in breadth, which probably equals its mean breadth from Yazooz to its mouth.

The margin of the river is the highest land to be found in the valley of the Mississippi.—As the river overflows its banks, the waters immediately begin to deposit their grossest particles, which are chiefly sand and black marl, and in their progress backwards this deposition is continued until at length, a matter is deposited so highly levigated that, upon the retiring of the waters, it assumes a compactness and solidity resembling pitch: when the river by disruption alters its course, and new accumulations of slime sand and marl are laid upon this very compact earth, a false belief might be induced that this solid soil is not the offspring of the river, but the original parent earth coeval with the Mississippi itself, upon which this great river had afterwards deposited the rich spoils of the northern regions, borne down by its mighty tide; this compact soil I have found at the depth of from 10 to 30 feet; and in other situations no appearance is to be seen of any other than the common soil formed of the mud of the river. The soil near the river is sandy, particularly that which has been lately formed; from a quarter to half a mile from the margin of the river the sand is less apparent, and it loses its name of 'terre sablonneuse,' acquiring that of 'terre grasse,' being the richest black marl, with a moderate admixture of sand; at greater distances, and frequently at some depth under the last mentioned soils, is found the above mentioned compact earth, called glaise (potters earth); it is no doubt eminently adapted to the use of the potter, though hitherto not much applied to the manufacture of earthen ware. Upon all lands long subject to culture and defended from the inundation, although near to the margin, the appearance of sand is almost lost, but it is evident from the friability of the soil, and the facility with which it is cultivated, that a large portion still remains intimately mixed with it, whereas the terre grasse (unmixed or pure marl) yields with difficulty to the plow; it exhibits proofs of the richest marl, a slight shower causing it to crumble into powder after being turned up; yet as our climate is exposed to sudden and violent falls of rain with subsequent hot sun-shine, it frequently becomes so firm and unyielding, after the crop has been planted, that no mode of cultivation can be conveniently applied, but barely scratching the surface with the hoe; yet this became with the French indigo planters a favourite soil; although less productive, it is more easily kept clear of weeds, the compacted soil refusing a passage to their tender fibrous roots, while the vigorous taproot of the indigo plant conquers the obstinacy of the subjacent stratum. From the river bank a natural glacis is formed, whose declivity at New-Orleans may be at the rate of 6 or 8 inches in 100 feet, to the distance of 6 or 700 toises, diminishing, after which the descent becomes almost imperceptible, and is gradually lost in swamps, marshes and lakes, which finally communicate with the sea.

This peculiar structure of the lands formed by the operation of the great river itself, has pointed out to the ingenuity of man, a simple and natural mode of defending his plantation against the encroachments of the inundation: he commences by forming an embankment near the margin of the river, elevated above the highest waters and of sufficient strength to resist their pressure; he is now protected from the direct influx of the Mississippi, but the transudation from the river is so considerable, that his plantation would be no better than a quag-mire; he is therefore under the necessity of establishing a regular system of ditches crossing each other at right angles, by which the soil is completely drained and placed in the most favorable situation to display the wonders of its inexhaustible fertility.—Within the Mississippi territory a vast body of alluvial land exists, but the scheme of draining by cross ditches would produce here no beneficial effect, because the waters find no means of escaping in the rear, but being hemmed in by the high land, would at length accumulate so as to produce an immense bason, bordered by the embankment on one hand, and by the high land on the other: although no successful attempt is likely to be made in our day, yet posterity will reclaim those lands: when the industry of a full population, shall have stamped an intrinsic value upon the soil of our country, the ingenuity of man will discover a remedy; probably the steam engine so highly improved of late years will be called in to accomplish this object. Its application in Holland to the draining of the Haerlem meer, and even for the reduction of the Zuyder-Zee, which the late war, it appears, has indeed suspended, leaves but little doubt of its full efficacy for a purpose of inferior magnitude. Lands susceptible of cultivation do not upon an average extend to three quarters of a mile from the river, although in some places they may reach to two miles, but in other situations do not exceed one quarter of a mile: there is no doubt that a scrupulous attention to the perfection of the embankments will every where augment the quantity of cultivable land; and we hazard nothing in predicting that at some future day, the productive surface of lower Louisiana will be multiplied ten fold: a rich and enterprising population, conducted by a wise and patriotic government, will pierce, with navigable canals, this alluvial country in all directions: grand issues will be provided to conduct to the ocean the superfluous waters which now drown, for three months of the year, nine tenths of the country; the whole surface of the land will then be reclaimed and become fit for the habitation of man; the richest harvests will be collected from a soil of the most exuberant fertility, which perhaps no time can exhaust: should however vegetation at length seem to advance with a sluggish pace, the planter has his remedy at hand, he may call in the aid of the elements; let the waters of a single inundation flow over his field, and it will receive a manure which 20 years cultivation cannot absorb. Reservoirs might be formed, as in ancient Egypt, to retain a portion of the waters of the inundation, but this happy climate does not require such precaution; the season of the inundation furnishes less rain than at other times, but it is so ordered by the course of nature, that about the time the waters retire, refreshing showers fall almost daily throughout lower Louisiana, which continue to invigorate the crops until the approach to the harvest season.

The inundation takes place during the season that the crops are under cultivation, and in the precise time when required for perfecting the culture of rice, which is therefore most conveniently placed in the rear of the plantation; nor is the inundation necessary for any other species of crops, but on the contrary is often extremely injurious by its excess; the embankments are frequently ruptured, and the crops of many plantations are totally lost; the lives of the inhabitants are sometimes in danger from the disruption of their levées in the night-time; this however is but a rare case. The planters possess great experimental knowledge in the art of arresting the progress of this devastation, and even entirely shutting up the breach which has been made by the torrent of the Mississippi. They begin their operations at some distance from the extremities of the breach at sound parts of the embankment, and, advancing in form of a crescent towards the margin of the river, where they know the land to be most elevated, they are often enabled to shut out the river by this process, the greater part of the work being thus carried on in water comparatively still; whereas every inch of the breach is acted upon by a furious torrent, becoming every instant deeper and wider. A very great breach happened during Governor Miro's administration about three leagues above New-Orleans; an immense body of water advanced on its rear and threatened to drown the city; the people were discouraged.—The Governor called out all the assistance which could be spared from town and country and placed himself in the row of common labourers, transferring his sod from hand to hand, to those who, from their superior knowledge in this species of hydraulic architecture, were employed in constructing the provisional embankment: they did not succeed in completely shutting up the breach, but the quantity of overflowing water was reduced to one quarter, and the extremities of the new levée were fortified until the retiring of the waters; vast quantities of fish were precipitated upon the land, which corrupted and filled the air with a pestilential stench. The town was unusually sickly that season.

The Mississippi is already celebrated on account of the salubrity of its waters; in which respect, no doubt, it rivals the Nile. It seems to be admitted (perhaps without due investigation) that it possesses properties favorable to the multiplication of the human species, by promoting fecundity; it is probably more certain that the use of its waters contributes to banish several disorders common in other countries: the gout would be unknown were it not introduced by strangers; and instances of the stone and gravel are extremely rare. The Creoles who drink this water are a comely race, both male and female, of middle stature, and handsome persons; the males are ingenious, active, bold and enterprising; fond of hunting and other laborious amusements, and capable of enduring great fatigue: the gracefulness and beauty of the ladies are universally acknowleged.

The water of the Mississippi is drunk in great purity by the first class of French planters, and inhabitants of New-Orleans; it is suffered to deposit by repose (in large earthen jars containing a hundred or more gallons) its sediment and feculencies; the precipitation is some times accelerated by bruised peach stones and kernels. Volney says that in Egypt bruised bitter almonds are applied to the same purpose; certainly the process of the Chinese is much neater by means of allum. The inhabitants generally employ two jars, in order that one may be filled while the other is in use, by which means they always drink the purest water: those who are long in the habit of drinking the Mississippi water, cannot immediately reconcile themselves to the taste of any other.

When the river is low and the current extremely gentle, the water possesses but a very slight degree of turbidness; the current is however at all times sufficiently strong to roll an immense body of water into the ocean, in which respect the diminutive Nile cannot bear a comparison; the waters of the latter being frequently in a state of *corruption immediately before the commencement of the inundation; the Nile becomes also shallow in many places, whereas a ship of the line might find, at all times, sufficient water 6 or 700 miles up the Mississippi, were the impediment on the bar removed.

There is a very striking difference in the momentum of the waters of the two rivers at their entrance into the sea; that of the Mississippi is at all times sufficient to preserve 17 feet of water upon the bar of the principal branch, whereas the mouths of the great branches of the Nile are so choaked up with mud and sand, that small coasting vessels can scarcely enter, and this is practicable only through a very narrow winding channel,

* Volney.

which resembles very much the entrance into many of the creeks, which to the westward of the Mississippi serve to disembogue the waters of the inundation.

The Mississippi has its Delta as well as the Nile, but that of the former is much more extensive than that of the latter; if we suppose the apex of the Delta of Egypt to be at Grand Cairo, near which the high land diverges considerably to the east, its latitude from south to north will be nearly a degree and a half; and its base, along the sea coast, about two degrees: if we admit the Delta of the Mississippi to commence only at Natchez (although there is an immense body of alluvial land above) opposite to which the high lands on the west of the valley open to the right with a rapid divergence, its latitude will be not less than two degrees and a half, and its longitude, on the coast, about three degrees; hence it results that the superficial content of the Mississippi Delta is to that of the Nile as 5 to 2, which may be adopted as the proportional magnitude of the two rivers, though there is reason to believe that our Nile pours into the ocean a much greater proportion of water than what we have stated, and that the Delta of the Mississippi would have been much more extensive, were it not placed in the tract of a perpetual vortex formed by an immense current in the sea, occasioned by the tropical east winds forcing the ocean against the oblique coast of America, which produces a continual flux between the main land and island of Cuba, giving birth to the well known gulph stream; but a great body of this current, rushing on with impetuosity in a direct line northerly, impinges against the west coast of East Florida, and is there deflected and dashed along the coasts of East and West Florida, Louisiana and Mexico; and by the promontory of Yucatan is thrown again into the main current, thus constituting a permanent vortex, which sweeps along a great proportion of the spoils of the Mississippi, as fast as they are projected into the ocean: in confirmation of this position it may be remarked that the bay of Campechy, so favourably situated for the reception and retention of alluvial matters, is exceedingly embarrassed with shoals of sand and mud; so that vessels of moderate burthen can scarcely get within 2 miles of any part of the coast; this evil is upon the encrease, and can only be attributed to the operation of the current, taking up every moveable matter along our coast, and depositing it in every bay or creek in contact with the circumference of the vortex: there are no alluvial rivers flowing into the bay of Campechy; but the Rio del Norte, and one or two others of less note, contribute no doubt to the production of this effect, by throwing their mite into the ocean.

Pursuing our parallel of the two rivers, we shall find that the Mississippi as well as the Nile, proceeds to the ocean by two permanent branches, that to the west breaks off, about two or three miles below the Red River, and bears the Indian name of Chafalaya, or river of the Apelousas: there is every appearance that this branch may have anciently been a continuation of the great Red river; the quantity of water delivered by the one and received by the other being nearly equal, and the general appearance of the banks and common breadth of the channels being very similar. The Chafalaya is dangerous for boats under the conduct of unskilful pilots descending the Mississippi; the velocity of the stream passing laterally out of the Mississippi, occasions an attraction (if the term may be admissible) of all floating bodies at a considerable distance from the shore; if the unwary or ignorant voyager falls within the sphere of this attraction, and his boat be not sufficiently manned to enable him to escape, by taking an oblique course out of this unexpected suction, he is precipitated into the western branch; heavy boats connot regain the Mississippi; the lightest must be well manned to stem the extreme rapidity of the current; the perpetual rising of the bank and bed of the great river from the influence of the inundation, is probably the cause of so precipitate a descent into the smaller river. The Chafalaya was formerly, but is not now navigable into the country of the Apelousas and Alacapas; the inconceivable quantity of drift timber which went down, had formed many islands, which so contracted the different channels, that at length they have been entirely shut up, (not to the passage of water, but) to the passage of every kind of craft; there is said to be at this time a floating bridge upon the Chafalaya, ten leagues along the course of the river, and continually accumulating by the cause which produced it: some parts of it are so compact as to have an appearance of solidity; and vegetation has made considerable progress thereon.* The Chafalaya in its progress through the Delta collects many other inferior streams, and before its junction with the ocean becomes, in certain situations, a mile in width; it is said to have nine or ten feet water on its bar; it is probably superior to the Phatmetic branch of the Nile, but is not equal to one tenth part of the Mississippi. The mouth of the Chafalaya is probably distant from the principal mouth of the Mississippi nearly 150 miles, and is now unnoticed; at some future period its river will be crowded with vessels and boats transporting the rich harvests of its ever-productive soil. There are many other inlets along the coast of the Delta which flow with fresh water during the inundation, and admit the waters of the ocean at other seasons: those have all got their bars, and are, as before observed, miniatures of the Mississippi; a small tide of about three feet perpendicular facilitates the passage of those bars for small craft, some of them are seen above water while the tide is out; the remedy for the removal of those bars has already been noticed: our posterity will see those inlets or *bayous* converted by the hand of industry into extensive navigable canals, penetrating in all directions this tract of inexhaustible fertility, which will become the garden of the United States.

Sugar having become of late a staple commodity of the lower country, it cannot be uninteresting to enquire how far, in its present state, it is susceptible of that culture. The following short statement is derived from the practical experience of the planters. It is now admitted that the sugar cane does not arrive (regularly) to full maturity beyond 75 miles above New-Orleans, following the sinuosities of the river; and this corresponds with a line drawn westerly along the sea coast of Pensacola and Mobille, crossing the island of New-Orleans: below the city the lands decline so rapidly that, beyond 15 miles, the soil is so much imbrued in the waters of the Mississippi, as to be totally unfit for the culture of the cane; within those limits, the most expe-

* Note. A certain extent of the Red River is in this situation; the water is heard gurgling under foot, being completely concealed by a stratum of timber upon which there is soil sufficient to support plants, and even trees of moderate size.

rienced planters admit that one quarter of the cultivated lands of any considerable plantation may be planted in cane, one quarter left for pasture, and the remaining half employed for provisions &c. and a reserve for change of crops. One Parisian arpent, of 180 feet square, may be expected to produce, on an average, 1 hhd. (12 cwt.) of sugar, and fifty gallons of rum. From the above data, admitting that both sides of the river are planted for ninety miles in extent, and about three quarters of a mile in depth, it will result that the annual product may amount, in round numbers, to twenty five thousand hhds. of sugar, with twelve thousand puncheons of rum. Enterprising young planters say, that one third, or even one half of the arable land might be planted in cane; it may also be remarked, that a regular supply of provisions from above, at a moderate price, would enable the planter to give his attention to a greater body of land cultivated in cane: several of the departing branches of the Mississippi furnish strips of land along their margins within the sugar latitude; there is also a portion of the Alacapas, parallel to the sea coast, favorable for this culture; every circumstance being therefore taken into view, we may admit that in the existing state of the lower country, double the quantities of sugar and rum above mentioned may be produced, although hitherto the annual product has only been about 5000 hhds. of sugar.

When the immense regions watered by the tributary streams of the Mississippi, particularly those extending to the sources of the Missouri, shall be opened up and cultivated by the persevering labor of man, our winters will be enchained in the north, and a milder climate will extend itself over the whole of the Delta; and as it lies under the same parallels of latitude, so will its productions be similar to those of the Delta of Egypt: and if we extend our views to a future period, when the waters of this great river shall be completely under the control of man, by a regular system of canals and embankments, such as probably existed in Egypt during its best days under its ancient kings, some idea may be formed of the inestimable value of a country, which most happily for itself and for the United States, now constitutes a very precious portion of the union.

It has already been said that the tides on the coast rise about three feet perpendicular, but they are not lunar tides; another cause must be sought: the bay of Mexico being a species of Mediterranean sea, surrounded by the continent and a close chain of islands, is not sensibly susceptible of the gravitating power of the sun and moon; the tides take place only once in twenty four hours, and nearly at the same hours in the morning; they depend altogether upon the winds, which, during the regular summer season, blow in upon the land all day; and in the night, it is either calm, or there is a small returning land breeze: the sea breeze commences in the morning about nine or ten o'clock, and ceases in the evening about sun set; the waters having acquired a momentum from the action of the wind continue to rise until about day break, when it is high water; a tide depending upon such a cause must be subject to frequent anomalies: in the winter, as may be expected from this theory, the tides are extremely irregular, being governed by the variable winds of that uncertain season.

This small tide produces an effect upon the Mississippi; I have noted at New-Orleans (during the absence of the inundation) a rise of fourteen inches, about sun rise; and at Manshac from 6 to 8 inches; this ascent of the waters of the Mississippi is produced merely by a swell or wave; the current at the same time continually issuing from the channel into the ocean; this tide requires a considerable time to make its progress upwards against the current: those who have perused Condamine's account of his voyage down the Maragnon are acquainted with every thing that can be said upon this curious subject. The great Newton has observed, that the tides which take place nearly at the same time at London-bridge, and at the mouth of the Thames, are not the same; but that at the bridge is the same which happened twelve hours before at the Nore.

It is probable that any tide coming up to New-Orleans is the same which arrived three days before at the mouth of the river, consequently the distance from New-Orleans to the mouth of the river is divided by the tides into three parts; (i. e.) one tide at each extremity, and two others making their progress upwards. This statement is only conjectural, founded upon probable circumstances, having been unable to procure a sufficient number of accurate observations to be made at different points.

When the river is very low, the velocity of the stream is scarcely a mile per hour at Natchez, and much slower at New-Orleans, probably not above half a mile; but during the time of the inundation from 4 to 5 miles.—It is asserted that the current is swifter during the night than the day; this perhaps might be accounted for by saying, that there is generally a breeze by day blowing up the river, which opposes the current and dams up the water to a certain degree; and that the night being generally still, the water descends with accelerated velocity; but another fact is not so easily accounted for, viz. that saw-mills, which are constructed upon canals leading from the Mississippi, perform more work (cæteris paribus) in the night than in the day, the number of strokes of the saw being found greater in a given time.—The encrease of the specific gravity of water by the coldness of the night will be of no avail in the solution of this question, because the weight and velocity of water in a lateral canal cannot thereby be encreased. We cannot suppose that the evaporation during the day produces a sensible effect in diminishing the quantity of water, because the water thus diminished in the course of the day arrives at the mill during the night. Is it not rather owing to the perfect stillness of the night, that the machine performs its office without any unnecessary agitation or friction, which in the day is greatly promoted by the vivifying influence of the sun, causing a more rapid circulation of the atmosphere, and exciting to motion every body on the surface of the earth, whether animate or inanimate? It is known to mariners that the relative cessation of motion on board a vessel under sail, contributes greatly to the rapidity of her movement. This phenomenon merits a more perfect solution.

Although the velocity of the water has been said to be from one to five miles per hour, yet this is to be understood of what may be called the thread of the current, it being considerably less along the shores, and very frequent counter-currents or eddies of great extent are found in favorable situations, which greatly facilitate the ascending navigation of the river; but as the current is continually deflected from shore to shore, boats are at many points unable to stem the force of the current, and are under the necessity of crossing frequently to get as far as possible out of the main current.

No abrasion takes place at the bottom of the channel of the Mississippi (in Lower Louisiana), an equilibrium has long since been established; it is believed rather that its bed is on the rise: as the margin of the river rises by the influence of every inundation which passes over it, it is thought that the bottom must rise also; but this effect must depend altogether upon the protrusion of the cradle of the river into the ocean, by which means the extremity of the inclined plane which the river has carved out for the conveyance of its waters, being prolonged horizontally, the waters within the channel must acquire a new elevation, placing themselves parallel to their former position, and the bed of the river will rise proportionably so far only as the alluvial bottom extends; and thus there will be a low but progressive rise of the margin and bed of the river, which is perfectly agreeable to observation.

The formation of land is surprisingly quick in certain situations; the moment the waters lose their great velocity, they begin to deposit their contents; the most favorable position is on either side of the main channel, where the current is nearly but not absolutely destroyed: as for example, when the river suddenly makes a breach or cut-off from bend to bend, leaving a circle of several leagues of the former bed with little or no current, the waters immediately begin to block up the two entrances, leaving the interior in form of a lake: in 5 years the soil will be tolerably firm, nearly of equal height with the adjoining lands, and covered with forests of willow and cotton-wood (probably populus deltoides*) 50 feet high; some parts of the old channels were perhaps not less than a hundred feet deep: this wonderful creative power of the Mississippi may, by the ingenuity of man, be applied to the accomplishment of grand objects: by proper embankments, and a regular supply and discharge of the waters of

* Of Bartram.

the Mississippi, the surface of the earth may be raised to a great height, far above the general level of the inundation: travellers inform us that the towns and villages of the Delta of the Nile are built upon elevated situations, which are so many islands during the season of the inundation. How shall we account for the formation of those islands? we have no reason to believe that they pre-existed in the Delta, and they could not be formed by the natural agency of the inundation; the accumulation of earth by mere labor for the formation of so many islands would have been an Herculean task; it is therefore more rational to suppose that the ingenuity of the aborigines of ancient Egypt, directed by the example of nature herself, pursued the more simple and facile mode of elevating the site of their habitations in the manner above described.

We shall conclude the above imperfect sketch by observing, that it is the result of occasional observation for a series of years, and of scattered information collected from various sources, probably often uncertain, from a cause which is unfortunately too general; viz. the extreme inattention of persons, even of some education, to the most curious phenomena passing daily under their review.

Circumstances did not favor the investigation of several points of curious enquiry. It would be desirable to ascertain the obliquity of the inclined plane by which the Mississippi conveys its waters to the ocean, both at the surface and at the bottom of the river, and at various distances from its mouth; as also the respective velocities of the water in those positions, at low and high water. The difference of the velocities of the water at and under the surface, was turned to account by an ingenious master of a vessel, who, finding himself detained in his descent by a calm, dropt his anchor ten or a dozen fathom below the surface, by which his vessel was so much retarded in the stream as to enable him to steer sufficiently to keep clear of the shore. This hint might perhaps be improved to advantage: a much more perfect instrument than an anchor may be invented for the purpose of holding the inferior current, and in situations similar to the Gulf-stream, a vessel may thereby be enabled to escape an enemy.

A Chart of the alluvial country is a desideratum, with which it is to be hoped the curious will in due time be obliged, under the present enlightened government: a correct sketch of the various reservoirs and canals which this great river has formed for the reception and disemboguement of its immense volume of waters, will become the basis of the vast improvements which at a future day will be made upon this inestimable portion of the United States.

WILLIAM DUNBAR.

NATCHEZ, January 1, 1804.

No. XXXI.

MONTHLY and annual Results of Meteorological Observations made by William Dunbar, Esq. at the Forest, 4 Miles East of the River Mississippi, in Latitude 31°. 28s. *North, and Longitude* 91°. 30s. *West of Greenwich. Communicated by the Author.*

Read, April 6th, 1804.

YEAR, 1801.	THERMOMETER. Greatest height.	Least height.	Mean height.	Range.	BAROMETER. Greatest height.	Least height.	Mean height.	Range.	RAIN. Total.
	Deg.	Deg.	Deg.	Deg.	Inches.	Inches.	Inches.	Inches.	Inches.
January.	77	25	51	52	30 30	29 74	30 06	0 56	2 82
February.	79	27	57½	52	30 15	29 61	29 93	0 54	4 81
March.	88	38	61	50	30 08	29 74	29 91	0 34	3 20
April.	89	39	62	50	30 10	29 65	29 88	0 45	4 85
May.	92½	47	72	45½	30 00	29 76	29 89	0 24	0 95
June.	98	68	82	30	30 00	29 77	29 92	0 23	0 50
July.	96	65	80	31	30 00	29 83	29 60	0 17	4 83
August.	92	70	79	22	30 00	29 75	29 92	0 25	3 12
September.	92	61	77	31	30 00	29 74	29 92	0 26	5 68
October.	85	44	76	41	30 08	29 76	30 97	0 32	3 22
November.	77	30	55	27	30 25	29 74	30 04	0 51	5 85
December.	72	24	49	48	30 25	29 46	30 30	0 79	5 67
Whole year.	98	24	66¼	74	30 25	29 46	30 02⅝	0 79	45 50
YEAR, 1802.	Deg.	Deg.	Deg.	Deg.	Inches.	Inches.	Inches.	Inches.	Inches.
January.	79	27	55	52	30 25	29 63	30 00	0 62	5 23
February.	78	24	59	54	30 22	29 71	30 36	0 51	4 79
March.	82	35	62	47	30 18	29 70	29 97	0 48	6 23
April.	88	52	71	36	30 18	29 71	30 08	0 47	4 98
May.	Thermom. broken.				30 04	29 61	29 62	0 43	3 67
June.	93	62	65	31	30 04	29 75	29 90	0 29	2 14
July.	93	66	78½	27	30 00	29 76	30 56	0 24	9 98
August.	92	61	78	31	30 06	29 79	29 92	0 27	6 32
September.	98	45	76	53	30 07	29 79	29 93	0 28	1 67
October.	90	32	65	58	30 20	29 72	29 85	0 48	2 33
November.	80	28	53	52	30 19	29 76	29 98	0 43	4 51
December.	70	26	47	44	30 25	29 75	30 00	0 50	6 07
Whole year.	98	24	59	74	30 25	29 61	30 01	0 64	57 92

YEAR, 1803.	THERMOMETER, within.				THERMOMETER, without.				BAROMETER.				RAIN.
	Greatest height.	Least height.	Mean height.	Range.	Greatest height.	Least height.	Mean height.	Range.	Greatest height.	Least height.	Mean height.	Range.	Total.
	Deg.	Deg.	Deg	Deg.	Deg.	Deg.	Deg.	Deg.	Inches.	Inches.	Inches.	Inches.	Inches.
January.					78	26	47	52	30 27	29 79	30 02	0 48	2 00
February.					84	28	52	56	30 27	29 73	29 56	0 54	2 15
March.					94	36	62	58	30 16	29 65	29 93	0 51	1 29
April					92	42	69	48	30 07	29 71	29 94	0 36	3 70
May.					92	48	71	44	30 13	29 59	29 85	0 54	3 77
June.	90	72	81	18	94	65	79	29	30 04	29 63	29 89	0 41	2 85
July.	90	70	82	20	95	68	81	27	30 05	29 71	29 92	0 34	2 41
August.	91	72	81	19	94	68	80	26	30 05	29 70	29 92	0 35	2 15
September.	90	64	77	26	94	62	76	32	30 03	29 73	29 89	0 30	4 01
October.	84	62	74	22	84	60	73	24	30 03	29 71	29 75	0 32	3 37
November.	79	38	62	41	80	30	57	50	30 13	29 73	29 95	0 40	5 41
December.	74	44	62	30	72	27	53	45	30 38	29 79	30 07	0 59	4 45
Whole year.	91	38	74	53	95	26	$66\frac{2}{3}$	69	30 38	29 59	29 89	0 79	37 56

REMARKS.

1803, June 30th, at $7\frac{1}{4}$ P. M. The sun being just set, a beautiful rain-bow was painted in the heavens forming a compleat semi-circle, excepting a small portion near the horizon which was imperfect; the external bow was very distinct: the inner bow, which was very vivid in the upper parts, struck the view with an unusual appearance, and, when inspected minutely, two other bows were distinctly seen, within the principal bow, concentric with it, and in contact with each other; (i. e.) where the purple of the first ended, the red of the second commenced, and so of the second and third; a dim ruddy appearance was seen within the third bow, which might have been taken for the rudiments of a fourth. The second bow was only about half the breadth of its principal, and the vividness of its colours was diminished in the same proportion. The third was of the same breadth with the second, but its brightness was reduced to half that of the other. These bows appeared to diminish in brightness, and to present appearances analogous to the images of a candle reflected from the double surfaces of a plate mirror. As the rain-bow is a reflector by which we can find the place of the sun, we must conclude from this phenomenon, that the horizontal refraction of the atmosphere had produced two images of the sun, above and in contact with the real sun, in the same order in which the bows were visible in the opposite side of the hemisphere.

1803, December 23d, at $5\frac{1}{2}$h. P. M. A very beautiful and very bright halo was seen around the moon; the prismatic colours were very distinct—red within, yellowish in the middle, and blue without.

On Monday, February 6th, 1804.

At Northumberland, (Pennsylvania), which had of late years been the place of his residence—died

The Rev. JOSEPH PRIESTLEY, L. L. D. F. R. S.

He was chosen a member of THE AMERICAN PHILOSOPHICAL SOCIETY, HELD AT PHILADELPHIA, &c." on the 22d January, 1785.

AT A STATED MEETING, *Feb.* 17, 1804.

It was resolved unanimously,

That a member of the Society be appointed to deliver an Eulogium on their late eminent Associate, Joseph Priestley, and that a special meeting of the Society be held on the 24th inst. at 6 P. M. for the purpose of electing the member who shall deliver it.

AT A SPECIAL MEETING, FEB. 24, 1804.

Benjamin Smith Barton, M. D. one of the Vice-Presidents of the Society, was chosen to deliver the Eulogium, as directed by the resolve of the 17th instant.

END OF PART FIRST.

TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT

PHILADELPHIA,

FOR PROMOTING

USEFUL KNOWLEDGE.

VOLUME VI.

PUBLISHED BY

C. AND A. CONRAD AND CO. PHILADELPHIA. CONRAD, LUCAS AND CO. BALTIMORE. SOMERVELL AND CONRAD, PETERSBURG, AND BONSAL, CONRAD AND CO. NORFOLK.

[JANE AITKEN, PRINTER.]

1809.

ADVERTISEMENT.

The following are the Rules adopted for the government of Committees in the choice of papers for publication.

First. "That the grounds of the Committee's "choice of papers for the press, should always be "the importance or singularity of the subjects, or "the advantageous manner of treating them, without "pretending to answer, or to make the Society an-"swerable, for the certainty of the facts, or propriety "of the reasonings, contained in the several papers "so published, which must still rest on the credit "or judgment of their respective authors.

Secondly. "That neither the Society, nor the "Committee of the press, do ever give their opinion "as a body, upon any paper they may publish, "or upon any subject of Art or Nature that comes "before them."

LIST

OF THE

OFFICERS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

FOR THE YEAR 1809.

PATRON. SIMON SNYDER, GOVERNOR of the STATE of PENNSYLVANIA.

PRESIDENT. Thomas Jefferson.

VICE-PRESIDENTS.
- Robert Patterson.
- Caspar Wistar.
- Benjamin Smith Barton.

SECRETARIES
- Thomas C. James.
- Thomas T. Hewson.
- Nathaniel Chapman.
- Mahlon Dickerson.

COUNCELLORS
- William White.
- Peter S. Duponceau.
- Jonathan Williams.
- William Short.
- John M'Dowell.
- Zaccheus Collins.
- Jonathan B. Smith.
- Nicholas Collin.
- Andrew Ellicott.
- Benjamin Rush.
- William Tilghman.
- James Woodhouse. (lately deceased.)

CURATORS
- Charles W. Peale.
- Robert Hare Jun.
- John R. Smith.

LIBRARIAN and TREASURER.
- John Vaughan.

LIST

OF THE MEMBERS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

ELECTED SINCE JANUARY, 1804.

Members resident in the United States.

William Short, Virginia.
Joseph Willard, D. D. late Pres. of Hav. Coll. Mass. (since deceased.)
Zaccheus Collins, Philadelphia.
John Maclean, M. D. Professor of Natural Philosophy and Chemistry in the College of New-Jersey.
Edward Miller, M. D. New-York.
Rev. John Prince, Salem, Massachusetts.
Captain William Jones, Philadelphia.
Charles Smith, Lancaster, Pennsylvania.
Samuel Webber, President of Havard College, Massachusetts.
Samuel Moore, Philadelphia.
F. Adrian Vanderkemp, State of New-York.
Benjamin Silliman, Professor of Chemistry and Natural History, Yale College, Connecticut.
William Tilghman, Chief Justice of Pennsylvania.
Bushrod Washington, Mount Vernon, Virginia.
Joseph Cloud, Philadelphia.
Rev. Samuel B. Wiley, Philadelphia.
William Dubourg, D. D. President of St. Mary's College, Baltimore.
Joseph Sansom, Philadelphia.
Samuel F. Conover, M. D. Philadelphia.
Mahlon Dickerson, Philadelphia.
Irene Dupont de Nemours, Wilmington, Delaware.
Nathaniel Chapman, M. D. Philadelphia.
John M'Dowell, Provost of the University of Pennsylvania.
Ferdinand R. Hassler, Math. Prof. at the U. S. Milit. Acad. West Point.
George Izard, Pennsylvania.
James Gibson, Philadelphia.
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Edward Penington, Philadelphia.
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Rev. William Staughton, D. D. ditto.
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Silvain Godon, Philadelphia.
George William Featherstonhaugh, Duanesborough, New-York.
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Thomas Moore, Maryland.
James Winthrop, Cambridge, Massachusetts.
Nathaniel Bowditch, Salem, Massachusetts.
Joel Barlow, District of Columbia.

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Don Pedro Cevallos, ditto.
Don Antonio Josef de Cavanilles, ditto. (since deceased.)
Edward Jenner, M. D. London.
William Hawes, M. D. London. (since deceased.)
Baron Alexander de Humboldt, of Berlin.
Destut Tracy, Paris.
Olaf Swartz, Professor of the Bergian Institute of Horticulture in Sweden.
Martinus Van Marum, M. D. Secretary to the Batavian Society of Sciences, at Haarlem.
Francisco de Borja G. Stockler, Secretary of the Royal Academy of Sciences, Lisbon.
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John Eric Forstrom, St. Bartholomews.
Charles Philibert de Lasteyrie, Paris.
Ross Cuthbert, of Lower Canada.
F. Andre Michaux, M. D. Paris.

CONDITIONS

OF THE

EXTRA MAGELLANIC-PREMIUM.

M. DE MAGELLAN having fixed at ten Guineas, the sum to be annually disposed of as a Premium, according to the *strict terms* of the donation, and the Magellanic Fund having been so managed as to produce an annual surplus, the Society, with a view to promote as far as may be in their power the liberal intentions of the donor, have determined that the above surplus shall be disposed of under the following

REGULATIONS.

1. The surplus Magellanic-Premium may be awarded at such stated meeting of the Society, as shall be agreed to, at a previous stated meeting, due notice being given thereof to the members.

2. Every communication which shall have been offered with a view to the Magellanic-Premium, and to which the same shall not have been awarded, shall (except such as the Society shall not think at all worthy of notice) be again taken into consideration, with a view to the awarding of the surplus premium; and if such communication shall, at such meeting, be thought within the general view of the donation, and to be sufficiently valuable to deserve a public reward, a surplus premium may be awarded to the author thereof.

3. The surplus premium shall consist of a gold medal, of the value of not less than twenty dollars, nor more than forty-five dollars, engraved with a similar device to that of the original premium, except that it shall contain the words "Extra Magellanic-Premium," or at the option of the successful candidate, the value of such medal in money, accompanied with a Diploma on parchment, with the seal of the Society.

4. All the rules and regulations concerning the application for the awarding of the original Magellanic-Premium, shall be adhered to in the case of the surplus premium, in so far as they are not hereby modified or derogated from; unless, in very special cases, for the rewarding of some essentially useful discovery or improvement, two thirds of the members of the Society present at a meeting, appointed for the awarding of the surplus Magellanic-Premium, shall, by their votes, taken by ballot or otherwise, direct.

5. The Society shall propose and publish, as often as they think proper, such a number of subjects as they think fit, to which they shall call the attention of the candidates for the original and surplus Magellanic-Premiums, and invite their communications thereon, informing them at the same time, that although communications on such subjects will be acceptable to the Society, yet they shall not entitle their authors to a preference over more meritorious communications on other subjects, equally within the strict or general view (as the case may be) of the Magellanic donation.

6. The surplus-premium will not be exclusively applied to actual inventions or improvements, but will also be extended to such valuable communications, within the general view of the donation, *as may lead* to useful discoveries, inventions or improvements.

The Society have thought proper at present to propose the following subjects:

1. The best experimental essay on native American permanent dyes or pigments, accompanied by specimens.

2. The best means of navigating our rapid rivers against the stream.

3. The best essay on the general natural history of the ranges of American mountains in the country east of the river Mississippi.

4. The best essay on the natural history and chemical qualities of the hot and warm springs of the United States, or of any one of them.

CONTENTS.

OF VOLUME VI.—PART II.

***

DONATIONS,

Received since printing the preceding list.

Humboldt (Le Baron de,) His ouvrage sur le nivellement barométrique de la Cordillera des Andes, Paris, 4to.

Dublin Society, the following Statistical Surveys, 8vo.

—— Of the county of Armagh by Sir Charles Coote, Bart. 1804.

ditto Kildare, by Thomas J. Rawson Esq. 1807.

ditto Wexford, by Robert Frazer Esq. 1807.

—— Observations on sowing spring wheat, publ. by their order, 1807.

——Catalogue of their Library, classed under proper heads, 1807.

——Sketch of Lectures on meadow and pasture grasses, delivered in the Botanical garden of the Dublin Society; by Walter Wade Esq. Prof. of Botany, 1808.

TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY, &c.

VOL. VI, PART II.

No. XXXII.

Appendix to a Memoir on the Mississippi, No. XXX. of the 1st part of this Volume.—By William Dunbar, of the Natchez, communicated by the Author, through the President of the Society.

Read October 5th, 1804.

ALTHOUGH the memoir was not intended to convey opinions upon the theory of rivers, yet as it contains observations and remarks, which are at variance with the doctrines delivered to us by several of the most eminent mathematicians of Europe, it may seem that a short apology is necessary.

This subject has been treated by mathematicians of the first order in Italy, France and Germany, but more especially the former; and generally such partial views only have been taken of the subject, as have furnished them with the amusement of an elegant application of calculus. The theorems of Guglielmini have been held in the highest estimation, and, perhaps unfortunately for the progress of science, prevail too generally at this day. The theory of spouting fluids issuing from orifices with velocities in the ratio of the square-roots of the respective columns, has been applied without modification to every motion of water. Mariotte, Varignon and Guglielmini have made it the basis of complete systems of hydraulicks. Varignon has composed many analytical memoirs upon this theory; and Gravesande, Musschenbroek and Belidor deliver no other principles: Guglielmini has (in addition to this theory) introduced something not very intelligible on the energy of deep waters, which he considers as the cause that rivers are not stagnant at their mouths, where there is, as he supposes, no declivity of surface.

Theories formed by ingenious men, without any regard to experiment, have too frequently led their authors into absurdities, and it is surprising that a theory so contrary to fact in the most familiar and obvious circumstances, should have met with so much attention: to defend it must involve its advocates in an inextricable dilemma: it results from this theory, that at one foot under the surface of the most sluggish stream, there exists a current at the rate of 8 feet per second ($5\frac{1}{2}$ miles per hour) exceeding that at the surface; so extraordinary a case must have been long since familiar to boatmen, but it is well known that if a person on board of a boat floating down the stream, thrust his hand and arm at full length under the surface, he will find the water (relatively) as still as a mill-pond; it cannot be supposed that river-navigators would have so long neglected to take advantage of so favorable a circumstance; oars and sails would have ceased to be necessary for descending great rivers; the velocity (from theory) at the small depth only of about 16 feet below the surface, exceeding that at the surface 32 feet per second, if we permit a drag of proper construction to sink to that depth, connected with a vessel, she would be drawn along with a velocity, exceeding that at the surface about 22 miles per hour. Again, however minute the velocity may be at the surface, that at the bottom of a deep river would be immensely great: what shall we think of that of the gulf stream? or even of the Mississippi, where the depth is supposed to be 50 fathoms, and which would produce 140 feet per second, little short of one hundred miles per hour? now as it is known that a velocity of 3 inches per second will just begin to work upon clay, and that of 3 feet will sweep along shivery angular stones of the size of an egg, and as according to our theory, the evil ought to be perpetually upon the encrease, in as much as the velocity augments with the depth, it must have resulted that by such incredible velocities as are deducible from the theory, the bowels of the earth must have been long since torn up, and this globe have been no longer a fit habitation for man: a system so pregnant with consequences contradictory to the order and regularity which are the result of the laws of nature, must be abandoned. Without the aid of philosophy it must have been remarked by every common observer, that the most furious torrent (directed into a new channel) after breaking up and tearing every thing before it, does at length fashion its own bed, in respect to breadth and depth, so as to be perfectly adapted to the momentum of its waters; it is no longer a furious torrent, but a mild placid stream. Nature aims continually at an equilibrium; in rivers which have for a course of ages occupied the same channel, the accelerations and resistances are so perfectly counterpoised, that a complete equability of current takes place for a great extent (i. e.) so far as the regimen of the river has established itself; abrasion at the bottom of the river ceases; this can only be the consequence of reduced velocity, contrary to our theory, which demands velocity encreasing with the square-root of the depth. Mathematicians and engineers who have calculated upon so false a theory have been most egregiously disappointed in their expectations; a canal was projected to supply the city of Edinburg with water, the celebrated M'Laurin calculated the quantity it ought to deliver, and the no less celebrated Desaguliers who was to conduct the enterprise, and whose theoretick principles were somewhat corrected by experimental knowledge, reduced to nearly one half the calculation of the former; the work was executed to the satisfaction of both, and the result was, that the actual quantity of water delivered was $\frac{1}{11}$ of that calculated by M'Laurin and $\frac{1}{6}$ of that of Desaguliers.

The great improver of the Steam-Engine, Mr. Watt, informs us, that a canal of 18 feet wide at the surface, 7 feet at bottom and 4 feet deep, runs with a velocity of 17 inches per second at the surface, 10 at the bottom, and 14 in the middle; according to the theory, the velocity at bottom ought to have been 16+17 or 33 inches in place of 10, abating the effect of friction upon the bottom of the canal.

A very few persons have thrown light on this subject by some valuable experiments, none have been more successful than the Chevalier Buat: aided by St. Honore, a young officer of Engineers, he has adapted analytical forms of expression conformable to the operations of nature. Buat measured velocities at the surface and bottom of canals and rivers, and has discovered the following laws. "In small velocities there "is great disproportion between the surface and bottom; and "in very great velocities, the ratio approaches to equality; in "general the following rule will solve the problem: Take unity "from the square-root of the superficial velocity per second "expressed in inches, the square of the remainder is the veloci-"ty at bottom." Thus a velocity of one inch at the surface will give no sensible velocity at bottom, but a velocity of 36 inches at the surface, will give 25 inches at bottom; Watt's canal corresponds with this law, and it is probable that the law holds good in all artificial canals and rivers of moderate depth; but in great and deep rivers, whose regimen is established, there is great reason to believe that the velocities at bottom are much less than would result from Buat's rule, because as has already been observed, that so far from abrasion taking effect at the bottom of such rivers, they are actually rising by a slow progress, which is regulated by the protrusion of the cradle of the river into the ocean. Many more arguments from fact might be drawn in opposition to this theory; I shall only observe that it is known to fishermen, that the migration of fishes is performed near the bottom of rivers against the stream, and in descending they almost float upon the surface; a curious account of the latter is given by Bartram in his account of St. John's river, in East Florida.

We shall now endeavour to shew that the theory is unphilosophical and contrary to hydrostatical laws.

Let A B (Plate V. Fig. 1.) represent the longitudinal section of a river flowing with uniform velocity from surface to bottom, and let us enquire what change ought to take place in the velocity at different depths, caused by the pressure of the fluid: Let us suppose a wall C D, forming a complete transverse section of the river, and moving uniformly with the current from A, to B, and that the whole inferior part B, is instantaneously removed; if now orifices be made in the wall at 1, and 2, the water will flow out in the direction of the stream, with velocities in the ratio of the square-roots of the columns above the respective orifices; upon this partial view of the subject, the theorists have built their system. Again, supposing all things to remain as before, the portion of the river B, being replaced, let us now suppose the superior portion A, to be removed, while the wall moves on uniformly with the current and portion B, if now the same orifices 1, and 2, be opened, the water will flow out with the same velocities as before, but in contrary directions, against the course of the river; hence it appears that the simple pressure of the water is equally disposed to produce inferior currents in any direction, the instant the equilibrium is destroyed; but it is certainly very unphilosophical to assert that the column 3, 4, will produce an increased current in the direction of the stream, while it is opposed by a column of equal pressure 1, 2: it cannot be asserted that any inequality of pressure, arising from the gentle declivity of the surface of large rivers, can produce any sensible effect; for should it be said that the pressing and opposing columns are not to be measured in contiguity to each other, but that the opposing column will be null, in consideration that a point is to be found on the surface of any river, upon the same level with any given depth higher up the stream; we reply, that this effect is totally destroyed by other concomitant circumstances. Great rivers whose regimen is long established flow with a very gentle declivity, perhaps in some cases not more than 2 inches per mile, but let it be supposed one foot; according to the theory the velocity of an inferior current a b, (Fig. 2.) at the depth of 16 feet a c, ought to be 32 feet per second, because at the point b, 16 miles below c, there is no opposing column: this is certainly the most favourable view in which the theory can be presented, but will not avail its advocates; for it cannot be shewn that the vis inertiæ of 16 miles of fluid can be overcome by a pressure of 16 feet, with the energy required by the theory; on the contrary, it is shewn by the experiments of M. Couplet at Versailles, that water conveyed in a smooth horizontal tube of 18 inches diameter and 43,200 inches in length, from a reservoir 12 feet high, issued with a velocity of less than 40 inches per second, (i. e.) less than $\frac{1}{8}$ of the velocity deduced from the theory; hence we see that the vis inertiæ of 43,200 inches of horizontal water combined with the friction of a tube 18 French inches in diameter, destroys $\frac{7}{8}$ of the velocity which the theory calls for; and if we should concede (what the theorist cannot demand) that of those $\frac{7}{8}$, $\frac{5}{8}$ are occasioned by the friction of so large a tube, and only $\frac{2}{8}$ left for the vis inertiæ of the water, and that it be allowed that every succeeding 43,200 inches destroy $\frac{1}{4}$ of the respective remaining velocities, we shall find that at the end of the 16 miles, the velocity of the issuing fluid will be less than $\frac{1}{2}$ inch per second. Were we to suppose a horizontal pressure at a, derived from a head of water e f, proportioned to the column f e, it is yet inconceivable that this should produce a continued velocity in the direction a b; water like all other bodies, when in a state of compression, will escape on the side of the least resistance, and in place of producing a current in the direction a b, against the vis inertiæ of 16 miles of fluid, will escape by the shortest passage to the surface, and bubble up at d, where it will form an elevation and encrease the superficial velocity. Were we disposed to suppress these arguments, and concede to the theorists the doctrine they have endeavoured to establish, the consequence would be equally ruinous of their system: let us therefore suppose that a current is produced from a, to b, with a velocity of 32 feet per second greater than at c; by a parity of reasoning it will at g be 64 feet greater than at c, and so in continuation gaining at the rate of 2 feet per second every mile; hence a river running one hundred miles, after it had gained the depth of 16 feet would run with a superficial velocity of more than 200 feet per second: had we assumed the depth of one foot only in the place of 16, it will be found from the above mode of reasoning, that the superficial velocity gained would be at the rate of 8 feet per mile: it is unnecessary to advance any thing further against a theory capable of yielding results so contradictory among themselves, and so totally at variance with fact and observations.

From what has been said we may conclude that the natural movement of fluids depends solely upon the declivity of the surface; the obstructions arising from friction, adhesion and vicidity, being greatest at the bottom and sides, the velocity of the current will consequently be greatest at the surface and in the middle of the channel where there is no deflecting cause. Buat observes, we may be assured that the central filament of water running through an inclined cylindric glass tube flows with the greatest velocity, it being known that however smooth and polished the interior surface of the tube may be, the retardations from friction are very considerable; if we suppose the superior half of the cylinder to be removed with its included water, the relative velocities of the inferior half will continue the same, and he sees no reason to doubt that all rivers and canals move upon the same principles. We shall consider this object in another point of view, leading to the same conclusion. Let the solid A B, (Fig. 3.) of indefinite length, be divided into a number of very thin and polished laminæ, and placed upon the inclined plane B C, with such declivity as that the solid may just begin to move by the power of gravity down the inclined plane from B, towards D, when the lamina 1, shall have gotten into the position I, the lamina 2, possessing a greater facility of motion over 1, than this last has over the inclined plane, will have also made one step over 1, and will be found in the position II; in like manner, the lamina 3, will at the same instant move over the lamina 2, and make one step beyond it and will be found in the position III, and so of all the other superior laminæ which will be found respectively in the situations represented in the figure. Water being composed of parts possessing extreme mobility, it is not unreasonable to conclude that its motion along an inclined plane, will be somewhat analagous to that of polished laminæ, but as fluids press laterally as well as perpendicularly, there must be corresponding retardations at the sides as well as at the bottoms of rivers and canals.

The energy of deep rivers which has been insisted upon by Guglielmini is not entitled to much notice: we must however admit that water, like solid gravitating bodies descending along an inclined plane, will acquire velocity until the accelerations and resistances are in equilibrio, but from its extreme mobility is more liable to lose it: a globe of solid matter rolling along a horizontal plane loses its motion instantaneously on its falling to pieces; it is not therefore astonishing that water, divisible into the minutest parts, descending into every cavity and deflected by the smallest obstacles, should be speedily deprived of its velocity. As a small body impinging with great velocity upon a large mass may communicate no sensible velocity to the compound, so in like manner, a descending torrent being received into a more capacious bed is totally disarmed of its fury and moves on with a new velocity proportioned to the new declivity.

Deep rivers moving with a certain velocity and meeting with obstacles will exert the energy spoken of by Guglielmini, that is, like all other heavy bodies in motion, they will endeavour to persevere in the right line of their last motion, and the waters will accumulate against the object, having a tendency to rise to the height of a reservoir, which would produce the actual velocity of the current: thus if M. Pitot's tube A B, (Fig. 4,) be set with its horizontal orifice B, against the current, the water will ascend to C, a height proportioned to the velocity of the current at B; that is, the column C D, pressing above an orifice in any reservoir would produce a velocity in the spouting fluid equal to that of the river at B: this instrument may be commodiously used for ascertaining the velocity of currents where great accuracy is not required, and in low velocities; the tube might be graduated so as to give the velocity by inspection: it may also be used to determine the difference of superficial and inferior currents. Were the theory true which we oppose, a remarkable effect would be seen in Pitot's tube; the water ought to rise in the tube to a height above the surface of the river, equal to the depth at which it is plunged below the surface, and if the tube be rendered stationary the water will rise still higher by an additional height corresponding to the superficial velocity: thus Pitot's tube placed at the depth of 16 feet in a river whose superficial velocity is 8 feet per second, would raise the water to the height of 17 feet above the surface of the river, and orifices being made in the side of the vertical tube, the water would flow out with various velocities depending on the position of the respective orifices. What a discovery this for raising of water without machinery!! however absurd this result may appear, it is fairly deducible from the theory.

In any great river, water flowing in the direction 1, 2, 3, (Fig. 5.) and impinging against the bank at 3, will there accumulate and rise higher than at 4 (which is always lower than at 2,) if the velocity of the current be 8 feet per second, it will have a tendency to rise one foot, but from the unconfined state of the water, a considerable abatement will take place; the water accumulated at 3, is the cause of all eddies; it falls off in all directions from the thread of the current, producing always an accelerated current in the direction 3, 5; an eddy will be formed from 3 to 4 and a portion of the flood passing over to 6, not unfrequently causes a smaller eddy from 6 to 7; in favoring situations the eddy from 3 to 4, appears sometimes to rival the strength and velocity of the principal stream: dangerous whirlpools are frequently produced in the situation w, occasioned by the counter currents; such a one exists at the grand gulf in the Mississippi, and in many other situations: we have seen one of about 5 feet diameter and 3 feet deep; all floating bodies passing within a certain distance of the vortex are attracted by it, and if not too large and buoyant, are precipitated to the bottom of the river, rising at the distance of 50, 100 or more yards from the place of descent: this imaginary energy of deep rivers, the result only of the descending fluid will nevertheless be extinguished as soon as the declivity of the surface is lost; rivers running a long course through an alluvial country, without the influx of auxiliary streams, are liable to stagnate before their junction with the ocean; the Nile is a remarkable example of this kind: and even the Mississippi, although we have said in general that it rolls a great body of water into the ocean, yet there has been at least one very extraordinary season, when the waters were sunken so uncommonly low, that there was no sensible current some distance within the mouth of the river. I have lately procured the following curious information from an intelligent *Gentleman of New Orleans who writes as follows, " In the beginning of " November 1800, when there was hardly any perceptible cur-" rent in the Mississippi, I set off from the upper gate of the " city, in company with the master of a vessel, and sounded " the river at every three or four boats length until we landed " at the opposite shore: the depth of water increased pretty re-" gularly, viz. 10, 12, 13, 15, 17, 19 and 20 fathoms, the " greatest depth was found about 120 yards from the shore. " This operation was accurately performed, and as the river ri-" ses about 12 feet at this place, the depth at high water will " be 22 fathoms. A gentleman informed me that his father, " who was chief pilot in the time of the French, has often said " that a little way below the English Turn there was 50 fathoms, " and about the upper Plaquemine 60 fathoms. A respectable " inhabitant living six leagues below New Orleans, informed " me that during the above mentioned low state of the river, " the water was there found so brackish, that recourse was had " to the wells for drinking water, and that abundance of por-" poises, shark, and other sea fish were seen still higher up the " river. Many people thought the water brackish opposite to " the town. It had a greenish appearance, and when taken " up was very clear; and although I did not think it brackish, " I found it vapid and disagreeable." From the above curious relation it appears, that the waters of one of the greatest rivers on the globe were so completely dissipated that all current ceased 20 leagues above its mouth, nay the waters of the ocean flowed in (as into the Mediterranean) in order to restore the general level of waters. During the same period at Natchez, 380 miles from the mouth, the river flowed with a regular though very gentle current, (perhaps ½ mile per hour) and a depth of 10 or 12 fathoms under the principal filament. What became of this great body of water? evaporation from

* William E. Hulings Esq. late Vice-Conful at New Orleans.

the limited surface of the river is insufficient to account for so great a dissipation, but we know that the spongy texture of the alluvial soil is remarkably pervious to the waters of the river: from the flat and humid surface of the Delta, a perpetual evaporation exists, the lateral pressure of the waters of the river must supply the waste by exhalation, and this immense expence of fresh water, is to be accounted for by filtration and evaporation.

No. XXXIII.

Demonstration of a Geometrical Theorem; by Joseph Clay Esq. of Philadelphia.

Read July 20th, 1804.

THE following proposition was mentioned to me, some years since, as one which had been proposed by Mr. Simpson some time before his death. I do not know that any demonstration has hitherto been published.

From the angles at the base of any triangle, let two right lines be drawn cutting each other in any point within the triangle, and cutting the sides of the triangle, the segments of the sides and of the lines so drawn will form a trapezium; draw and bisect the diagonals, the right line joining the points of bisection, will, if produced, bisect the base of the triangle.

In the triangle ABC, (Fig. 6, Plate V.) draw CD, BE, cutting each other in F, and the sides of the triangle E and D. Draw AF and DE, and bisect them in G and H; draw GH, which if produced, will bisect the base of the triangle in K, making BK equal to KC.

Through F, draw LFM, NFO, parallel to AB and AC cutting the sides in M and O and the base in L and N: now because of the similar triangles, as CF is to CD so is FL to BD and LM to AB. Therefore by alternation as FL is to LM so is BD to AB. But as FL is to LM so is FN to CM; Therefore as BD is to AB so is FN to CM and the rectangle under BD, CM is equal to the rectangle under AB, FN. Again, as BF is to BE so is BO to AB and so is FN to CE; therefore as BO is to AB, so is FN to CE; and the rectangle under BO, CE is equal to the rectangle under AB, FN. But the rectangle under BD, CM is also equal to the rectangle under AB, FN, it is therefore equal to the rectangle under BO, CE. Therefore as BD is to CE, so is BO to CM. Through H draw HI, HP, parallel to AB and AC. Then because EH is equal to HD, and HI is parallel to BD, BE is bisected in I, and HI is one half of BD. In the same manner CD is bisected in P, and PH is one half of CE. Bisect BC in K and draw KP, and KI which produce to S and T. Then because CK is equal to KB, and CP is equal to PD, KP is parallel to BD and equal to one half of BD, and in the same manner KI is parallel to CE and equal to one half of CE; and K, P, H, I is a parallelogram. And CS is equal to AS, and BT to AT. Through G draw VG parallel to AC, and produce VG to X, cutting CD in X, KS in W, and HI produced in Z: draw XY parallel to AB. Then because AG is equal to GF and VG is parallel to AC, and consequently to OF, AV is equal to VO; But AT is equal to BT, therefore BO which is equal to the difference between twice AT and twice AV, is equal to twice TV. Because AG is equal to GF and GX is parallel to AC, FX is equal to CX, and because XY is parallel to AB and consequently to FM, CY is one half of CM; but CS is equal to SA. And AM which is equal to the difference between twice CS and twice CY is equal to twice SY. Because GA is equal to FG and GX is parallel to AC, GX is equal to one half of AC, it is therefore equal to CS. WX is parallel to SY, and SW to XY, therefore SWXY is a parallelogram and SY is equal to WX, GW is therefore equal to CY, and CM is equal to twice GW; and because KW is parallel to TV and VW to KT, KTVW is a parallelogram and KW is equal to TV, and BO is equal to twice KW. But as BD is to CE so is BO to CM, that is as twice KP is to twice PH so is twice KW to twice GW, so as KP is to PH so is KW to GW, and therefore as KP is to the difference between KW and KP, so is WZ which is equal to PH to the difference between GW and WZ, that is as KP is to HZ which is equal to PW so is PH to ZG. Join GH and HK; now the triangles GZH, HPK, have equal angles, GZH and HPK, because GZ is parallel to HP and ZH to KW, and the sides ZH, ZG, KP, PH which are about the equal angles proportional, therefore the remaining angles HGZ, GHZ of the triangle GZH are equal to the remaining angles PHK, PKH of the triangle HPK, each to each which are opposite to the homologous sides, so the angle HGZ is equal to the angle PHK and the angle GHZ is equal to the angle PKH. The angle ZHP is equal to the angle HPK, because ZH is parallel to PK and PH falls upon them; and the three angles GHZ, ZHP, and PHK taken together are equal to the three angles HKP, HPK, and PHK taken together, that is to two right angles. So to the point H in the right line ZH are drawn two right lines KH and GH on opposite sides, making the two angles KHZ and GHZ taken together equal to two right angles; therefore the two right lines form one straight line; But BC is bisected in K by construction, and the right line GHK drawn through G and H bisects BC. Therefore in the triangle ABC, CD and BE being drawn, cutting each other in F, and the sides of the triangle in D and E, and the diagonals AF DE of the trapezium ADFE being drawn and bisected in G and H, the right line GH joining the points of bisection being produced bisect the base. Q. E. D.

No. XXXIV.

An Account and description of a TEMPORARY RUDDER, *invented by Captain William Mugford, of Salem, (Massachusetts) and for which the Society awarded to him a Gold Medal, from the Extra-Magellanic fund.*

Motto. Nil desperandum—cras iterabimus æquor.

Read November 16th 1804.

THE Ship Ulysses of Salem (Massachusetts) under the command of Captain William Mugford, sailed from that port on the 2d day of January 1804, bound to Marseilles. On the

5th of that month being in Latitude 41 Longitude 65 from the meridian of London, she experienced a heavy gale of wind, and while running 8 and 9 knots, a large sea struck her stern and carried away the rudder at the waters edge, when the vessel immediately broached to. The main-mast was sprung and the hull lay exposed to every sea. In this unfortunate situation, Capt. Mugford was reduced to the necessity of steering the ship with cables over the quarters for upwards of twenty days, making however the best of his way towards the western Islands and Madeira. The weather during all this time was extremely boisterous, and the ship much exposed to the Sea. It was during this interval that Capt. Mugford planned and executed his temporary rudder. This rudder is made of a spare top-mast and other spars well lashed and secured together, and fastened to a false stern-post by eye-bolts serving as braces, and crowbars and other substitutes for pintles. The false post is also firmly secured to the old stern-post by the guys and old rudder braces which are tennoned into it, tiller ropes are fixed to each end of an old iron tiller; or for want of it, an iron anchor-stock, or a piece of scantling, or a spar is fixed across the rudder and supported with rope-braces, so that the vessel is steered in the usual manner with the wheel:—and in order to keep this rudder steady in its place, while fixing it, a cannon or some other sufficient weight is fastened to the bottom of it.

Capt. Mugford (after observing that great difficulty would be avoided in the construction, if the master of every vessel, was in possession of the measure of the rudder and the precise distance of the gudgeons,) informs us that he found it to answer every purpose which could be expected from a temporary rudder, that his vessel was found to steer by it with the greatest ease, and that he sailed with it during fifty days, at the end of which time he arrived in safety at the port of his destination.

The drawing of the rudder, the following description of it, and the remarks subjoined, were furnished to the society by Capt. William Jones, one of their associates, from the model of the rudder sent by the Inventor and deposited in the cabinet of the Society.

MUGFORD'S TEMPORARY RUDDER.

A, (Plate V. Fig. 7.) Is the main stern-post from which the original rudder has been torn.

B. Is the *false stern-post* made of a spare top-mast sided so as to fit the main stern-post, with mortices to receive the braces h h h, or the fragments thereof which remain upon the post.

C, Is the temporary rudder made of the (residue of the) top-mast and the sprit sail yard, studding sail booms, or any spars that can be spared with the least inconvenience—They are cut to the proper length and partially sided and firmly bolted or *treenailed* together. The sides are then flatted a little with the adze and boards nailed across and wooldings of rope bind the whole together as represented in the figure.

D D D D, Represent the spars of which the rudder is constructed.

E, Is a small spar or piece of plank fitted on each side of the false post to lead the guys clear and prevent their chafing; they are also bolted through from side to side and rivetted to secure the false post from splitting, or if bolts are not to be had lashings are substituted as represented in the figure.

F F, Are stout flat cleats well nailed or bolted on each side of the false post under the spars E, and embrace the main post. Their use is to sustain the false post against a lateral shock.

G, Is a yoke made of an iron tiller, or other sufficient substitute, firmly fitted through the after part of the rudder near the surface of the water.

H H H, Are the temporary braces and pintles—They are formed of eye bolts drawn out of the gun carriages or from the various parts of the hull, masts, or caps, and driven into the false post and rudder alternately so that the eyes just meet each other; some of those in the post, below those in the rudder, and others above, in order to confine the rudder from rising—The pintles are made of crowbars, a kedge anchor-stock, or the long stout bolts out of the windlass bits.

h h h, Are the old rudder braces or the fragments thereof remaining on the post.

I, Is the profile of the stern of the ship.

K K, Are guys, the bites of which are well served and lashed to the after part of the false post, and lead separately (or combined as represented in the figure) to the fore and after parts of the main chains.

L L, Are knots worked on the guys to preserve them from chafing against the bottom and quarters.

M, Is a rope the bite of which is lashed to the after part of the rudder below the yoke, and also to the extremities of the yoke, and from thence led through blocks attached to the end of a spar projecting over each quarter to the wheel by which the ship is steered.

N, Is a slip rope rove through a hole in the heel of the rudder and both ends passed up through the rudder case to the head of the false post and made fast.

O, Is a grommet (travelling on the slip rope) to which a gun or kedge anchor or any sufficient weight is attached, in order to sink the rudder until it is hung and secured.

P, Is a hauling line attached to the grommet, and by which the weight is lowered down and hauled up. When the rudder is secured in its place, the weight is removed, and the slip rope unrove.

Q, are the rudder pendents to save the rudder in case of accident.

R, Is the lower deck.

S, Is the quarter deck.

T, Is the quarter rail.

V, The arch board of the Stern.

REMARKS.

The merit of this invention is to be tested by a just comparison with the best substitute hitherto known, which is undoubtedly that of Capt. Pakenham's excellent invention, an account and description of which may be found in the 7th volume of the Transactions of the London Society for the encouragement of arts, manufactures and commerce.

The difference consists in Captain Mugford's new and ingenious contrivance of a *false stern post,* to which his rudder is secured by eye bolts serving as braces, and crow-bars or other substitutes as pintles, on which it works with as much ease and effect as the original rudder. The false post is also firmly secured to the main post by the guys, and the old rudder braces which are tenoned into it.

Captain Pakenham's rudder depends entirely upon the very slight hold which the cap has on the post, and does not appear to be sufficiently secured to resist a sudden lateral shock; it is however very simple in its construction, and requires, perhaps, less labor and fewer materials (particularly of iron) than Capt. Mugford's, and has the advantage of steering upon deck with a common tiller in the usual way.

Capt. Mugford's rudder must work with much less friction, and consequently will require less power, as the axis on which it moves is only an inch and a half in diameter, whereas that of Capt. Pakenham's is the diameter of the top-mast; say 10 or 12 inches.

Upon the whole, as the construction of Capt. Mugford's rudder requires only the skill and materials which are usually to be found on ship board, and as it appears to be better secured, and works with more ease than Capt. Pakenham's, it may (without derogating from the merit of the latter) be justly considered as a valuable and useful invention.

Capt. Mugford's rudder is susceptible of a very simple and important improvement, viz. If the archboard of the stern V was cut off, and the after part of the rudder case taken down, the stock of the rudder might be continued to the upper deck, and steer with the tiller in the usual way. Capt. Mugford's mode of steering is exceptionable, as the yoke is at the surface of the water, and the wheel ropes leading from the yoke to the spar, broad upon the quarter; the angle which the rope makes with the yoke when the rudder is hard over, is so obtuse as greatly to diminish the effort of the power; and moreover the rudder is necessarily so broad at the surface of the water, as to expose a dangerous resistance to the action of the sea.

It is also to be observed, that few merchant ships under 350 ton's burthen have either wheel or iron tiller. If the rudder was continued to the deck, the breadth might be diminished at the surface of the water and enlarged at the heel, which would increase its effect and render it less liable to injury.

In the drawing, the cleats F F, are added to the side of the false post, and overlapping the main post, which will give it great additional security. Some minor alterations are also made, viz. In the drawing the four guys I I I I, (which are separate in the model) are combined into two K K, leading through a thimble or clinch; the reason is, that am ore equal tension can be obtained of two ropes than of four, and that when combined they lead in a fairer direction under the buttock of the ship.

Indeed the number of guys are superfluous, the lower one would be amply sufficient, as the upper end of the post can be made very secure. Captain Pakenham has but a *single* guy leading from the cap on each side.

The drawing represents a mode of applying and removing the weight to sink the rudder, by which the whole can be removed with more ease when the rudder is secured.

When the rudder is fixed, the only apprehension is, the guys chafing off. There is however on board every ship a complete remedy viz. Take two of the topmast back stay chain plates and one of the bolts, and bolt them to the heel of the false stern post, one on each side; to these hook the top-blocks and mouse the hooks well; then reeve the guys through the blocks, and take both parts to the fore part of the main chains: by this means the guys may be overhauled through the blocks and examined at pleasure, keeping them always well taught and veering away one part as you haul in upon the other. These remarks are the more diffuse as the subject is considered important, and is still susceptible of great improvement.

Captain Mugford was some days before he could hang his rudder, owing to bad weather.

The man will deserve well who shall invent a simple substitute for a rudder that can be made and applied immediately *in any weather;* and it need not be despaired of, if men of ingenuity, without waiting for the calamity, would only try experiments while their ships are in a sound state.

No. XXXV.

Facts and Observations relative to THE BEAVER *of North-America. Collected by Mr. John Heckewelder, in answer to Queries proposed by Professor Barton.—Communicated to the Society by Professor Barton.*

Read November 16th, 1804.

I. PEMAHOLEND, a famous Beaver-Trapper, an aged and much respected Delaware-Indian, and a friend of mine, gives the following account.

The Beavers build their dams for the safety of themselves and their young; and in order to convey food to their houses. They are very particular in chusing the ground or situation upon which they intend to build. They always, in the first place, carefully examine, whether there be near them a sufficiency of trees and shrubs, especially Aspin, Sassafras, and Shellbark-Hickery near at hand, so that they need not venture too far out, to cut them: for the barks of these trees are their principal foods.

They carefully examine the run or brook; whether it be permanent, or does not dry up in the summer season, and whether there be a sufficient quantity of water to extend or enlarge the dam, if occasion should require it.

Having surveyed the ground well, and chosen the time when the waters are neither too high nor too low, they cut down bushes, and drag and lay them in a line for the foundation, which, at this time, has the appearance of a brush-fence. They sometimes make one or more offsets, altering their course as they think best, both for the security of the dam, and to give them advantages.

The foundation being finished, they cut down small trees, from six to twelve, and even fifteen inches, in diameter; and these they cut up into blocks, of three, four, five, and sometimes six feet in length. These blocks they draw by their teeth, walking backwards, to the brush foundation, and place, in a sloping direction, every block, with one end on the brush, and the other end on the ground, on the inside of the dam. In order that the blocks may not be suddenly removed or carried off (by a fresh) before the dam be finished, they bind them together with brush, as they lay them down, so that the blocks are, in a manner, interwoven in the brush.

Satisfied, that the work so far, is good, they cut roots, small brush (rushes and long grass, if at hand,) and by means of mud or clay, fill up, and daub over, all holes or places, through which the water has a passage: so that when it is finished, it has the appearance of having been made by the hands of man.

They chuse a proper depth of water where they build their houses; both for safety and for an easy conveyance of food. The houses are built of brush, roots and mud (or clay), well covered, and secured against the rain, by being rounded off at the top. Their apartments are perfectly dry, being above high-water mark. The inside is daubed very smooth. Their beds are made of shavings, which they draw from wood, with their teeth, and resemble the finest shavings that have been carefully drawn with a drawing knife. One house will contain from eight to nine beavers, young and old together. They have several passages into their apartments. There are sometimes as many as eight houses in one dam; yet every family is by itself.

They never work at broad-day. In the mornings and evenings they do all their work, both in building, repairing, enlarging the dam, and also in cutting down trees, and digging roots, for provision. They eat no fish, nor make use of any animal food whatever. The bark of Aspin (and another species of Aspin), the bark of the Shellbark-Hickery, the Sassafras entire, and occasionally the bark of the Willow, constitute their principal food, in the winter season. In the spring and summer, they feed on a certain root, which has an agreeable smell.

The Beaver is a very cleanly animal, and cannot bear any thing dirty, or any thing that has a disagreeable smell, about them. Sassafras-bark, nutmeg and Fennel-seed, soaked in rum, or any other sweet or well-scented article, make the best bait for catching them.

In general, they have but two young ones at a litter: but there are instances of old beavers having three, and even four, young ones at a time. A single pair or couple undertake the building of a dam, and when their offspring become too numerous to dwell together in one house, they build for themselves. They drag all by their teeth, and roll none. They take every advantage of the water they can, in conveying materials, food, &c. They are always on guard.

They suckle their young sometimes sitting, and sometimes lying down, much in the manner of a cat. They are extremely fond of their young.

II. Samuel, an aged Indian of the Nanticok tribe, brought up neart he sea-shore, in Maryland, and formerly a distinguished trapper of beavers, says,

The beavers build their houses for the sake of breeding, for their preservation, and for obtaining food. Their food is principally Aspin-bark, Sassafras, the bark of Willows, and the root of the Water-Lilly. They eat no fish, nor feed on any flesh whatever. They do not like to go far from the water, for their food; and, therefore, they dam up grounds, with a number of Aspin-trees thereon, which may serve them for many years.

They never work in the day-time, but do all their work, in the evenings and mornings. They work together, and keep a watch. In a large dam, there are sometimes eight or nine houses. These houses are very dry, and clean in the inside. They extend their dams, as they find it necessary. In Maryland, there was formerly one dam, which by means of frequent enlargement, extended nine miles. They sometimes cut trees eighteen inches in diameter.

They frequently sit upon their hams, while suckling their young, which stand before them, holding the pap or tit, with their hands (fore-legs). They copulate in the fall, and, in general, have but two young ones at a time: yet sometimes an old beaver has three, and even four, at a time. They are much attached to their young. Are very cleanly.

The beaver is a very cunning animal, so that it requires art and ingenuity to deceive and catch them. They possess great bodily strength; drag all by their teeth, walking backwards, They view their works with great attention, and know how to apply every piece of wood, brush, or root, in the best manner, and for the security of the dam. They wash themselves, after their labour is over.

III. Account of the beaver by a French trader (at Detroit), who has spent a number of years among the Chippeewas, far to the North of Detroit, and is said to understand beaver-trapping as well as any Indian. Recommended by John Aikin, Esq. as a person of credit. Answers to my queries.

Self-preservation, breeding, wintering, and the greater facility of obtaining their food, are their principal motives for building their dams. Here they live secure, and can pass the winter comfortably, having previously well provided themselves with the necessary food, such as the barks of trees, roots, &c.

In building their dams, they make use of all kinds of sticks, logs, and rubbish, some of which are laid crossways, others in a position nearly upright, but somewhat leaning. For stopping up holes or breaches, they make use of roots and clay or mud; and they are always careful to keep their dams in good order, never delaying a necessary repair.

Their houses are from nine to twelve feet in diameter. Several couple live together in one house; and there are from one to ten houses in one dam. From two to ten beavers have been seen working together. When at work, they keep a watch, who will sometimes ascend to the height of ten or twelve feet; but on the approach of an enemy, or even on only supposed danger, instantly descends, when all the labourers retire to their houses. The female works the same as the male.

They are very fond of their young, which they suckle much in the manner that the cat does. They frequently lean their backs against a tree, while suckling their young ones. In general, they have but two young at a litter; but old beavers are known to have had three and even four young at one litter. I know but one kind of beaver.

No. XXXVI.

Memoir on the Occultation of Aldebaran by the moon on the 21st of October 1793. By Jose Joaquin de Ferrer.

Read November 16th 1804.

OBSERVATIONS ON THIS OCCULTATION.

		Apparent Time. h ′ ″
In the Capital of Porto-Rico by Don Cosme de Churruca, Captain of a Ship in the Royal Navy.	Immersion.	12 30 33 76
	Emersion.	12 57 55 80
In the Observatory of Ferrol by Don Manuel Herrera, Lieutenant in the Navy.	Im.	18 03 40 0
	Em.	19 09 59 0
In Figueras by Mr. Mechain.	Im.	18 59 27 7
	Em.	20 00 17 6
In the Observatory of Gotha.	Im.	19 33 09 1
	Em.	20 13 20 7
In Paris at the Naval Observatory.	Im.	18 53 28 0
	Em.	19 45 36 0
In Berlin.	Im.	19 46 17 0
In Marseilles.	Im.	19 10 04 5
In Dantzick.	Im.	20 14 32 9

		h
From these observations results the longitude of Porto-Rico west of Paris according to	Lalande.	4 33 27 0
	Mechain.	4 33 36 2
	Triesnecker.	4 33 58 6

According to the statement of Mr. Lalande in the *Connoissance des Temps* for the year 8, Triesnecker has, contrary to the opinion of this astronomer, diminished the horizontal parallax of the moon given, in the third Edition of his Astronomy, 6″; but this variation cannot produce so great a difference. As the position of Porto-Rico is very interesting to geographers, I have proposed to calculate all the observations, to examine the elements, and point out the dependence to be placed on these results.

I had formerly calculated these observations, supposing the proportion between the polar and equatorial diameters of the earth to be as 229 : 230 conformably to the theory of Newton, and the horizontal parallax in Paris = 57′ 44″ 8. Since that period this proportion has been ascertained to be as 333 : 334. The constant parallax of the equator 57′ 1″, from which the parallax at Paris = 57′ 36″ 8. for the moment of the conjunction.—It follows then from the first elements that the longitude of Porto-Rico West of Paris=4^h 33′ 26″ 6, and the difference of latitudes in conjunction 22′ 58″.—It is to be remarked that calculating from the different elements, there resulted an increase in the difference of meridians between Porto-Rico and Paris viz:

	h ′ ″
From the difference between 1-230 and 1-334 for the figure of the earth.	+08 3
From the differences of parallaxes between 57′ 44″ 8, and 57′ 36″ 8.	+17 1
Longitude of Porto-Rico by the first elements	4 33 26 6
Longitude of Porto-Rico West of Paris corrected.	4 33 52 0

These results inclined me, at the moment, to believe that the longitude determined by Triesnecker was nearer the truth than any of the others, I immediately began a careful investigation, making use of the best elements astronomy has as yet afforded.

In consideration of the great influence of the parallax and oblate figure of the earth, upon the longitude of Porto-Rico, we may infer the great importance of repeating this kind of observations, for if we can once with accuracy determine the difference of meridians, we can then determine the proportion of the earth's axes, with more certainty than by the *Geodesical* method; or supposing this proportion known, the lunar parallax could then be determined.

		′ ″
The horizontal equatorial parallax agreeably to Mayer.		=57 11 4
These results are on the supposition of the difference of the axes of the earth being 1-300.	Lalande.	57 05 0
	Burg.	57 01 0
	Laplace.	56 57 3

The parallax which I have adopted is that of Burg, who deduced it from observations of a great number of solar eclipses and occultations of stars.

The inflection of the moon I have deduced from the same observations. It will not be amiss to observe, that comparing the conjunctions deduced from immersions and emersions, or immersions with immersions, they give the difference of meridians, so that the doubt which may exist as to the quantity of inflection, cannot be such as to affect the result. To determine the difference of latitudes at the conjunction, I have made use of the observations at Gotha and Porto-Rico.

It is to be remarked that at Porto-Rico the apparent center of the moon passed to the North of Aldebaran supposing 2″ of inflection.			Immer.	13′ 56″ 38
			Emer.	15 49 18
At Gotha to the South of Aldebaran.			Immer.	10 55 35
			Emer.	12 20 35
Difference of Latitude at conjunction with 2″ inflection.	Porto-Rico.	= 22′ 55″9	=	22 57 3
	Gotha	22 58 7		
Supposing 1″ of inflection	Porto-Rico.	22 57 0		22 57 5
	Gotha.	22 57 1		

It appears therefore that the center of the moon having passed at such a distance from Aldebaran and in different quarters, the errors proceeding from the semidiameter of the moon, or quantities of inflections, have contrary signs, that is if we suppose 1″ more in the inflection, we diminish the difference of latitudes at conjunction by the observations in Porto-Rico 1″ 1 and augment it by those of Gotha 1″ 6, consequently we determine at the same time both elements, which is reduced to the following question: To find the horizontal semidiameter of the moon at the moment of the conjunction; by applying the corrections of the horary variations and the corresponding increase of altitude, there results the same difference of latitude at conjunction, by the observations at both places. By applying the calculation we find the inflection of the horizontal semidiameter of the moon=1″ 0, and the difference of latitudes 22′ 57″ 0. At Figueras and Ferrol the apparent centers of the

		In its Immersion.	Emersion.
Moon and Aldebaran pass	Ferrol.	2′ 1″ 0	3′ 47″
	Figueras.	2 28 0	2 47

These observations after having determined the difference of latitudes at conjunction, are the most proper to determine the quantity of inflection.

By applying the calculation to the observations of Ferrol, there results the inflection of the semidiameter of the moon. 0″ 9

Applied to the observations of Figueras. . .	0 5
To those of Porto-Rico and Gotha. . . .	1 0
Mean inflection. . .	0 8

According to Lalande, the inflection increases the semidiameter of the moon 2″; Mr. Du Sejour, after having calculated the observations of Mr Short on the Solar eclipse of 1st April

1764, says that an inflection of 1″ 8 and a diminution of the semidiameter of the moon of 1″ 5 agreed with some of the observations, but he could come to no final conclusion upon this point. To determine the quantity of the inflection it is necessary to know precisely the following data, viz. the precise diameter of the moon, the beginning and end of the occultation, the true difference of latitude, the parallaxes in longitude and latitude, and the horary motions of the two bodies.

Let us suppose the diameter observed to be less than that calculated by the tables 0″ 8, as in the present case, and that in other respects the elements that have been made use of are correct, we cannot on that account suppose it to be the effect of the irradiation, it being certain that the doubt respecting the lunar diameter, measured by different astronomers, is much greater than the above difference.

The diameter of the sun has been frequently the object of the attention of astronomers, and although it is much more easily determined than that of the moon, there is notwithstanding, a great difference in the various determinations.

			′	″	
The Apogee diameter of the Sun by,	Picard.	in 1670 =	31	38	0
	Mouton.	——	31	31	0
	Louville.	1724	31	33	0
Gentil, Lemonnier and	La Caille	1750	31	34	5
	Bradley.	——	31	30	5
	Lalande.	1764	31	31	0
	Maskelyne.	——	31	29	0
	Short.	——	31	28	0

If we confine ourselves even to the determination of Lalande, Maskelyne, Bradley, and Short we find a difference from 2″ to 3″ and there is reason to believe that the uncertainty of the diameter of the moon is much greater, consequently we may well doubt whether the diminution of 1″ or 2″ resulting from the observations of the moon by eclipses of the sun and occultations, is the effect of the irradiation or of an error in the diameter represented in tables.

Remark on the elements of the tables.

I have calculated the place of Aldebaran taking the right ascension from the catalogue of Maskelyne and the declination of Piazzi; and the place of the moon from the theory of Laplace. The horizontal parallax of the moon, from the statements ot the tables of Lalande, in the third edition of his astronomy, I have diminished 3″ 1, conformably to the determination of Burg as mentioned above.

I have also taken care to calculate the horary motions corresponding to the intervals between the immersions and emersions, and between the true conjunction and the moments of the immersions and emersions, the variation of the parallax, semidiameter, equation of time and all the other elements, which are subject to variation.

Elements of the

Occultation of Aldebaran by the moon.

October 21st, 1793.

		h	′	″	
Conjunction in Paris by the tables,	Mean time.	17	51	02	3
	Apparent time.	18	06	29	3
Apparent obliquity of the ecliptic.		23°	27	48	0
Apparent longitude of Aldebaran.		66	54	33	4
Southern latitude of Aldebaran.		5	28	49	0
Southern latitude of the moon.		5	05	58	27
Horary motion of the longitude of the moon.			33	50	15
Horary diminution, of the horary motion in longitude.				2	66
Horary motion of the moon in north latitude.				7	79
Horary increase of horary motion in latitude.				1	77
Proportion of the axes of the earth, as 333 : 334			′	″	
Horizontal parallax of the moon at Paris.			57	36	80
Polar horizontal parallax.			57	32	30
Horary variation of the parallax decreasing.				2	30
Horizontal semidiameter of the moon.			15	45	0
Horary diminution of the semidiameter of the moon.				0	63
Latitude of Aldebaran.——Latitude of the moon.			22	50	73
Right ascension of the sun.		207	13	54	0
Horary motion of the right ascension of the sun.			2	23	0
Equation of time.			—15	27	0
Horary augmentation of the equation of time.				0	34
Horary motion of the moon between the immersion and emersion at Paris.			33	46	7
Do. between the immersion and the true conjunction.			33	49	1
Do. between the true conjunction and the emersion.			33	47	9
Paris. Horary motion in latitude between	immersion and emersion.			9	9
	immersion and true conjunction.			8	4
	true conjunction and emersion.			9	3
Horary motion at Porto-Rico between the immersion and emersion.			33	52	2
	immersion and true conjunction.		33	51	5
	true conjunction and emersion.		33	50	8
Porto-Rico. Horary motion in latitude between	immersion and emersion.			6	4
	immersion and true conjunction.			6	9
	true conjunction and emersion.			7	3

Application of the calculation of the observation at Gotha.

Latitude—Vertical angle=50° 47′ 41″ 49. Logarithm of the radius=9,9992171
Radius at the Pole 9,9986978

	Immersion. ° ′ ″	Emersion. ° ′ ″
H=Altitude of the nonagesime	56 34 06	54 01 40
N=Distance of the ☾ from the nonages.	58 23 10	65 06 30
N+Parallax in longitude	59 04 34	65 49 10
L Latitude of the moon by the tables	5 5 50 8	5 05 44 2
Horizontal polar parallax	57 30 24	57 28 70

	Immersion		Emersion
Sine horizontal polar parallax.	8,2234038		8,2232030
Logarithmic radius at Gotha. } Logarithmic radius at the Pole. }	0,0005193		0,0005193
Co-arithmetical cosine latitude of the moon.	0,0017209		0,0017200
Sine altitude of the nonagesime.	9,9214490		9,9081105
Sine (N + parallax in longitude)	9,9334117		9,9601182
P=Sine parallax in long. = 41′ 22″ 79	= 8,0805047	Sine P.=42′ 39″ 22	8,0936710
Cosine latitude of the moon.	9,9982791		9,9982800
Co-ar: sine N.	0,0697644		0,0423423
Constant logarithm.	8,1485482		8,1342933
Cotangent H.	9,8196570		9,8608182
Cosine latitude apparent of the moon 5° 39′50″	9,9978740	5° 41 17	9,9978563
Sine Q=31′ 47″ 71.	7,9660792	Sine Q=33′ 49″ 55	7,9929678
Constant logarithm.	8,1485482		8,1342933
Cosine (N + ½ P.)	9,7152204		9,6183552
Cosine apparent latitude of the moon.	9,9978740		9,9978563
Tangent the true latitude of the moon.	8,9505967		8,9504777
Sine Q′=2′ 13″ 86.	6,8122393	Sine Q′. 1′ 43″ 61.	6,7009825

Parallax in latitude=Q+Q′=34 01 57. Parallax in latitude=Q+Q′=35 33 16
Parallax in longitude 41 22 79. Parallax in longitude 42 39 22
Difference of apparent latitudes in the interval. . . . 1 25 0
Difference of apparent longitudes do. 21 21 0

$$Y = \frac{\text{mean apparent latitude of the moon} + \text{latitude of Aldebaran}}{2} = 5° \; 34 \; 40$$

Apparent inclination of the orbit 3° 48′ 51 arc or chord 1277″ 76

Apparent semidiameter—2″ inflection= { I. 15′ 48″ 38; E. 15 46 33

Angles of conjunction. { I. 46° 17′ 18″; E. 38 31 26

We have the distances of the apparent conjunction. { I.= 11 28 78; E. 9 52 51

Difference of apparent latitudes. { I.= 10 55 35; E 12 20 35

True conjunction in apparent time = 18h 40′ 06″ 1

	Immersion	Emersion
Latitude of the ☽ by the table at the imm. =5° 5′ 50″ 80 at the em.=		5° 5′ 44″ 20
Parallaxes in latitude.	+34 1 57	+35 33 16
(a) Apparent latitude of the ☽ by the tables	5 39 52 37	5 41 17 36
Difference of latitudes observed.	—10 55 35	—12 20 35
Lat. of the ☽ in the region of the star.	5 28 57 02	5 28 57 01
Latitude of Aldebaran.	5 28 49 00	5 28 49 00
Error of the tables	— 0 00 08 02	— 0 00 08 01

Difference of latitudes at the conjunction.	22′ 50″ 73
Error of tables.	+ 8 01
Difference of latitudes at conjunction.	22 58 74
Supposing the inflection = 1″ the difference of latitudes at the conjunction would have been 22′ 57″ 1	
Supposing 22′ 57″ for difference of latitude at the conjunction, we have an error in the tables in latitude =	— 6″ 27
Apparent latitude by the tables. (a p. 218)	5 39 52 37
Apparent latitude corrected.	5 39 46 10
Aldebaran.	5 28 49 00
Difference of apparent latitude at the immersion.	10 57 10
With 22′ 57″ difference of latitude at conjunction there results 10′ 57″ 10 for difference of apparent latitude at the immersion, and supposing	
2″ of inflection we have true conjunction.	18h 40′ 03″ 1
1″ of inflection do. do	18 40 05 5

Note. The altitudes and longitudes of the nonagesime have been calculated with the latitude diminished by the vertical angle corresponding to 333 : 334, for the proportion of the axes: I have omitted the forms which I made use of, and have only given the calculation of the parallaxes to shew the method I have used, which is the same with that of Cagnoli.—See his treatise of trigonometry, printed in Paris, page 411—427.

Determination of the difference of latitudes at the conjunction.

It will appear by the annexed table of the occultation, as observed in the capital of Porto-Rico and different places in Europe, that the mean difference of latitudes at conjunction, (supposing 1″ of inflection) is 22′ 58″ 00.

The emersion at Paris was observed rather late, as appears by a comparison of the observations, and consequently cannot be much confided in; the observations at Figueras and Ferrol are not the most proper in order to determine the latitudes at conjunction, because the center of the moon passed near to the star, we shall therefore confine ourselves to those of Gotha and Porto-Rico, which give 22′ 57″ 0 without risk of an error of 1″.

If we diminish the horizontal polar parallax of the ☾ by 4″ according to the theory of Laplace, there would have resulted a difference of latitudes at conjunction by the observations at Porto-Rico and Gotha = 22′ 56″.

Determination of the longitude of Porto-Rico west of Paris.

Conjunctions at Paris resulting from three suppositions.

1. By the immersions and emersions at Paris, Gotha and Figueras, reduced to the national observatory.

2. Supposing 22′ 57″ difference of latitude at the conjunction, and making use of the immersions with 1″ of inflection.

3. Making use of the same difference of latitude at the conjunction with 2″ inflection.

Conjunction at Paris by observations.

	h ′ ″	h ′ ″	h ′ ″
At Gotha.	18 06 30 6	18 06 30 0	18 06 27 6
Paris.	18 06 36 9	18 06 31 3	18 06 29 0
Figueras.	18 06 35 5	18 06 35 5	18 06 33 3
Berlin.		18 06 33 5	18 06 30 4
Marseilles.		18 06 33 2	18 06 31 4
Dantzick.		18 06 32 0	18 06 26 1
Conjunction on three hypotheses.	18 06 34 3	18 06 32 5	18 06 29 7
Same at Porto-Rico.	13 32 41 8	13 32 41 3	13 32 37 7
Longitude of Porto-Rico on the three hypotheses.	4 33 52 5	4 33 51 2	4 33 52 0

	h ′ ″
Mean longitude of Porto-Rico.	4 33 51 9

Supposing 22′ 57″ difference of latitudes at conjunction and 1″ of inflection we have the longitude of Paris by the immersions.

Conjunction at the national observatory, apparent time, by the mean of the observations at Paris, Gotha, Figueras, Berlin, Marseilles and Dantzick. = 18h 06′ 32″ 5

	h ′ ″
Gotha east of Paris.	33 33 0
Figueras.	2 32 5
Ferrol west.	42 11 0
Berlin east.	44 10 0
Marseilles.	12 08 7
Dantzick.	1 05 14 5
Porto-Rico west.	4 33 51 2

If we suppose the proportion of the difference of the earth axes 1-300, it diminishes the difference of meridians between Porto-Rico and Paris. . . . . = —2″ 65

1″ diminution of the parallax, ... + 2 14

1″ more in the horary motion of longitude. + 3 70

If we suppose the polar horizontal parallax diminished 4″, conformably to Laplace's theory, it would increase the longitude of Porto-Rico by 8″ 5 of time: in this case the longitude of Porto-Rico would be (=4^h 33′ 51″ 2+8″ 5)=4^h 33′ 59″ 7
According to Triesnecker. 4 33 58 6

The variations in the elements, have no sensible influence on the difference of meridians between the observations in Europe.—So that we may consider the above results to have as much accuracy as the observations can possibly be susceptible of.

No. XXXVII.

The geographical position of sundry places in North America and in the West Indies, calculated from astronomical observations: By Jose Joaquin de Ferrer.

Read at sundry times, 1805.

OCCULTATION OF JUPITER BY THE MOON.

January 15th, 1799.

Observations.		Apparent time. h ′ ″
At New-Orleans by Mr Andrew Ellicott.	Immersion of the center of Jupiter. .	5 45 46 5
	Emersion of the center.	7 06 20 0
At the royal observatory of the Island of Leon by Don Julian Ortiz Canelas.	Immersion of the 1st limb. . . .	13 29 43 8
At the national observatory at Paris by Mr. Mechain.	Immersion of the center. . . .	13 50 12 5

Elements by the tables at 13$_h$ 00′ 00″ mean time or 12^h 49′ 50″ 1 apparent time at Paris.

		° ′ ″
Moon's	Longitude reckoned from the apparent equinox. . . .	46 26 38
	Latitude. S.	34 26 7
	Equatorial horizontal parallax.	55 04 0
	Horizontal diameter—3″ inflection.	30 00 0
	Horary motion in longitude.	30 27 7
	Horary motion in latitude northerly.	2 41 1
	Horary augmentation of parallax.	1 4

		° ′ ″
Jupiter's	Geocentric longitude.	46 24 46
	Geocentric latitude.	57 16
	Horary motion in longitude direct. . . . ,	2 40
	Horizontal parallax.	1 87
	Semidiameter.	20 33

Proportion of the equatorial and polar diameters of the earth 334 : 333.

	New-Orleans. Im. of center.	New-Orleans. Em. of center.	Island of Leon. Im. 2d limb.	Paris. Im. of center.
	h ′ ″	h ′ ″	h ′ ″	h ′ ″
Apparent time of the observations,	5 45 46 5	7 06 20	13 29 43 8	13 50 12 5
Longitude west from Paris,	6 10 16	6 10 16	34 08 0	00 00 0
Apparent time at Paris,	11 56 02 5	13 16 36	14 03 51 8	13 50 12 5
Latitude—Vertical angle,	29 48 34		36 18 00	48 40 01
Parallax in longitude,	11 18 6	3 54 3	51 34 0	46 01 0
Parallax in latitude,	18 02 5	12 26 7	18 41 0	29 42 4

Apparent inclination of the orbit for New-Orleans,	19° 45′ 01″
Conjunction at New-Orleans, apparent time,	6h 37 53 1
Difference of latitudes at the conjunction,	22 11 4
Idem by the tables,	22 43 9
Correction of the tables,	— 32 5

	h ′ ″
Conjunction at Paris, by the observation on the Island of Leon apparent time,	12 47 42 2
Do. by the observation of Mr. Mechain,	12 47 35 8
Mean	12 47 39 0
At New-Orleans,	6 37 53 0
Longitude of New-Orleans West from Paris.	6 09 46 0

Table of the results of longitude by the lunar distance observed with a circular reflector.

Capital of Porto-Rico.

1796		Apparent time. h ′ ″	Apparent distances of ☾ from ⊙ and stars.	° ′ ″	Long. W. from Paris. h ′ ″
January	30	20 20 41	☽ and ⊙ nearest limb.	93 29 52	4 32 53
	31	20 48 15	. . . .	82 32 12	4 33 00
February	2	23 22 02	. . . .	59 50 10	4 33 15
	3	20 53 21	. . . .	49 39 36	4 33 18
	4	0 20 36	. . . .	48 42 36	4 33 47
	12	22 48 28	. . . .	58 38 42	4 33 06
		23 3 29	. . . .	58 46 18	4 33 14
	14	3 44 06	. . . .	73 38 15	4 33 47
	15	4 38 0	. . . .	87 09 18	4 34 32
	16	0 57 34	. . . .	98 54 02	4 33 42
March	2	21 17 31	. . . .	70 14 20	4 32 44
		21 27 31	. . . .	70 11 40	4 32 39
	3	21 11 11	. . . .	59 6 42	4 33 11
		21 20 14	. . . .	59 4 40	4 32 35
	4	22 58 18	. . . .	47 14 18	4 33 22
	11	22 48 48	. . . .	40 56 54	4 33 02
	13	22 59 39	. . . .	67 36 45	4 33 32
		23 08 02	. . . .	67 41 22	4 33 09
	14	23 41 33	. . . .	81 11 45	4 34 08
		23 51 19	. . . .	81 17 42	4 34 17
				Mean.	4 33 21.4
Correction of the Epochs,					+ 35 0
Longitude of Porto-Rico West from Paris,					4 33 56

Table of the results of longitude continued.

New Veracruz.

1792	Apparent time. h ′ ″	Apparent distances of ☾ from ⊙ and stars.	° ′ ″	Long. W. from Paris. h ′ ″
Septembr. 21	0 16 2	⊙ and ☾ nearest limbs.	66 55 45	6 32 54
	0 38 48	. . . . .	67 5 45	6 32 0
28	10 56 24	α aquilæ & ☾ nearest limb	57 56 45	6 32 47
	11 05 44	. . . . .	57 59 15	6 32 47
October 2	11 40 52	α ♉ and ☾ nearest limb.	19 50 58	6 33 38
	11 54 28	. . . . .	19 45 56	6 33 43
3	12 00 25	. . . . .	6 54 07	6 33 51
	12 17 56	. . . . .	6 47 34	6 33 42
4	11 42 26	α ♉ and ☾ remote limb.	5 28 00	6 33 44
	11 54 53	. . . . .	5 33 16	6 33 57
9	23 6 57	⊙ and ☾ nearest limbs.	61 13 00	6 33 47
	23 49 57	. . . . .	61 1 45	6 33 32
11	22 17 09	. . . . .	38 38 00	6 32 44
12	0 31 19	. . . . .	37 57 16	6 33 51
	0 43 14	. . . . .	37 53 22	6 33 35
19	3 15 12	. . . . .	50 48 39	6 33 09
	3 46 02	. . . . .	50 48 04	6 33 05
November 4	21 11 14	. . . . .	104 5 45	6 32 46
	21 23 54	. . . . .	104 1 8	6 32 57
5	21 44 02	. . . . .	93 0 26	6 32 08
	21 53 23	. . . . .	92 56 54	6 32 42
18	3 13 41	. . . . .	59 49 40	6 33 07
	3 24 23	. . . . .	59 53 10	6 32 57
21	2 46 22	. . . . .	99 16 37	6 32 45
	2 55 51	. . . . .	99 20 45	6 32 40
December 17	3 50 55	. . . . .	54 52 45	6 33 4
			Mean.	6 33 09
Correction of the Epochs,				+ 39
Longitude of Veracruz west from Paris,				6 33 48

The preceding Table contains observations of distances of the moon from the sun and stars in Vera Cruz and Porto-Rico, and the number of observations being equal on the east and west of the moon, the errors of them must be very nearly destroyed.

The longitudes are deduced by a comparison with the nautical almanac; and to the mean of the results I have added the corrections which are found in the tables, arising from the following considerations.

The tables of Mason which have been used for the calculations of the moon in the nautical almanac, suppose the epoch of the mean longitude of the moon in 1750 $6^s\ 08°\ 22'\ 21''$

The secular motion. 10 07 53 35

From a comparison with the new tables, the following corrections arise.

Correction of epochs in 1750	— 13″ 0
Idem of the secular equation.	= 54 96

Coefficient of Mr. Laplace=15″ sin (☾'s apog. + 2 long. ☊—3 ☉'s apog.)

To determine the error of the solar tables, I have calculated various observations of the Rev. Nevil Maskelyne corresponding to the epochs of observations in the said tables.

I have further applied the equation XVIII of the lunar tables, of which no use is made in the calculations of the nautical almanac. The result of all the corrections, I have reduced to time, to apply it to the mean of the results of longitude as I have mentioned above.

Difference of longitude between Paris and Veracruz.

Veracruz, apparent time.			h ′ ″		h ′ ″
1795, Aug.	8. Emer. I Sat. of ♃		8 53 45 2	difference of longitudes, by the comparison of the observations in Europe.	6 33 32 0
	14	II.	8 57 29 8		
Oct.	9	I.	8 03 00 8		
	10	II.	5 58 55 5		
	25	I.	6 26 32 1		
By 26 series of ☾'s distances (page 223)					6 33 48 0
By the occultation of o Sagittarius by the ☾(page 160, Vol. VI, part I.)					6 33 42 8
Longitude of Veracruz west from Paris.					6 33 40 9

Veracruz and Havanna.

		h ′ ″
Aug. 8. 1795 Em. I Sat of ♃ observed at Havanna by Don Cosme Churruca.		9 48 50 7
Observed by me at Veracruz.		8 53 45 2
Difference of longitudes.		0 55 05 5
Difference of longitudes by the cronometer.		55 02 5
Veracruz west from Havanna.	Mean.	0 55 04 0

Capital of Porto-Rico and Paris.

		h ′ ″
By 20 series of ☾'s distances (page 222)		4 33 56
By 4 series of ☾'s distances compared with the observations of the Rev Nevil Maskelyne at Greenwich, on Jan. and Feb. 1796.		4 33 42
By the occultation of *a* ♉ by the ☾. Oct. 21, 1793. (page 220)		4 33 52
Porto-Rico west from Paris.	Mean.	4 33 50

Havanna and Paris.

		Mean time. h ′ ″
Jannary 26. 1800. Emer. of I Sat. of ♃ observed at Havanna.		6 36 30
Vivier.		12 24 20
		5 47 50
Vivier east from Paris.		9 24
Havanna west from Paris.	h ′ ″	5 38 26
Veracruz west from Paris.	6 33 40 9	
Havanna east from Veracruz.	55 04 0	
Havanna west from Paris.		5 38 36 9
Porto-Rico west from Paris.	4 33 50	
Havanna west from Porto-Rico by the Cronometer.	1 4 44	
Havanna west from Paris.		5 38 34
Mean.		5 38 32 3

Natchez and Paris.

	h ′ ″
New-Orleans west from Paris by the occultation of Jupiter by the ☾ (p. 222)	6 09 46
Natchez west from New-Orleans by the Cronometer.	5 16
Natchez west from Paris.	6 15 02

Occultation of the I *Satellite of Jupiter by the moon, observed at New-Orleans by Mr. Andrew Ellicott, and at the Royal Observatory of the Island of Leon by Don Julian Ortiz de Canelas, on the* 15*th of January,* 1799.

I have sent to the American Philosophical Society the result of this occultation, which was observed the same day in the island of Leon and at New-Orleans. This determination besides being very exact, has appeared to me to merit attention, was it for no other reason than that it appears to be the first time that the longitude has been deduced from such an observation; at least I have not had any knowledge of its having been done before.

	New-Orleans.		Island of Leon.
	Immersion. h ′ ″	Emersion. h ′ ″	Immersion. h ′ ″
Apparent time.	5 41 40	7 02 34	13 25 35
Longitude west of Paris.	6 9 56	6 4 56	34 8
Apparent time at Paris.	11 51 36	13 12 30	13 59 43
Distance of the ☾ from the nonagesime.	13°07 53	3°20 12	83°26 57
Altitudes of the nonagesime.	71 23 50	77 26 30	70 24 10
Horiz. parallax. of the ☾ corresponding to the lat.—horiz. parallax of the 1 Sat.	54 58 1	55 00	55 00 0
Parallax in longitude.	12 00 4	3 10 4	31 33 4
Parallax in latitude.	18 20 3	12 40 5	18 30 8
Apparent semidiameter of the ☾—inflection.	15 13 4	15 14 0	15 01 0
Distance of the I Satellite from Jupiter.	7s 09° 5′	7s 20° 32′	

	h ′ ″	′ ″
RESULT.—Conjunction in New-Orleans.	6 34 54 1	
Difference of the latitudes at the conjunction.	22 01 2	
By the tables.	22 36 0	
Sum of the errors.	34 8	
Difference of apparent latitudes at the moment of immersion in the island of Leon.		=7 24 8
Errors of the tables according to the observations at New-Orleans.		— 34 8
Difference of the apparent latitudes at the immersion.		6 50 0

	h ′ ″	W. of Paris. h ′ ″	Greenwich. h ′ ″
Conjunction in the Island of Leon.	12 10 39		
Idem. New-Orleans.	6 34 54		
Difference of Meridians.	5 35 45	6 09 53	6 0 33
Result by the occultation of ♃	5 35 48	6 09 56	6 0 36

Note, The horizontal parallax of the moon in this calculation, as also in the calculation of Jupiter, supposes the constant equatorial 57′ 01″ 0.

Ratio of the equatorial and polar diameters of the earth as 334 : 333.

The parallax of I Sat. = horiz. parallax of Jupiter = 1″ 9

Horary motion of the moon at New-Orleans + horary geocentric motion of I Sat. of Jupiter = 30′ 37″ 6.

At the Island of Leon 30′ 37″ 7—horary motion of the Satellite during the observations, which was retrogade.

Inclination of the orbit of I Satellite. 3° 18′ 38″

Position of the node idem. 10ˢ 14 30

Passage of Mercury over the disk of the Sun, May 7th, 1799. *Calculated by Jose Joaquin de Ferrer.*

The principal object of this memoir, is to determine the longitude of Miller's Place on the river Coenecuch (Am. Phil. Trans. Vol. V. p. 197.) by the *Egress* of Mercury observed by Mr. Andrew Ellicott, Commissioner on the part of the United States to fix the line which should divide them from the Possessions of Spain.

The position of this point is interesting to Geography and Navigation, from its vicinity to Pensacola and the head of the river Perdido. According to the map of Mr. Lafon, which has this point laid down, Pensacola is 28″ of time east of *Miller's Place*, and the river Perdido 46″ of time west of *Miller's Place.* I have calculated fifteen observations of ingress and thirteen of egress observed in Europe, and comparing each of these observations with the mean determination for Paris, it appears that the greatest error in longitude has twice been at 8″ of time. The errors of the mean of the observations of the time of the ingress and egress, seems to be within 3″, as may be seen in the table. Mr. Ellicott's observation appears worthy of the utmost confidence and he says that the exterior contact is within the limits of half a second. By the European observations it will be seen, that the time employed by the diameter of Mercury in the egress = 3′ 02″, 1 and according to Mr. Ellicott's observations = 3′ 05″, 5 which proves that both contacts were well observed: taking the mean, the uncertainty appears to be 1″ 7 and, all circumstances considered, the error of longitude can scarcely equal 6″ of time.

From the new tables of Mr. Lalande.

	h ′ ″
Conjunction in the ecliptic.	1 04 36
☉'s true longitude from the mean equinox.	46 54 17 3
☿'s Helioncentric latitude. S.	5 47 470
☉'s aberration =—19″ 80 ; nutation	=—12″ 6
☿'s aberration in longitude. =+ 6 85 ; aberration in latitude	=— 3 28
☉'s horary motion.	144 926
☉ and ☿ relative geocentric horary motion in the interval between the ingress and egress.	235 926
☿'s horary motion in latitude.	43 607
☉ and ☿'s relative horary motion between the ingress and the time of the conjunction.	235 866
———between the egress and the conjunction.	235 984
☿'s horizontal parallax—☉'s horizontal parallax at the time of the ingress	7 089
do. do. egress	7 109
Equation of time at the ingress.	—3 43 0
do. egress.	—3 44 2
½ diameter of the sun.	15 51 8

Observations made in Europe, May 7th, 1799. *Mean time*

	Limb.	Ingress of ☿ h ′ ″	Egress of ☿ h ′ ″	′ ″	′ ″
Mr. de Lambre. Paris.	1	21 17 09 6	4 38 04 4	3 00 2	3 00 9
	2	21 20 09 8	4 41 05 3		
Mr. Mechain. Paris.	1	. . . . .	4 38 20 0	. . . .	2 59 0
	2	21 19 52 7	4 41 19 0		
Mr. Messier. Paris.	1	21 16 41 0	4 38 22 0	3 10 0	3 08 0
	2	21 19 51 0	4 41 30 0		
Island of Leon.	1	. . . . .	4 03 58 3		
	2	20 46 06			
Marseilles.	1	. . . . .	4 50 26		
	2	21 32 11			

	Limb.	Ingress of ☿ h ′ ″	Egress of ☿ h ′ ″	′ ″	′ ″
Mirepoix.	1	21 15 24	4 36 15	2 46	2 50
	2	21 18 10	4 39 05		
Berlin.	1	22 00 28	5 22 17	3 18	3 13
	2	22 03 46	5 25 30		
Naples.	1	22 04 03 6	5 25 20	3 14	3 21
	2	22 07 17 6	5 28 41		
Bremen.	1	31 42 34 3	5 03 57	2 05 7	
	2	21 45 40 0			
Hamburg.	1	. . . . . .	5 08 39		
	2	21 50 02			
Dresden.	1	22 02 12	5 23 37	3 00	2 57
	2	22 05 12	5 26 34		
Messersdoff.	1	. . . . . .	5 31 16		3 08
	2	22 12 37	5 34 24		
Gotha.	1	21 50 11	. . . .	3 03	
	2	21 53 14 2	. . .		
Lilienthal.	1	21 42 52 7	. . .	2 53 9	
	2	21 45 46 6	. . .		
Madrid.	2	20 56 00 0			
Dantzick.	1	. . . . . .	5 43 18		
Breslaw.	1	. . . . . .	5 36 51	. . . . .	3 01 0
	2	22 15 15	5 39 52		
			Mean.	3 03 7	3 04 0

Mean of the best observations. . . . . . . 3′ 02″ 2

Time of the passage of the ½ diameter of ☿ 1 31 1

	h ′ ″
By the mean result of three observations for the meridian of Paris, the Ingress reduced to the center of the earth was. . . .	21 17 41
the Egress.	4 41 18
Duration.. . .	7 23 37

Semidiameter of the ⊙=950″ $\ominus$=10° 28′ 18″

		° ′ ″	
l=Appt. latitude of ☿ for the center of the earth at the Ingress	=	173 44	by observ
l′= ditto ditto Egress.	=	495 84	ditto.
E=Elongation at the Ingress.	=	934 034	ditto.
E′= ditto Egress. . . , . . .	=	810 226	ditto.
$\ominus$=Inclination of the orbit at the Ingress.	=	10 27 55	
$\ominus$′= ditto . . Egress.	=	10 28 40	
h=Horary relative motion at the Ingress.	=	235 818	
h= ditto . . Egress.	=	236 026	

$a = \frac{3600}{235\ 818}$ $a' = \frac{3600}{236\ 026}$

P=Parallax in longitude. Q= ditto latitude.

π =Coefficient of the Parallax in longitude at the Ingress.

Π= ditto. latitude Ingress.

π′= ditto. longitude Egress.

Π′= ditto. latitude Egress.

$$\pi = \frac{E}{E + l.\ \text{tang.}\ \ominus} \times a = 15{,}8072$$

$$\Pi = \frac{l}{E - l.\ \text{tang.}\ \ominus} \times a = 2{,}9354$$

$$\pi' = \frac{E'}{E' + l'\ \text{tang.}\ \ominus'} \times a' = 13{,}7041$$

$$\Pi' = \frac{l'}{E' - l'\ \text{tang.}\ \ominus'} \times a' = 8{,}3865$$

Ingress for the center of the earth=apparent Ingress—15,8072 P—2,9354 Q

Egress . . ditto. . =apparent Egress —13,7041 P+8,3865 Q

TABLE.

		P	Q	d h
				′ ″
Paris.	I.	+1,716	+4,730	—0 41 0
	E.	—5,584	+3,216	+1 43 5
Island of Leon	I.	+3,266	+4,000	—1 03 4
	E.	—5,805	+1,687	+1 33 7
Marseilles.	I.	+1,987	+4,167	—0 43 6
	E.	—5,990	+2,649	+1 44 3
Berlin.	I.	+0,750	+4,700	— 25 6
	E.	—5,550	+3,855	+1 49 1
Mirapoix.	I.	+2,235	+4,370	— 50 1
	E.	—5,820	+2,540	+1 41 0
Bremen.	I.	+1,002	+4,890	—0 29 8
	E.	—5,527	+3,762	+1 47 7
Breslaw.	I.	+0,654	+4,500	—0 23 2
	E.	—5,574	+3,732	+1 45 9
Naples.	I.	+1,542	+3,620	—0 35 2
	E.	—6,337	+2,540	+1 48 1
Dresden.	I.	+0,830	+4,600	—0 26 6
	E.	—5,700	+3,670	+1 48 5
Hamburg.	I.	+1,000	+4,880	—0 29 4
	E.	—5,527	+3,762	+1 47 3
Messersdoff.	I.	+0,770	+4,500	—0 26 0
	E.	—5,740	+3,640	+1 48 5
Madrid.	I.	+2,730	+4,249	—0 55 6
Gotha.	I.	+1,006	+4,327	—0 29 3
Lilienthal.	I.	+1,002	+4,860	—0 29 8
Dantzick.	E.	—5,531	+4,047	+1 49 3

Paris.	I	E	L	I′	E′	L′	dL
	h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	″
Mess & Delambre	21 17 58	4 41 19	0 0	21 17 58	4 41 19	— 9	9
Messier.	21 17 41	4 41 34	0 0	21 17 41	4 41 34	+ 5	5
Mechain.	21 17 39	4 41 35	0 0	21 17 39	4 41 35	+ 5	5
Island of Leon	20 43 31	4 07 03	+34 08	21 17 39	4 41 11	34 15	7
Marseilles.	21 29 56	4 53 41	—12 08	21 17 48	4 41 33	12 16	8
Mirapoix.	21 15 49	4 39 27	1 51	21 17 40	4 41 18	1 50	1
Berlin.	22 01 41	5 25 42	44 10	21 17 31	4 41 32	44 10	0
Naples.	22 05 05	5 28 48	47 26	31 17 39	4 41 22	47 25	1
Bremen.	21 43 37	5 07 15	25 51	21 17 46	4 41 24	25 54	3
Dresden.	22 03 15	5 26 54	45 27	21 17 48	4 41 27	45 32	5
Breslaw.	22 16 22	5 40 09	58 51	21 17 31	4 41 18	58 44	7
Hamburg.	21 48 02	5 11 57	30 32	21 17 30	4 41 25	30 33	1
Madrid.	20 53 33		24 09	21 17 42		24 04	5
Gotha.	21 51 14		33 35	21 17 39		33 37	2
Lilienthal.	21 43 46		26 16	21 17 30		26 09	7
Dantzick.		5 46 38	1 05 15		4 41 23	1 5 13	2
Messersdoff.	22 10 40	5 34 38				53 07	
Mean.				21 17 40	4 41 25		
Mean of the best observations. . .				21 17 37	4 41 27		

NOTE.

P=parallax in longitude. Q=parallax in latitude.

d h = Reduction to the center of the earth in time.

I=Ingress of the center of Mercury corresponding to the center of the earth.

E=Egress.

L=Longitudes from the meridian of Paris, from the best authorities.

I′ and E′=Ingress and Egress for the meridian of Paris, reduced to the center of the earth.

L′=Longitudes resulting from the observations of the ingress and egress, supposing they happened in Paris 21h 17′ 37″ and 4h 41′ 27″ as appears from the best observations.

d L=Difference of longitudes of the columns L and L′ or errors of the observations in longitudes, supposing the longitudes in the column L to be exact.

Egress of Mercury by Mr. Andrew Ellicott, at Millers Place, Coenecuch River.

	° ′ ″
Latitude.	30 49 33
Corrected latitude supposing the ratio of the polar and equatorial diameters of the earth = 333 : 334	30 40 28
Interior contact 6th of May, 1799. Mean time.	22 41 19 (a)
Exterior contact. Certain to ½ second.	22 44 24 5 (a)
Mean = to the egress of the center of ☿.	22 42 51 7
Longitude from Paris by an approximated calculation.	5 58 30
Mean time in Paris May 7th.	4 41 21 7

(a) Magnifying power 200

	h ′ ″
Equation of time = —3′ 44″ 2. ☉'s right ascension =	2 58 19
Horizontal parallax of ☿ — horizontal parallax of the ☉ =	7 117
P = Parallax in longitude.	+ 1 316
Q = Parallax in latitude.	+ 2 268

	h ′ ″
Egress reduced to the center of the earth = 22 42 51 7 — 13,7041 P + 8,3865 Q =	22 42 52 7
Egress ditto. observed in Paris.	4 41 27 0
Longitude of Miller's Place west from Paris.	5 58 34 3

Pensacola 28″ time east from Miller's Place.
Rio Perdido 46 do. west from Miller's Place.

	h ′ ″ ″	h ′ ″		° ′ ″
Pensacola west from Paris	= (5 58 34 3 — 28)	= 5 58 06	latitude	30 24 00
Source of Rio Perdido.	= (5 58 34 3 + 46)	= 5 59 20		30 42 00
Miller's Place.		5 58 34 3		30 49 33

	h ′ ″		° ′ ″
Pensacola west from Greenwich.	5 48 46	=	87 11 30
Rio Perdido.	5 50 00	=	87 30 00
Miller's Place.	5 49 14 3	=	87 18 30

Determination of the tabular error in latitude, by observations of distances of limbs, observed at the observatory of the Island of Leon with a heliometre and reduced to the diameter of the sun 31′ 43″ 6. The observations published in the nautical almanac of the Island of Leon are made before and after the apparent conjunctions.—It is to be observed, that the distance stated 1^h 38′ 16″ involves without doubt an error of the press, of 20″, which is easily noticed by a comparison with the other distances. To compare the observations with the Tables, I have calculated the following table of the parallaxes of longitude and latitude.

Appt. time in the Island of Leon. h ′ ″	Par. in Long. ″	Par. in Lat. ″
22 00 00	+2 02	+3 29
23 00 00	+0 74	+2 75
00 00 00	−0 66	+2 27
1 00 00	−2 11	+1 90
2 00 00	−3 49	+1 67
3 00 00	−4 70	+1 58
4 00 00	−5 67	+1 66

	h ′ ″	h ′ ″
Mean of three series of of observations; apparent time .	23 44 09	2 07 25
Eqn. of time=−3′ 44″ diff. of mer. 34′ 08″ mean time in Paris.	00 14 33	2 03 41
Distance of the centers of ☉ & ☿ by the mean of three observs.	6 25 00	0 8 44 3
Parallax in longitude	−0 27	−3 62
Parallax in latitude	+2 40	+1 66
Latitudes by the tables	5 07 82	6 51 56
Difference of apparent longitudes.	566 80	
Idem. latitudes	103 40	
Inclination of the apparent orbit=10° 20′ 19″		
Chord	576 155	
Angle of conjunction at 23h 44′ 09″ = 52° 05′ 48″		
Apparent conjunction for the center of the earth in mean time.		

	h ′ ″
In the Island of Leon . . .	0 40 38
In the Ecliptic	0 33 52
Corresponds at Paris to	1 08 00
Correction of the tables in latitude . =	6 4

These observations are more proper to determine the latitude than the conjunction, on account of being very near the apparent conjunction.

Four series of observations (the most to be depended upon) made in the Island of Leon, give the following mean results.

	h ′ ″		h ′ ″
Conjunction in the Ecliptic.	0 33 52 0 34 12 0 34 16 0 34 02	Mean. Longitude	0 34 02 0 34 08
Conjunction in the ecliptic for Paris by the observation of distances.			1 08 10
Error of the tables in latitude =	− 6″ 4 − 7 0 − 6 0 − 6 0	Mean =	− 6″ 3

Mr. Messier found the nearest distance of the centers . . = 5′ 45″
and the diameter of the ☉ . . = 15 56

The distances of the limbs should have been observed 10 11

$$\text{Distance of the limbs} = \frac{31'\ 43''\ 6 \times 10'\ 11''}{32'\ 56''} = 10'\ 08''\ 31$$

½ Diameter of the ☉ . . . = 15 51 80

Apparent distance of the limbs . . = 5 43 45

At Berlin the observed nearest distance, corrected from the influence of refraction and parallax, was . . . . . 5′ 40″ 33
(Mem. of the R. Academy of Berlin.)

By the above data we find the following error of the tables in latitude.

By the observation of Mr. Messier	— 5″ 77
Idem. at Berlin.	— 5 77
Idem. in the Island of Leon.	— 6 30
Mean error.	—5 8

Determination of the diameters of the Sun and Mercury, conjunction in the Ecliptic and error of the tables in longitude.

		h ′ ″
Ingress at Paris for the center of the earth, from the mean of the observations most to be depended upon		21 17 37
	Egress.	4 41 27
	Duration.	7 23 50

Difference of apparent elongations	= 1745″ 18
Apparent latitude of Mercury by the tables at the ingress	179 31
Correction in latitude	— 5 80
Apparent latitude of ☿	173 51

		° ′ ″
Inclination of the orbit		10 28 18
Chord		1774 643
Hence nearest distance of the centers	=	5 40 44
Angle of conjunction at the ingress.	=	79 28 52
½ Diameter of the sun resulting from above		15 50 34

$$\text{Logarithm} = \frac{\text{distance of the} \odot \text{ at the time}}{\text{Apogee—distance of the} \odot} = 9{,}9971062$$

Apogee diameter of the ⊙, resulting therefrom . . = 31′ 28″ 0
Time employed by the diameter of Mercury in the ingress and egress. = 3 01 1
Logarithmic distance of Mercury at the conjunction. = 9,74550
Hence the diam. of ☿ reduced to the mean distance of the earth from the ⊙ = 6″ 2988
Apparent elongation at the ingress . . = 934 416
Aberration of the ⊙—aberration of ☿ . = 26 662

Elongation in the ecliptic 907 775
Conjunction in the ecliptic; mean time of Paris . . . . =1h 08′ 32″
Geocentric latitude of Mercury, corrected from aberration . = 5 44 55
Correction of the tables to the longitude of Mercury supposing the longitude of the ⊙ to be exact. . . =+ 15 52
Longitude of the ⊙ from the mean equinox at the conjunction. = 1 16 54 26 7 =
Heliocentric longitude of Mercury 7 16 54 26 7

No. XXXVIII.

Continuation of the Astronomical Observations made at Lancaster, in Pennsylvania, by Mr. Andrew Ellicott.

Read October 18th, 1805.

☞ *Note:*—The eclipses of Jupiter's Satellites were all observed with an achromatic telescope magnifying about 100 times.

1804. *March 11th.* Immersion of the 2d satellite of Jupiter observed at $12^h\ 9'\ 11''$ mean time, *night clear.*

May 13th. Emersion of the 1st satellite of Jupiter observed at $8^h\ 30'\ 20''$ mean time, *night clear.*

20th. Emersion of the 1st satellite of Jupiter observed at $10^h\ 25'\ 14''$ mean time, *night clear;* but from the proximity of the moon to the planet, it is probable that the emersion was observed 9 or 10 seconds too late.

22d. Emersion of the 3d satellite of Jupiter observed at $9^h\ 45'\ 50''$ mean time, *night clear.*

June 5th. Emersion of the 1st satellite of Jupiter observed at $8^h\ 43'\ 1''$, mean time, *a little hazy.*

28th. Emersion of the 1st satellite of Jupiter observed at $8^h\ 56'\ 5''$ mean time, *a little hazy.*

July 4th. Emersion of the 3d satellite of Jupiter observed at $9^h\ 37'\ 56''$ mean time, *a little hazy.*

1805, *January 14th.* Observations on a lunar eclipse.

☽'s limb began to be obscured at	13^h	$45'$	$42''$	Mean time.
Indented at	13	48	0	
Totally eclipsed at	14	44	43	

The end of the eclipse, and of total darkness. could not be observed on account of a snow storm.

April 30th. Immersion of the 1st satellite of Jupiter observed at $10^h\ 54'\ 23''$ mean time, *night clear.*

June 1st. Emersion of the 1st satellite of Jupiter observed at $9^h\ 37'\ 19''$ mean time, *night clear.*

2d. Emersion of the 2d satellite of Jupiter observed at $9^h\ 19'\ 3''$ mean time, *night clear.*

26th. Observations on the beginning of a solar eclipse.

The afternoon was remarkably clear and serene, but the sun being low, his limb was very tremulous, though not so much so as to occasion an error of more than 5 or 6 seconds.—My eye was directed to the precise spot where the eclipse began, which was observed at 6^h 45′ 48″ mean time, or 6^h 43′ 26″ apparent time.

The beginning of this eclipse was observed by Mr. Patterson in Philadelphia, at 6^h 47′ $40\frac{1}{2}$″ apparent time.

The longitude of Lancaster by the above eclipse appears to be 5^h 4′ 19″ west from Greenwich, which is 47″ less than I have stated it from the result of a considerable number of the eclipses of Jupiter's satellites, and some lunar distances.—The longitude of the city of Philadelphia, by the same eclipse as observed by Mr. Patterson, appears to be 4^h 59′ 33″ west from Greenwich; which is about 1′ 4″ less than it has been settled by a great number of corresponding observations made there, and at the royal observatory of Greenwich. This difference, no doubt principally arises from the imperfection of the lunar theory, and probably much the greater part of it from the errors in the moon's latitude.

July 4th. Emersion of the 2d satellite of Jupiter observed at 8^h 55′* 4″ mean time, *night clear*.

10*th*. Emersion of the 1st satellite of Jupiter observed at 8^h 9′ 6″ mean time, *twilight very strong*.

11*th*. Emersion of the 2d satellite of Jupiter observed at 11^h 29′ 38″ mean time, *night clear*.

17*th*. Emersion of the 1st satellite of Jupiter observed at 10^h 4′ 16″ mean time, *night clear*.

26*th*. Emersion of the 3d satellite of Jupiter observed at 8^h 22′ 39″ mean time, *twilight very strong*.

August 2d. Emersion of the 1st satellite of Jupiter observed at 8^h 23′ 9″ mean time, *twilight very strong*.

2*d*. Immersion of the 3d satellite of Jupiter observed at 10^h 5′ 5″ mean time, *night clear*.

9*th*. Emersion of the 1st satellite of Jupiter observed at 10^h 18′ 20″ mean time, *a little hazy*.

September 6th. Emersion of the 2d satellite of Jupiter observed at 8^h 18′ 9″ mean time, *very clear, but the planet tremulous*.

* The person who noted the time, had some doubts whether this should not be 54′.

7th. Emersion of the 3d satellite of Jupiter observed at 8^h 23′ 15″ mean time, *very clear.*

By Mr. Delambre's tables, the longitude of Lancaster as deduced from each of the foregoing observations on the eclipses of Jupiter's satellites will stand as follows.

						Longitude West from Greenwich. h ′ ″
1804.	March	11th.	Immersion of the	2d	satellite	5 3 58
	May	13th.	Emersion of the	1st	ditto.	5 5 36
		20th.	ditto.	1st	ditto.	5 5 15
		22d	ditto.	3d	ditto.	5 5 9
	June	5th.	ditto.	1st	ditto.	5 5 20
		28th.	ditto.	1st	ditto.	5 5 11
	July	4th.	ditto.	3d	ditto.	5 5 0
1805.	April	30th.	Immersion of the	1st	ditto.	5 5 32
	June	1st.	Emersion of the	1st	ditto.	5 5 43
		2d.	ditto.	2d	ditto.	5 4 51
	July	4th.	ditto.	2d	ditto.	5 4 36
		10th.	ditto.	1st	ditto.	5 5 55
		11th.	ditto.	2d	ditto.	5 5 11
		17th.	ditto.	1st	ditto.	5 5 45
		26th.	ditto.	3d	ditto.	5 4 34
	Aug.	2d.	ditto.	1st	ditto.	5 5 53
		do.	Immersion of the	3d	ditto.	5 2 54
		9th.	Emersion of the	1st	ditto.	5 5 50
	Sep.	6th.	ditto.	2d	ditto.	5 5 22
		7th.	ditto.	3d	ditto.	5 4 42

No. XXXIX.

A Description of a Cave on Crooked creek, with Remarks and Observations on Nitre and Gun-Powder, by Samuel Brown, M. D. of Lexington, Kentucky.

Read February 7th, 1806.

THERE are few works on Natural History or Chemistry which do not contain some facts or opinions concerning the formation and properties of nitre. To recapitulate these facts, or to state the various theories to which they have given rise, would be a task very different from that which I have undertaken; which is merely to communicate a short account of some of the most remarkable caverns and rocks from which that salt is obtained in Kentucky; and to offer some conjectures relative to the causes of the imperfection of the gun-powder manufactured in the United States.

The quality of the nitre procured from the earth in calcareous caverns, is universally believed to be different from that which is found in the sand rocks. I have not been able to ascertain, with any degree of precision, the quantity annually manufactured in this State, nor the number of caverns which are known to contain it. I have however visited several of the most remarkable of them and from the best information I could procure I have formed the following estimate.

	℔ of Nitre.
The great cave on Crooked creek, a branch of Rock castle, supposed to contain - -	1000000
Scott's cave, two miles distant from the great cave	200000
Davis's cave, six miles distant from the great cave	50000
Two other caves, within a mile of the great cave	20000
A cave on Rough creek, a branch of Green river	10000

Besides these, which I have had an opportunity of examining, I have heard of many others in various parts of the State; some of which are esteemed very rich in nitre, and are said to be of great extent.

The great cave on Crooked creek in Madison county, is situated about 60 miles south east of Lexington. It has two mouths which are 646 yards distant from each other, and about 150 yards from a large creek, which winds round the hill through which the cave affords a commodious passage for horses and waggons. The general level of the floor of the cave is 80 feet above the creek. The average height of the arch is ten feet, though in many places it rises to fifty or sixty. The breadth of the passage is generally about forty feet, in some parts it is seventy or eighty feet. The floor has the appearance of a large public road, which has been much frequented. The ceiling is in most places smooth, with but few incrustations or stalactites. In some of the chambers however there are appearances of Gothic rudeness and irregularity which are truly sublime. When these vast chambers are sufficiently illuminated by the torches and lamps of the workmen, they present scenes so uncommon and so romantic, that the most stupid beholder cannot contemplate them without expressions of the greatest astonishment. During the winter season the effect of these scenes is greatly increased by a stream of water which issuing from a small opening in the arch of the cave, about twenty feet above the floor and falling into a bason, occasions a noise which in these calm regions can be heard at great distance, and echoing from arch to arch, fills the mind with the idea of some mighty cataract*.

The temperature of this cave, during the last winter (the coldest we have had for several years) was generally 52° of F. sometimes the mercury rose as high as 57° but never sunk to the freezing point, when the thermometer was placed at any considerable distance within the cave. In one chamber however, the heat was frequently so great as to be disagreeable. About sixty paces from the south entrance, a passage leading from the main avenue conducts you to this chamber, which is nearly circular and about twenty feet in diameter. The arch over this part of the main avenue and that over the passage leading to the warm chamber, are equally elevated. But the ceiling of the chamber is twenty or thirty feet higher. As you approach the chamber, the floor gradually rises until it ascends above the level of the arch of the passage. As soon as you ascend above that level, you perceive the air uncommonly warm, even when the temperature of the passage is near the freezing point. The air which fills the main avenue in summer and autumn is forced into this chamber, whenever the external atmospheric air becomes so much condensed by cold as

* This cave was discovered about seven years ago by a Mr. Baker. He entered it by the north mouth, but proceeded only a small distance into it, on the succeeding day he brought his wife and two or three of their children to explore it, he carried a torch and his wife a supply of pine. After they had advanced within hearing of this torrent 400 or 500 yards from the north mouth, the only one then known, he dropped his torch and it was completely extinguished. During two days and two nights this miserable family wandered in total darkness, without provisions and without water, though sometimes within hearing of a cataract which they durst not approach, at length Mrs. Baker in attempting to support herself on a rock, perceived that it was wet, she conjectured that this was caused by the mud which they had brought in on their feet, Baker immediately ascended the rock, and saw the light of day.

to rush into the mouth of the cave; and whenever during the winter, any portion of air in the main avenue, where the passage leads off, is accidentally heated by fires, or by carrying torches or lamps through the cave, as this heated air cannot escape by the mouth of the cave (for the arch descends towards the mouth) it ascends into this chamber, and rises to the ceiling, where it must remain until the external air and that in the passage and avenue acquire a higher temperature than the air in the chamber. This chamber then is constructed precisely upon the principles of the Russian vapour bath, so minutety described by count Rumford.

During the winter season, the walls and floor of this cave remain perfectly dry; but in summer, innumerable drops of water collect upon the rocks and trickle down upon the floor which sometimes becomes as moist as a bed of mortar. This is particularly the case during very hot weather when the atmosphere is loaded with vapours. I collected a quantity of the liquid condensed upon the rocks, and found that it possessed the same properties with the liquor obtained by lixiviating the earth on the floor of the cave. It would appear from this fact, that the nitric acid is formed in the cave and is condensed upon the rocks, the lime of which it dissolves. But in what manner this nitric acid is formed, I confess myself wholly ignorant, as there are no substances in a state of putrefaction within the cave which could yield the requisite supply of nitrogene gas. It is to be remarked, that the whole of the water condensed upon the rocks, does not taste of the nitrate of lime. A great part of it is quite insipid, although dropping upon earth which is rich in nitre, and many parts of the cavern have been found so completely filled with clay, that it is not easy to conjecture how it was possible for atmospheric air to reach them, and this clay too, is strongly impregnated with nitrate of lime. The depth of the earth on the floor of this cave has never yet been ascertained. In some places the workmen have dug down fifteen feet and the earth even at that depth still contains nitre. It is commonly supposed that throughout the cave, every bushel of earth contains at least one pound of nitre. In many places it will yield more than two pounds to the bushel. Formerly the earth was taken out of the cave and lixiviated near the stream, at present hoppers are erected in the cave, and the earth after lixiviation, is left to be impregnated again with nitrate of lime; but what length of time will be requisite to saturate it, has not yet been ascertained.

The workmen have different modes of forming an opinion with regard to the quantity of nitre with which the earth may be impregnated. They generally trust to their taste; but it is always considered as a proof of the presence of nitre, when the impression made on the dust by the hand or foot, is in a very short time effaced. Where the nitre is very abundant the impression made to-day, will be scarcely visible to-morrow. Where there is a great deal of sand mixed with the dust, it is commonly believed that a small quantity of pot-ash will suffice for the saturation of the acid.

The method of making saltpetre usually practised in Kentucky, is as follows.

The earth is dug and carried to hoppers of a very simple construction, which contain about fifty bushels, cold water is poured on it from time to time, and in a day or two a solution of the salts runs into troughs placed beneath the hoppers. The lixiviation is continued as long as any strength remains in the earth. The liquor is then put into iron kettles, and heated to ebullition; it is afterwards thrown upon a hopper containing wood ashes, through which it is suffered to filtrate. As the alkaline part of the ashes is discharged before the nitrate passes through, the first runnings of this hopper are thrown back; and after some time, the clear solution of nitrate of pot-ash runs out, mixed with a white curd, which settles at the bottom of the trough. This clear liquor is boiled to the point of crystallization, then settled for a short time and put into troughs to crystallize, where it remains twenty-four hours, the crystals are then taken out, and the mother-water thrown upon the ash-hopper, with the next running of the nitrate of lime. When the quantity of the nitrate of lime is too great for the portion of ashes employed, the workmen say their saltpetre is in the "*grease*" and that they do not obtain a due quantity of nitre. If there has been too great a proportion of ashes employed, they say it is in the "*ley,*" and when it is left to settle previous to crystallization, a large quantity of salt will be deposited in the settling troughs, which they call "*cubic salts,.*" These salts are again thrown upon the ash-hoppers and are supposed to assist in precipitating the lime from the nitrate of lime, and in the opinion of the workmen, are changed into pure saltpetre. They consider this salt as nitre *killed,* as they express it, by the excessive strength of the ley. To make 100 pounds of good saltpetre at the great cave, eighteen bushels of oak ashes are necessary; ten of elm, or two of ashes made by burning the dry wood in hollow trees. In the discovery of the value of this latter kind of ashes, the philosophers and chemists of Europe have been anticipated by the saltpetre-makers of Kentucky.* The earth in some caves does not require half this quantity of ashes to precipitate the impure salts.

When wood ashes cannot be readily obtained near the caves, the liquor which runs from the earth in the hoppers is boiled down to the point of crystallization, and suffered to become solid by cooling. In this form, which is called "*thick stuff,*" it is transported to a part of the country, where ashes can be procured, dissolved in ley sufficiently strong to precipitate the lime, settled in troughs and then boiled down and crystallized. This thick stuff is extremely liable to deliquesce in warm moist weather, and is therefore commonly melted down and put into casks before it is carried from the caves. Horned cattle are very fond of it, and a small portion of it is almost instantly fatal to them. Those who have had frequent opportunities of seeing cattle perish in this way, remark that the blood when drawn from their veins, is of a very black colour, and flows with great difficulty. A substance possessing such active properties, might deserve the attention of experimental physicians, and may possibly merit a share of that praise which has been so liberally and perhaps so injudiciously bestowed upon the nitrate of pot-ash.

After these observations on the calcareous nitre beds in Kentucky, and the modes commonly employed for obtaining that salt, I shall mention some of the most remarkable circumstan-

* See Vol. X. p. 330. Philosophical Magazine.

ces which have come to my knowledge, relative to the rock ore or sand rocks which yield nitre supposed to possess peculiar qualities.

These sand rocks are generally situated at the head of a ravine or narrow valley, lead up a steep hill or mountain: ascending the streamlets which run through these valleys, the banks close in upon you and become perpendicular. The rocks are frequently from sixty to one hundred feet in height, and jutting over their bases, which rest on a calcareous stratum, often form a shelter large enough to secure a thousand men from the inclemencies of the weather. During the winter season a small rill is precipitated from the top of these rocks, and in summer water generally issues from between the silicious and calcareous strata. These sand rocks which probably once formed a complete upper stratum, have been for ages exposed to the destructive operations of rains and frosts, and as they crumble off are carried by torrents into the plains and rivers beneath. The summits of all the hills in the vicinity of Rock castle, Licking and Sandy are still covered by masses of these rocks, which from their beauty and variety of figure, might at a small distance be mistaken for the ruins of Gothic cathedrals or Baronial castles. Vast blocks of them have rolled down into the valleys, at a period of time so remote, that they are now covered by trees of a luxuriant growth. These rocks when broken perpendicularly, present a surface consisting of strata so irregular, with regard to their position, and so different in colour and in the size of the particles of sand, that it is impossible to doubt of their Neptunian origin. The minute inspection of them never fails of awakening in the mind the recollection of the shore of some vast lake, where the rage of the winds and the waves has piled up hills of sand, which time consolidates into rock.

Several years ago the saltpetre-makers discovered that the sand and rubbish sheltered from rains by these rocks contained a rich impregnation of nitre, and that only a small portion of ashes was necessary for its purification. They soon after found that the sand rock itself tasted strongly of saltpetre, and immediately commenced the new method of working.

After blowing off large blocks of the rock, they break them into small pieces with hammers, and throw them into kettles containing boiling water; as soon as the rock falls into sand by the action of the hot water upon it, they put it into hoppers and wash out all the nitre by frequent additions of cold water, this solution is boiled down and crystallized without any mixture of ashes or pot-ash. Sometimes when the mother-water has been very often added to fresh solutions of the nitre, they find it necessary to use a very small quantity of ashes.

I have been informed by a Mr. Fowler, that he and his associates have made saltpetre at twenty-eight different rock houses or caverns, from which they have obtained about 100000 pounds of nitre, all these are situated on the north side of Kentucky river, within seventy miles of Lexington. He remarks that he has never seen a rock facing the north or west, which was very rich in nitre. He has always desisted from working a rock when it failed to yield him ten pounds to the bushel of sand. He has often obtained twenty or thirty pounds per bushel. He assured me that he once discovered a mass of very pure nitre, which was found to weigh 1600 pounds. Mr. Foley, another saltpetre-maker, found one containing 100 pounds; another mass was found on Rock castle, which report says weighed 500 pounds. I have now in my possession a solid mass of native nitrate of pot-ash of singular purity, which weighs three pounds, it is more than four inches in thickness, and is only a small portion of a block of nitre found last summer on Licking river, I have likewise a number of smaller specimens, which I myself procured from the different caves which I visited some weeks ago. These are generally found between the rocks which have fallen from the cliff, or the crevices of those rocks which still remain in their primitive situation. The rocks which contain the greatest quantity of nitre are extremely difficult to bore, and are generally tinged with a brownish or yellow ocre colour. Sometimes they contain an oxide like manganese, and sometimes great quantities of iron ore, which resembles the bark of the scaly bark hickory, surrounded by a finely powdered brown oxide. At some of these rock houses three hands can make one hundred pounds of good nitre daily, but forty pounds may be considered as the average product of the labour of three men at those works which I had an opportunity of visiting.

The workmen being badly provided with tools and apparatus, desert a rock whenever its size or hardness renders it difficult for them to manage it, and go in quest of a new establishment. Several caves and rocks which these strolling chemists have deserted, still contain many thousand pounds of nitre. These men are continually searching for masses of pure nitre, or rich veins of ore, by which much of their time is unprofitably dissipated. Still however most of our saltpetre-makers find it their interest to work the sand rock rather than the calcareous caverns, which last yield a mixture of nitrate of pot-ash and nitrate of lime. The rock saltpetre is greatly preferred by our merchants and powder-makers, and commands a higher price.

Mr. Barrow, in his travels through the southern parts of the continent of Africa, discovered native nitre, which is probably similar to the rock saltpetre of Kentucky. But Bowles, Dillon and Townshend assure us that those districts in Spain, which afford nitre most abundantly, contain neither chalk, limestone, gypsum, nor any other calcareous substance. The nitrate of pot-ash is obtained there by filtrating a certain kind of black mould which will continue for ages to yield annual supplies of it, together with muriate of soda, sulphate of magnesia, nitrate and sulphate of lime. Here then appears to be such a relation existing between the different saline substances, both acids and alkalies, that the causes which produce one of them, owing to some yet undiscovered circumstance, regularly produce all the rest. According to these authors the same mould will continue forever to yield these salts annually. This observation if correct, would induce us to believe, that both acids and alkalies are wholly formed from atmospheric air and not from the soil; as the soil would certainly be exhausted if any considerable portion of it entered into the composition of either the acids or alkalies, and would soon lose its power of attracting from the air the other constituent principles of the salts. Both in Spain and India, we are informed, that the mould which for fifty years in succession has yielded nitre, still continues to afford it in undiminished quantities. But how shall we reconcile this fact with that before related concerning the production of nitre in the cavities of calcareous mountains which are, in many instances, so closely filled up with clay, that the air can have no access, from which every ray of solar light is excluded, and where the temperature can never exceed 57° of Fahrenheit? Is it absolutely certain, that nitre formed by natural processes so very dissimilar, possesses no properties necessarily resulting from the circumstances attendant on its formation? That all the nitrates of pot-ash with which we are acquainted, have certain properties in which they agree, is unquestionable, but the same may be said of lime and barytes, of soda and pot-ash, and many other substances, which in the early ages of chemical science, were probably identified. Hoffman, long ago proved, that nitrate of pot-ash afforded an alkali very different from that of wood ashes or salt of tartar. The observations of so distinguished a philosopher deserve much attention, and his experiments if repeated by modern chemists could scarcely fail of affording important results: that the sand rock saltpetre differs from that procured from the calcareous caverns, in the form of the crystal, in hardness and dryness, is known to all who deal in that article, and every powder-maker affirms that it makes better gun-powder. Whether this superiority is owing merely to its greater purity or exemption from an admixture of nitrate of lime, or whether the constituent acid and alkali are modified in some unknown manner, is yet altogether problematical. Chaptal, Thouverel, Guyton, and indeed most of the modern chemists, suppose, that pot-ash is a compound of lime and hydrogen, and that lime itself is formed of carbon, azote and hydrogen, and consequently that pot-ash consists of hydrogen, carbon and azote. Mr. Guyton thinks that soda is composed of magnesia and hydrogen, and that magnesia is a compound of lime and azote, and therefore, that soda is made up of hydrogen, carbon and azote. He is then of opinion that pot-ash, soda, lime and magnesia are nothing more than varied forms and proportions of the same constituent ingredients, differing from each other in the quantities and forces of attraction. This opinion derives great probability from an experiment of Bishop Watson, by which it would appear, that soda was actually converted into pot-ash. It is likewise corroborated by the apparent conversion of lime and soda into pot-ash in our calcareous caverns, and by the change of what the workmen call *cubic salts,* into nitrate of pot-ash. Thouverel affirms that he witnessed the real conversion of washed chalk into pot-ash, in his experiments on nitrous vapours, and Chaptal observed the same phenomenon when exposing chalk to the vapours of putrid bullock's blood. Now as the nitric acid combines readily with lime, soda and magnesia, as well as with pot-ash, it may be easily conceived, that it still retains its affinity for those substances, in every form which they may assume, whilst changing into each other, and that the "*tertium quid*" formed by the union of nitric acid and lime *in the intermediate stage between lime and pot-ash,* may possess properties very different from nitrate of lime or nitrate of pot-ash. The same may be remarked with regard to soda and magnesia. Here every chemist will recollect the ingenious observations of Dr. Mitchel, concerning nitric acid and the essential differences between that substance and septic acid at the moment of its formation. No person can doubt of the possibility of charging nitrogene with different portions of oxegen. The explosive efficient property of nitre may depend on a certain dose of this principle. But even admitting that pot-ash and nitric acid never vary in their nature, it may still be contended, that powder-makers have no means of ascertaining what proportion of acid and alkali that nitre ought to contain, which would form the best gun-powder. And whilst this is confessed, it surely can avail us little, to be very scrupulous in the adjustment of the proportions of the nitre to the charcoal and sulphur. The consumers of pot-ash, in every part of the world have remarked varieties in the quality of the salt, for which no particular cause can be assigned. It is very much to be regretted, that a regular series of experiments has never been instituted, to discover what kind of ashes would yield an alkali most proper for the formation of nitre. Charcoal should be examined with a similar view. Mr. Coleman has published experiments and remarks on this subject, (Philosophical Magazine, V. IX. p. 355.) which appear to me very interesting. By his mode of distilling wood in iron cylinders, he deprives it completely, of all the volatile oil, hydrogenous gas and pyroligneous acid. The charcoal prepared in this way, possesses uniformly the same properties, and by the employment of it, the powder now used in the British ordnance, is increased in strength one third.

The gun-powder manufactured in the United States, is said to be defective, from a disposition either to effloresce or deliquesce. The salts most liable to effloresce are such as have soda for their base. In many of our saltpetre caves, small quantities of the sulphate of soda have been discovered, which for want of sufficient care or skill in refining, are suffered to remain with the nitre. The disposition to efflorescence appears to be directly opposite to that of deliquescence; as in the one case, the air has a stronger affinity for the water of combination of the salt than that which exists in the salt for the water; in the other case the salt attracts moisture from its combination with air. It would seem then, that, as the air is capable of depriving the sulphate of soda of its water of combination, and as nitrate of lime attracts moisture from the surrounding air, it is possible, that a mixture of these two salts may be so made with nitrate of pot-ash, that the nitrate of lime may deprive the sulphate of soda of its water of combination, and in consequence of this addition of water, deliquescence may ensue, even when the atmospheric air and moisture are excluded. If Count Rumford is correct in supposing that the explosive force of gun-powder depends not upon the evolution of permanently elastic fluids or gases; but upon the almost instantaneous conversion of the water of combination existing in the powder, into steam by the caloric resulting from its inflammation; this explosive force may be diminished for want of that water which might have escaped by *efflorescence*, or on account of the slow combustion of the powder consequent on *deliquescence*.

A concern for the glory and defence of our country should prompt such of our chemists as have talents and leisure to investigate this interesting subject. In 1776, at the request of

M. Turgot, the celebrated M. Lavoisier was appointed superintendant of the French national powder works, and with what success he executed the duties of his important commission the history of their subsequent naval campaigns have sufficiently evinced. The efforts of European chemists, seem to have been principally directed to the removal of the marine salt which the nitre of Spain and India contains in great quantities. In the nitre of Kentucky, I have never detected a particle of that salt, and I am confident, that if any is found in it, the proportion must be very inconsiderable indeed. The rock saltpetre I am persuaded, would, with very little refinement, make gun-powder capable of retaining its efficient properties during the longest voyages, as I have never discovered, in that species of nitre, the smallest tendency either to deliquescence or efflorescence.

It will be observed, that I have not in this paper, hazarded any opinion with regard to the formation of nitre in our sand rocks. I freely confess that I have no theory on that subject which is satisfactory to my own mind, I am even disposed to suspect, that our greatest chemists have still much to learn with regard to this salt, so valuable in time of peace, so indispensable in time of war.

No. XL.

An Essay on the vermilion colour of the blood, and on the different colours of the metallic oxides, with an application of these principles to the arts. By Samuel F. Conover M. D.

Read June 20th, 1806.

On the Vermilion colour of the blood.

THESE subjects have excited the attention of some of the most eminent philosophers of the last and present century, though little progress was made in the explanation of these phenomena, previously to the institution of the *pneumatic philosophy*, when truth burst forth upon mankind, dispelled the errors of former ages, and rendered plain and easy the path to the temple of science.—The ancient philosophers, seem to have entertained very incorrect ideas of the cause of the *red* colour of the blood, and I believe it was very little understood, before the celebrated Priestley Lavoisier and Scheele discovered *oxiginous gas, or vital air;* since that memorable period, many and various have been the opinions adopted on the vermilion colour of the blood, and each one has had its votaries.

It has been proved by a variety of experiments made by these eminent chemists, that atmospheric air, is a mixture of oxigene and azotic gases, in the proportion of twenty-five parts of the former, and seventy-five parts of the latter. Priestley, Cigna, Hewson, Thouvenel and Beccaria, have made many experiments on the blood, and have all united in the opinion that its vermilion colour, should be attributed to the absorption of oxigene, by the blood, in its passage through the lungs during respiration. This doctrine sanctioned by such imposing names, influenced for a long time, physiologists and chemists to adopt it as the only true philosophy, which had ever been promulgated. The great Darwin, whose imagination was too transcendant to be imprisoned within the bounds of ordinary men, instituted a new theory of the vermilion colour of the blood, partly founded upon the foregoing principles, which nevertheless is infinitely more fanciful than philosophical; for he observes, "that during respiration, the blood imbibes the vital part of the air, called oxigene, through the membranes of the lungs; and that hence respiration may be aptly compared to a slow combustion.—As in combustion the oxigene of the atmosphere unites with some phlogistic or inflammable body, and forms an acid (as in the production of the vitriolic acid from sulphur, or carbonic acid from charcoal) giving out at the same time a quantity of the matter of heat, so in respiration, the oxigene of the air unites with the phlogistic part of the blood, and probably produces phosphoric or animal acid, changing the colour of the blood from a dark to a bright red."

Chaptal in his treatise on the blood, remarks that "the colour of the blood has been attributed to iron; that the blood does not become coloured without the concourse of air, and that as *oxigene alone* is absorbed in respiration, it appears that the colour is owing to iron calcined by the pure air, and reduced to the state of a red oxide." This evidently, is advancing one step further towards the truth than the foregoing doctrines, nevertheless he has stopped short of explaining the true phenomenon, for it is very manifest that he has endeavoured to prove in all his experiments, that oxigene gas is nothing but *oxigene* and *caloric*. But, by the experiments of Mr. Berthollet, it appears, that "oxigene and light have great affinity, that light is susceptible of combining with it, and that it contributes along with caloric to change it into the state of gas." Mr. Fourcroy in his general system of chemistry, and particularly on the colouring part of the blood, has offered the following theory.

He says "it must be observed that there are two phosphates of this metal," alluding to iron, "the one white-grey, frequently of a pearly brilliancy, insoluble in water, soluble in the acids; and the other red, more or less brown, and less soluble in the acids; this is phosphate with excess of oxide of iron, and the other is saturated with its acid." "The white phosphate of iron is decomposed only in a partial manner by the caustic alkalis, which take from it only a part of its acid, and leave the salt with an excess of this base. It is in this state of phosphate supersaturated with iron, a state maintained by the presence of the soda, that this metal is dissolved in the blood, and in particular in its serum. The blood of all animals, when it is red, is coloured by the phosphate of iron," How far this theory corresponds with the laws of the affinities, and the experiments of eminent chemists, the following observations will shew. If the phosphorus in the blood has a greater attraction for the oxigene taken in during respiration than the iron, the phosphoric acid must consequently first take place, before the phosphate of iron can be produced. If we take for granted that the phosphoric acid is produced in the blood, the *soda* with which the blood abounds, having a greater affinity to phosphoric acid, than what iron has, the phosphate of *soda* must be the necessary result, and the iron would consequently be left free. For the experiments of Mr. Lavoisier, and his tables of combinations of the phosphoric acids with salifiable bases in the order of affinity, clearly prove, the doctrine of Fourcroy to be highly chimerical.—Also Chaptal remarks "that *phosphorus* precipitates some metallic oxides from their solution in the metallic state; phosphoric acid is formed in this operation, which proves that the oxigene quits the metal to unite with the phosphorus," and that "phosphoric acid acts only on a small number of metallic substances." These arguments are sufficient to refute the theory of Mr. Fourcroy, without the assistance of any additional ones.

Mr. Davy, who has contributed much to the stock of chemical knowledge, denies that vital air is decomposed in respiration, and endeavours to maintain, that the disengaged carbonic acid and water, are constituent principles of venous blood, which are displaced by the vital air; for which the venous blood has a greater elective attraction, than for its constituent elements, water and carbonic acid.—He also denies the existence of caloric altogether, and says that oxigene gas consists of oxigene and light, which he has denominated phos-oxigene; from which he infers that in the process of respiration, the phos-oxigene combines with the venous blood in the lungs, and disengages the carbonic acid and aqueous gas from it, and further, that the vermilion colour of the blood, is produced by phos-oxigene combining with it in its intire state.—If it were a fact, that phos-oxigene combined with the blood in its *intire state*, the blood instead of assuming the vermilion colour, would in consequence of absorbing all the rays of light, take on the appearance of absolute blackness.—Hence his method of resolving the phenomenon of the red colour of the blood is inadmissible.

Mr Joseph Trent, who graduated in the University of Pennsylvania, A. D. 1800, observes that "light is a constituent of oxigene gas, and that it is to the disengagement and operation of this substance in respiration, that some of its phenomena ought, in part, to be attributed, more especially the vermilion colour of pulmonary blood."—I have endeavoured to give a fair and judicious exposition of the different doctrines on the vermilion colour of the blood, and shall now proceed to offer for the consideration of this learned Society, my observations and arguments in favour of a new theory, predicated on the Newtonian and pneumatic philosophy, in explaining the subjects of this Essay.

From the experiments which I have made on *light*, and from those detailed by the great Newton and other celebrated philosophers, on which we may rely, it appears, that *light* is a mixture of seven different coloured rays, of different refrangibilities and reflexibilities, and that we are indebted to the sun for all the light we enjoy; that heat is a simple elementary body, and a necessary constituent of this planet; that oxigene gas is a compound of *light, heat,* and *oxigene,* and that oxigene is held in its gaseous state by the means of *caloric;* all of which have been proved by numerous experiments made by Berthollet, Davy*, and other eminent chemists, which being conceded, renders it unnecessary to detail them here.—It has also been proved beyond the possibility of doubt, by the experiments of the most respectable chemists, that the blood contains *iron.*—Hence when atmospheric air is taken into the lungs, the oxigene gas is absorbed by the blood in its passage through the lungs during respiration, and from the great affinity of oxigene to the iron in the blood, it unites with that metal, and the *red ray,* a constituent of oxigene gas (the most difficult of refrangibility) is absorbed at the same time by the iron and becomes fixed, which constitutes the red oxide of iron, and illustrates in a philosophical manner, the beautiful phenomenon of the vermilion colour of the blood; while the heat is set at liberty, and the other six constituent rays of light, either become fixed in the other parts of the blood, or are carried off in a latent state, by expiration; for it is an established principle in optics, "that some rays enter into the combination of bodies, while others are reflected, and this in proportion to the greater or less affinity of the several rays with these bodies."

According to the experiments of Mr. Davy, on the composition of the *nitrous oxide gas,* and its comparative influence

* With the exception that Mr. Davy makes to the existence of *caloric* altogether.—The first evidence of the existence of matter, is that, it has motion, all the experiments on heat, prove its momentum, and consequently it has attached to it all the properties of matter.

on the venous blood of animals, exposed to it, compared with the effects produced on similar quantities of blood exposed to atmospheric air; and also the effects produced on the blood of animals who have breathed the *nitrous oxide gas,* compared with the blood of those who have breathed atmospheric air, support in a very conclusive manner the doctrine I have adopted to explain the red colour of the blood.—For he observes that '*nitrous oxide gas,*' is composed of oxigene 37 parts, and nitrogene 63 parts,—"existing *perhaps* in the most intimate union which those substances are capable of assuming; for it is unalterable by those bodies which are capable of attracting oxigene from nitrous gas, and nitrous acid at common temperatures."*—He exposed two vials of venous blood, one to the nitrous oxide, and the other to atmospheric air, and found that the coagulum of the blood exposed to the nitrous oxide, was rendered darker and more purple, than the blood exposed to atmospheric air.—Also blood drawn from two animals, one who had breathed the nitrous oxide, and the other atmospheric air, and he found that the blood of the two animals assumed different colours, corresponding with the blood exposed to the two different gases, mentioned in the above experiment.—Hence the inference is, that the affinity between the oxigene and the nitrogene of the nitrous oxide, is much stronger than the affinity between the oxigene and the nitrogene of the atmospheric air; that the temperature of the blood, together with the attraction of the iron therein, being insufficient to disengage much oxigene from the nitrous oxide, consequently less heat is evolved from the partial decomposition of the nitrous oxide, than from atmospheric air in the process of respiration, therefore the iron in the blood is only oxided in an inferior degree, which accounts for the fixation of the violet coloured ray, (the easiest of refrangibility) and resolves the phenomenon of the purple colour, the blood assumes from the effects of the *nitrous oxide.*—"Likewise the blood altered by nitrous oxide gas, is capable of being again rendered vermilion by exposure to common air, or to oxigene gas."

* See Davy's Chemical Researches.

On the different colours of the metallic oxides, with an application of these principles to the Arts.

I shall now proceed to offer for your further consideration a few remarks on the different colours of the metallic oxides, with an application of these principles to the *Arts*.—When metals are oxided by means of heat, "they are converted into earthy-like powders of different colours and properties." The *oxigene gas* during calcination is absorbed by the metal, and the oxigene and the light, (constituents of oxigene gas) become fixed in the oxide according to the degree of heat employed; for the oxide assumes the violet coloured ray first, and by increasing the temperature, the violet colour is thrown off, in consequence of its being the weakest, or the most refrangible ray: in like manner some oxides assume in rotation the different colours, according to their respective refrangibilities, and they are dissipated in that ratio to the increase of heat: the red ray, the strongest and the most difficult of refrangibility, requires still a higher temperature than the other six constituent colours of light, and from its greater affinity to oxigene than the other rays of light, it is not so easily driven off, hence the red ray becomes fixed in the oxide, which constitutes its red colour, while the heat and the other six constituents of light are set at liberty: even this red ray may be driven off by increasing the heat, and then the red oxide is converted into white.—According to the experiments of Macquer, he oxided gold with a burning glass, more powerful than that of Tschirnhausen, and remarked that the oxide assumed the violet colour.—If it were possible to increase the temperature sufficient to produce the *red oxide* of gold, it appears reasonable to infer that all the intermediate coloured oxides of this metal, might be made, provided the heat could be applied in that proportion or degree to the different refrangibilities of the various colours. This doctrine is eminently supported, by the process employed to make vermilion.—If we take four ounces of sublimed sulphur and fuse it in an unglazed earthen pot, and to this add one pound of mercury, and let it be mixed with the sulphur by stiring or agitation.—When these substances have combined to a certain degree, the mixture spontaneously takes fire, and is suffered to burn about a minute. The flame is then smothered, and the residue pulverised, which forms a *violet powder*. This powder being sublimed, affords a sublimate of a livid red colour, which when powdered, exhibits a fine red colour, known by the name of vermilion."—Here it is very obvious, that the high degree of heat, necessary to produce this sublimate, dissipated the violet colour, in consequence of its great refrangibility, and fixed the *red ray* in the oxide, which constitutes the *vermilion colour*.—To these I could add numberless facts, on the different coloured oxides of the different metals, in support of the doctrine which I have adopted, "but no more causes are necessary than are sufficient to explain the phenomena."—Hence this exposition most elegantly proves and illustrates the doctrine of Sir Isaac Newton, on the seven different rays of light, and their different refrangibilities and reflexibilities.

It must now appear very evident, that a knowledge of these principles, and an application of them to the arts, would in a very great degree assist the manufacturers, and particularly those who work in porcelain, china, glass, and in all kinds of pottery, to *burn in*, and fix the different colours, according to their *different refrangibilities*.—That is to say, the degree of heat which would be necessary to fix permanently the *red colour*, would be a temperature so high, as to burn out and dissipate, all the other colours, provided all the seven coloured oxides, were made from the same metal, and painted on a piece of porcelain; therefore to avoid an error of this kind, the manufacturer would be obliged to burn in the *red colour* first, secondly the orange, thirdly the yellow, fourthly the green, fifthly the blue, sixthly the indigo, and seventhly and lastly, the violet colour; for by an attempt to burn in and fix the violet colour first, and afterwards to burn in the red, before the latter could be accomplished, the former would be dissipated.—Therefore it is necessary to know that *the degree* of heat sufficient to produce the violet coloured oxide of gold, would be of so high a temperature as to drive off all colour from the red oxide of lead, and convert it into a white litharge: hence when several colours are to be fixed in, or burnt on porcelain at the same time, the different coloured oxides from the different metals should be selected, which would all bear the same degree of heat.—Say 1300 degrees of Fahrenheit's thermometer, consequently no two oxides of different colours from the same metal would answer, therefore a knowledge of these principles and their application, would enable the manufacturer to adorn and beautify his wares, and to bring to greater perfection the different branches of the arts.

No. XLI.

Observations of the eclipse of the sun, June 16th, 1806; made at Lancaster, by Andrew Ellicott Esquire,

Read August 15th, 1806.

Lancaster, August 1st, 1806.

DEAR SIR,

THE following observations, which I request the favour of you to hand to the Philosophical Society, were made at this place on the solar eclipse of the 16th of June last.

The morning was cloudy till about 9 o'clock, when the sun became visible through thin flying clouds: a short time before the beginning of the eclipse, the clouds were so far dissipated, that the limb of the sun was very distinct, and well defined. At $9^h\ 33'\ 8''$ A. M. apparent time, the eclipse began; the first impression made by the moon was at the point expected, and to which my eye was constantly directed.—The end of the eclipse was at $0^h\ 18'\ 56''$ P. M. apparent time.—A few minutes after the eclipse began, the clouds increased so much as to prevent any measures between the points of the cusps or horns being taken till $10^h\ 44'\ 25''$, when the following series commenced.

	Apparent time.			Distance between the points of the cusps by the Micrometer.		Value of the Micrometer in sexagesimals.	
	h	'	"	'	"	'	"
	10	44	25	58	8	31	32 2
	10	45	20	58	8	31	32 2
	10	46	3	58	5	31	30 2
1	10	46	52	57	48	31	25 7
2	10	47	37	57	34	31	16 6
3	10	48	11	57	5	30	57 7
4	10	48	36	56	43	30	49 9
5	10	49	16	56	23	30	36 9
6	10	49	53	56	8	30	27 1
7	10	50	24	55	49	30	21 3
8	10	50	49	55	37	30	13 5
9	10	51	18	55	23	30	4 4
10	10	51	46	55	12	29	57 2
11	10	52	20	55	4	29	52 0
12	10	53	0	54	48	29	48 1
	10	55	27	53	48	29	15 6
12	10	57	16	55	23	30	4 4
11	10	57	52	55	38	30	14 4
10	10	58	31	56	2	30	23 3
9	11	0	2	56	33	30	43 4
8	11	0	30	56	45	30	50 2
7	11	0	47	57	8	30	59 7
6	11	1	27	57	15	31	4 2
5	11	1	58	57	25	31	10 8
4	11	2	22	57	33	31	15 9
3	11	2	57	57	37	31	18 5
2	11	3	45	57	45	31	23 8
1	11	4	27	57	48	31	25 7
	11	4	55	58	6	31	30 9
	11	5	30	58	8	31	32 2
	11	6	27	58	8	31	32 2

The irregular decrease and increase of the distances between the points of the cusps, is greater than would arise in so excellent a micrometer from the small imperfections inseparable from such observations. These irregularities were principally occasioned by the uneven surface of the moon, particularly that part, which formed the southern cusp or horn.—The northern cusp was well defined, and finely terminated, but the southern one was sometimes obtuse, at others terminated by a parallel thread of light, which disappeared from one end to the other, at the same time; and frequently one or two luminous points of the sun's limb, were observed to be completely detached from the point of the cusp.—The most remarkable of these phenomena was observed between $10^h\ 52'$, and $10^h\ 55'$. To give some idea of this appearance, let the circle A B C D Fig. 2d, Pl. VI. represent the periphery of the sun's disk, and EBFD that of the moon's: the line EAFC a vertical, supposed to pass through the centre of the sun:—then B will represent the point of the southern cusp. At about 10^h 53′ the point of the cusp appeared as in Fig. 3, the thread of light, a b, disappeared from one end to the other, at the same instant, the point of the cusp then appeared as in Fig. 4.—In a very short time the thread of light which connected b with the body of the cusp disappeared, and left b visible for a number of seconds, after it was detached from the other visible part of the sun. The cusp then appeared very obtuse, as represented in Fig. 5 which was observed by those who were using the most indifferent glasses.

Those detached luminous points of the sun's limb, seemed to retain their brilliancy, till the instant of their disappearance. which it would appear should not have been the case, if the moon was surrounded with an atmosphere:—those points particularly, which were formed by depressions in the moon's limb, would have had their splendor somewhat diminished, by the density of the atmosphere, if one existed:—but nothing of the kind was observed.

The sun's diameter was found by a great number of observations, made both on the day of the eclipse, and the day preceding, to be $58\frac{8}{50}$ divisions of the micrometer:—the denominator of the fractional part of a division being constantly 50 the numerators only are entered in the observations.—When the first measures were taken, a line joining the points of the cusps passed nearly through the centre of the sun:—in that situation it will easily be seen that the distances must remain for a few minutes so nearly the same, that but little advantage can be drawn from the observations; on this account I have only made out the results of twelve observations on each side of the measure, taken at 10^h 55′ 27″, which turns out accidentally to be, not only the middle observation, but the shortest observed distance between the points of the cusps:—the first and three last observations, are therefore omitted in the calculations. These observations may be so varied, as to furnish a great number of results, because any two, however taken, on different sides of the apparent conjunction, may be considered almost equivalent to the observation of an eclipse, and the calculation made upon the same principles, only using the distance of the centres, instead of the sum of the semidiameters.—Those which I used, are marked numerically in the margin, on each side of the nearest observed distance between the points of the cusps:—the corresponding numbers answer to the two observations for which a particular calculation was made.—This arrangement furnished me with twelve separate determinations, from the mean of which it appeared, that upon the supposition of the longitude of Lancaster being $5^h\ 5'\ 6''$ and the latitnde $40°\ 2'\ 36''$ the moon's longitude as deduced from Mason's tables will be $1'\ 1''$ too great, and the latitude $11''$ too small:—But by the eclipse, independently of the measures taken by the micrometer, the moon's longitude by the tables will be $52''$ too great, and her latitude $3''$ too small.—If, however, the tables should be found correct, at the royal observatory of Greenwich, by the observation of the same eclipse, or other methods, the longitude of Lancaster must be reduced about $1'\ 33''$ in time, by the beginning and end of the eclipse, and still more by the measures taken with the micrometer.—It is probable that the error is partly in the tables, and partly in the assumed longitude of Lancaster.

By the beginning and end of the eclipse, the true conjunction under the meridian of Lancaster, was at $11^h\ 15'\ 31''$ A. M. apparent time; and by the measures taken with the micrometer at $11^h\ 15'\ 47''$.

In making the calculations I have allowed $5''$ for inflexion, and irradiation, and diminished the altitude of the pole $14'\ 38''$, and the moons horizontal parallax $6''$ on account of the spheroidal figure of the earth.

I am, dear sir, with great esteem,

your friend and humble servant,

ANDREW ELLICOTT.

Robert Patterson Esq.
V. P. of the A. P. S.

From the same to the same.

Read September 19th, 1806.

Lancaster, August 16th, 1806.

Three days ago, I received a letter from my friend, Mr. Dunbar, at Natchez, containing his observations on the solar eclipse of the 16th of June last: they are as below.

"Beginning } at { 8h 5′ 19″ } A. M. Apparent time."
"End } at { 10 38 43 }

In deducing the latitude and longitude of the moon, from the above observations, I have diminished the sum of the semi-diameters of the sun, and moon 5″, for the effect of irradiation and inflexion:—the altitude of the pole 13′, and the horizontal parallax of the moon 4″ on account of the spheroidal figure of the earth.

	h	′	″	
By { the beginning / the end } the conjunction was at { 10h 15′ 21″ / 10 15 20 } Mean.	10	15	20	5
The conjunction at Philadelphia by your observations.	11	20	17	5
Difference of meridians.	1	4	57	0
Whilst residing at Natchez, some years ago, I settled the difference of meridians between that place and Philadelphia, from my observations at 16° 15′ 46″* =	1	5	3	
difference only	0	0	6	
Let us now take the longitude of Philadelphia, (as long settled) for a given point	5	0	37	
Add the difference of meridians between Philadelphia and Natchez.	1	4	57	
Longitude of Natchez.	6	5	34	
Conjunction at Philadelphia by your observations.	11	20	17	
Conjunction at Lancaster.	11	15	31	
Difference of meridians.	0	4	46	
Add longitude of Philadelphia.	5	0	37	
Longitude of Lancaster.	5	5	23	
This longitude exceeds that drawn from the measure of the turnpike road, and some of my former observations.	0	0	17	

The difference of the meridians as above stated, agree so nearly with former determinations, that there can remain but little doubt, that the difference in longitude, between the places above mentioned, and Greenwich, as drawn from the late eclipse of the sun, and as heretofore settled, arises principally

* See Philosophical Transactions, Vol. IV. page 451.

from the imperfections of the lunar tables, which appear to give the moon's longitude at the time of the eclipse at least 1′ too much: the error in latitude at the same time is almost insensible.

No. XLII.

Observations of the eclipse of the sun, June 16th, 1806: made at the Forest, near Natchez.—Latitude 31° 27′ 48″ N. and supposed Longitude about 6ʰ 5′ 25″ to 40″, W. of Greenwich, by William Dunbar Esq.

Read August 15th, 1806.

IN these observations, an excellent clock with a gridiron pendulum was used, made by J. Bullock of London; a portable chronometer served occasionally as a companion to the clock, which last was frequently regulated and corrected, by equal altitudes of the sun, taken by a circle of reflection.

☽ April 28th, 1806, astronomical time. With a six-feet Gregorian reflecting telescope, power 100, observed an occultation of e leonis by the moon, as follows:

☽ e ♌ Immersion at 8ʰ 49′ 10½″, per clock. The emersion was not seen; the star was at some distance from the moon's limb, before it was noticed, which was ascribed to the extreme brightness of the moon, then nearly on the meridian.

The following new and short formula was used, for finding the equation of equal altitudes, viz. To the logarithmic cosine of the latitude, add the sine of the half-interval, in degrees, and the arith. comp. of the cosine (or secant) of the altitude; the sum, rejecting tens from the index, is the sine of an angle: take out the corresponding cotangent, to which add the arith. comp. of the cosine (or secant) of the sun's declination, and the logarithm of the declination, gained or lost during the half-interval, reduced to seconds of time; the sum, rejecting tens from the index, is the logarithm of the correction or equation of equal altitudes, in seconds of time; additive when the sun is receding from the elevated pole, and vice versa.

Note, when the index in the last result turns out to be 8 or 9, which can happen only when the sun is very near the solstices, the equation must then be considered as a fraction.

May 1st. Equal altitudes of the sun's lower limb.

	A. M. h ′ ″	Double altitude ° ′ ″		P. M. h ′ ″
At	8 38 31½	82 11 35	at	3 20 35½
	42 42½	83 57 30		16 23½
	50 32¼	87 15 42		8 35
	57 2	89 59 10		2 3

Contacts of the sun with his image for finding the index error. Index on 18′ 10″; off 45 30

	h ′ ″
A mean of the above gives apparent noon uncorrected per clock, at	11 59 33 22
Equation of equal altitudes.	— 5 63
Apparent noon per clock corrected at.	11 59 27 59
Equation of time.	+ 3 3 25
Clock fast for mean time.	2 30 84

June 2d. Equal altitudes of the sun's lower limb.

	A. M. h ′ ″	Double altitude ° ′		P. M. h ′ ″		
At	8 36 46	88 20	at	3 19 29½	Index on	18′ 30″
	41 27½	90 20		14 48½	off	44 45
	51 14½	94 30		5 2		
	53 35	95 30		2 41		

By these the clock was too fast for mean time 36″ 4, and by a comparison with those of May the 1st, the clock loses at the rate of 3″ 6 per day, which correction being applied to the occultation of e leonis, we shall have the immersion at 8^h 46′ 30″ 2 mean time, or 8^h 49′ 11″ 37 apparent time.

June 3d. Shortened the pendulum of the clock, by putting round the index of the bob, one degree or division.

June 5th. Equal altitudes of the sun's lower limb.

	A. M. h ′ ″	Double altitude °		P. M. h ′ ″		
At	8 38 7½	89	at	3 19 1½	Index on	17′ 35″
	42 48½	91		14 19½	off	45 33
	45 9	92		11 58½		
	47 30	93		9 39		
	49 50½	94		7 17½		
	52 11½	95		4 56½		
	54 32½	96		2 36½		

By these the clock was too fast for mean time. . . . . . 34″ 11

June 9th. Equal altitudes of the sun's lower limb.

	A. M. h ′ ″	Double altitude °		P. M. h ′ ″		
At	8 59 13	98	at	2 59 18½	Index on	17′ 50″
	9 1 33½	99		56 57½	off	45 10
	3 54	100		54 36½		
	6 15½	101		52 16		

By these the clock was fast for mean time. . . . . . 32″ 75

☿ June 11th, astronomical time, with the reflector, power 100, observed an immersion of Jupiter's 1st satellite at $11^h\ 18'\ 16\frac{1}{2}''$ per clock: clouds were passing, and a thin vapour overspread the disk of Jupiter; it is conjectured that the true time of the immersion might have been 10 or 15 seconds later.

June 12th. Equal altitudes of the sun's lower limb.

	A. M.	Double altitude		P. M.		
	h ′ ″	°		h ′ ″		
At	9 8 47	102	at	2 50 52 4	Index on	18′ 22″
	11 $7\frac{1}{2}$	103		48 32	off	44 46

By these the clock was fast for mean time 31″ 58, and by a comparison with those of the 5th and 9th, the clock loses at the rate of 0″ 368 per day, which correction being applied to the time per clock, of the immersion of Jupiter's 1st satellite, we shall have for the moment of the immersion, $11^h\ 17'\ 44''\ 644$ mean time. The longitude deduced from this observation would be $6^h\ 5'\ 41''\ 4$, or $91°\ 25'\ 21''$ West of Greenwich.

⊙ June 15th, astronomical time. Prepared to observe the eclipse of the sun, which (from calculation) was expected to begin soon after 20^h; at 19^h got the telescopes prepared: found a great undulation upon the limb of the sun, seen through the six-feet reflector; the red colour of the image was offensive to the eye; I therefore gave the preference to the fine mild yellow image (most perfectly defined) of a $2\frac{1}{2}$ feet achromatic telescope, belonging to a set of astronomical circles, although the power did not exceed 40.

The moment of the expected impression approached, and reflecting that this eclipse was to be seen all over Europe and North America, which renders it a very important phenomenon for settling comparative longitudes, I conceived that all the zealous astronomers of both worlds were then looking with me at the great luminary and centre of our system: I kept my eye riveted upon that point of the disk where the eclipse was to commence, with an anxiety known only to astronomers; with the chronometer watch at my ear, I attended to the most doubtful appearances which my perturbation perhaps presented to the eye, and upon every alarm, began to count the beats of the watch, (five in two seconds) in order that I might not lose the very first instant of the impression, and I am confident that not one quarter of a second was lost, of the time when the impression was visible by my telescope. Dr. Maskelyne seems to be of opinion, that five seconds ought to be allowed for the time elapsed from the first contact until the impression becomes visible in our telescopes. The atmosphere was remarkably fine and serene during the whole time of the eclipse, although the weather was extremely unfavourable for many days both before and after. The limb of the sun was well defined, by a fine circular line, but that of the moon was irregularly indented, more particularly when seen by the reflector with a power of 200.

The result is as follows.

Visible commencement of the eclipse per clock, at	20h 5′ 59″
Dr. Maskelyne's correction.	— 5
True commencement per clock	20 5 54
End of the eclipse per clock.	22 39 24

June 18th. Equal altitudes of the sun's lower limb.

	A. M. h ′ ″	Double altitude °		P. M. h ′ ″		′ ″
At	8 48 23	93	at	3 13 40¾	Index on	17 10
	50 43¾	94		11 19	off	45 50
	53 5	95		8 58		
	55 26½	96		6 37½		
	57 47½	97		4 17		
	9 0 7	98		1 56		

By these the clock was fast for mean time 28″ 19, and by a comparison with those of the 12th, the clock loses at the rate of 0″ 565 per day, which correction being applied to the observed times of the eclipse per clock, the true results will be as follows.

On the astronomical 15th of June.	Mean time.	Apparent time.
Beginning of the eclipse at. .	20h 5′ 24″ 6	20h 5′ 19″
End of the eclipse. . .	22 38 54 67	22 38 47 72

July 5th. Equal altitudes of the sun's lower limb.

	A. M. h ′ ″	Double altitude °		P. M. h ′ ″	
At	8 57 26	95	at	3 11 14½	Index error of the morning. 13′ 15″
	59 47	96		8 54	Index error of the evening. 13′ 30″
	9 2 7	97		6 33	
	4 28	98		4 12	
	6 47	99		1 50½	
	9 9¾	100		cloudy	
	11 30½	101		2 57 9½	
	13 50½	102		54 48½	

By these the clock was fast for mean time 19″ 85, and by a comparison with those of the 18th, the clock loses at the rate of 0″ 49 per day.

On the evening of the same day ♄ the astronomical 5th, with the reflecting telescope, power 100, observed an emersion of Jupiter's 2d satellite at $9^h\ 44'\ 42''$ per clock; the above correction being applied, we shall have for the moment of the visible emersion, $9^h\ 44'\ 22''\ 35$, mean time. Clouds were passing and a vapour obscured, in some degree, the disk of the planet, similar to that of the 11th of June, though rather more dense, and it is thought probable, that the emersion was seen too late by 20 or 30 seconds: the longitude deduced without correction would be $6^h\ 5'\ 0''$ west of Greenwich.

☉ July 6th, astronomical time, observed with the reflector, power 100, an emersion of Jupiter's first satellite, at $8^h\ 12'\ 24''$ per clock, and the correction for the rate of the clock being applied, the visible emersion took place at $8^h\ 12'\ 4''\ 81$, mean time, the longitude deduced would be $6^h\ 5'\ 12''\ 19$.—Now as the density of the vapour of this evening and that of the 11th of June are supposed to be equal, and that the one observation was an immersion and the other an emersion of the same satellite, the imperfection of vision caused by the vapour or by the great and strong light of the planet, so near to the points of observation, would produce errors in contrary directions, the one advancing, the other retarding the moment of visible contact, a mean of the two results will therefore probably be near the truth.

Result of the immersion of the 11th of June.	6^h	$5'$	$41''$	4
Result of the emersion of the 6th of July.	6	5	12	19
Mean longitude.	6	5	26	8

No. XLIII.

Observations of the eclipse of the sun, June 16th, 1806, made at Kinderhook, in the State of New-York, by Jose Joaquin de Ferrer.

Read August 15th, 1806.

ACCORDING to the latitudes and longitudes of the moon inserted in the French connoissance de temps, the conjunction ought to have happened 4h 29′ 40″ 8, mean time in Paris, latitude of the moon in conjunction 19′ 19″ N.

Latitude of Albany 40° 42′ 38″. Longitude east of New-York, according to the chronometer, No. 63, in time = 58″, the maximum of the total obscurity ought to have taken place in latitude 42° 23′ on the bank of the North river.—The following are the results of an approximated calculation.

	h ′ ″	
Beginning of the eclipse in mean time.	9 49 00	First contact 45° to the left of the inferior vertex, by inverse vision.
Ditto of total obscurity.	11 06 30	
End of total obscurity.	11 11 30	
End of the eclipse.	0 33 00	

On the 8th of June I embarked in a packet for Kinderhook south landing, which is 15 geographic miles south of Albany on the bank of the river Hudson, to observe the eclipse, taking for that purpose an excellent chronometer of Arnold, No. 63; a circle of reflection; and an achromatic telescope, constructed by Troughton according to particular directions.

The circle of reflection is not a multiplier, it is 11 English inches diameter, graduated upon silver, with three indexes, which divide the circle into three equal parts, and sub-divide it to 10″; mounted on a pedestal, and the telescope magnifies 17 times. A complete, or double observation is a compound of two observations, one direct, the other inverse, each observation has three readings, consequently the error of the divisions, in the double observations, is reduced to $\frac{1}{6}$, the eccentricity destroyed, as also the error of the index, coloured glasses, small speculum, and of almost the whole of the large one.

The telescope is $4\frac{1}{2}$ feet in length, it has a triple object glass of $2\frac{70}{100}$ inches aperture, a terrestrial eye glass, and three astronomical ones No. 1, 2, 3, and from the manner in which it is mounted, the zenith may be observed with as much exactness as any other elevation.

Rate of going of the chronometer in New-York.

	′ ″	
June 4th, slower than mean time.	11 16 5	mean daily loss = 0″ 5
6th,	11 17 0	
8th,	11 18 5	

On the 10th of June I arrived at Kinderhook south landing, the place where it was intended to observe the eclipse. By observations of meridian altitudes of the sun and stars, the latitude of the place was ascertained as follows.

		° ′ ″
June 12th.	By double altitudes inverse and direct of ursa minor. .	42 23 11
12th.	ditto. . . ditto. . Antares. .	42 23 18
13th.	By one meridian altitude of ☉, direct observation. .	42 22 54
13th.	ditto. . . . ursa minor. . .	42 23 00
14th.	By double altitudes direct and inverse, 50′ of time before and after the meridian.	42 22 53
	Mean latitude.	42 23 03

Rate of going of the chronometer according to mean time, by corresponding altitudes of the sun.

		′ ″	
June 11th.	Chronometer too slow. . . .	= 12 09 9	daily gain. = 1″ 18
12th.	. . . .	12 08 4	
14th.	. . . .	12 06 2	
15th.	. . . .	12 05 0	
16th.	. . . .	12 04 0	

Observation of the eclipse, 16th of June, 1806, with the achromatic telescope, $2\frac{7}{100}$ English inches aperture, triple object glass No. 1, was used which magnifies 90 times.

9^h 37′ 33″, (chronometer.) Beginning 45° from the left inferior vertex, in the very point on which the eye was fixed, the impression was so slight, that 4″ elapsed before it was certain that it had commenced.

10^h 55′ 58″, (chron.) First interior contact or total obscurity, certain to half a second, 50° from the right superior vertex: 4″ or 5″ before the total obscurity, the remainder of the disk of the sun was reduced to a very short line, interrupted in many parts.—The darkened glass with which this phenomenon had been observed, was sufficiently clear to distinguish terrestrial objects. After this observation I laid aside the coloured glass, to observe the end of total darkness. I examined the moon during two minutes, without observing one luminous point in her disk. The disk had round it a ring or illuminated atmosphere, which was of a pearl colour, and projected 6′ from the limb, the diameter of the ring was estimated at 45′. The darkness was not so great as was expected, and without doubt the light was greater than that of the full moon. From the extremity of the ring, many luminous rays were projected to more than 3 degrees distance.—The lunar disk was ill defined, very dark, forming a contrast with the luminous corona; with the telescope I distinguished some very slender columns of smoke, which issued from the western part of the moon. The ring appeared concentric with the sun, but the greatest light was in the very edge of the moon, and terminated confusedly at 6′ distance.

11^h 00′ 20″, (chron.) Observed the appearance of a ribbon or border, similar to a very white cloud, concentric with the sun, and which appeared to me to belong to its atmosphere, 90° to the left of the moon.

11^h 00′ 28″, (chron.) Observed the illumination of various points in the disk of the moon on the same side.

11^h 00′ 30″, (chron.) The illumination of the moon was very distinguishable, shewing the irregularities of its disk, the colour of a palish yellow.—In the moment of the sun's re-appearance, the versed sine of the illuminated segment of the moon, was equal to $\frac{1}{6}$ part of the apparent diameter of Jupiter, observed in opposition with the same tube,

11^h 00′ 34″ 8, (chron.) End of total darkness, 90° on the left; the sun appeared as a very bright star of the third magnitude; at the call of the 35″, such was the intensity of the light that I abandoned the telescope, having received a violent impression on the eye: from the appearance of the first ray, to the moment when it became insupportable to the eye, was so instantaneous, that I have estimated it at less than $\frac{3}{10}$ of a second. It is to be remarked, that this observation was made without a darkened glass, with *tube No.* 1, which magnifies 90 times, and is remarkably clear.

0^h 21′ 38″, (chronometer.) End of the eclipse.

During the whole of the eclipse, the sky was very clear, not a single cloud was visible, and there was scarcely any wind. The sun was without a spot. A little dew fell during the darkness; five or six principal stars and planets were visible.

Mr. John Garnett (of New-Brunswick, New-Jersey,) who also observed the eclipse with an excellent telescope of Dolland, with a triple object glass, and $2\frac{7}{100}$ inches aperture, tube No. 1, of the same power as the one I used, was placed four or five paces from the person who counted aloud the seconds of the chronometer. Mr Garnett, besides being a good astronomer, was much accustomed to the use of the telescope.—He directed his view to the 45° on the left of the inferior vertex, inversed vision, according to a previous calculation, and determined the following phenomena.

	Chronometer. h ′ ″
Commencement of the eclipse.	9 37 36
Total darkness.	10 55 58
Illumination of the lunar disk, which he observed without a darkened glass	11 00 28
End of the eclipse.	00 21 41

Owing to an accident he did not observe the end of total darkness.

Mr. Garnett is positive, that the end observed is correct to a second, and that the impression was sensible to him three seconds previous.—We have then,

	Chronometer. h ′ ″	Mean time. h ′ ″	Siderial time. h ′ ″
Commencement.	9 37 33	9 49 37	3 26 19 7
Total darkness.	10 55 58	11 08 02	4 44 57 5
End of ditto.	11 00 35	11 12 39	4 49 35 0
End of the eclipse.	21 41	33 45	6 10 54 8

The interior contacts were instantaneous, consequently they may be ascertained at least to half a second; the beginning to less than 3″, and the end according to M. Garnett to 1″.

June 16th. Equal altitudes of the sun.

	A. M. h ′ ″	P. M. h ′ ″	M. h ′ ″
Chronometer.	7 11 06 0	4 25 04 7	11 48 05 35
	7 16 08 9	4 19 59 0	11 48 03 95
	7 20 44 1	4 15 24 2	11 48 04 15
	7 26 56 3	4 09 11 8	11 48 04 05
	7 30 22 0	4 05 44 3	11 48 03 15
	7 37 44 0	3 58 24 7	11 48 04 35
A mean of these gives noon uncorrected			11 48 04 17
Equation of equal altitudes.			— 1 27
Apparent noon by the chronometer.			11 48 02 90
Equation of time.			+ 6 98
Chronometer slower than mean time.			00 12 04 08

Chronometer. h ′ ″	☉'s true altitude. ° ′ ″
7 13 11 37	30 53 54
7 20 44 10	32 17 18
7 26 56 30	33 26 06
4 09 11 80	33 26 04
4 11 17 10	33 03 03
4 15 24 20	32 17 17

Chronometer slower than mean time, by the ☉'s altitudes at noon.	12′ 04″ 10
By the equal altitudes.	12 04 08
Mean	12 04 09

The above altitudes of the sun are the result of direct and inverse observations, corrected for refraction and parallax.

June 18th, we embarked in a packet for the house of Chancellor Levingston, which is on the bank of the river, and by two direct observations of meridian altitudes on the 19th and 20th, the latitude of said house appears to be 42° 04′ 39″.

Chronometer slow with respect to mean time, by three series of complete observations of altitudes of the sun 19th of June in the morning.	11′ 34″ 8
By three series, 20th, ditto.	11 33 2

June 21st, we embarked for New-York, and having put into Newburg on account of the wind, I observed the latitude from the wharf of that town, from a meridian altitude of the sun, and found it to be 41° 30′ 20″.

By four series of altitudes of the sun, taken in the afternoon of the 22d of June, the chronometer was slow with respect to mean time 0^h 11′ 11″ 50.

June 23d, we arrived at New-York.—By observations of altitudes of the sun in Partition street, the chronometer was ascertained to be slow with respect to mean time,

June 24th. . . 11′ 09″ 3
July 4th. . . . 11 17 5

If we compare the absolute state of the chronometer from the day of departure to the 24th, when I returned to this city, it will appear that in 16 days the gain was = 9″ 2, daily gain, $= \frac{9'' 2}{16} = 0'' 571$

Mean gain between the observations of New-York before our departure, and the observations of Kinderhook.	0″ 35
Between Kinderhook and the observations at New-York on our return.	0 25

	° ′ ″		Long. in time. ″
Latitude of New-York, Partition street. . .	40 42 40	Longitude	00
Newburg.	41 30 20	East.	2
House of Chancellor Levingston. . . .	42 04 39	East.	23 6
Kinderhook, S. landing, where the eclipse was observed	42 23 03	East.	51 3
Albany, Pomerat's Hotel.	42 38 38½	East.	58

The position of Albany I determined last year, in the month of August, with the same chronometer and circle of reflection, and its correctness is to be depended upon, as much as that of the other observations. The rate of going of the chronometer was, with a very slight difference, the same as it was found to be this year; from the 4th of August, 1805, the day the chronometer was taken out of New-York for Albany, to the 15th that it was again examined, on my return to New-York, the daily gain was = 0″ 54.

Elements calculated by the astronomical tables of Lalande, third edition.

16th of June 1806, 4h 29′ 40″ 8 mean time in Paris.

		° ′ ″	′ ″
Longitude of the ☾ apparent equinox.		84 44 31 1	
Idem ☉ idem.		84 44 34 3	
Northern latitude of the ☾		19 24 0	
Horizontal parallax for Paris.	60′ 13″ 4		
Correction of the tables.	— 4 5		
Horizontal parallax for Paris.	60 08 9		
Horizontal parallax of the ☉	8 5		
Horary motion of the ☾ in longitude.		36 41 92	in Lat. = 3 22 86
The hour that precedes.		36 41 24	3 22 80
The hour that follows.		36 42 60	3 22 92
Horary increase of the horizontal parallax of the ☾		1 16	
Horizontal semidiameter of the ☾		16 26 96	
Horary increase of the horizontal semidiameter of the ☾		0 26	
Horizontal semidiameter of the ☉		15 46 08	
Horary motion of the ☉		2 23 16	
Right ascension of the ☉		5h 37 05 2	
Horary variation in right ascension of the ☉		10 4	
Proportion of the axes of the earth	334 to 333		
Latitude of Kinderhook—Vertical angle		=42° 12 47	

	′ ″
Relative horary motion between the commencement and conj. in Kinderhook	34 17 52
the end and conjunction	34 19 62
1st interior contact and the conjunction.	34 18 54
2d interior contact and the conjunction.	34 18 60
Apparent obliquity of the ecliptic.	23 27 56

The epoch of the lunar tables I have corrected according to the equations of De Burg, which in 1806. $= 1^s\ 15°\ 07'\ 11''\ 4 + 11''\ 5 - 1''\ 4$

Mean anomaly. $3\ 25\ 37\ 27 \quad + 46 \quad - 1\ 4$

To calculate the latitude, I have diminished the inclination of the lunar orbit, 6″, and have further applied the correction = —6″ sine long. ☾.

☾'s Horizontal parallax for Kinderhook=(60′ 08″ 9—1″ 2 on account of the spheroidal figure of the earth,) = 60′ 10″ I.

Difference of horizontal parallaxes of the of the ☉ and ☾ = 60′ 02″ 6

	h ′ ″	h ′ ″	h ′ ″	h ′ ″
June 16, 1806. At Kinderhook south landing, mean time.	9 49 37	11 08 02	11 12 39	0 33 45
Longitude West of Paris.	5 04 50	5 04 50	5 04 50	5 04 50
Mean time in Paris.	2 54 27	4 12 52	4 17 29	5 38 35
Right ascen. of the mid-heaven.	51 34 56	71 14 22	72 23 52	92 43 42
Latitudes of the ☾ by the tables.	24 46 0	20 20 86	20 05 27	15 30 94

	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Altitudes of the nonagesimal.	67 20 23	70 18 06	70 24 58	71 14 00
Longitudes of the nonagesimal.	60 05 00	75 20 39	76 14 50	92 08 02
Dist. of the ☾ to the nonag.	+23 41 18	+9 13 35	+8 22 13	—6 41 21
Horizontal parallaxes of the ☾ —par. of the ⊙ in Kinderhook.	60 01 7	60 02 3	60 02 3	60 03 9
Parallaxes in longitude.	+22 34 50	+ 9 12 20	+ 8 21 60	— 6 44 50
Parallaxes in latitude.	—23 05 5	—20 13 7	—20 07 11	—19 23 95
Apparent latitudes of the ☾	N. 1 40 5	N. 7 1	S. 1 80	S. 3 52 00
Inclination of the orbit in the interior contacts.		4 49 30		
Chord.		1 48 16		
Apparent semidiameter of the ☾ not corrected for inflection.	16 41 15	16 42 95	16 43 02	16 43 58

In Albany the eclipse was observed by Mr. Simeon de Witt.

	h ′ ″
Beginning, apparent time	9 50 12
1st interior contact	11 08 06
2d ditto.	11 12 57
End of the eclipse.	33 09 5

M. De Witt did not apply the correction of corresponding altitudes, on account of the variation in the sun's declination, and in this case we have the observations as follows.

$$
\begin{array}{rrrr}
9^h & 50' & 13'' & 1 \\
11 & 08 & 07 & 1 \\
11 & 12 & 58 & 1 \\
 & 33 & 09 & 1
\end{array}
$$

The end of total darkness was observed by the naked eye, the other observations were made with a telescope which magnified 30 times.—It is observable that the end of total darkness was so instantaneous, (as is expressed in my account,) that the error made between the observations, made by the best telescope and the naked eye, could scarcely amount to half a second.

Latitude of Albany as stated in my observations, page 269, is 42° 38′ 38½″.—Longitude east of New-York by chronometer No. 63 in time = 58″

The beginning and end of the eclipse at Albany do not appear to have been correctly ascertained, which it is easy to see by reference to calculation.

The interior contacts are to be depended upon.—It results therefore from the interior contacts at 11h 08′ 07″ 1 Parallax in long. 9′ 06″ 9 Parallax in lat. = 20′ 29″ 8
11 12 58 1 ditto 8 14 1 ditto 20 22 6
Inclination of the apparent orbit = 4° 30′ 35″ Chord = 1′ 53″ 00

In Lancaster it was observed by Mr. Andrew Ellicott.

Beginning in mean time.	9h 33′ 14″
End.	0 19 02
Latitude of Lancaster—Vertical angle	=39° 52′ 27″

Parallaxes of Longitude $\left\{\begin{matrix} 26' & 13'' & 0 \\ 3 & 55 & 8 \end{matrix}\right\}$ Parallaxes of Latitude = $\left\{\begin{matrix} 21' & 43'' & 5 \\ 16 & 54 & 2 \end{matrix}\right\}$

In Philadelphia by Mr. Robert Patterson, corrected Latitude = 39° 46′ 53″

Beginning in apparent time	9h 39′ 59″ 0
End	0 25 48 9

Parallaxes in Longitude = $\left\{\begin{matrix} +25' & 08'' & 9 \\ -\ 5 & 22 & 4 \end{matrix}\right\}$ Parallaxes in Latitude= $\left\{\begin{matrix} -21' & 16'' & 9 \\ -16 & 53 & 3 \end{matrix}\right\}$

On the banks of Schuylkill, in the western part of the city by F. R. Hassler, west of the State House in time 7″

Corrected Latitude	39° 46′ 53″
Beginning, apparent time	9h 39′ 48″ 5
End	0 25 48 9

Parallaxes in Longitude = $\left\{\begin{matrix} +25' & 11'' & 5 \\ -\ 5 & 18 & 0 \end{matrix}\right\}$ Parallaxes in Latitude= $\left\{\begin{matrix} 21' & 16'' & 6 \\ 16 & 53 & 9 \end{matrix}\right\}$

Mr. Dunbar, at his plantation latitude 31° 27′ 48″, longitude 6h 14′ 50″, at 4½ miles east of the river Mississippi, near the Natchez, 8 miles distance, 9″ in time east from the fort of Natchez.

Beginning.	20h 05′ 29″ mean time.	The Telescope magnified 40 times.
End.	22 38 55 idem.	

Parallaxes in Longitude = $\left\{\begin{matrix} +42' & 41'' & 9 \\ +17 & 55 & 7 \end{matrix}\right\}$ Parallaxes in Latitude= $\left\{\begin{matrix} 19' & 44'' & 6 \\ 10 & 08 & 2 \end{matrix}\right\}$

By the observations of Kinderhook.

The latitude of the ☾ in conjunction	=19′ 35″ 8
Inflection of the semidiameter of the ☾	= −2 05
Ditto. ☉	= −1 95

From these elements I have calculated the following table.

The longitude of Philadelphia I have supposed to be 5h 09′ 57″ west of Paris, and that of New-York 5h 05′ 25″ 4. By the combination of different observations with these data, and the differences of longitude resulting from the different observations of the eclipse, I have determined the longitudes of Mr. Dunbar's house near Natchez, and of Lancaster.—That of Albany I have determined from the mean result of the chronometer and eclipse.

The situation of the house of Chancellor Levingston and of Newburg are ascertained by the chronometer referred to Kinderhook and New-York.

		Mean time of Observations. h ′ ″	Parallax in Longitude. ′ ″	Parallax in Latitude. ′ ″	Conjunction in mean time. h ′ ″	h ′ ″
Kinderhook South landing.	Commencement of the eclipse.	9 49 37	+ 22 34 5	+ 23 05 5	11 25 40 9	11 25 39 5
	Total darkness.	11 08 02	+ 9 12 2	+ 20 13 7	11 25 39 5	
	End of total darkness.	11 12 39	+ 8 21 7	+ 20 07 2	11 25 39 5	
	End of the eclipse.	0 33 45	— 6 44 5	+ 19 22 9	11 25.38 1	
Albany, observed by Mr. S. de Witt.	Total darkness.	11 08 13 7	+ 9 06 9	+ 20 29 4	11 25 48 0	11 25 48 0
	End of total darkness.	11 13 04 7	— 8 14 1	+ 20 22 7	11 25 48 0	
Philadelphia, by Robert Patterson Esq.	Commencement of the eclipse.	9 40 04 9	+ 25 09 9	+ 21 16 9	11 20 22 0	11 20 17 8
	End of the eclipse.	0 26 14 8	— 5 22 4	+ 16 53 3	11 20 13 0	
Bowdoin College by Rev. Dr. M'Keen.	End of the eclipse.	0 55 27 0	— 10 47 8	21 03 0	11 40 56 2	
On the banks of Schuylkill, by Mr F. R. Hassler.	Commencement of the eclipse.	9 39 54 4	+ 25 11 5	+ 21 16 6	11 20 13 0	11 20 07 0
	End of the eclipse.	0 25 56 2	— 5 18 2	+ 16 53 9	11 20 01 0	
Lancaster, by Andrew Ellicott, Esq.	Commencement of the eclipse.	9 33 14 0	+ 26 13 0	+ 21 43 5	11 15 24 5	11 15 26 9
	End of the eclipse.	0 19 02 0	— 3 55 8	+ 16 54 2	11 15 29 3	
At the Forest near Natchez by William Dunbar, Esq.	Commencement of the eclipse.	8 05 29 0	+ 42 41 9	+ 19 44 6	10 15 21 9	10 15 21 9
	End of the eclipse.	10 38 55 0	+ 17 55 7	+ 10 08 2	10 15 21 9	
Williamsburg, by Rev. James Madison.	End of the eclipse.	0 15 06 8	— 3 09 8	+ 14 07 9	11 13 08 2	

	h ′ ″		° ′ ″
Albany west from Paris.	5 04 24 5	Latitude=	42 38 38
Kinderhook south landing.	5 04 33 0	. .	42 23 03
Chancellor Levingston's Place.	5 05 01 2	. .	42 04 39
Newburg.	5 05 22 8	. .	41 30 20
New-York.	5 05 24 8	. .	40 42 40
Philadelphia.	5 09 56 5	. .	39 57 02
Lancaster.	5 14 42 0	. .	40 02 36
Forest near Natchez. .	6 14 50 5	. .	31 27 48
Williamsburg.	5 17 04 3	. .	37 15 50
Bowdoin College, in the District of Maine.	4 49 16 4	. .	43 52 00

Albany east from Kinderhook south landing by the chronometer in time. . .	6″ 7	
by the eclipse.	8 5	
Mean.	7 6	
Albany and New-York by the chronometer. .	=	58″
Kinderhook west from Albany.		7 6
Kinderhook and New-York.		50 4
By the chronometer.		51 3
Kinderhook south landing and New-York. . .		50 8
Albany and New-York.		58 4

Fig. 1 in Plate VI, represents the total eclipse, I shall only remark, that the luminous ring round the moon, is exactly as it appeared in the middle of the eclipse, the illumination which is seen in the lunar disk, preceded 6″ 8 the appearance of the first rays of the sun. Two minutes previous to the emersion, I had fixed my eye on the point from whence it was to proceed, and as the field of the telescope did not embrace more than a third part of the disk, I could not observe whether or not the circumference of the ring was diminished on the opposite side.—In the part where the emersion took place, the ring was illuminated by degrees, and the atmosphere was more dense and brilliant near the edge of the moon. A little before the illumination of the lunar disk, I observed a zone to issue concentric with the sun, similar to the appearance of a cloud illuminated by the rays of the sun, and as it is represented in the figure, the versed sine of which was very nearly equal to that of the illuminated part of the moon.—We have seen that the radius of the luminous ring was $22\frac{1}{2}$ minutes, the horizontal semidiameter of the moon deducting the inflection 16′ 23″ 8, and the horizontal equatorial parallax at the time of conjunction =60′ 15″. With these elements if we suppose the ring to be the visible atmosphere of the moon, it would follow, that the height of the lunar atmosphere, would be 348 geographical miles above its surface, which is fifty times more extensive than the atmosphere of the earth. It will moreover appear, that such an atmosphere cannot belong to the moon, but must without any doubt belong to the sun.

If the moon possessed such an atmosphere, it would be manifested by a diminution of the duration of eclipses, and occultations.—We have seen that the diminution of the semidiameter of the moon resulting from the observations of this eclipse is 2″ 5, by comparing it with various occultations which I have calculated, the inflection appears to be 2″, it may be the effect of the irradiation of light, but supposing it even to be caused by the horizontal refraction of the moon, we know that the inflection is double the horizontal refraction. The horizontal terrestrial refraction, is nearly 33′, therefore the density of the atmosphere of the earth, is 1980 times more than that of the moon.—*We must conclude that so rare an atmosphere cannot cause any evaporation.*

Some of the lunar mountains are $1\frac{3}{4}$ miles high, and we can clearly perceive them with a telescope, which magnifies 100 times, and it is constantly observed, that the spots and inequalities of the superficies of the moon, are always seen in the same form, whence it follows, that there can be no cloud which covers even one mile in extent. Again, it has been observed that the edges of the moon emit more light than the centre, which is the very reverse of what happens in the sun, comets and planets, of which the centres are more luminous than the edges, on account of their being surrounded by atmospheres.

It has appeared to me, that the cause of the illumination of the moon, as noticed above, is the irradiation of the solar disk, and this observation may serve to give an idea of the extension of the luminous corona of the sun. Suppose then that there is no density in the lunar atmosphere.—By the preceding calculations, the apparent relative inclination of the orbits between the interior contacts was $4^\circ\ 49'\ 30''$, the duration of the total obscurity $4'\ 37''$ and the relative apparent chord $1'\ 48''\ 16$.

Moreover, the illumination preceded the emersion $6''\ 8$; we have therefore very nearly the irradiation of the semidiameter

$$\text{of the } \odot = \frac{1'\ 48''\ 16 \times 6''\ 8}{4'\ 49''\ 30} = 2''\ 6.$$

No. XLIV.

Observations on the solar eclipse of June 16th, 1806, made at Bowdoin College in the District of Maine. Communicated by a member of this Society to Mr. John Vaughan.

Read March 6th, 1807.

YOU ask for the result of the observations made at Bowdoin College, (in the township of Brunswick and district of

Maine,) on the subject of the solar eclipse, of June 16, 1806. I send it to you as I have received it from the respectable President of that institution, the Rev. Dr. M'Keen.

I shall begin by an extract from the letter of President M'Keen.

Brunswick, August 22d, 1806

"DEAR SIR,

"On several days previous to the solar eclipse of June 16th, "I paid particular attention to my clock, and by a great num-"ber of double altitudes ascertained the rate of its going. Pro-"fessor Cleaveland and Mr. Parker observed with me.

"We rated the beginning of the eclipse at . .	10h 14′ 00″	Apparent time.
"the end	12 55 20	

"As we had no micrometer fitted to either of of our tele-"scopes, we could not determine accurately, the quantity "eclipsed; but by receiving an image of the sun through a "reflecting telescope, upon a plane surface with twelve con-"centric circles drawn upon it, we were assured that it ex-"ceeded eleven digits. We did not find it easy to keep the "limb of the sun's disk long in perfect coincidence with the "arc of the greatest circle, and therefore could not measure it "with perfect accuracy. The Rev. Mr. Jenks, who assisted "me in this observation, thought it exceeded $11\frac{1}{3}$ digits; I "judged it to be somewhat less. It may be presumed there-"fore, that at the greatest obscuration, $11\frac{1}{3}$ digits, nearly, were "eclipsed.

"The latitude of the College is about 43° 53′ N; and its "longitude, as determined by an eclipse of the moon in Ja-"nuary, 1805, is 69° 50′ W. of Greenwich.

"Three or four stars, about the middle of the eclipse, were "easily seen with the naked eye.

"Professors Abbot and Cleaveland noted a series of observa-"tions of the thermometer, barometer and hygrometer of Du-"luc, during the eclipse. The barometer did not appear to "be at all affected by it; the mercury in the thermometer fell "6 degrees and rose again, and the hygrometer varied from

"59 to 57 and returned after the eclipse nearly to its former "position."

I shall now proceed to give you the supplementary remarks which have been furnished by Professor Cleaveland.

"Our large *reflecting telescope* has the magnifying power of "450. I used the shortest eye-glass and middle-sized specu- "lum, which, if I am correct, magnifies 360 times.

"The President used his own telescope, and left the ma- "nagement of the large one to myself.—Its magnifying pow- "er is so great, that fearing lest I should not discover the com- "mencement of the eclipse, I kept the telescope in a slow mo- "tion, ranging backwards and forwards in a small arc. The "telescope was probably at one extremity of this arc, while "the immersion actually took place, for at the moment when "it was actually discovered by the telescope belonging to the "equatorial, I moved my telescope, and found the shadow "must have been discoverable two seconds at least. I allowed "one second for the motion of the telescope, after the eclipse "was seen by the observer with the equatorial, and the time "of the commencement was noted one second back accord- "ingly. This perfectly agreed with the observation of the "emersion.—We had some one at the clock, counting seconds; "and the shadow was visible one second longer by the large "telescope, than by the other, which circumstance was con- "sidered confirmatory of the allowance of one second made at "the commencement." So far the college observations extend.

I do not recollect to have heard of any accurate astronomical observations, made in the United States to the north of Brunswick.

No. XLV.

On finding the longitude from the moon's meridian altitude, by William Dunbar of Natchez.

Read August 15th, 1806.

THE usual mode of making the lunar observation for the purpose of ascertaining the longitude, requires the aid of a chronometer or good watch, to a single observer, and as time-pieces of a delicate construction are liable to derangement, the discovery of a method, by which one observer without a knowledge of the precise time, may be enabled to ascertain his longitude, becomes a desideratum of value.

There are two portions of time during each lunation, when the moon's change of declination is sufficiently rapid to afford the means of solving this useful problem; those times are, when the moon is on or near the celestial equator, and may be extended to four or five days at least, i. e. two before and two after the day on which the moon crosses the equator: the moon's change of declination in the most favourable circumstances, exceeds 6° in twenty-four hours, or 15″ in one minute of time and although this is scarcely half the moon's motion in longitude, yet it is to be remembered, that this method is no other than a meridian altitude, which may be taken to a degree of precision, never to be attained in the usual manner of taking the moon's distance from a star, and if the altitude be taken at land, with the aid of a mercurial horizon, the double angle will place this method on a footing of equality (nearly) with the usual mode, in respect to the moon's change of place, other circumstances being in its favour. The accuracy of this method, depends upon the correctness of the lunar meridian altitude, and the precision with which the latitude of the place of observation has been ascertained.

At sea, this method cannot always be used to advantage, on account of the ship's change of place, which might render the latitude doubtful to several minutes, and thereby affect the longitude an equal number of degrees.

The moon's greatest altitude being taken, a correction becomes necessary, because the greatest altitude is not on the meridian, but to the east or west, according as the moon is increasing or diminishing, by change of declination, her zenith distance, and which may be calculated as follows.—Having cleared the moon's apparent altitude from the effects of refraction and parallax, the difference between it and the co-latitude of the place of observation, will give the moon's declination nearly, from which by even proportion may be found, the approximate time at Greenwich: for this time find the rate of change of the moon's declination for one minute of time, and also the difference between the moon's meridian altitude, and its altitude one minute before or after, caused by the diurnal rotation of the earth, combined with the progress in right ascension; those two effects may be considered (at small distances from the meridian) as operating in the same line, and in opposite directions. Put x, to represent the time from the meridian, when the moon's altitude will be the same as when on the meridian, a, for the change in declination, and b, for the depression from the meridian in one minute of time; the first increases or diminishes in the direct, and the second (for small quantities) in the duplicate ratio of the times; hence we shall have $bx^2 = ax$, and therefore $x = \frac{a}{b}$; i. e. the time (in minutes) from the meridian, when the change in declination will be equalized by the depression, will be found by dividing the change of declination by the depression for one minute of time; at half this distance in time from the meridian, the change in declination will be double the depression, and will be the maximum, or point of greatest altitude, therefore $\frac{a^2}{4b}$ will represent the correction; i. e. the square of the rate of change of declination, divided by four times the depression for one minute of time, will be the correction for the moon's meridian altitude; which may be conveniently found by the following formula, expressed in logarithmic language.

RULE.

To twice the sine of 14′ 29″ 5 add the arith. comp. of the sine (or cosecant) of 1′ and the logarithm of 120, the sum, abating 20 from the index, will produce the constant logarithm .8651414. To the constant logarithm add the cosine of the declination of the moon, the cosine of the latitude, and the arith. comp. of the cosine (or secant) of the altitude, the sum, rejecting tens from the index, will be the logarithm of four times the depression, which subtracted from twice the logarithm of the rate of change of declination for one minute of time, the remainder will be the logarithm of the correction in seconds.

EXAMPLE.

Given the moon's greatest altitude near the meridian, corrected from the effects of paral. and refraction, 45° 40′ 20″ 59; the latitude of the place, 32° 29′ 25″, and therefore the moon's declination (nearly) is 11° 50′ 14″ 41.

Constant logarithm. . .	.8651414	Change in declination for 1′ of time	12″ 86
Decl. 11° 50′ 14″ 41 cosine.	9.9906648	Logarithm of ditto. . . .	1.1092412
			× 2
Lat. 32 29 25 cosine.	9.9260761	Square of change of decl.	Log. 2.2184820
Alt. 45 40 20 59 cos. ar. co.	.1556719	4 times the depression.	Log.—.9375542
Log. of 4 times the depression.	.9375542	Cor. for mer. alt. 19″ 096	Log. 1.2809278

The correction being found by the foregoing formula, is to be subtracted from the greatest altitude, cleared of the effects of refraction and parallax, the remainder will be the true altitude of the moon, when she was on the meridian. The difference between the corrected altitude of the moon's centre on the meridian and the colatitude, will be the moon's true declination, when on the meridian: the time at Greenwich, when the moon had that declination, being found, and also the time of the moon's transit over the meridian of Greenwich, take their difference, take also the difference of the increase of the A. R. of the ☽ and ☉ for the interval of time elapsed in passing the two meridians, which last difference being subtracted from the first difference, the remainder will be longitude in time.

In order to calculate with sufficient accuracy, the times corresponding to the moon's declination, and her transit over the meridian of Greenwich, it will be necessary to prepare four right ascensions and four declinations of the moon to seconds, which in the nautical almanac, are set down to minutes only, by the aid of which, with the tables of second differences, we can find very correctly the times which are sought, and in regard to the moon's declination, the effects of aberration and nutation should not be omitted, because an error of seconds in the calculated declination, might produce an error of a like number of minutes of a degree in the longitude; those effects though of less importance in the moon's right ascension, may also be brought into calculation.

EXAMPLE I.

On the evening of the 10th of November, 1804, at Fort Miro, on the river Washita, took the apparent double altitude of the moon's lower limb (greatest) near the meridian, 89° 17′ 20″, index error + 13′ 47″ 5, the latitude of the place of observation 32° 29′ 25″. Required the longitude.

	° ′ ″
Double altitude of ☽'s lower limb.	89 17 20
Index error	+ 13 47 5
	2) 89 31 7 5
Apparent altitude of ☽'s lower limb.	44 45 33 75
Effects of refraction and parallax.	+ 39 8 36
True altitude of ☽'s lower limb.	45 24 42 11
☽'s semidiameter and augmentation.	+ 15 38 48
Altitude of ☽'s centre.	45 40 20 59
Correction by formula.	— 19 10
True altitude of ☽'s centre on meridian.	45 40 1 49
Colatitude.	57 30 34 91
☽'s declination on the meridian.	11 50 33 42

Rate of change of ☽'s declination in 1′ of time by even proportion.	13″ 25
Correct by second differences.	— 0 39
True rate of change per minute at 12h 40′ Greenwich time.	12 86

	h ′ ″
Appt. time at Greenwich when the ☽ had this declination by even proportion.	12 39 56 17
Correct by the equation of second difference.	+ 1 15 09
Apparent time at Greenwich when the ☽ was on the meridian of Fort Miro.	12 41 11 26
ditto. at ditto. when the ☽ was on the mer. of Greenwich interpolated.	6 22 39 22
Diff. of appt. time corrected by the equation of time —1″ 74 gives mean time.	6 18 30 3
Difference of increase of A. R. of the ☽ and ☉ during the interval.	—11 41
Longitude of Fort Miro.	6 6 49 3

Comparison of the above with other results.

	h ′ ″
Longitude deduced from a mean of six distances of the sun west of the moon.	6 5 59
a mean of three distances of α Arietis east of ditto.	6 7 40
Longitude. . . . . a lunar eclipse 14th of Jan. 1805, (a fine observation.)	6 6 42 5
Mean longitude of Fort Miro, differing from the result by the meridian altitude, only 2″ 13, or about 32″ of a degree.	6 6 47 17

EXAMPLE II.

October 7th, 1805, at the Forest plantation, latitude 31° 27′ 48″, observed the apparent double altitude of the moon's lower limb (greatest) near the meridian, 133° 11′ 14″

The index error being subtractive, add the lesser contact of the sun with his image taken immediately after observation. 15 30

			2)133 26 44
Lat. 31° 27′ 48″	.	Apparent altitude of the ☽'s centre.	66 43 22
Colat. 58 32 12	.	Parallax and refraction. . . .	+ 22 41 75
		True altitude of the ☽'s centre. .	67 6 3 75
		Correction per formula. . .	—11 43
		True alt. of ☽'s centre on the mer.	67 5 52 32
		Colatitude.	58 32 12
		☽'s declination when on the meridian.	8 33 40 32

	h ′ ″
Appt. time at Greenwich when the ☽ had this declination by even proportion	17 43 52 18
Correction by the equation of second difference. .	— 2 12 47
Appt. time at Greenwich, when the ☽ was on the mer. of place of observation.	17 41 39 71
Appt. time corrected, when the ☽ was on the meridian of Greenwich. .	11 24 18 15
Difference of apparent time.	6 17 21 56
Correct for the equation of time.	+ 4 39
Difference in mean time, of the ☽ passing the two meridians. . . .	6 17 25 95
Difference of A. R. of the ☽ and ☉, gained during the interval. . .	—12 5
Longitude of the place of observation.	6 5 20 95

Mr. Ellicott has made 30 calculations, on which he seems to rely for the longitude of the Natchez, (others were rejected,) his extreme results are 6h 4′ 27″ to 6h 6′ 41″, and a mean of the whole is 6h 5′ 49″. The position of the Forest plantation is about 2¼ miles east of Natchez, i. e. 9″ in time, which being added to the above result, gives 6h 5′ 30″ for the longitude of Natchez, differing from the mean of Mr. Ellicott's observations 19″ or 4¾ miles.

An immersion of Jupiter's 1st satellite was taken just before his opposition, and an emersion of the same soon after, and as they were probably both affected by the near vicinity of the light of Jupiter's disk, but acting in contrary directions, a mean of the two results may be supposed near to the truth, subject to the correction which the Greenwich calculations may require.

June 11th. By an immersion of Jupiter's 1st satellite. .	6h 5′ 41″ 4
July 6th an emersion of ditto.	6 5 12 19
Mean longitude.	6 5 26 8

The mean differs only 5″ 8, nearly 1¼ mile from the result of the meridian altitude.

☞ In the above method of finding the longitude, as a small error in the meridian altitude of the moon, will produce a considerable one in the longitude, a correction ought to be applied on account of the spheroidal figure of the earth.......... EDIT.

No. XLVI.

An account of the Freestone quarries on the Potomac and Rappahannoc rivers, by B. H. Latrobe.

Read February 10th, 1807.

ON the 19th of December, 1798, I presented to the American Philosophical Society, a memoir on the sand hills of Virginia, which the Society did me the honor to publish in the fourth volume of their Transactions, page 439.—It was my intention then, to have offered to the Society, a series of geological papers, the materials of which I had collected, and of which this memoir was the first. But my intention was delayed and partly defeated by the loss of a very large collection of all the principal fossils, necessary to elucidate my observations, in their passage by water, from Fredericksburg to Philadelphia.—This collection, intended for the American Philosophical Society, was made by the industry of my excellent friends, Mr. William Maclure now at Paris, of the late Dr. Scandella whose untimely death in 1798 science and friendship equally have to deplore, and of myself.—It consisted of specimens of loose and undecayed fossil shells, found on and near *the surface*, from the coast to the falls of the rivers of Virginia, of the shell rocks of York river, of the clays with impressions of shells in every fracture, but which shew no remaining evidence of any calcareous matter when subjected to chemical tests; of the exuviæ of sea animals*, bones of fishes, sharks' teeth, marsh mud, fossil wood and coral rock, dug from the deep wells about Richmond, of the marles of Pamunky and Mattapony, of all the strata of the coal mines on James's river, of the varieties of the granite of Virginia, of the free stone of James's river and the Rappahannoc, with the vegetable petrefactions and coal belonging to it; and of a variety of miscellaneous fossils.—My object in reciting

* Drawings of some of the exuviæ accompanied my memoir, to which refer.—The bones of the foot there represented, are probably those of a sea tortoise. Vide Vol. IV. p. 444

this catalogue, is to encourage some member of the Society, who may read it, and whose opportunities of collection are better than my own, to remedy this loss.—All these specimens may be procured with very little trouble in Virginia.

The loss of this collection dispirited me, and the occupations of a most laborious profession deprived me of time. Having now for some years waited in vain, for the leisure necessary to reduce into something like system, the various notes I have made, I must content myself with giving to the Society, unconnected papers, which will contain the facts collectively, proving beyond doubt, that a line drawn along the falls of our rivers, is the ancient line of our sea coast, from New-York to the south west; as it still is from New-York to the north eastward, and that the water of the ocean rose, perpendicularly, at least 120 feet higher along the ancient coast, than it rises along our present coast.—And lest this assertion should appear extravagant, I will here mention, somewhat out of place, that in the year 1796, I followed with a spirit level, in the neighbourhood of Richmond, the pebble stratum, which has all the external appearance of a sea beach, for more than five miles, and found it a *perfect level,* elevated about 120 feet above the tide at Rockets.—The subject of my present communication, is immediately connected with the memoir on the sand hills of Virginia. Its object is, to give to the Society, an account of the freestone quarries on the Potomac and Rappahannoc, from the former of which, the freestone employed in the public buildings of the United States at Washington, is obtained.—The range of sand stone rocks in which the quarries are situated, was, in fact, the ancient sea coast, bounded by sand hills like the present, and the description which I shall give of them, will, I believe, remove all doubt on this subject.

On consulting the map of the middle states, it will be found, that the river Potomac, at the confluence of the river Piscataway, in Maryland, a few miles above Mount Vernon, takes a remarkable turn to the south of west, and continues to run in a south westerly course, as far as the confluence of Acquia creek, on the Virginia side, when it gradually turns to the east of south, and in the course of ten miles lower, pursues a north easterly direction. At the point at which the Potomac again resumes its course eastward to the ocean, its distance from the river Rappahannoc does not exceed six miles in a straight line. High land separates these streams.—The navigation of the Potomac is much superior to that of the Rappahannoc, and very great advantages would accrue from their junction at this point; but the task of connecting them by a tunnel through this narrow ridge, must be reserved for wealth and population infinitely superior to that of the present age.—From Piscataway to *Potomac creek*, the course of the river Potomac is parallel to that of the sea coast, and measuring along a line running about S. 60° east*, the distance from the present coast will be about 120 miles.—The range of sand stone rock lies on the west side of the Potomac, beginning a few miles below the bend, and continues running in a direction parallel to its south western course, until the river again turns to the eastward.—There it crosses under the ridge which separates the Potomac from the Rappahannoc, reaches and crosses the Rappahannoc, and appears to run out about two miles on the west side of this river.—I have not seen, or heard of its having been found further to the south west for 50 or 60 miles, but it is again found 12 miles above the foot of the falls of James's river, in a situation much higher above the tide, than at the Potomac and Rappahannoc, a situation apparently inexplicable upon any supposition which applies to the sand rocks of these latter rivers; and yet, so exactly similar are these James's river rocks, in all their geological characteristics, that it is impossible not to attribute their formation to the same process of nature. The present state of these rocks is very irregular.—They make their appearance upon the slopes of the vallies and water courses, along the whole line which I have described, in large disrupted masses, or in regular ranges,

* The courses of north 40° east, and south 60° east, form a spherical angle, at which, *with occasional, but never very great variation,* the two principal planes of Rhomboidal crystallization, not only of our rocks of every description, granite, slate, marble, limestone, wacke, and of all those numerous and ambiguous genera of rocks, lying in character, between a distinct granite on one side, and homogenous basaltes on the other, intersect each other, but which decide the position.—I had almost ventured to say the crystallization of the constituent parts of the globe, from the equator to the pole, and from the Mississippi at least to the Atlantic. On inspection of any map of North America, especially if drawn on Mercator's principle, this fact is evident to the eye.

the external parts of which are generally weather-worn, flaky and broken. The most extensive ranges are found in elevated situations.—In the bottoms of vallies the masses that are found there, appear to have fallen or slided down into the water course, and the large masses that form the shore of Potomac and Rappahannoc, are evidently much below their original position.—On quarrying into the rock, the stone is found to be amorphous, often *stratified* with layers of clay or pebbles between the strata, having also frequently upright joints or fractures, so regular as to look like planes of crystallization. The stone is however undoubtedly amorphous and aggregate. The sand stone is covered with a superstratum of alluvial materials, deposited to appearance, subsequent to the formation of the stone; as sand, clay, gravel and pebbles, large and small, rounded by attrition out of many species of mountain stone. Along this superstratum is found the ancient pebble beach, mentioned above, it forms the soil of the high land of the country, is from ten to thirty feet deep, and where it is thinner along the edges and slopes of the vallies, it seems to have been washed away; for in considering the whole country, below the falls of our rivers, we must necessarily perceive, that, if the phrase may be admitted, it has no hills, but only vallies; that is, it was originally a plain, into which the vallies have been gullied by the drainage of water, on the receding and depression of the ocean from its former level of 120 feet above its present elevation. As I am not going to form any hypothesis, the difficulty arising from the existence of the ancient pebble beach, at an elevation considerably above the still more ancient sand beach, presents to me no difficulty in my opinion of the origin of this sand stone.

The component parts of the stone are,

Sand, generally sharp, but often rounded by attrition, of variously sized grains, from very coarse to extremely fine.—This forms the mass and body of the stone:—in this sand is found a variety of extraneous matters.

Clay, in nodules, generally round, sometimes, but rarely, stratified as if deposited. The clay is white and remarkably pure. The clay holes are very troublesome to the stone cutter and diminish the value of these quarries exceedingly, They are found from the size of a pea, to many inches in diameter.

Pebbles, large and small, of quartz, sand stone, granite, whin, rounded by attrition, and amorphous lumps of quartz.

Pyrites, or lumps of marsh mud mixed with sulphat or sulphuret of iron, efflorescing in the air. Often when one of these pyrites happens to be concealed near the surface of a wrought stone, so that the air and water may reach it, it swells and bursts the stone, thereby defacing the work. This is another disadvantage in using it.

Nodules of iron ore in sand, these nodules dissolve in the air and water, and stain the stone disagreeably. In a spherical hole of the stone, I once found a nest of very beautiful parallelopipedal crystals, quite transparent. I had no opportunity of examining them chemically.

Wood, from trunks and branches of trees of large size, to small twigs, either entirely carbonated, or the wood carbonated and the bark in a fibrous state, so as to have the appearance of a net, and a considerable degree of tenacity; or the bark fibrous, and the wood in a state quite friable; or the wood replaced by pyrites, which effloresce in the air*; or in *cavities*, the sides of which have the impression of branches, in minute ramification, and are lined with a pellucid crust, probably calcareous spar. This latter evidenee of the admixture of wood, is to be found chiefly near Fredericksburg.

Iron, appearing in stains, either of masses, or in dark ferruginous spots and clouds; and *clay*, infused through the whole mass, with probably an infusion of lime, which appears to be the cement by which the sand particles are held together; for the acids indicate no existence of carbonate of lime, and I have not yet been able to submit the stone to any chemical examination.

* I had a piece of this species of pyrites, in appearance the branch of a tree, with a small twig attached to it; about 3 inches long. and $\frac{3}{4}$ of an inch diameter, very hard and heavy, I carried it in my pocket for a fortnight, and then threw it into a small box in my office, containing drawing instruments. It remained there for two years, but last summer during very damp and hot weather, it effloresced, and fell into powder, corroding and injuring my instruments exceedingly.

Native allum, is found on the lower projecting surfaces of the rocks, where they are in wet situations, probably produced by the sulphur of the pyrites combining with the clay of aggregation.

The colour of the stone varies from white to a dark rusty tint. Herewith I present to the Society, two blocks, the one of the whitest, the other of the darkest tint. The dark block was, when cut, of a rusty brown, but wishing to weigh the stone in its driest state, I placed it on the plate of an iron stove. In a quarter of an hour its colour was changed almost to black.

The degree of hardness is very various. When moderately hard, its fracture is rough and irregular, when very hard, concave and even, when breathed upon, it has a strong earthy, and somewhat hepatic smell.

The specific gravity of the stone is as various as its colour and texture. The two blocks herewith presented, are very accurately four inches square and two inches thick.—They weigh as follows:—

The brown block 2lb 6.69oz Averd.
white block 2 3.96
———— . . . . difference 2.73oz

54 of these blocks make a cube foot, therefore the difference of weight in one cube foot, between the white and brown stone would be, 9lb 3.42.oz

The white block absorbed in 24 hours, of river water 6.25oz, or at the rate of upwards of 21lb per cubic foot.

One of the most remarkable circumstances belonging to this stone, is the arrangement of the particles of sand of which it consists. In whatever direction a block is cut, the successive accumulations or strata, which may be easily distinguished by the different size of the grains, their colour, the admixture with other substances, and their *individual* parallelism, appear not to lie in beds parallel to each other, but in masses bounded by wavy lines; or which are suddenly cut off by other masses, the lines of which wave in another direction; and this appearance is such, that many stones exhibit by the lines of their strata, a good representation of the wavy hills of the sand coast, as will be seen by reference to the plate in the fourth volume of the Transactions of the Society.

This mode of stratification appears to me to be an incontestible proof, that the wind has been the agent of accumulations of the sand of which the stone consists, as it is now of the sand hills of our present coast. For if it could be supposed, that the agitation of the surf, or of the whirls which occur in all water running through an interrupted course, could have caused this appearance, it would have occurred, as in cases where there is no doubt of aqueous deposition, that the stone would have separated more easily at the lines of stratification than elsewhere. But such is not the case in this stone, for it is as solid at the lines separating the strata as elsewhere.

As the difference of granulation is exceedingly various, often within a very small space, so is also the cohesion of the stone very uncertain. Often with the fairest prospect of a hard sound mass of rock, of great depth and thickness, the quarrier suddenly strikes into a mere friable sand bank. Quarrying is therefore a lottery, in which the blanks are often more numerous than the prizes.

The quality of the stone, as a building material, is also in other respects various. Of the stone most even in its grain and texture, most pleasant to work, and of the most durable appearance, a great part cracks and falls to pieces, on exposure to the sun and air, especially if rapidly dried, after being taken from the quarry. Sometimes contrary to all expectation, the frost tears it to pieces.—All of it expands when wet, and contracts in drying. This property it seems never to lose. When buried in the walls of a heavy building, it is controuled by the incumbent weight, but those blocks that are more at liberty, either at one or both ends, are subject to this variation of size; and the joints of the work open and shut, according to the dryness or humidity of the weather. Window and door selles therefore, which are confined at both ends, and free in the middle, generally break, and the fissure opens and shuts alternately, to the amount, when open, of one tenth of an inch in a block of six feet.

Below the freestone is found, on *Potomac*, most frequently loose sand, sometimes a stratum of round gravel or pebbles,—seldom clay,—very often loose stone very full of carbonated wood:—on the *Rappahannoc*, loam, marsh mud, quicksand, clay and dry sand:—and *near Mansfield* below Fredericksburg, the largest mass of timber, which I have yet seen:—on *James's river*, sand, gravel, loam. The wood mixed with the stone on James's river, is, I think, less carbonated than on the Rappahannoc and Potomac.—The superstrata are generally, soft clay, loam, and tolerably pure clay, in a state of excessive compactness. On the level country, light loamy sand, and on the slopes of the vallies, *the line of sea beach* above mentioned, often washed and spread over the declivity, often in heaps and ridges. But it will be observed by any traveller, that neither in the bottoms of vallies, out of the beds of the present rivers, nor on the tops of the levels, is gravel to be found.

The superstrata however vary considerably, in one of Mess. Cook and Brent's quarries on Acquia, the following are the strata:—

	ft.	in.
Mould.	0	4
Loam, with some gravel.	3	0
Coarse, irregular, ill compacted, disrupted sandstone	5	0
Gravel, hard clay, lumps of coarse sandstone.	10	0
Four strata of marsh mud, and four strata of excessively hard and pure clay, alternately, one foot thick each lying quite horizontally.	8	0
Loose sand.	3	0
	29	4

Very excellent and solid freeestone, containing fewer clay holes and less wood or iron than ordinary, 8 feet, and running out landwards to 2 feet.

Then sand of great depth.

The best quarry now in work, lies two miles S. W. from Acquia creek, and belongs to Mr. Robertson. Like all others, it is on the top of the slope of a valley, and the face shews as follows:—

	ft.	in.
Mould.	1	0
Clay, very hard, and some gravel.	2	0
Rough disrupted sandstone.	2	0
Loose sand.	2	0
Sound and excellent rock.	15	0

Under the rock fine loose sand.

In this rock, which runs N. E. and S. W. there is no joint horizontal or perpendicular, and columns of any size, not exceeding 15 feet diameter, might be got out of it, if they could afterwards be removed.—The largest blocks however which I have had taken out, do not exceed in weight four tons.

In working these quarries, the workmen having cut the face perpendicularly, first undermine the rock;—an easy operation, the substratum being loose sand. If the block is intended to be 8 feet thick, they undermine it 5 feet, in a horizontal direction, in order that it may fall over when cut off. They then cut two perpendicular channels on each hand, 1ft. 6in. wide, at the distance from each other of the length of their block, having then removed the earth and rubbish from a ditch or channel along the top of the rock, they cut into the rock itself, a groove, and put in wedges along its whole length. These wedges are successively driven, the rock cracks very regularly from top to bottom, and it falls over, brought down partly by its own weight. Blocks have been thus quarried 40 feet long, 15 feet high, and 6 feet thick. The block which was quarried at my last visit to the quarry, was of the following dimensions:—

26 feet long, $\times$ 8 feet deep, $\times$ 14 feet high $= 2912$ feet, which at 15 feet to the ton, agreeably to the quarry rate, amounts to near 200 tons.—These masses are then cut by wedges into the sizes required.

On referring to my memoir on the sand hills of cape Henry, it will be seen that the sand is blown up from the margin of the sea, inland;—that it soon forms a ridge or down of shifting sand, along the shore above high water mark, covering the old surface of the earth with all its vegetation, that in the course of no very great length of time, it accumulates into hills that destroy and swallow up forests in their progress; that its surface is constantly changing with the operation of the wind:—and that, therefore, this sand mass, must contain broken limbs and bodies of trees, iron in greater or less quantity, together with all kinds of extraneous matters, blown up from the ocean by storms, as clay and mud, mixed with sea water, when a tremendous and muddy surf is blown ashore through the air by violent winds. If we now suppose, that by any operation of nature whatever, these sand hills from a loose state were to become concrete, the rock thus formed, could not in any of its characters differ from that which now forms the freestone quarries of which I am speaking.

These considerations therefore irresistibly impress the belief that both masses are of the same origin.—The disrupture of the ancient hills, is not difficult to account for, if we suppose the ocean to have retired so much below its ancient level, as appearances seem to prove, the sand hills would be undermined by the water from below them, seeking the lower level of the sea, and washed to pieces by the torrents from above. Thus masses of stone, undermined and broken, would fall into the bottoms of the new vallies, and appear on the levels of the present rivers, while others would retain their original situation high above the new level of the sea.—Thus far, rational conjecture will lead us, but further we cannot venture.—Who can answer the questions that then present themselves? If these concreted sand hills were once the ancient shore, rising above the level of the ancient ocean, at what æra was the gravel beach created at their summits? or the marine exuviæ deposited far below their base, as well as upon the mountains rising thousands of feet above their tops? It is fortunate that the solution of these ænigmas of nature are of no consequence whatever to our happiness, or of use to our enjoyments.—But the pleasures of investigation, and of *wonder*, the offspring of ignorance, are not without a charm, which often entices the mere speculative philosopher into researches that produce results beneficial to mankind.

I will here close my description of these sand rocks, and endeavour to find an early opportunity of transmitting to the Society some further remarks upon those of James's river in particular, connected with that most singular and unaccountable region,—the coal region, of which I will only at present hint, that it appears formerly to have been a spacious lagoon of the sea, of which these particular sand hills are the shore.

B. HENRY LATROBE, F. A. P. S.

Surveyor of the Public buildings of the U. States.

No. XLVII.

Further Observations on the Eclipse of 16th June, 1806, being an Appendix to No. XLIII, page 264 of this Volume, by J. J. de Ferrer.

Read April 17th, 1807.

SINCE the Memoir was printed I have received the following observations.

At the Hydrographic Repository at Madrid, Don Philip Bauza lieutenant in the Royal Navy, observed the beginning of the eclipse at $4^h\ 27'\ 48''\ 6$, and the end at $6^h\ 09'\ 07''\ 2$ apparent time. Latitude of the Repository $40^\circ\ 25'\ 08''$. Longitude west of Paris $24'\ 08''$ in time. Magnifying power of the telescope 110.

At the Royal Observatory in the Island of Leon, Don J. M. de la Cuesta, lieutenant in the Royal Navy, observed the commencement $4^h\ 18'\ 42''\ 2$ apparent time. The end was not observed on account of the clouds. Latitude of the observatory $36^\circ\ 27'\ 45''$. Longitude west of Paris $34'\ 08''$.—Magnifying power of the telescope 53.

I have re-calculated all the observations of page 273, making use of the new solilunar tables, published in Paris, 1806, by the Commissioners of longitude. They are as follows, for $4^h\ 29'\ 41''$, mean time in Paris.

	° ′ ″
Longitude of the ☉'s apparent equinox.	84 44 37 2
Idem. ☽'s	84 44 47 8
North latitude of the ☽	00 19 19 3
Horary relative motion in longitude.	34 18 5
Horary motion in latitude, south.	3 23 6
Horizontal equatorial parallax of the ☽.	60 15 8
Idem. ☉.	8 6
Horizontal semidiameter of the ☽.	16 26 85
Horizontal semidiameter of the ☉.	15 46 04
Horary increase of the ☽'s parallax.	1 10
Increase of the ☽'s horary movement.	1 41

The other elements are the same as those in page 270.

Comparing the commencement at Madrid, with the commencement at the island of Leon, it appears that the observation at Madrid was delayed 7″.

Combining the beginning at the island of Leon with the end observed in Madrid, supposing the sum of the apparent semidiameters diminished 4″ 5 for the irradiation, we have the conjunction in Paris mean time 4ʰ 30′ 11″ 6. Correction of tables in latitude of the moon=+10″ 9.

In Boston, latitude 42° 21′ 13″, longitude west of Paris 4° 53′ 28″, it was observed by three persons with achromatic telescopes, which I shall distinguish by the numbers 1, 2, 3.

	Beginning of the Eclipse. h ′ ″	Total obscurity. h ′ ″	End of obscurity. h ′ ″	End of the Eclipse. o ′ ″
No. 1.	10 03 21	11 22 31	11 27 09	0 48 01
2.	10 03 21	11 22 31	11 27 09	0 48 59
3.	10 03 20	11 22 40	11 27 08	0 48 07

The state of the chronometer is not known, because no observations were made to ascertain the time, and the only use that can be made of these observations, is to determine the error of the tables in latitude, or, knowing this element, to determine the difference of the semidiameter of the sun and moon.

I have again examined the corresponding altitudes observed by M. de Witt at Albany, and have determined that

	h ′ ″
The commencement of the total obscurity, mean time.	11 08 14 6
End. ditto.	11 13 05 6
Duration according to M. de Witt.	4 51

Applying the calculation to the observations of Kinderhook, supposing the correction of the tables in latitude =+ 10″ 9 as it results from the observations of Madrid and the island of Leon.

We have irradiation of the semidiameter of the ☽.	=−3″ 25
Idem. ☉.	−1 25

With these elements we have the conjunction

At Kinderhook.	Mean time. h ′ ″	
For the beginning of the eclipse.	11 25 40 9	11h 25′ 40″ 7
Total obscurity.	11 25 40 7	
End of total obscurity.	11 25 40 7	
End of the eclipse.	11 25 40 5	
In Albany with the same elements, conjunction in mean time.		
For the beginning of total obscurity.	11h 25′ 47″ 2	
End. ditto.	11 25 57 0	

Comparing the beginning of the total obscurity at Kinderhook with the beginning of the total obscurity at Albany, it results that Albany is east of Kinderhook. . . = 6″ 5

By the chronometer, page 269. . . . = 6 7

This determination appears to be correctly ascertained, and to prove indubitably, that there was an error of about 10″ in the end of total obscurity: it will not be improper to note that the interior contacts are instantaneous, and therefore the half second easily distinguishable.—Therefore the error should be attributed, to taking one decimal for another, the same remark should be made on the Boston observations.

Indeed, on applying the calculation, it results that the number 3, in place of taking 11h 22′ 30″, made a mistake and took 11h 22′ 40″, so that the duration of total obscurity No. 1, 2, appears to be the most likely to be correct.

Suppose the longitude of Boston 4h 53′ 28″, we have the chronometer slow to mean time 2′ 02″.

	′ ″
Duration of total obscurity by observations 1 and 2.	4 38
In Albany.	4 41
In Kinderhook.	4 37
In Boston the shortest distance from the centres.	14 7 N.
Albany.	6 1 S.
Kinderhook.	9 7 N.

As the moon at Albany passed to the south of the centre of the sun, and in Kinderhook and Boston to the north of it, by combining the three observations, the result is as follows:

Correction of the tables in latitude.	+ 10″ 5
Irradiation of the ☾'s semidiameter.	3 15
Irradiation of the ☉'s semidiameter.	1 35

With the same elements we have the conjunction in Lancaster.

For the beginning 11h 15′ 25″ 3 mean time.
End. . 11 15 31 9 ditto.

It appears that the commencement has been anticipated 6″ or 7″ by some error, let us see whether this doubt can be cleared up.

The solar eclipse of the 26th of June 1805 was observed by Mr. Ellicott in Lancaster.

Beginning, apparent time.	6h 43′ 26″	from whence diff. of mer.	= 9′ 16″
Observed by myself in New-York.	6 50 10		
Kinderhook east of New-York page 269.			0 51 3
Kinderhook east of Lancaster.			10 07 3
Comparing the beginning at Lancaster, with the commencement observed at Kinderhook, June 16th, 1806.			10 14 6
Ditto the end at Lancaster with the end at Kinderhook.			10 08 6
By this comparison it appears that the error is in the commencement at Lancaster, and that the difference of the meridians of the two places is			= 10 08 6
At Mr. Dunbar's habitation near Natchez, the conjunction	by the Commencement		10 15 22 7
	———End.		10 15 21 0

These results confirm the allowance of the irradiations of the semidiameters which I have adopted, it being very probable that the beginning was delayed 2″.

M. De Lalande, member of the Board of longitude, has favored me with an answer to the observations I communicated to him, it is dated Paris, 27th September, 1806, and states that he had calculated my observations at Kinderhook, and that he found

	h ′ ″
The conjunction in mean time	11 25 39 65
In Paris by the observations of Europe.	4 30 12 65
Difference of meridians.	5 04 33 00
This result is the same with that established in page 273. By the observations of Mr. Patterson we find	
The conjunction in mean time at Philadelphia.	11 20 17 0
Philadelphia west of Paris by the mean result of many observations.	5 09 56 5
Result, conjunction in Paris mean time.	4 30 13 5
By the observations at Madrid and the island of Leon.	4 30 11 6
By M. Lalande.	4 30 12 6
Conjunction mean result.	4 30 12 6

Determination of the longitude of Natchez and New-Orleans.

		h ′ ″
By comparison of the end observed in Kinderhook, with the end observed at Mr. Dunbar's house,—longitude west of Paris.		= 6 14 51 5
The Fort of Natchez west.		9
Fort of Natchez west of Paris.		6 15 00 5
New-Orleans west of Paris page 222.	= 6h 09′ 46″	
Fort of Natchez west of New-Orleans page 159 =	5 16	
Fort of Natchez west of Paris		6 15 02 0
Fort of Natchez west of Paris mean result.		6 15 01 0
New-Orleans. ditto.		6 09 45 0

Table of the results of geographical positions which should be substituted for those in page 273.

	Long. W. from Paris. h ′ ″	Latitudes. ° ′ ″
Bowdoin College.	4 49 16	43 52 00
Albany.	5 04 25	42 38 38
Kinderhook south landing.	5 04 32	42 23 03
Chancellor Levingston's place.	5 04 58	42 04 39
Newburg.	5 05 21	41 30 20
New-York.	5 05 23	40 42 40
Philadelphia.	5 09 57	39 57 02
Lancaster.	5 14 41	40 02 36
Williamsburg.	5 17 04	37 15 50
Fort at Natchez.	6 15 01	31 33 48
New-Orleans.	6 09 45	29 57 30

Sum of errors of the longitudes of the moon and sun or correction to be subtracted from the new tables, supposing exact the longitude of the sun =−27″.
North latitude of the moon in conjunction at 4h 30′ 12″ 6=19′ 27″ 1
Correction of the Tables = + 10″ 9

Investigation of the semidiameters of the sun and moon.

The horizontal semidiameter of the ☽ in conjunction is by the tables	16′ 26″ 85
idem. ☉	15 46 04
Difference of the horizontal semidiameter by the tables	40 81
Supposing the correction of the tables in latitude of the moon.	=+ 10″ 9 then
Difference of the horizontal semidiameters in conjunction.	
For the observed duration of total obscurity at Kinderhook.	38 72
For Albany, supposing the duration of total obscurity 4′ 41	38 85
For Boston, ditto ditto. 4 38	39 64
Mean difference of the horizontal semidiameter in conjunction.	39 07

It is to be remarked that the difference of the semidiameters, resulting from the total eclipse is that of the lowest points of the moon's surface, as, according to the statement, page 266, "4″ or 5″ before the total obscurity, the remainder of the disk "of the sun was reduced to a very short line, interrupted in "many parts."

At this time the most prominent points of the lunar disk were projected on the sun; consequently, the duration of the total obscurity, had it not been for the concavities of the limb of the moon, would have been at Kinderhook 4′ 46″ instead of 4′ 37″, as it was observed. Supposing the duration of total obscurity to have been 4′ 46″,

The difference of semidiameters would be augmented.	1″ 80
Difference by the above mean	39 07
Difference of semidiameters reckoned from the most prominent points of the ☽	40 87

By the duration between the beginning and end of the eclipse, at Kinderhook we find the sum of the horiz. semid. reduced to the time of the conjunc.	32′	08″	33
If we suppose that the true duration was greater than what was observed, by 4″, which appears very probable, we shall have. . .	32	09	17
By the observation at Natchez, supposing the beginning 4″ before it was perceived by Mr. Dunbar.	32	09	00
Sum of the horiz. semidiam. in conjunction by a mean of the observations	32	09	08

Comparing these sums and differences of semidiameters with the tables we find the correction of the semidiameter of the ☽. . —1″ 93

Idem. . . . . ⊙. . —1 87

The occultation of Spica Virginis, May 24th, 1801, was observed in all Europe, the observations most to be confided in and the most proper to determine the diameter of the moon are the following.

		h	′	″	
At the National Observatory at Paris by M. Mechain.	Im. Mean time.	9	05	42	4
	Em.	10	16	37	2
Military School.	Im. Mean time.	9	05	28	9
	Em	10	16	24	2
Royal observatory in the island of Leon.	Im. Mean time.	8	49	16	2
	Em.	9	29	01	9

Making use of the elements of the new tables, I find

Conjunction in Paris (National Observatory) mean time =	10h	02′	47″	7
Island of Leon (Royal Observatory)	9	28	37	0
Difference of meridians.	00	34	10	7

Difference of latitudes in conjunction by the observations in the island of Leon.		51′	19″ 5
Correction of the semidiameters of the ☽ by the observations of M. Mechain, combined with the difference of latitudes observed in the island of Leon.	—	2	0
By the observations in the Military School.	—	1	65
Mean correction.	—	1	82

I have also calculated the annular eclipse, April 1st, 1764, by the new tables, and have deduced

Correction of the semidiameter of the ☽ = — 1″ 35

Idem. . . . . ⊙ — 2 15

Recapitulation of the different results.

	Correction of the diameters. ⊙.	☽.
By total eclipse 1806.	1″ 87	1″ 93
Annular eclipse 1764.	2 15	1 35
Occultation of Spica Virginis above.		1 82
Passage of Mercury page 232.	1 50	
Mean correction.	1 84	1 70

Semidiameter of the ⊙ in apogee by the tables.	15′	45″	50
Correction by the above observations.		1	84
Semidiameter of the ⊙ in apogee.	15	43	66
Therefore diameter of the ⊙ in apogee.	31	27	32

Semidiameter corresponding to the constant lunar parallax of the tables.	15′ 33″ 69
Correction.	1 70
Constant semidiameter of the ☽	15 31 99
Therefore constant diameter of the ☽	31 03 98

From this statement, it will appear, that the semidiameter of the moon, ascertained in the occultations, may vary 2″ on account of the irregularities of the disk of the moon; it may be further remarked, that the periodical variations of the parallax of the moon, by the new tables, are those which Mayer found by his theory, and which differ from the coefficients determined by Laplace. According to the calculations of Mr. Burckhardt, the sum of the periodical differences of the two authors above mentioned, may, under very extraordinary circumstances, amount to 7″.—In this case the uncertainty of the semidiameter of the moon would be 1″ 9.

In the explanation of these tables, it is maintained that M. Burg has diminished the diameter of the moon by 2″, but it is easy to see that the diameter of the moon by these tables, is the same as has been determined by M. De Lalande. For the proportion of the horizontal equatorial parallax of the moon, and the horizontal diameter of the moon according to Burg, is 60 : 32′ 45″ 1.

According to De Lalande, the proportion between the horizontal parallax at Paris and the horizontal diameter of the moon, 60 : 32′ 46″ 6, vide the tables of the third edition of his astronomy, printed in 1797, page 77.

According to Burg, the constant equatorial parallax.	=57′ 01″ 0
De Lalande, for Paris.	=56 58 3

And although the constant parallax of De Lalande referred to the equator differs nearly 4″, nevertheless, the constant semidiameters are the same.

From the above data, the horizontal diameter of the moon corresponding to the constant parallax for Paris, will be,

$$\text{according to De Lalande} = \frac{32'\,46''\,6 \times 56'\,58''\,3}{60} = 31'\ 07''\ 35$$

$$\text{Burg.} \quad . = \frac{32'\,41''\,1 \times 57'\,01''\,0}{60} = 31'\ 07''\ 39$$

which proves that the results are sensibly the same.

No. XLVIII.

Observations on the Eclipse of 16 June, 1806, made by Simeon De Witt Esq. of Albany, State of New-York, addressed to Benjamin Rush M. D. to be by him communicated to the American Philosophical Society.

Read May 1807.

Albany, April 25th, 1807.

DEAR SIR,

WITH this I send you for the American Philosophical Society, a painting, intended to represent the central eclipse of the sun on the 16th of last June. It is executed by Mr. Ezra Ames, an eminent portrait painter of this place, and gives, I believe, as true a representation of that grand and beautiful phenomenon, as can be artificially expressed. The edge of the moon was strongly illuminated, and had the brilliancy of polished silver. No common colours could express this; I therefore directed it to be attempted as you will see, by a raised silvered rim, which in a proper light, produces tolerably well, the intended effect*.

As no verbal description can give any thing like a true idea of this sublime spectacle, with which man is so rarely gratified, I thought this painting would not be an unwelcome present to the Society, or an improper article to be preserved among its collection of subjects for philosophical speculation. But, in order to have a proper conception of what is intended to be represented, you must transfer your ideas to the heavens, and imagine, at the departure of the last ray of the sun, in its retreat behind the moon, an awful gloom immediately diffused over the face of nature; and round a dark circle, near the zenith, an immense radiated *glory*, like a new creation, in a moment bursting on the sight, and for several minutes fixing the gaze of man in silent amazement.

* This painting is deposited in the Hall of the Society, and strongly resembles the drawing made by Mr Ferrer, 15 mile. below Albany, which is represented in Pl. VI. Fig. 1

The luminous circle on the edge of the moon, as well as the rays which were darted from her, were remarkably pale, and had that bluish tint, which distinguishes the colour of quicksilver from a dead white.

I attempted to make observations on the different stages of the eclipse, but for the want of a meridian, and glasses of sufficient powers, I am sorry I could not make them with the accuracy I wished. I however send them as they are,—they may possibly be of some use among the collections from other quarters. I have also taken some pains to ascertain the extent of the moon's shadow, in a northerly and southerly direction. The best information I have obtained is from Judge Thorn of the County of Washington, who assures me that the northern edge of the shadow passed nearly along the south bounds of Campbell's patent in the town of Granville, which on my map of the State, lies in latitude 43° 22′ and longitude 0° 45′ east of the meridian of New-York; and from Johannes Miller Esq. of the county of Orange, who determined the southern edge of the shadow in the town of Montgomery, to have crossed the road leading from Ward's bridge to Goshen, three miles and five chains, counted from the bridge. This will be in latitude of about 41° 30′ and longitude 0° 14′ west from the meridian of New-York. The middle of a straight line between those two points, falls on Hudson's river, in latitude 42° 26′ which is near the village of New-Baltimore, at which place, therefore, the centre of the shadow must have passed, that is about fifteen miles below this city.

The following observations on the eclipse of the sun, June 16th, 1806, were made in the city of Albany, in latitude 42° 38′ 42″, longitude 73° 47′ west from Greenwich. The latitude has been ascertained by a series of observations on stars near the zenith, chiefly *α Lyræ* and *Capella*, with a sector made for me by the late David Rittenhouse. The longitude I computed by taking 75° 09′ for Philadelphia, and deducting 1° 22′ for the difference between Philadelphia and Albany. This difference is deduced from surveys connecting the two places. I regulated my clock by observations of equal altitudes of the sun, taken with one of Ramsden's best brass sextants, furnished with a small telescope. Four of these observations were made on the 14th, one on the 16th, and three on the 17th. In observing the eclipse, I used the achromatic telescope of my sector already mentioned, its magnifying power is about 30. The commencement of total obscuration is mostly to be depended on. Before the re-appearance of the sun, I lost it out of the field of the telescope, and I unfortunately omitted to remove the dark glass; I therefore noted the end of total obscuration, only by the naked eye, and of course cannot so much depend on it. It is probably taken some seconds too late. The arrival and departure of the penumbra, were taken tolerably accurate. The air was uncommonly serene, and afforded the finest opportunity for observations.

	h	′	″
Commencement of the eclipse, A. M. Apparent time.	9	50	12
Commencement of total obscuration.	11	8	06
End of . . . . ditto.	11	12	57
End of the eclipse.	12	33	08
Duration of total obscuration.		4	51
Duration of the eclipse.	2	42	56

I intended to have forwarded this last fall, as soon as I could get the painting done, but the navigation of our river being obstructed earlier than usual, my intentions were defeated.

I am, with great regard
Your obedient humble Servant,
S. DE WITT.

Doctor Benjamin Rush.

The following errata have been found in the communications of J. J. De Ferrer in this Volume.——

Page 163, line 31. Cayo Sta. Maria. Lat. for 23° 12′ 00″ *read* 22° 39′ 24″.
164, last line, for Teneriffe, *read* In the Azores.
224, line 4. for Idem of the secular equation = 54″ 96 *read*
Idem of the secular motion =— 54 96
226, line 11. for 5^h 35′ 48″ *read* 5^h 35′ 38″
11. for 6 09 56 *read* 6 09 46
11. for 6 0 36 *read* 6 00 26
228, line 48. for $\pi = \frac{E}{E + 1 \text{ tang. } \Theta} \times a = 15{,}8072$ *read*
$\pi = \frac{E}{E - 1. \text{ tang. } \Theta} \times a = 15{,}8072$
228, line 51. for $\Pi' = \frac{1'}{E' - 1' \text{ tang. } \Theta'} \times a' = 8{,}3865$ *read*
$\Pi' = \frac{1'}{E' + 1' \text{ tang. } \Theta'} \times a' = 8{,}3865$
232, line 32. for apparent elongation at the ingress 934″ 416 *read* 934″ 437

No. XLIX.

Description and use of a new and simple Nautical Chart, for working the different problems in Navigation; with examples of its application according to Mercator's Sailing, and sailing by the Arc of a Great Circle; with a demonstration of its principles.
By John Garnett, of New Brunswick, New Jersey,

"*Segniùs irritant animos demissa per aurem,*
"*Quàm quæ sunt oculis subjecta fidelibus, et quæ*
"*Ipse sibi tradit spectator.*"

☞ To the Author of this Communication an Extra-Magellanic Premium of a Gold medal was awarded by the Society.

Read August 25th, 1807.

THIS Chart is a partial projection of a portion of a spherical or spheroidal surface, containing in length the different degrees of latitude, and in breadth as many of longitude as are found necessary. The parallels of latitude are projected into right lines, parallel and equidistant to each other, (the reason of which will plainly appear in the demonstration of the principle at the end;) and are divided into degrees of longitude by a scale of equal parts, according to the length of each degree at different latitudes, either in the sphere or spheroid, or by Table *T* of the Requisite Tables.*—Through these divisions the different meridians are drawn or engraved, on both sides the *Central Meridian*, which is always a right line.—*Vide chart.*

The Index (which is separate) contains all the courses in the quadrant of a circle, both in degrees, and quarter points, and also the distance sailed as far as necessary; in using it, the chief attention requisite is *to place the center* C *of the quadrant on that point in any given parallel of latitude, from which* the distance sailed shall subtend *nearly*† *an equal difference of longitude on each side the Central Meridian* or middle line of

* Garnett's Requisite Tables.

† It is not necessary that it should be exactly so, as the beginning of the distance, or Center *C*, had better be placed on an engraved meridian, so that the difference of longitude may be seen at one view at the other extremity of the distance.

the Chart, and that the given parallel of latitude shall cut the course on the Index, either in degrees or points of the compass; extending naturally towards the North or South as the course directs, but indifferently whether to the right or left, as either may occasionally represent the East or West (the difference of longitude being equal on either side,) so that the centre *C* of the Index must be placed on the *right hand* of the centre of the Chart, when the course is *towards* the equator, and on the *left hand* when *from* it, as will readily appear in the practice.

The solutions of all the cases being on a more correct principle than the common method by middle latitude, will be found more accurate—particularly where the difference of latitude is great.

Should the distance exceed the extent of the Index, or the whole difference of longitude on the Chart, the work must be repeated from the last found latitude, until the difference of longitude and latitude corresponding to the whole distance is obtained.

The following examples of the different Cases of Sailing by this Chart, will make its use sufficiently easy.

CASE I.

Given the Latitudes *and* Longitudes *of two places; to find the Course and Distance between them.*

EXAMPLE.

Suppose the Latitudes of the two places to be 49° 10′ N. and 53° 20′ N. respectively, and their difference of Longitude 6° 10′; required the *course* and *distance* between them.

1st. Lay the centre C of the Index on the meridian which is about half the given difference of longitude, or 3 degrees on the *left side* of the Central Meridian, and in the parallel of latitude 49° 10′.

2nd. Extend the distance line of the Index to the parallel of 53° 20′ of latitude, on the meridian of 3° 10′ diff. of long. at the *right side* of the Central Meridian,—and the distance found on the Index will be 340 miles ;—and the course crossed by the parallel of latitude, will be N. 42 3-4 degrees, either East or West; according as the latter place is Eastward or Westward of the former. Q. E. I.

N. B. When the differences of latitude and longitude are great, as it often happens in this Case, the course and distance may be found sufficiently accurate for practice on the *general* Chart of this projection. But in *Great Circle Sailing* the angles of position should be found by Spherical Trigonometry.

CASE II.

Given one Latitude, Course *and* Distance, *to find the other Latitude, and difference of Longitude.*

EXAMPLE.

A ship from latitude 52° 10′ N. and longitude 35° 6′ West, sails N. W. b. W. 229 miles; required the *latitude* and *longitude* arrived at.

1st. Lay the centre *C* of the Index (to the left side) on the parallel of latitude 50° 10′ and turn it about until the parallel passes through the 5 point course; then slide it on the parallel until the distance 229 miles subtends nearly an equal difference of longitude on each side the Central Meridian; which will be found 2° 40′ on each side, or 5° 20′ diff. of longitude, when the distance will also reach the parallel of latitude 54° 17′; for the latitude arrived at. Q. E. I.

CASE III.

Given both Latitudes *and the* Course; *to find the Distance, and Difference of Longitude.*

EXAMPLE.

A ship sails N. E. b. E. from latitude 42° 25′ N. and longitude 15° 6′ W. and then finds by observation she is in latitude 46° 20′ N.; required the *distance,* and present *longitude.*

N. B. If the distance extend beyond the Chart, which can seldom happen in practice, it will require two operations as in this instance. (Or it may be performed at once on the general Chart.)

1st. Set the center *C* of the Index on the *left side* of the Central Meridian (because sailing *from* the Equator) to 2° 30′ diff. of longitude, and on the given parallel of latitude 42° 25′.

2nd, Extend the distance line on a 5 point course, to 2° 30′ diff. of longitude on the *right hand* of the Central Meridian, and the first latitude will be found 44° 48′ N. diff. of longitude 5° East; and distance 258 miles; which write down as under, for the first operation. Then set the Index *C* to the last found latitude, and the distance line on a 5 point course will extend from 1° 40′ diff. longitude on each side, to the given latitude of 46° 20′, and measure 167 miles; which added as under to the first found distance and difference of longitude, gives the whole distance and difference of longitude.

Lat. sailed from 42° 25′ longit. 15° 6′ W. course N. 5 pts. E.

To latit.	44 48	diff. long. 5 0 E.	distance 258 miles,
To latit.	46 20	diff. long. 3 20 E.	distance 167 miles.

Gives the required diff. longitude 8° 20′ E and dist. 425 miles.

CASE IV.

Given the Latitudes *of two Places, and the* Distance *between them to find the Course and Difference of Longitude.*

EXAMPLE.

A ship from St. Alban's Head, in latitude 50° 35′ N. and longitude 2° 5′ W. sailed 171 miles upon a direct course between the S. and W. and by observation is found to be in latitude 48° 26′ N. required the *course* steered, and *longitude* come to?

1st. Set the center *C* of the Index on the given parallel of latitude 50° 35′ (on the *right hand,* because sailing towards the Equator) and turn the distance line until the given distance 171 miles falls on the parallel of 48° 26′, *extended equally on each side the central line;* when the course will be found S. 41° W. and the difference of longitude 2° 50′. Q. E. I.

CASE V.

Given one Latitude, Course, *and* Difference of Longitude, *to find the other Longitude, and distance.*

EXAMPLE.

A ship from latitude 47° 30′ N. sails S. 51° W. and then finds her difference of longitude by observation to be 9° 40′ W. required the *distance* run, and the *latitude* come to?

N. B. As this difference of longitude exceeds the extent of the chart; it requires, (unless performed by the general Chart,) a double operation.

1st. Set the index *C* on the given parallel of 47° 30′ at the *right hand* of the Central Meridian, (sailing towards the Equator) and the given course 51° will give the distance 264 miles, and latitude 44° 44′ at 5° difference of longitude; (2° 30′ on each side of the central meridian.)

2nd. Set the Index on the last found parallel of latitude 44° 44′, and to the same course; when the distance corresponding to 4° 40′ (the remainder of the difference of longitude) setting 2° 20′ on each side the central meridian, will give a farther distance of 265 miles, making the whole distance 529 miles, and the latitude come to 41° 57′. Q. E. I.

* CASE VI.

Given one Latitude, Distance *and* Difference of Longitude, *to find the other Latitude and Course.*

EXAMPLE.

A ship sails from the latitude of 50° 20′ N. between the North and East, 300 miles, and finds by a chronometer her

* This is Dr. Halley's celebrated problem. See Baron Masseres' "Scriptores Logarithmici." vol 4th. *It may be seen on the general chart, that this problem will sometimes admit of two answers.*

difference of longitude to be 6° 0′ required the *latitude* arrived at, and the *course* the vessel has steered?

1st, Place the Index to the given latitude, and on the *left hand* on 3 degrees, (the half of the given difference of longitude) and extend the given distance 300 miles, to 3° difference of longitude on the *right hand;* then the latitude arrived at will be found 53° 45′ N. and the course N. 47° E. Q. E. I.

CASE VII.

Given the Course, Distance, *and* Difference of Longitude, *to find both Latitudes.*

RULE.

Place the Index on any parallel of latitude to the required course, and if the given distance subtend a less difference of longitude that the given, (always making an equal difference of longitude on both sides the central meridian) move it upwards to a higher latitude, or if it subtend a greater difference of longitude, move it downwards to a lower latitude until the distance subtend the given difference of longitude, and the required latitudes will be found.

N. B. When the course is on the meridian, this case is indeterminate, and the nearer to the meridian, the less accurate will be the solution.

CASE VIII.

Given the Course, Difference of Latitude, *and* Difference of Longitude, *to find both Latitudes.*

This case is similar to case 7th. using the difference of latitude instead of the distance, which is always known when the course and difference of latitude are given.

N. B. This CASE like the LAST is also indeterminate when the course is on the meridian, and less accurate when near it.

CASE IX.

Given the Distance, Difference of Latitude, *and* Difference of Longitude, *to find the Course and both Latitudes*

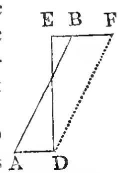
RULE.

Make the distance on the Index subtend the difference of latitude. N. or S. between *any* parallels of latitude, and the Course will be found; and if the difference of longitude on the Chart exceed that given, move the Index to a less latitude: or if it be too little, to a greater latitude, until the given differences of longitudes and latitudes are subtended by the given distance; when both latitudes will be known. Q. E. I.

N. B. This case is indeterminate in the same circumstance, as are the cases 7 and 8, which are only given, to shew that *every* case can be readily solved by this Chart; but the three last cases can seldom be of use in practice.

To demonstrate the principles on which this Chart is constructed, and to shew its application to *Sailing by the Arc of a Great Circle.*

Let A, B, be two places on the Chart, whose difference of longitude is equally divided by the central meridian E D which is the part of it between the two latitudes; draw the line A B; and D F parallel to it; also the parallels of latitude E F, A D; then E F = E B + A D; but E B and A D by the construction of the Chart are = the cosines of their respective latitudes × by half the difference of longitude between A and B; and therefore E F = *half the sum of the cosines × by the difference of longitude.*



In the right angled triangle E D F, E F: tangent E D F:: E D: radius. Or *half the sum of the cosines of the latitudes: tangent of the course* :: *difference of latitude*: *the difference of longitude,* which is a well known theorem in navigation; *half the sum of the cosines of the two latitudes* being generally* more accurate than the *cosine of the middle latitude* commonly used. Q. E. D.

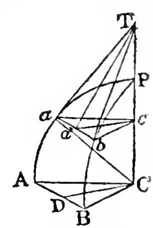
* The exceptions are of no consequence in practice. See Emerson's Navigation, Page 71.

The principles of the Chart together with the application to *sailing by the Arc of a Great Circle,* can also be deduced from the following propositions.

PROPOSITION I.

The angle of convergence, or inclination of two meridians to each other, at any given latitude, is = *the difference of longitude* × *by the sine of the latitude.*

Let P A, P B, be two meridians, on which let *a*, *b*, be two places in the same latitude; draw the two tangents *a* T, *b* T, meeting the axis C P T in T, and *a c*, *b c*, perpendiculars to it; also *c d*, T *d* perpendiculars to *a b*, and draw *a* C to the center C; then will the angle *a* T *b* represent the inclination of the meridians P *a*, P *b*, to each other at the points *a* and *b*.



From the right angled triangles *a d* T, *a d c* and the similar triangles *a c* T, *a c* C.

a T : rad.:: *a d* : sine $\frac{1}{2}$ inclination of merid. and rad.: *a c* :: sine (*d c a* =) $\frac{1}{2}$ diff. of lon. : *a d*. By composition. (*a* T : *a c* =) *a* C : C *c* :: sine $\frac{1}{2}$ difference of longitude : sine $\frac{1}{2}$ the inclination of meridians; that is, *radius* : *sine of the latitude* :: *sine* $\frac{1}{2}$ *difference of longitude* : *sine* $\frac{1}{2}$ *the inclination of meridians.* Or taking the arcs themselves for their sines, which is sufficiently accurate in small arcs, and agrees with the construction of the Chart; *the angle of convergence of any two meridians at a given latitude, is = to the sine of the latitude* × *by the difference of longitude.* Q. E. D.

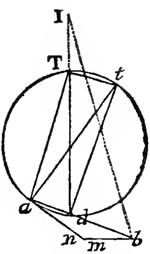
REMARK.

If the meridians be considered as great circles of the sphere, and their inclination to the *central meridian* (or that which bisects the angle at the Pole) as the complement of the angle made by a great circle passing through them at any given latitude, then in the spher. triangle P*ad* we have *rad.*: *cosine* P*a* :: *tang. a* P *d* : *cotan.* P *a d*; *that is, rad.*: *sine of the latitude* :: *tangent of half the difference of longitude* : *tangent of the inclination to the central meridian*; which seems more correct.

See the Table of the Inclination of Meridians, deduced from this Proposition.

PROPOSITION II.

The ANGLE of POSITION at the middle longitude between two places is very nearly equal to the loxodromic angle or course between them; and differs at each place from the loxodromic course, by the inclination of the meridian at each place to the *central meridian.*



Let *a, b,* be two places on the arc of a great circle, extended into a right line which is crossed by the central meridian T *d,* and the meridians T *a,* I *b,* at their respective angles of position, then the angles *a* T *d, d* I *b* will be the inclination of the meridians at *a* and *b,* to the central meridian, respectively. Draw T *t, d t* perpendiculars to *a* T, *a b,* and draw *a t;* then because the loxodromic course, cuts the meridians at equal angles, the course near *a,* may be considered as a portion of the logarithmic spiral; by the known property of which, *t a,* will be the radius of curvature at the point *a,* and *n a* perpendicular to *t a,* its tangent, making the angle *d a n*=*d t a*=*d* T *a,* (being on the same segment *a d* of the circle passing through *a d t* T;) and therefore, the exterior angle T *d b* is=T *a d*+(*d* T *a*=) *d a n*=T *a n,* the course; and the *course must be parallel to a b wherever it crosses the central meridian* T *d, otherwise it cannot make an angle with it*=T *a n.*

In the same manner I *b m* may be proved =*d b* I +*d* I *b* =I *d a.* Q. E. D.

SCHOLIUM.

From these propositions may be deduced an easy practical method of *Sailing by the Arc of a Great Circle,* by means of a SPECIAL CHART, on a convenient scale, of the intended tract, constructed in the following manner. (*See the* Chart.)

Having calculated by spherical trigonometry, as in the following example, the angles of position *b a* T, *a b* I, the distance *a b,* and also the latitude of the point *d* at the middle longitude; draw on a sheet of paper from a moderate scale the line *a b* equal to the distance; and cross it at the extremities *a*, *b*, by the lines *a* T, *b* I; forming the angles of position at those points *b a* T, *a b* I, continued on both sides of *a b*. The latitude of the places *a* and *b*, being given, set off from the same scale of equal parts, a sufficient number of degrees of latitudes on the lines *a* T, and *b* I produced so that some common latitude shall be on both those lines, (as the latitude of 45° on the annexed *special chart)* and a perpendicular *d* T, to the middle of two points of the common latitude on the lines *a* T, *b* I will be the CENTRAL MERIDIAN, or that which passes through the middle longitude of the chart; and as the latitude of the point *d* has been found, the degrees of latitude can also be marked on the line T *d* produced on both sides of *a b*. Then the parallels of latitude will be *very nearly* represented by circles passing through the three points of each degree on the three lines *a* T, *d* T, *b* I, produced on both sides of *a b;* and dividing the extreme parallels into as many parts as there are five degrees of longitude between the two places; the several meridians can be drawn, shewing the angles of position at every five degrees of longitude, and having the same appearance as on the globe. On this SPECIAL CHART the ship's place can be marked, whenever a good observation of the latitude and longitude is taken, and a new direct course on a great circle to the intended port readily seen, with the angles of position; and the course which will meet the same great circle, after sailing 5° of longitude, can be found from the Table in page 315, by adding half the inclination of the meridians at 5 degrees difference of longitude, to the angle of position; *(the loxodromic course being always between the great circle, and the equator)* or by taking as a course, the angle of position on the special chart at 2 ½ degrees of longitude farther onwards than the longitude of the ship; which course will serve for sailing the distance corresponding to 5° difference of longitude, (which distance can readily be found by the chart) after which the course must be altered either by adding the *whole inclination* of the meridians for 5° corresponding to the new latitude, or again taking the angle of position at 2½ degrees of longitude farther on, as before, which method can be continued at pleasure.

But whenever the ship is driven out of her intended course, or her latitude and longitude has been determined more correctly by astronomical observations, the *course* must be again adjusted, either by drawing a new distance-line on the Special Chart, which will shew the new angle of position to the intended port sufficiently correct, or calculated by case seven of Spherical Trigonometry, where two sides (the co-latitudes or polar distances of the two points) and the included angle (difference of longitude) are given; as in the following example, which is also necessary to shew in what manner a Special Chart is constructed, being considered as part of a great circle, containing in length the distance of the two places, with a few contiguous degrees in breadth on each side, straightened into a plane superficies or parallelogram; the meridians crossing the great circle at every five degrees of longitude, and shewing the different angles of position.

EXAMPLE.

Suppose it was intended to sail from the latitude of 40° N. and longitude 65° W. by *the arc of a great circle,* to the latitude of 49° 26′ N. and longitude of 5° W. making the nearest course to the Lizard from the above place; and to construct a *Special chart* in order to lay down the ships track. Required the angles of position, nearest distance, and the courses that will meet the great circle, at every five degrees difference of longitude?

To find the Angles of Position.

Co-lat. or Polar-dist.	50° 0′	(N. B. These two P. dists. must be from the same Pole.)			
Co-lat. or Polar-dist.	40 34				
As ½ the sum of P. dists. (x)	45 17	log. sine	9.851622	log. cos.	9.847327
: ½ the difference of ditto.	4 43	log. sine	8.915022	log. cos.	9.998527
: : ½ the diff. of longitude	30 0	log. cot.	0.238561	log. cot.	0.238561
: the corresponding arcs	11 20	log. tang.	9.301961	log. tan.	0.389761
	67 49	(take the supplement of this if x exceeds 90°.)			
Sum of corresponding arcs	79 9	=Angle of Position at the greater latitude			
Difference of ditto	56 29	=Angle of Position at the less latitude.			

To find the Distance.

As either angle of position	as	79° 9′	log. sine.	9.992160
: its opposite polar distance		50 0	log. sine.	9.884254
: : the difference of longitude		60 0	log. sine.	9.937531
: nearest distance 42° 29′=2549 miles			log. sine.	9.829619

To find the Latitude at the middle Longitude.

Latitude	40° 0′	nat. tang.	0.839100	(N. B. Should no table of nat. tang. be at hand, take the numbers to the log. tangents.)
Latitude	49 26	nat. tang.	1.168095	
Sum of natural tangents.			2.007195	
Half sum of ditto.			1.003597	log. 0.001558
Half the diff. of longitude			30°	subtr. log cos. 9.937531

Gives the lat. at the middle long. or central mer. 49° 12′½ tang. 0.064027
So that the angles of position T *a b*, I *b a* are 79 9 and 56° 29′
The distance *a b* . . . . . . 42 29=2549 miles
The latitude of *d*, at the middle longitude 49 12½

From which data the *Special Chart* has been constructed according to the directions given in the Scholium, and the first course as far as 5° difference of longitude is found by adding 96′=1° 36′, (half the angle of the inclination of the meridians in the latitude 40° by the Table in page 315) to the angle of position 56° 29′; making N. 58° 5′ E. for the *course* from the longitude of 65° W. to 60° W. or if the course had been taken from the angle of position in the special chart at the longitude of 62½° it would be the same, according to Prop. 2d. and perhaps this last is as simple a rule as can be given, for it appears to be a useless labour to calculate all the angles of position by Spherical Trigonometry, as different accidents may make the ship occasionally deviate from the intended calculated track, and a *Special Chart* will always shew the courses to sufficient exactness, if the ship were even to deviate 5 degrees of latitude on either side of the first intended track or great circle.

In the same manner a SPECIAL CHART can be constructed for any other track, by means of which it is easy to sail from any part on the globe to any other, the shortest way possible, supposing there are no intervening obstructions, or local reasons for taking a different course; the *Special Chart* being an extension of that part of the globe through which the track lies, all the bearings and distances are truly represented.

Should any intelligent navigator be inclined to try this method of sailing by the *Navigation Chart* or by the *Arc of a great Circle,* he will find these directions sufficiently correct for practice, always depending on ASTRONOMICAL OBSERVATIONS to correct his reckoning; and as the very great improvements lately made and almost universally adopted in the astronomical part of navigation, seem to require some corresponding improvements in the other parts; this attempt, the author hopes will be candidly examined.

The Loxodromic Chart from the latitude of 15° to 55° will serve where the distances greatly exceed the limits of the lesser charts, they being on a much larger scale—every 10 miles of the latter making a degree on the former, so that the same index will serve, reckoning 10 degrees for every 100 miles; and all the problems solved by Mercator's Chart, can be more readily and simply solved by the general Loxodromic Chart.

The following table, shewing the inclination of the meridians in minutes and tenths, corresponding to 5 degrees difference of longitude for every degree of latitude, is readily constructed by means of a Traverse table; using the latitude as a course, and against 300′ (the minutes in 5°) as a distance, the inclination of the meridians, as under, will be found in the column of departure.

Table of the Inclination of Meridians in Minutes and Tenths, at every Degree of Latitude for 5° Difference of Longitude.

Lat.	in. mer.	Lat.	in. mer.	Lat.	in. mer.	Lat.	in. mer.	Lat.	in. mer.	Lat.	in. mer.
°	′	°	′	°	′	°	′	°	′	°	′
1	5.2	13	67.5	25	126.8	37	180.5	49	226 4	60	259.8
2	10.5	14	72.6	26	131.5	38	184.7	50	229.8	61	262.4
3	15.7	15	77.6	27	136.2	39	188.8	51	233.1	62	264.9
4	20.9	16	82.7	28	140.8	40	192.8	52	236.4	63	267.3
5	26.1	17	87.7	29	145.4	41	196 8	53	239.6	64	269.6
6	31.4	18	92.7	30	150 0	42	200.7	54	242.7	65	271.9
7	36.6	19	97.7	31	154.5	43	204.6	55	245.7	70	281.9
8	41.8	20	102.6	32	159.0	44	208.4	56	248.7	75	289.8
9	46.9	21	107.5	33	163.4	45	212.1	57	251.6	80	295.4
10	52.1	22	112.4	34	167.8	46	215.8	58	254 4	85	298.9
11	57.2	23	117.2	35	172.1	47	219.4	59	257.2	90	300.0
12	62 4	24	122.0	36	176.3	48	222.9				

REMARK.

It appears that a general chart on this projection has all the valuable properties of Mercator's Chart; the rhumb lines and distances being right lines;

in other respects it is superior, as equal surfaces on the globe are represented by equal areas on the chart, and all distances are measured by the same scale of equal parts. It has also the advantage of shewing both the loxodromic course, and the angles of position (that is the angles made by the different meridians with the great circle passing through any two places:) the first being measured by the complement of the angle formed by the parallels of latitude and line of distance, the latter very nearly by the different meridians and line of distance; and in the great simplicity of its construction it seems also to merit the preference.

The Chart might also be enlarged so as to give any required accuracy in the solutions; but as no greater accuracy can be expected in any estimation of a ship's course and distance by the log-line and compass, (the chief dependence being on astronomical observations, for longitude as well as latitude) it would be useless.

MR. EMERSON, *in page 52 of his Geography, has also given this projection, as useful for maps; but its properties, and great use in* practical navigation, *have not, I believe, been hitherto investigated.*

TABLE I, shewing the correction in minutes and tenths, to be *added* to the Middle Latitude, in Middle Latitude Sailing.

Argument. Diff. of LAT.	ARGUMENT. LESSER LATITUDE.													
	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°
°	′	′	′	′	′		′	′	′	′	′	′	′	′
1	6.7	0.8	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2
2	9.1	1.8	0.9	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.9
3	13.9	3.5	2.1	1.6	1.3	1.2	1.1	1.1	1.1	1.2	1.3	1.5	1.7	2.0
4	18.5	5.9	3.6	2.7	2.3	2.1	2.0	2.0	2.0	2.1	2.4	2.6	3.0	3.6
5	23.3	8.5	5.4	4.1	3.5	3.2	3.1	3.1	3.2	3.4	3.7	4.1	4.8	5.7
6	28.0	11.5	7.5	5.8	5.0	4.6	4.5	4.5	4.6	4.9	5.4	6.0	7.0	8.4
7	32.9	14.8	9.9	7.8	6.8	6.3	6.1	6.1	6.3	6.7	7.4	8.3	9.7	11.8
8	37.6	18.2	12.5	10.0	8.7	8.1	8.0	8.0	8.3	8.8	9.8	11.0	12.9	15.8
9	42.3	21.9	15.4	12.4	11.0	10.2	10.0	10.1	10.5	11.3	12.5	14.2	16.6	20.5
10	47.0	25.7	18.4	15.1	13.4	12.6	12.3	12.5	13.1	14.1	15.6	17.7	20.9	26.0
11	51.8	29.8	21.7	18.0	16.1	15.2	14.9	15.2	16.0	17.2	19.1	21.8	[illegible]	32.4
12	56.7	34.0	25.2	21.1	19.0	18.0	17.8	18.2	19.1	20.7	23.0	26.4	31.5	39.7
13	61.6	38.3	28.9	24.4	22.1	21.1	20.9	21.4	22.6	24.5	27.4	31.5	37.8	48.1
14	66.6	42.8	32.7	27.9	25.4	24.4	24.4	25.0	26.4	28.8	32.2	37.2	45.0	57.8
15	71.6	47.3	36.7	31.6	28.9	27.9	27.9	28.8	30.6	33.4	37.5	43.6	53.0	68.8
20	97.6	72.0	59.5	53.1	50.1	49.3	50.2	52.7	56.9	63.1	72.4	86.5		
25	125.5	99.7	86.5	79.8	77.2	77.5	80.3	85.7	94.1	106.6				
30	155.9	131.2	118.1	112.1	110.8	113.4	119.6	129.9	145.5					
35	189.4	165.5	154.9	150.7	152.2	158.7	170.5	188.9						
40	226.9	206.8	197.9	197.0	202.9	215.7	236.6							
45	269.2	253.1	248.4	252.7	265.7	288.4								
50	317.7	307.0	308.4	320.6	344.5	383.7								
55	373.8	430.5	320.8	405.0	446.6	600.0								
60	439.7	446.6	470.1	513.2	586.1	720.2								

CONSTRUCTION.

Log. of diff. of lat.—log. of merid. diff. lat.=the log. cosine of the MEAN PARALLEL A.
A—middle latit = the correction of this table.

TABLE II, to calculate the exact difference between the new Loxodromic Chart and Mercator's; which in practice is nearly insensible. It also shews the error in taking the arithmetic mean of the natural cosines of two latitudes for the cosine of the mean parallel in Middle Latitude Sailing,

Argument. Diff. of LATS.	Argument. LESSER LATITUDE. 0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°
°	− ′	− ′	− ′	− ′	− ′	− ′	− ′	− ′	− ′	− ′	+ ′	+ ′	+ ′	+ ′
1	8.1	1.0	1.1	0 6	0.3	0.2	0.1	0.1	0.1	0.0	0.1	0.1	0.2	0.3
2	22.3	6.0	3.2	2.1	1 4	1 0	0.7	0.4	0 2	0 1	0 3	0.6	0.9	1.2
3	33 0	11.2	6 6	4.4	3.1	2.2	1.5	0.9	0 6	0.2	0 7	1 3	2.0	2 9
4	44.0	17 6	10 8	7.2	5.3	3.8	2.6	1.5	0 6	0.4	1.4	2.5	3 7	5.3
5	55.0	25.0	15.8	11.0	7.9	5.6	3.8	2.2	0.7	0.7	2 3	4 0	6.0	8.6
6	66.1	32.7	21.3	15.0	10.3	7.7	5.2	2.9	0 8	1 2	3.5	6.0	8 9	12.8
7	77.2	40 9	27 2	19.3	14.0	10.0	6.6	3.6	0.8	2.0	5.1	8.4	12.6	18.1
8	88.4	49.3	33.4	24.0	17.5	12 4	8.1	4.3	0 6	3.1	7.1	11.5	16.1	24.5
9	99.6	56.9	39.8	28.9	21.1	15 0	9 7	5.0	0 4	4 3	9.4	15.2	22 4	32.2
10	109 9	66 7	46.5	34.0	24 8	18.6	11.3	5.5	0 1	5 9	12.2	19.5	28.7	41.3
15	161.6	111.2	81.7	60.7	44 4	30.4	17.8	5.6	6.7	20.0	35 1	53.5	78.1	
20	211.7	154.7	116 4	87.0	62.4	40.4	19 5	1.5	23 7	48.6	78.4	117.0		
25	259.4	195.0	148.2	109.8	75.9	44.1	12 6	20.4	56.7	99.4				
30	300 7	230.5	174 7	126.3	81.6	36.9	7 6	56.7	113.7					
35	337 4	259 6	193.7	133.9	76.1	17.2	46.2	118 7						
40	367.0	280.2	202.9	129.2	55.8	23.6	112.3							
45	387.8	290 1	199.0	108.4	13.3	92.8								
50	397.5	286 4	178.9	61 5	58.7	205 6								
55	393.2	265.0	133.9	8 9	175 8	541 0								
60	370.8	219.9	57.8	129.6	368.5	730.6								

The corrections on this side the black line must be added to the greater latitude; those on the left hand side must be subtracted.

CONSTRUCTION. { 2 Nat. cos. *mean parallel*—nat. cos. les. lat.=nat. cos. of an angle A. A—greater latitude=the *correction* of this table.

N B. This correction × by the tangent of the greatest latitude × tangent of half the difference of longitude, is=the correction of the longitude found by the chart for any given course and distance.

USE OF THE PRECEDING TABLES.

EXAMPLE I.

Required the Course and Distance between Cape Clear in Ireland, in latitude 51° 18′ N. and Island of St. Mary's one of the Azores, in latitude 37° N. difference of latitude 14° 18′= 858 miles, and their difference of longitude being 15° 10′, or 910′. (See Robertson's Navig. prob. III. p. 156.)

	Middle Latitude	44° 9′		
Correction to lat. 37° and diff. of latits. 14° 18′ about		26	from Table I.	
	Mean Parallel	44° 35′		
As difference of latitude	858′ log.	2.933487	log. A	2.933487

: Difference of longitude	910′	log.	2.959041			
: : Cos. of mean parallel	44° 35′	log. cos.	9.852620			
: Tan. of Course	37° 4′	log. tang.	9.878174	l. cos.	B	9.901967
A—B=distance - -	1074,6 miles	log.				3.031520

which agrees with the solution by Meridional Parts, or logarithmic tangents; but by the middle latitude not corrected, the course would have been 37° 16′ and distance 1078 miles.

EXAMPLE II.

A ship from the latitude of 51° 18′ N. in longitude 22° 6′ W. sailing on a course between the S. and E. has made 564 miles of departure, and 786 miles difference of longitude. Required the latitude of the place arrived at? (See Robertson's Navigation, prob. X. page 170.)

As difference of longitude	786′	log	2.895423
: Departure - -	564′	log.	2.751279
:: Radius - - -		-	10.000000
: Cos. Mean Parallel	44° 9′	log. cos.	9.855856

	°	′
Mean par. × 2 =	88	18
Subtract given lat.	51	18
Lesser lat. (nearly)	37	0
Diff. of lat. (nearly)	14	18

As the approximate lesser latitude must be diminished by twice the correction in Table I to obtain the true lesser latitude, assume it 36° 10′, and difference of latitude 15° 8′, the correction from Table I will then be 30′;—this subtracted

from 44° 9′ the mean parallel, leaves -	43° 39′	for the Middle Latitude.
From the double of which - - - -	87 18	
Subtract the greater latitude - - - -	51 18	
Leaves the true lesser latitude - -	36 0	differing a whole degree from

the latitude found by the common method.

These examples sufficiently shew the great use of Table I, to correct the errors of middle latitude sailing; which by this means is made equally correct, and is more simple than Mercator's sailing by the table of meridional parts.

Table II is intended to make the Loxodromic Chart strictly accurate, although this correction in practice will be found insensible. It also shews the error of taking half the sum of the natural cosines for the cosine of the mean parallel, which has been recommended in middle latitude sailing.

This small correction of the Loxodromic Chart, by means of table II, will be easily understood from the following

EXAMPLE.

Suppose a ship to sail from the latitude of 20° N. to the latitude of 45° N. on a course between the N. and E. and make 40° difference of longitude; required the course and distance. (See the Loxodromic Chart.)

By table II, the correction for 20° lesser latitude and 25° diff. of latitudes is—75′,9, which measure off to the parallel of 45° from the meridian of 20° (the half diff. of longitude) from *a* to *b* perpendicular to the parallel, so that *a b* = 75′,9; then draw the line *c b* from the parallel of 20° latitude to the parallel of 45°, making the half difference of longitude 20° on each side the central meridian (which is essential to the principle of the chart,) and it will be the correct course and distance. The line *c d* represents the course and distance on the chart, without the tabular correctioo, which correction in all practical cases will be insensible.

No. L.

Observations to serve for the Mineralogical Map of the State of Maryland. By M. Godon.

Read November 6th, 1807.

ALLUVION SOIL.

All the country which extends from Baltimore bay, to the right bank of Potomac river, where Washington city is situate, is wholly alluvial. The soil which constitutes it is, in general, a *quartzose* sand, diversly coloured by iron. This sand very frequently contains *mica; aluminous* earth also appears to exist in it, in a very small proportion. It is probably to the want of a sufficient quantity of clay in this alluvial ground, that the remarkable barrenness of the land which stretches on the line that I have occasionally travelled, must be attributed.

At some distance under the surface of the soil, a bed of quartzose white stones is frequently found. This bed is horizontally disposed, or appears to follow the inequality of the ground.

Immediately under this bed of flint, a stratum of a ferruginous sand-stone commonly occurs, the thickness whereof varies from six lines to one foot or more. This mineral, the only one which is found, or which can be expected to be found in this soil, deserves a particular examination, on account of its importance as it regards the geology of this locality. It is most commonly compounded of quartzose grains; sometimes of flakes of mica. Its tenacity at times is very great, but most frequently it is disunited with ease by the stroke of the hammer.

It sometimes includes concretions of a strongly ferruginous clay, analogous to those stones, which, though a variety of iron ore, are vulgarly known by the name of *ætites*, or *eagle-stone*. These concretions are almost always involved in thin concentric strata of *oxydated iron, (hematites)* which are sometimes shining. Federal Hill, near Baltimore, affords on its flanks numerous examples of this variety. When the grains of which this sand-stone is formed are of great tenuity, they take the appearance and characters of *Tripoli,* and probably may be employed for the same uses;* such is that found on a new road, which communicates with the Frederick road, two miles from Baltimore. This last variety very frequently accompanies a small bed of oxydated iron, which is cellular, sometimes two inches thick; but, most frequently, this iron forms only a thin pellicle, which exhibits the colours of the iris.

This sand-stone is found on the top of almost every hill that occurs on the road from Baltimore to Washington; it is easily observed in the places where the soil has been washed away by floods, or cut down for public roads.

Sometimes the bed of quartzose stones has been itself agluti nated by a ferruginous cement, and constitutes a sort of pud ding-stone. This pudding-stone is often found of the thickness of one or two feet.

The rocks of *transport,* which are found in this soil are, in general, the *Amphibolic* rock, (grunstein of the Germans) a coarse quartz, and the variety of quartz designated by Werner, under the name of *Hornstein.*

Some fossil bodies are also found in this soil, namely, some remains of shells, and particularly a deposit of fossil wood, which is observed in a ravine at a little distance from Rock-Creek church. This wood lies immediately under the ferruginous sand-stone, in which it is sometimes, as it were, enveloped. It appears that the ligneous particles of this wood, have been wholly replaced by siliceous earth; the parts in which were interstices, as the bark for example, are covered with a multitude of small crystals of quartz, which belong to the variety *prismed* of Hauy.

All these sand-stones and ferruginous puddings, seem to have a common origin. When the limits of this stratum shall have been observed, and the space which it occupies shall have

* To polish metals and hard stones.

been traced, we shall perhaps have some light thrown on the circumstances which have produced it; and perhaps it will even be possible to form some hypothesis concerning the origin of this vast deposit of sand, which is observed through the space of 50 miles, in the direction from North-East to South-West,* and which appears to be much more extensively in the direction from East to West.

Washington city is built on the alluvial land; but Rock-Creek, which separates this capital from George-town, appears to present the boundary line between the primitive and the alluvial soil.

PRIMITIVE SOIL.

The first rock which presents itself must be considered as a *gneiss;* its direction is nearly N. N. E. to S. S. W. Or inclining about 20 degrees to the East. The substances which compose it are *quartz, felspar, mica,* and very often *talc.* The mica and the talc have the grey colour of lead; but this last is sometimes distinguished by the green colour of the emerald. Besides those substances, the gneiss often contains the *dodecahedral garnet,* commonly in small crystals, but some are four or five lines in diameter, and *sulphureted magnetic iron* crystallized in small cubes. This mineral sometimes exists so abundantly that every part of the rock is sensible to the magnet. Considerable veins of quartz run through the rock, without any constant direction; the veins of felspar are more rare. This gneiss crosses the Potomac river, and in the opposite bank of this river observes the same direction, the same inclination in the strata, and the same elements in their composition. This rock is generally split into tabular fragments, which are employed in the construction of the foundation of buildings, and in the lining of causeways.

Immediately after the *gneiss,* in going up the river, we find the Amphibolic rock, (grunstein;) this rock is not uniform in its composition, most frequently it is an aggregate of Amphibol, (hornblende) and felspar, then it is nearly decomposed;

* The primitive soil appears near Baltimore, and it is manifest in the valley through which the Patapsco river flows.

but it appears to be only an intimate mixture of quartz, amphibol, mica, and talc, which shows itself by its green colour. This rock often includes the *sulphureted* magnetic iron. The tint of this pyrites resembling that of copper pyrites, and light spots even of carbonate of copper, indicate that this mineral conceals a small proportion of copper. This rock, as the former, is crossed in several directions by veins of quartz, sometimes more than two feet thick. A distinct stratification is not observed in it; it is divided into polyhedral fragments.

In continuing up the Potomac, at a little distance from George-town, *gneiss* is again found, analogous in its nature to that already described. The inclination of these new strata, appears to be the same, but their direction somewhat nearer to that of the North and South. This *gneiss* shows some veins of white felspar, mixed with a mica of a greenish white, but the opaque white quartz, exists in numerous, and powerful veins. This quartz is sterile in metallic substances; some signs of *oxidulated* iron only and of *magnetic pyrites* are found in it. This quartz is sometimes accompanied by the *chloritic talc*, and pretty often includes the *tourmalin* in small acicular crystals. Sometimes the quartz presents a large surface covered with a crust of a fine black substance; at first sight, this matter would be taken for manganese, but by attentive observation, it appears to be nothing more than the substance of tourmalin itself, in a state of confused crystallization.

You go up the Potomac river to the little falls, four miles above Washington, without finding any remarkable change in the constitution of the gneiss. This rock also crosses the river, and you may observe, on both the banks, the same disposition in the strata, and the same characters. The vegetable earth, which covers the tops of steep hills on the left side, is nothing but the gneiss itself in a state of decomposition, which is capable of being turned up by the plough; and the fields are covered by numerous fragments of quartz, which have suffered no alteration.

The two beds of *gneiss* which are distinctly observed, on the right bank of Potomac river, and which are separated on this side by the *Amphibolic* rock, appear to be re-united on the left bank. I expected to find the grunstein again in this last, but I found only some fragments of this rock—an insufficient proof to justify an inference, that these rocks extend beyond the bed of the river.

We find, in the bed of the Potomac river, several fragments of rocks, which indicate a change in the constitution of the soil running along the upper part of the river: among these fragments is particularly distinguished an *amygdaloid* (wacke of the Germans) of a dark colour, including globules of a substance sometimes white, sometimes of a fine rose-colour. In the centre of these globules, another substance of a fibrous texture, and of a fine green colour often occurs. This substance seems to be the *epidote*. These several substances are disposed in the rock, in a very elegant manner.

Specimens of most of the minerals mentioned in this memoir, are deposited in the collection of the Philosophical Society of Philadelphia.

No. LI.

Memoir on the origin and composition of the meteoric stones which fell from the Atmosphere, in the County of Fairfield, and State of Connecticut, on the 14*th of December* 1807; *in a Letter, dated February* 18*th* 1808, *from Benjamin Silliman, Professor of Chemistry in Yale College, Connecticut, and Mr. James L. Kingsley, to Mr. John Vaughan, Librarian of the American Philosophical Society.*

Read March 4th, 1808.

SIR,

We transmit, through you, to the Philosophical Society of Philadelphia, a revised, corrected, and somewhat enlarged account of the meteor which lately appeared in this vicinity. The substance of this account was first published in the Connecticut Herald, as public curiosity demanded an early statement of facts. Since that, the stone has been carefully analysed, and the details of the analysis, forming a distinct paper, having never been published, are now transmitted to the society. The result of this analysis has been such as to confirm the general statement of the composition of the stone, which was published in the Herald, but without any of the details or the exact proportions. Under these circumstances, our present communication will probably be considered as sufficiently original, to merit the attention of the respectable body to whom it is transmitted.

It may be well to repeat, that in the investigation of the facts, we spent several days, visited and carefully examined every place where the stones had been ascertained to have fallen, and several where it had been only suspected without any discovery; conversed with all the principal original witnesses, and obtained specimens of every stone.

We are Sir, respectfully,

your very obedient servants.

BENJAMIN SILLIMAN.

JAMES L. KINGSLEY.

On the 14th of December 1807, about half past 6 o'clock in the morning, a meteor was seen moving through the atmosphere with great velocity, and was heard to explode over the town of Weston, in Connecticut, about 25 miles West of New-Haven. Nathan Wheeler esq. of Weston, one of the justices of the court of common pleas for the county of Fairfield, a gentleman of great respectability and undoubted veracity, who seems to have been entirely uninfluenced by fear, or imagination, was passing, at the time, through an enclosure adjoining his house, and had an opportunity of witnessing the whole phenomenon. From him the account of the appearance, progress, and explosion of the meteor is principally derived.

The morning was somewhat cloudy. The clouds were dispersed in unequal masses; being in some places thick and opaque, and in others fleecy, and partially transparent. Numerous spots of unclouded sky were visible, and along the Northern part of the horizon, a space of 10 or 15 degrees was perfectly clear.

The attention of judge Wheeler was first drawn by a sudden flash of light, which illuminated every object; looking up, he discovered in the North, a globe of fire, just then passing behind the first cloud, which obscured although it did not entirely hide the meteor.

In this situation, its appearance was distinct and well defined, like that of the sun seen through a mist. It rose from the North, and proceeded in a direction nearly perpendicular to the horizon, but inclining by a very small angle to the West, and deviating a little from the plane of a great circle, though in pretty large curves, sometimes on one side of the plane, and sometimes on the other, but never making an angle with it of more than four or five degrees. Its apparent diameter was about one half or two thirds the apparent diameter of the full moon.

Its progress was not so rapid as that of common meteors and shooting stars. When it passed behind the thinner clouds, it appeared brighter than before; and, when it passed the spots of clear sky, it flashed with a vivid light, yet not so intense as the lightning in a thunder-storm, but rather like what is commonly called *heat-lightning*. Where it was not too much obscured by thicks clouds, a waving conical train of paler light was seen to attend it, in length about 10 or 12 diameters of the body In the clear sky a brisk scintillation was observed about the body of the meteor, like that of a burning fire-brand, carried against the wind.

It disappeared about 15 degrees short of the zenith, and about the same number of degrees West of the meridian. It did not vanish instantaneously, but grew pretty rapidly fainter and fainter, as a red hot cannon-ball would do, if cooling in the dark, only with much more rapidity. There was no peculiar smell in the atmosphere, nor were any luminous masses seen to separate from the body. The whole period between its first appearance and total extinction was estimated at about 30 seconds.

About 30 or 40 seconds after, three loud and distinct reports like those of a four-pounder near at hand, were heard. They succeeded each other with as much rapidity as was consistent with distinctness, and, all together, did not occupy three seconds. Then followed a rapid succession of reports less loud, and running into each other so as to produce a continued rumbling, like that of a cannon-ball rolling over a floor, sometimes louder, and at other times fainter: some compared it to the noise of a waggon, running rapidly down a long and stony hill; or, to a volley of musquetry, protracted into what is called in military language, *a running fire*. This noise continued about as long as the body was in rising, and died away apparently in the direction from which the meteor came. The accounts of others corresponded substantially with this. Time was differently estimated by different people. Some augmented the number of loud reports, and terror and imagination seem, in various instances, to have magnified every circumstance of the phenomenon.

The only observation which seemed of any importance beyond this statement, was derived from Mr. Elihu Staples, who said, that when the meteor disappeared, there were apparently three successive efforts or leaps of the fire-ball, which grew more dim at every throe, and disappeared with the last.

The meteor was seen East of the Connecticut, and West of Hudson river, as far South as New-York, and as far North as the county of Berkshire Massachusetts; and the explosion was heard, and a tremulous motion of the earth perceived, between 40 and 50 miles North of Weston, and in other directions. We do not however pretend to give this as the extent of the appearance of the meteor; all that we affirm is, that we have not heard any thing beyond this statement.

From the various accounts which we have received of the appearance of this body at different places, we are inclined to believe, the time between the disappearance and report as estimated by judge Wheeler to be too little, and that a minute is the least time which could have intervened. Taking this, therefore, for the time, and the apparent diameter of the body as only half that of the full moon, its real diameter could not be less than 300 feet.

We now proceed to detail the consequences which followed the explosion and apparent extinction of this luminary.

We allude to the fall of a number of masses of stone in several places, within the town of Weston, and on the confines of adjoining towns*. The places which had been well ascertained, at the period of our investigation, were six. The most remote were about 9 or 10 miles distant from each other, in a line differing little from the course of the meteor. It is therefore probable that the masses fell in this order—the most northerly first, and the most southerly last. We think we are able to point out three principal places where stones have fallen, corresponding with the three loud cannon-like reports, and with the three leaps of the meteor, observed by Mr. Staples. There were some circumstances common to all the cases. There was in every instance, immediately after the explosions had ceased, a loud, whizzing or roaring noise in the air, observed at all the places, and so far as was ascertained, at the moment of the fall. It excited in some, the idea of a tornado; in others, of a large cannon-shot, in rapid motion, and it filled all with astonishment and apprehension of some impending catastrophe. In every instance, immediately after this, was heard a sudden and abrupt noise, like that of a ponderous body striking the ground in its fall. Excepting two, all the stones which have been found were more or less broken. The most important circumstances of the particular cases were as follows:

1st. The most northerly fall was within the limits of the town of Huntingdon on the border of Weston, about 40 or 50 rods east of the great road leading from Bridgeport to Newtown, in a cross-road, and contiguous to the house of Mr. Merwin Burr. Mr. Burr was standing in the road, in front of his house, when the stone fell. The noise produced by its collision with a rock of granite, on which it struck, was very loud. Mr. Burr was within 50 feet, and searched immediately for the body, but, it being still dark, he did not find it

* It may be necessary to remark that the term *town*, is, in Connecticut, a territorial designation, meaning a given extent of ground, (anciently 6 miles square) and has no necessary reference to a collection of houses.

till half an hour after. By the fall, some of it was reduced to powder, and the rest was broken into very small pieces, which were thrown around to the distance of 20 or 30 feet.

The rock was stained at the place of contact, with a deep lead-colour. The largest fragment which remained, did not exceed the size of a goose-egg, and this, Mr. Burr found to be still warm to his hand. There was reason to conclude, from all the circumstances, that this stone must have weighed from 20 to 25 pounds.

Mr. Burr had a strong impression that another stone fell in an adjoining field, and it was confidently believed that a large mass had fallen into a neighbouring swamp; but neither of these had been found.

It is probable that the stone whose fall has now been described, together with any other masses which may have fallen at the same time, was thrown from the meteor at the first explosion.

2nd. The masses projected at the second explosion seem to have fallen principally at, and in the vicinity of Mr. William Prince's in Weston, distant about five miles from Mr. Burr's, in a southerly direction.

Mr. Prince and family were still in bed, when they heard the explosions, and immediately after, a noise like that ordinarily produced by the fall of a very heavy body to the ground. They formed various unsatisfactory conjectures concerning the cause, nor, did even a fresh-made hole through the turf in the door-yard, about 25 feet from the house, lead to any conception of the cause. They had indeed formed a vague conjecture that the hole might have been made by lightning; but, would probably have paid no farther attention to the circumstance, had they not heard, in the course of the day, that stones had fallen that morning, in other parts of the town. This induced them, towards evening, to search the hole in the yard, where they found a stone buried in the loose earth, which had fallen in upon it. It lay at the depth of two feet; the hole was about 12 inches in diameter, and as the earth was soft and nearly free from stones, the mass had sustained little injury, only a few small fragments having been detached by the shock. The weight of this stone was about thirty five pounds. From the descriptions which we have heard, it must have been a noble specimen, and men of science will not cease to regret, that so rare a treasure should have been sacrificed to the dreams of avarice, and the violence of ignorant and impatient curiosity; for, it was immediately broken in pieces with hammers, and, in the hands of unskilful pretenders, heated in the crucible and forge, with the vain hope of extracting from it silver and gold: all that remained unbroken of this mass, was a piece of 12 pounds weight, since purchased by Isaac Bronson Esq of Greenfield, with the liberal view of presenting it to some public institution.

Six days after, another mass was discovered, half a mile north west from Mr. Prince's. The search was induced by the confident persuasion of the neighbours, that they heard it fall near the spot where it was actually found, buried in the earth, and weighing from 7 to 10 pounds. It was found by Gideon Hall and Isaac Fairchild. It was in small fragments, having fallen on a globular detached mass of gneiss rock, which it split in two, and by which it was itself shivered to pieces.

The same men informed us, that they suspected another stone had fallen in the vicinity, as the report had been distinctly heard, and could be referred to a particular region, somewhat to the east. Returning to the place, after an excursion of a few hours to another part of the town, we were gratified to find the conjecture verified, by the actual discovery of a mass of 13 pounds weight, which had fallen half a mile to the north east of Mr. Prince's. Having fallen in a ploughed field, without coming into contact with a rock, it was broken only into two principal pieces, one of which, possessing all the characters of the stone in a remarkable degree, we purchased, for, it had now become an article of sale.

Two miles south east from Mr. Prince's, at the foot of Tashowa hill, a fifth mass fell. Its fall was distinctly heard by Mr. Ephraim Porter and his family, who live within 40 rods of the place, and in full view. They saw a smoke rise from the spot as they did also from the hill, where they were positive that another stone struck, as they heard it distinctly. At the time of the fall, having never heard of any such thing as stones descending from the atmosphere, they supposed that lightning had struck the ground; but, after three or four days, hearing of the stones which had fallen in their vicinity, they were induced to search, and the result was, the discovery of a mass of stone in the road, at the place where they supposed the lightning had struck. It penetrated the ground to the depth of two feet, in the deepest place; the hole was about 20 inches in diameter, and its margin was coloured blue, from the powder of the stone, struck off in its fall. It was broken into fragments of moderate size, and, from the best calculations might have weighed 20 or 25 pounds. The hole exhibited marks of violence, the turf being very much torn, and thrown about to some distance.

We searched several hours for the stone which was heard to fall on the hill, but without success. Since that time, however, it has been discovered. It is unbroken, and on a careful comparison we find that it corresponds exactly, in appearance, with the other specimens, except that from its magnitude, some of the characteristic marks are more striking than in the smaller specimens. This stone weighs 36 1-2 pounds; it was found by a little boy of the name of Jennings, and was, a few days since, in the possession of his father, who was exhibiting it at New York, as a show, for money.

It is probable, that the five stones last described, were all projected at the second explosion.

3d. At the third explosion a mass of stone far exceeding the united weight of all which we have hitherto described, fell in a field belonging to Mr. Elijah Seeley, and within 30 rods of his house. Mr. Seeley's is at the distance of about four miles south from Mr. Prince's. Mr. Elihu Staples lives on the hill, at the bottom of which the body fell, and carefully observed the whole phenomenon.

After the explosion, a rending noise, like that of a whirlwind passed along to the east of his house, and immediately over his orchard, which is on the declivity of the hill. At the same instant, a streak of light passed over the orchard in a large curve and seemed to pierce the ground. A shock was felt, and a report heard, like that of a heavy body falling to the ground; but, no conception being entertained of the real cause, (for no one in this vicinity, with whom we conversed, appeared to have heard of the fall of stones from the skies) it was supposed that lightning had struck the ground. Some time after the event, Mr. Seeley went into his field to look after his cattle. He found that some of them had leaped into the adjoining enclosure, and all exhibited strong indications of terror. Passing on, he was struck with surprise at seeing a spot of ground which he knew to have been recently turfed over, all torn up, and the earth looking fresh, as if from recent violence. Coming to the place he found a great mass of fragments of a strange looking stone, and immediately called for his wife, who was second on the ground.

Here were exhibited the most striking proofs of violent collision. A ridge of micaceous schistus, lying nearly even with the ground, and somewhat inclining like the hill, to the south east, was shivered to pieces to a certain extent, by the impulse of the stone, which thus received a still more oblique direction, and forced itself into the earth, to the depth of three feet, tearing a hole of 5 feet in length and 4 1-2 in breadth, and throwing masses of stone and earth to the distance of 50 and 100 feet. Had there been no meteor, no explosions, and no witnesses of the light and shock, it would have been impossible for any one contemplating the scene, to doubt, that a large and heavy body had really fallen from the atmosphere, with tremendous momentum.

From the best information which we could obtain of the quantity of fragments of this last stone, compared with its specific gravity, we concluded that its weight could not have fallen much short of 200 pounds. All the stones, when first found, were friable, being easily broken between the fingers; this was especially the case where they had been buried in the moist earth, but by exposure to the air, they gradually hardened.

This stone was all in fragments, none of which exceeded the size of a man's fist, and was rapidly dispersed by numerous visitors, who carried it away at pleasure. Indeed, we found it difficult to obtain a sufficient supply of specimens of the various stones, an object which was at length accomplished by importunity and purchase.

We have been more particular in detailing the circumstances which attended the fall of these bodies, and the views and conduct of those who first found them, that the proof of the facts might be the more complete and satisfactory.

The specimens obtained from all the different places are perfectly similar to each other. The most careless observer would instantly pronounce them portions of a common mass. Few of the specimens weigh one pound, most of them less than half a pound, and from that to the fraction of an ounce.

The piece lately found on Tashowa hill, is the largest with which we are acquainted, Mr. Bronson's is the next in size. The largest specimen in our possession weighs six pounds and is very perfect in its characteristic marks. Of smaller pieces we have a good collection. They possess every variety of form which might be supposed to arise from fracture, with violent force. On many of them, and chiefly on the large specimens, may be distinctly perceived portions of the external part of the meteor. It is every where covered with a thin black crust, destitute of splendor, and bounded by portions of the large irregular curve which seems to have inclosed the meteoric mass. This curve is far from being uniform. It is sometimes depressed with concavities, such as might be produced by pressing a soft, yielding substance. The surface of the crust feels harsh, like the prepared fish-skin or shagreen. It gives sparks with the steel. There are certain portions of the stone covered with the black crust, which appear not to have formed a part of the outside of the meteor, but to have received this coating in the interior part, in consequence of fissures or cracks, produced probably by the intense heat to which the body seems to have been subjected. These portions are very uneven, being full of little protuberances. The specific gravity of the stone is 3.6, water being 1. The specific gravity of different pieces varies a little, this is the mean of three.

The colour of the mass of the stone is, in general, a dark ash, or more properly a leaden colour. It is interspersed with distinct masses, from the size of a pin's head to the diameter of one or two inches, which are almost white, resembling in many instances the crystals of felspar, in some varieties of granite. The texture of the stone is granular and coarse, resembling some pieces of grit-stone. It cannot be broken by the fingers; but gives a rough and irregular fracture with the hammer, to which it readily yields. On inspecting the mass, five distinct kinds of matter may be perceived by the eye.

1. The stone is thickly interspersed with black or grey globular masses, most of them spherical, but some are oblong. Some of them are of the size of a pigeon-shot, and even of a pea, but generally they are much smaller. They can be detached by any pointed iron instrument, and leave a concavity in the stone. They are not attractable by the magnet, and can be broken by the hammer. If any of them appear to be affected by the magnet, it will be found to be owing to the adherence of a portion of metallic iron.

2. Masses of pyrites may be observed. Some of them are of a brilliant golden colour, and are readily distinguished by the eye. Some are reddish, and others whitish. The pyrites appear most abundant in the light-coloured spots, where they exhibit very numerous and brilliant points, which are very conspicuous through a lens.

3. The whole stone is interspersed with malleable iron, alloyed with nickel. These masses of malleable iron are very various in size, from mere points to the diameter of an inch. They may be made very visible by drawing a file across the stone, when they become brilliant.

4. The lead-coloured mass, which cements these things together, has been described already, and constitutes by far the greater part of the stone. After being wet and exposed to the air, the stone becomes covered with numerous reddish spots, which do not appear in a fresh fracture, and arise manifestly from the rusting of the iron.

5. There are a few instances of matter dispersed irregularly through the stone, which for reasons that will appear in the analysis, are considered as intermediate between pyrites and malleable iron. They are sometimes in masses apparently crystalline, but usually irregular. They are black, commonly

destitute of splendor, and for the most part lie bedded in the stone, tho' they sometimes appear like a glossy superficial coating. They are sometimes attracted by the magnet, and sometimes not.

Finally, the stone has been analysed in the laboratory of this College, and appears to consist of the following ingredients.

Silex, iron, magnesia, nickel, sulphur.—The two first constitute by far the greater part of the stone, the third is in considerable proportion, but much less than either of the two first, the fourth is still less, and the sulphur exists in a small but indeterminate quantity.

Most of the iron is in a metallic state; the whole stone attracts the magnet, and this instrument takes up a large proportion of it when pulverized. Portions of malleable iron may be separated so large, that they can be readily extended under the hammer.

It remains to be observed, that this account of the appearance of the stone accords exactly with the descriptions, now become numerous, of similar bodies which have fallen in other countries, at various periods, and with specimens which one of us has inspected, of stones that have fallen in India, France and Scotland. The chemical analysis also proves that their composition is the same; and it is well known to mineralogists and chemists, that no such stones have been found among the productions of this globe. These considerations must, in connection with the testimony, place the credibility of the facts said to have recently occurred in Weston, beyond all controversy.

To account for events so singular, theories not less extraordinary have been invented. It is scarcely necessary to mention that theory which supposes them to be common masses of stone fused by lightning, or that which derives them from terrestrial volcanoes; both these hypotheses are now abandoned. Their atmospheric formation, from gaseous ingredients, is a *crude* unphilosophical conception, inconsistent with known chemical facts, and physically impossible.—Even the favourite notion of their lunar-volcanic origin, seems not to be reconcileable with the magnitude of these bodies, and is strongly opposed by a number of other facts.

The late President Clap of this College, in his Theory of Meteors, supposes them to be terrestrial comets, revolving about the earth in the same manner as the solar comets revolve about the sun. That, moving in very excentric orbits, when in perigee, they pass through the atmosphere, are highly electrified, and in consequence become luminous. As they approach their lower apside, their electricity is discharged, the body disappears, and a report is heard. This being admitted, it is not strange, that by the violence of the shock, portions of the meteor should be thrown to the earth, while the main body, not sensibly affected by so small a loss, continues to move on in its orbit, and, of course, ceases to be luminous. It is however, with much deference, that we submit this theory to the scientific world; although to us it appears to correspond with the analogy of the creation, and the least embarrassed with difficulties. Yet there are such numerous objections to this and every other hypothesis, that, until we have more facts and better observations, the phenomenon must be considered as in a great measure inexplicable. Two things however we consider as established:—

1. These bodies did not originate from this earth.

2. They have all come from a common source, but that source is unknown.

Chemical examination of the stones which fell at Weston (Connecticut) December 14th, 1807. By Benjamin Silliman, Professor of Chemistry, in Yale College.

The public are already in possession of ample details, concerning the fall of these bodies, and the phenomena which preceded the event. I have made an attempt to ascertain their nature, by a series of experiments, the result of which is now communicated to the public. It will be necessary to make some observations, and to detail some experiments, upon each of the constituent parts of the stone.

I. Of the stone at large.

II. Of the pyrites.

III. Of the malleable iron.

IV. Of the black, irregular masses.
V. Of the crust.
VI. Of the globular bodies.

I. *Of the stone at large.*

The account now to be given, supposes the reader acquainted with the statement which Mr. Kingsley and myself have already published, especially with the mineralogical description.

1. One hundred grains of the stone, taken without any particular reference to the various bodies, and, containing, promiscuously, portions of all of them, were pulverised in a porphyry mortar. The malleable iron resisted the pestle, so that the mass could be reduced only to a coarse powder. It was then digested for 11 hours, with a moderate lamp-heat, in strong nitric acid, in a capsule of porcelain. Nitrous gas was disengaged, with the usual red fumes, and a light whitish matter appeared, dispersed through the solution, resembling gelatinous silex.

2. The clear fluid was decanted from the insoluble residuum, all of which, except a small portion of the white floculent matter, had subsided; to separate this, the fluid was filtered, and exhibited a decidedly greenish colour.

3. The solid residuum was heated over Argand's lamp, till it was quite dry, and then triturated for an hour in mortars of porphyry and jasper. As the malleable iron had now been removed by the acid, the residuum was easily reduced to a fine powder, which had a brick red colour, and was digested again for an hour, with a mixture of nitric and muriatic acids, somewhat diluted, and then boiled for some time in the same fluid. This was decanted and filtered, and the residuum was washed, with water, till it came off tasteless; the washings were all filtered, and added to the two solutions, No. 2 and 3. The entire fluid had now a light yellow colour, owing to the nitro-muriatic acid, present in excess.

4. The solid residuum, together with the solid matter arrested by the filters, being ignited in a platinum crucible, became nearly white, and weighed 51,5 grains. It was fused with potash in a silver crucible, and the crucible with its contents

immersed in water contained in a silver bason; the resulting fluid was decomposed by muriatic acid, and evaporation, and the precipitate, after ignition, in a platinum crucible, was white. There could now be no hesitation in pronouncing it to be silex; and the conclusion seemed sufficiently established, that more than half the stone consisted of this earth.

5. The entire solution was next examined, to discover what was the soluble part of the stone. After the superfluous acid was saturated with ammonia, a voluminous red precipitate appeared, which was oxid of iron. The fluid was filtered and heated on a sand-bath, to expel the excess of alkali, and to precipitate any additional portion of oxid of iron, which it might have suspended; but none was obtained.

6. As much of the precipitate, as could be collected from the filter, being washed, dried, and ignited strongly in a platinum crucible, became of a dark brown colour, inclining to red, and weighed 32 grains. The filter which had been accurately weighed before it was used, and after it had been thoroughly dried on a heated slab of Portland-stone, was found to have gained six grains. The whole precipitate, was therefore estimated at 38 grains. The oxid of iron, thus obtained, was not in the highest state of oxidizement, for, it was completely, although not powerfully, attractable by the magnet, by which the whole of it was actually transferred from a glass plate to a wine glass.

7. The fluid from which the oxid of iron had been precipitated, was now greenish, being precisely of the same colour as in No. 2. Carbonat of potash produced no precipitate; but caustic potash threw down a voluminous, fleecy, white precipitate. This being separated by the filter, dried, collected and moderately heated, became almost black; but, on being heated strongly in a platinum crucible, covered by an inverted crucible of the same metal, it became white. It weighed 13 grains. It dissolved rapidly in sulphuric acid, and afforded, by evaporation, prismatic crystals, which had an acidulous, bitter taste, (the acidity was produced by a redundancy of the sulphuric acid.) It afforded a white precipitate, with caustic potash, suffered the aqueous fusion, and became a dry mass on a live coal. From all these indications it was concluded, that the 13

grains were magnesia. These crystals of sulphat of magnesia, had a very slight tinge of green, a circumstance which was doubtless connected with the dark appearance of the magnesia, when first heated. It shall be resumed presently. It should be observed, that in some of the experiments with sulphuric acid, on the supposed magnesia, a white matter, in small quantity, remained undissolved at the bottom of the vessel. It could hardly be silex, and preliminary experiments led me to conclude that no lime was present. Was it accidental, or was there a small portion of alumine? This white matter, when heated with sulphuric acid, and sulphat of potash, did not afford crystals of alum, on evaporation. I have not yet had leisure, fully to decide this point, but, intend to resume it. The stone has a very slight argillaceous smell, when breathed upon.

8. The remaining solution still retained its greenish colour. Previous trials had decided that neither copper nor iron was present in the solution. Nickel was therefore sought for, and the observation of Howard and Vauquelin, in their analyses of the stone of Benares, led me to expect it in triple combination with the ammoniacal metal and muriat, which had been formed in the liquor by a previous step of the process.—According to the experience of Howard, I found the hydro-sulphuret and the prussiat of ammonia, the only agents among those which I tried, that would precipitate the nickel. The prussiat of ammonia gave a white precipitate, inclining to purple; the hidro-sulphuret of ammonia, a voluminous black precipitate. The hidro-sulphuret was used, and the precipitate was separated by the filter. The filter being dried, it was with great difficulty that about three fourths of a grain were collected. The portion adhering to the filter, was estimated at about a grain. That which had been collected was ignited, in a platinum crucible, and became green. It was, without doubt, the oxid of nickel, and, with every allowance for loss and other circumstances, the whole cannot be estimated at more than 1,5 grain. In this estimate is included a portion of nickel, adhering to the magnesia, when it was precipitated, which caused it to turn black, when first heated, gave the sulphat of magnesia formed from it, a slightly greenish tinge, and whose existence

is still farther proved, by the production of a black colour, when a solution of this salt was mixed with the hidro-sulphuret of ammonia.

9. The fluid from which the nickel had been precipitated was now of a yellow colour, unmixed with green. This must have resulted from the hidro-sulphuret ot ammonia, and nothing could now be detected in the solution, except what had proceeded from the various re-agents employed. There was, however, one other constituent of the stone, of whose existence the eye furnished decisive evidence, of which no account has hitherto been given, namely, the sulphur. As to the quantity of this, I can give only an estimate. Of the grounds of that estimate, together with the fruitless attempts which were made to collect the sulphur, I will speak presently, but, for the sake of concluding this head I will now add, that the sulphur was estimated at 1,. If this analysis be correct, then, the 100 grains which were examined, afforded,

Silex, - - - - - - - - - - - - - - -	51,5
Attractable brown oxid of iron, - - - - - -	38,
Magnesia, - - - - - - - - - - - - - -	13,
Oxid of nickel, - - - - - - - - - - - - -	1,5
Sulphur, - - - - - - - - - - - - - -	1,
	105,

The excess, instead of the usual loss, proceeds manifestly from the oxidizement of the iron, in a considerable, but unknown proportion. I must add, that the proportions of these ingredients vary in different parts of the stone, as is manifest to the eye, and will be immediately more fully evinced. In the analyses of others, should there be found some difference of proportion, it will not necessarily indicate a contradiction. The great point of the similarity of the stones to those which have fallen in other countries, and which have been analysed by Howard, Vauquelin, Klaproth, and Fourcroy, who have been my guides in this investigation, will now, in all probability, be considered as sufficiently established. Had the daily avocations of a course of public lectures, allowed the necessary time, I should have attempted something like a complete analysis of each of the constituent parts of the stone. If circumstances permit, this may be still done, but in the mean time, a few observations, perhaps of some utility, may be offered.

II. *Of the Pyrites.*

In the stones in our possession, very few masses of pyrites of any considerable size are to be found, and they are generally so friable, that it was only with great difficulty, and patience, that 20 grains could be collected from 200 or 300 pieces. Their powder is blackish. I digested these 20 grains, for 12 hours, in muriatic acid, somewhat diluted, hoping to separate the sulphur, so as to collect it, as Mr. Howard had done. But in this I was disappointed. Only a very few minute portions of sulphur appeared; they did not, as with Mr. Howard, float, but subsided among the earthy sediment, and only enough of them was collected to decide the existence of sulphur, by their burning with the peculiar smell of that substance. During the solution, the smell of sulphureted hidrogen gas was emitted. As the stone, or, at least some parts of it, emits the smell of sulphur, when heated, I attempted to procure the sulphur by sublimation. A portion of the powdered stone was placed in a coated glass tube, the upper part of which was kept cold, while the coated part was ignited for an hour, but no sulphur was obtained.

I caused the gas which arose from the solution of the metallic part of the stone, in the sulphuric and muriatic acids, to pass into a solution of caustic potash. Only a small portion of the gas was absorbed; the potash became slightly hidro-sulphureted, since it precipitated the acitat of lead, black, and deposited a little sulphur, upon the addition of sulphuric acid. As I had already robbed the specimens of almost every tangible mass of pyrites, and injured them considerably by the extraction, I was compelled to relinquish the idea of obtaining the exact proportion of the sulphur. Mr Howard, in the analysis of the stone of Benares, states the sulphur at 2 parts in 14 of pyrites, or about 15 per ct. If we may suppose these pyrites to be of the same composition (and their physical properties correspond with Count Bournon's description)we might deduce the proportion of sulphur from the proportion of pyrites in the stone; for, there is every reason to believe, that the sulphur exists in no other part of the stone, except the pyrites, and those masses which have proceeded from their decomposition. It is impossible, however, to separate the pyrites from the other parts of the stone, so as to estimate their proportion exactly, but, they evidently do not exceed one fifteenth of the whole stone. If therefore the sulphur be estimated at 1, it is probable the estimate will not be very erroneous.

The muriatic solution of the pyrites had a greenish colour; ammonia threw down the iron in a black precipitate, becoming rapidly red, when exposed to the air. The filtered fluid gave no traces of magnesia, when examined with caustic potash, but hidro-sulphuret of ammonia, gave an abundant precipitate of nickel. Hence these pyrites are composed of iron, nickel, and sulphur. Having saved the precipitates, I hope still to obtain the proportions of the two former.

III. *The malleable Iron.*

When the stone is pulverized, the magnet takes up, usually, more than 40,—I have taken up even 50, but, once, only 23,. This is however, far from being all iron; there is much adhering earthy matter; some adhering pyrites, and, in short, all the principles of the stone adhere. A separate analysis of the attractable part gives us nothing different from the results already stated, except an increase in the proportion of metallic matter, and a diminution in that of the earthy principles. The malleable iron contains nickel equally with that in the pyrites. On the other hand, a separate analysis of the unattractable part, presents no other diversity than a diminution of the metallic, and an increase of the earthy principles. I have separated a piece of malleable iron, so large, that by alternately heating and hammering, it was extended into a bar six tenths of an inch long, and one tenth thick:—another mass was hammered into a plate more than half an inch in diameter. The attractable part of the stone dissolves rapidly in the strong acids; the muriatic and sulphuric, *diluted*, give abundance of hidrogen gas, partially sulphureted, and nitric acid gives copious fumes of nitrous gas. In the same masses are found malleable iron, pyrites, and matter in an intermediate condition, intimately blended, and adhering to each other.

IV. *The irregular black masses.*

Some of these appear somewhat regular, like crystals of schorl, but, most of them are irregular. While examining them, I found, in some, appearances of pyrites, in a state of decomposition. This led to a suspicion, that these masses were merely pyrites, which, by the force of the heat, had been decomposed more or less completely. Accordingly, on separating a good many portions of these bodies, some were found readily, others feebly, and others not at all attractable by the magnet. But, the latter, by being heated, for a few minutes with the blow pipe, became decidedly attractable. As a standard of comparison, some golden coloured pyrites from Peru, were heated by the blow pipe, to expel the sulphur, and were made to pass through all the shades of colour, and degrees of magnetic attractability, corresponding with the various conditions of the black irregular masses. No doubt could now remain that the conjecture concerning their nature was well founded. The glossy interior coating, mentioned in the mineralogical description, appeared to be of the same nature and to approach nearly to the condition of malleable iron.

V. *The Crust.*

The black external crust adheres so closely to the earthy matter within, that it is not easy to separate it. Indeed it appeared scarcely worth while to subject it to a separate analysis, since the blow pipe sufficiently indicates the difference between it, and the rest of the stone. For, on heating any small portion of the stone, with the most intense flame that a blow pipe can give, it becomes covered with a black crust, similar to that of the stone. The only point then in which the crust differs from the rest of the stone is, *that it has been changed by strong ignition*, having suffered a sort of vitrification, and its metallic parts a partial oxidizement; I say partial, for when detached it is attractable by the magnet, and the file discovers points of malleable iron.

VI. *The globular Bodies.*

These appear to be merely portions of the stone, embracing probably all its principles, which have been melted by intense heat, and being surrounded by solid matter, have become more or less globular, like the globules of metal which appear dispersed through a flux in a crucible, after an operation with a very high degree of heat, upon a very refractory metal. The globular bodies in this stone, although not attractable by the magnet, readily become so by being heated with the blow pipe. Is the iron in them too highly oxidized, to admit of attraction, and, are they partially reduced by ignition on charcoal? Finally, is there not reason to conclude, that these meteoric stones, originally presented nothing distinguishable by the eye, except pyrites and the enveloping earthy matrix, that by the operation of heat, the irregular black masses have been produced, by a partial decomposition of the pyrites, that by a still more intense heat in certain parts, the pyrites have been altogether decomposed, and malleable iron produced, that the crust is produced by a mere oxigenizement and vitrification, that the difference of colour in the earthy part, is owing to the unequal operation of heat, the pyrites being left, in some places, especially in the white spots, almost wholly undecomposed, and that the globular bodies have been formed by a complete fusion of certain portions, by intense ingition?

Yale College, January 14th, 1808.

POSTSCRIPT.

February 22, 1808.

In Nicholson's Journal for October, 1806, (No. 61, p. 147,) is an abstract of a memoir, by A. Saugier, taken from the 58th volume of the Annals of Chemistry, in which the author asserts the existence of a new principle in meteoric stones, viz. *chrome.* Before adverting to this subject it will be well to point out another assertion in M. Saugier's memoir, which appears to have been erroneously expressed. After remarking that all chemists who have examined meteoric stones, "have obtained similar results" he enumerates the principles which have been discovered in them, and says they are, " silex, iron, *manganese*, sulphur, nickel, with a few accidental traces of lime and alumine." It seems plain that manganese has here been carelessly written instead of magnesia, for, neither Mr. Howard, nor any of the able chemists who succeeded him in the examination of meteoric stones, before M. Saugier, ever found manganese, but constantly magnesia, and as magnesia is not mentioned at all by this latter chemist, I think it plain, that magnesia is intended by him, where he writes *manganese*.

Dismissing this for an inadvertency, we will therefore return to *chrome*.

I have carefully repeated and somewhat varied and extended the experiments of Saugier on the discovery of chrome in meteoric stones.

1. A strong solution of caustic potash was boiled for an hour on a portion of the stone in powder, the fluid was filtered; it had a slightly yellowish colour.

2. Nitric acid was added, somewhat in excess, in order that the potash might all be saturated.

3. Nitrat of mercury, recently formed, without heat, was added, but there was no precipitate whatever; at this stage of the process, Saugier threw down a red, orange coloured precipitate, or chromate of mercury.

4. A small portion of the stone was now fused with pure potash, in a silver crucible, and maintained for some time in a red heat; every thing soluble was then taken up by water, the fluid was filtered, and had a green colour.

5. Nitric acid was added, a little in excess, and then nitrat of mercury, as before, but no precipitate ensued, these experiments were several times repeated, and with the same success.

6. Other portions of the fluid, resulting from the boiling of potash upon the stone, and from its fusion upon it, and subsequent solution, were now mixed with the nitrat of mercury, without the previous addition of nitric acid. A copious yellow precipitate was thrown down, this was heated to ignition

in a platinum crucible, the oxid of mercury was decomposed, and its elements expelled, and a small portion of a green oxid remained in the crucible. In several repetitions of the process this, invariably, occurred. I had been led to suspect that this was the oxid of nickel, because the alkaline solution, from which it had been obtained, gave a black precipitate, with the hidro-sulphuret of ammonia; accordingly, on fusing a portion of this oxid, with borax, under the blow-pipe, it produced a glass of a hyacinth red; the same fact took place with a portion of a substance, known to be the oxid of nickel, which was fused with borax, for the sake of comparison. On fusing a portion of the chromat of lead, or Siberian red lead ore, with borax, and afterwards with vitreous phosphoric acid, glasses of an emerald green colour were produced.

Hence it was concluded, that the meteoric stones of Weston do not contain *chrome*, but that the green oxid obtained, was the oxid of nickel.

No. LII.

Observations of the Comet which appeared in September 1807, *in the Island of Cuba, by J. J. de Ferrer.*

Read August 19th, 1808.

		Mean time at the City of Havanna. h ′ ″	The observed long. of the Comet. ° ′ ″	The observed lat. of the Comet. ° ′ ″
1807. Octr.	1	6 54 50	220 21 12	18 46 03 N.
	18	6 54 42	234 36 58	37 41 11
Novr.	3	6 56 05	251 41 25	51 13 00
	4	6 49 30	252 57 08	51 54 42
	7	6 44 20	257 02 22	53 54 18
	17	7 04 26	272 54 40	59 17 31
	18	6 27 36	274 37 42	59 42 37
	19	6 44 10	276 27 40	60 06 13
	25	6 59 07	287 53 57	61 56 32
Decr.	1	7 26 00	299 55 31	62 51 30

The longitudes and latitudes of the preceding table, have been deduced from angular distances observed of Arcturus, Vega, Altair, α, β and ν in the Swan, with the circle of reflection, described in page 265 of this volume.

The observations from the 1st Octr. till the 7th Novr. were made in the city of Havanna, the others at the plantation of

Don Joseph de Cotilla, situated in latitude 22° 55′ 16″ N. and 44″,3, in time, E. of Havanna.

The times of the observations were determined by a good chronometer, regulated by absolute and corresponding altitudes of the sun and stars, and the times observed at the plantation, are referred to the city of Havanna, by the difference of meridians.

To determine the place of the comet, many series of observations were made with two or three of the above named stars, choosing those that made the most convenient triangles, and as the different observations could not be made at the same time, care has been taken, to refer all the distances observed, to the same instant, by means of the variation observed of the distances of the said stars from the comet.

The distances observed were freed from the effects of refraction, corrected by reference to the state of the thermometer and barometer.

The places of the stars were taken from the *Connoisance de temps*, of Paris, 1806; allowance being made for the proper motion, precession of the equinox, nutation and aberration. Further, the latitudes and longitudes of the said table are the apparent, that is, affected by the nutation and aberration. The elements of the orbit of the comet were calculated from the first observations which I made in Havanna, that is, from 1st Octr. to 7th Novr., by Don Francis Leamur, Lieutenant Col. of the Royal Corps of Engineers, and are the following:—

Passage through the perihelion, mean time at the city of Havanna, Septr. 18th	11h 58′ 59″
Longitude of the ascending node.	8s 26° 39′ 09″
Inclination of the orbit.	63 12 30
Place of the perihelion.	9 00 45 01
Perihelion distance, that of the sun being 1.	0,6462128

After having concluded the observations, namely up to the 1st December, I determined to calculate the elements of the parabolic orbit, by the combination of all the observations, and the following elements are the results.

Passage through the perihelion, mean time, at the city of Havanna, Septr. 18.	12h 37′ 00″
at Greenwich,	18 06 40
Longitude of the ascending node from the mean equinox=	8s 26° 42′ 12″
Inclination of the orbit.	63 12 51
Place of the perihelion.	9 00 51 35
Perihelion distance, that of the sun being 1	0,6462667.

Comparison of the observations with the results of the theory calculated by the above elements.

The longitudes and latitudes observed and calculated in the following table, are freed from nutation and aberration.

The two last columns shew the difference between the longitude and latitude, observed and calculated.

1807.	Mean time, Havanna.	The observed Longitude.	The observed Latitude.	Calculated Longitude.	Calculated Latitude.	Diff. long.	Diff. lat.
	h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	″	″
Octr. 1	6 54 50	220 21 14	18 46 32 N	220 21 37	18 46 30 N	—23	+02
18	6 54 42	234 37 06	37 41 36	234 36 19	37 42 15	+47	—39
Novr. 3	6 56 05	251 41 39	51 13 17	251 41 36	51 12 55	+ 3	+22
4	6 49 30	252 57 25	51 55 00	252 58 12	51 54 21	— 49	+39
7	6 44 20	257 02 42	53 54 33	257 02 25	53 55 01	+17	—28
17	7 04 26	272 55 16	59 17 42	272 55 03	59 18 36	+13	—48
18	6 27 36	274 38 23	59 42 49	274 38 50	59 42 58	—27	—09
19	6 44 10	276 28 21	60 06 25	276 28 39	60 06 46	—18	—21
25	6 59 07	287 54 41	61 56 37	287 55 14	61 56 51	—33	—14
Decr. 1	7 26 00	299 56 18	62 51 30	299 56 44	62 51 22	—26	+08

Continuation of Astronomical Observations, made at the plantation of Don Joseph de Cotilla.

Determination of Latitude.

1807, Novr. 13	By 8 series of ☉'s double altitudes, observed near the meridian, with a circle of reflection.	22° 55′ 14½″ N.		
17	ditto ☉'s diameter.	22 55 15½		
21	ditto ditto.	22 55 09½		
			mean.	22° 55′ 13″,5 N.
Novr. 17	By 4 series of double altitudes of the pole-star.	22 55 20		
20	By 2 series of Fomalhat.	22 55 17		
			mean.	22 55 18, 5
	Mean Latitude.			22 55 16

By astronomical observations, I have determined the bearing of the highest hill of Camoa, N. 13° 34′ 10″ W.

The hill of Camoa, from the city of Havanna, according to the survey which was made by the order of Government, was determined =29250. Varas of Castilla =13,11 geographical miles, bearing S. 45° E.

Latitude of Havanna, according to a great number of observations made with the same circular reflector.	23° 08′ 30″
Hill of Camoa S. 45 E. 13′,11 miles, difference of latitude =	9 16
Latitude of the hill of Camoa.	22 59 14
By direct observations on the hill, with the circular.	22 59 18
Mean latitude of the hill.	22 59 16

The combination of the two bearings, and the latitudes of the hill of Camoa and Havanna, gives the former E. of the city of Havanna 11′ 05″,2=44″,3 in time.

Observations made on a lunar eclipse, on the 14th Novr. 1807.

	h	′	″
The beginning of the eclipse, apparent time.	13	52	12
beginning of immersion of Tycho.	14	15	52
end of immersion of Tycho.	14	19	12
beginning of Mare humorum.	14	23	32
end of the eclipse.	15	58	42

Observation of apparent lunar distances, observed with the circle of reflection, at the plantation.—The distances in the following table are the result of 4 series of direct and inverse observations.

1807.		Appt. time.		Appt. Dist.	Ther.	Barom.
		h ′ ″		° ′ ″		
Novr.	14	8 01 12	α ♉ ☾'s remote limb.	19 06 40	65½	30 10
		8 26 51	ditto. ditto.	18 57 52		
		15 37 40	α ♉ ☾'s nearest limb.	16 45 37		
	17	9 07 30	ditto. ditto.	20 51 04	66	30 00
		9 24 40	ditto. ditto.	21 00 46		
	19	20 31 20	☉ ☾ nearest limbs.	118 10 53	72	30 00
		21 17 28	ditto.	117 50 13		
	21	21 33 52	ditto.	92 16 37	75	29 96
	22	17 25 27	α ♍ ☾'s nearest limb.	41 43 54	67	30 10
	24	17 53 15	ditto. ditto.	12 37 06	65	30 15
		22 01 38	☉ ☾	51 56 57	72	30 10
		22 16 12	ditto.	51 51 26		
Decr.	2	22 57 34	ditto.	52 58 33	77	30 00
		23 23 09	ditto.	53 09 29½		
		23 57 20	ditto.	53 22 46		
	3	0 50 54	ditto.	58 42 14½		
	4	3 50 27	ditto.	66 14 57½	74	30 12
		4 11 51	ditto.	66 19 55		
	7	1 51 48	ditto.	99 05 41	74	30 10
		2 11 58	ditto.	99 12 32		
		6 14 33	☾'s and Atair nearest limb.	58 57 49	70	29 98
		6 26 30	ditto.	59 00 25		
	9	6 33 59	☾ α ♉ remote limb.	47 53 01	69	30 00
	15	7 04 51	☾ α ♉ remote limb.	29 03 30½	74	29 95
		7 16 24	ditto. ditto.	29 10 25		
	20	12 13 28	☾ and Regulus remote limb.	21 25 48	70	30 10
		12 18 16	ditto.	21 28 25		
1808.		12 31 02	ditto.	21 35 14		
Jan.	11	14 06 42	☾ α ♉ nearest limb.	26 13 05	68	30 15
		14 23 14	ditto.	26 18 48		
	19	16 08 31	☾ and Antares nearest limb.	37 44 55	55	30 14
		16 23 02	ditto.	37 39 58		
	21	21 25 35	☉ ☾	61 55 05	71	30 08
		21 45 24	ditto.	61 49 10		

January 11th, 1808. Occultation of ᵛ ♊ *by the moon.*

Immersion on the dark limb.	Apparent time.	11h 46′ 11″,4
	Mean time. . .	14 54 32, 0

The disappearance was instantaneous—magnifying power of the telescope, 75.

January 27. By four series of double altitudes of Canopus, near the meridian, observed with the circular reflector, corrected by the horary angles, and refraction, the meridian altitude was determined. . . . . . 14° 28′ 53,5″

By 4 series of similar observations on Sirius. 50 36 54,4

By 10 series of angular distances, observed with the circular reflector, and corrected for refraction, the mutual distance was determined =36° 17′ 19,4″.

The difference of right ascension in time, of the above stars =16′ 59,5″.

By the distance observed, and the difference of right ascension results the difference of declination. 36° 08′ 00,4″

The difference of meridional altitudes =difference of declinations. . . . , . 36 08 00,9

Taking the latitude of the place as stated above 22° 55′ 16″ and correcting the meridional altitudes observed, from nutation, aberration, and precession, we have the true, or mean declinations of the two stars on 1st January 1808.

Canopus.	52° 35′ 34,9″
Sirius.	16 27 36,8

Comparing the observations of la Caille on 1750, and supposing the annual precession in longitude=50,1″ we have the proper motion of Canopus in declination in 58 years—0′ 10,1″

Sirius. . . . +1 02,0

Mean declination of Sirius, according to the Rev. Nevill Maskelyne on the 1st of January, 1808.	16° 27′ 30″
Connoisance de temps.	16 27 38,6
By the observation with the circular reflector.	16 27 36,8

Astronomical observations made at the city of Havanna. Latitude of the place 23° 08′ 30″.

Occultations of stars by the moon, observed with an Achromatic telescope—magnifying power 75.

April 5th, 1808.	☾ 1 α ♋ on the dark limb, apparent time.	. . .	11h 53′ 34″
May 2d,	374 of Mayer on the dark limb. ditto.	. . . .	9 01 49
3d,	ϖ Lion on the dark limb. ditto.	. . . .	10 33 49

The immersions were instantaneous.

Observations made on a lunar eclipse at the city of Havanna, on the 9th of May, 1808:—magnifying power of the telescope 70.

IMMERSIONS.	Mean time. h ′ ″	EMERSIONS.	Mean time. h ′ ″
Beginning of the Eclipse.	12 22 29	End of total darkness of the ☾	14 55 10
Beginning of Grimaldus.	12 27 18	End of Grimaldus.	15 01 50
End of ditto.	12 27 58		
Beginning of Aristarcus.	12 28 38		
End of ditto.	12 30 08	End of Aristarcus.	15 05 45
Beginning of Mare humorum.	12 37 57	Beginning of Tycho.	15 14 14
ditto. of Copernicus.	12 39 37	End of ditto.	15 15 47
End of ditto.	12 40 57	Center of Schikardus.	15 19 28
Beginning of Plato.	12 43 57		
End of do.	12 45 07	End of Plato.	15 21 23
Beginning of Mare serenitat.	12 50 57	Beginning of Mare serenitat.	15 28 29
Center of ditto.	12 55 16	Center of ditto.	15 33 07
Beginning of Tycho.	12 56 46	End of ditto.	15 37 57
End of ditto.	12 58 41	End of Taruntius.	15 44 17
Beginning of Mare Crisium.	13 09 21	Beginning of Mare crisium.	15 46 46
End of ditto.	13 14 20	End of ditto.	15 49 26
End of Langrenus.	13 18 00		
Total darkness of the ☾.	13 21 25	The end of the eclipse.	15 54 36

The above observations of the lunar eclipse are very exact, excepting the beginning and the end of the eclipse, which are liable to the error of one and a half minute, on account of the strong penumbra.

Table of the results of the occultations of the stars by the moon.

	Imm. ν ♊ ☾ at plantation Jan. 11, 1808.	Imm. 1 *a* ♋ ☾ Havanna. April 5, 1808	Im. 347 mayer Havanna. May 2, 1808.	Imm. w ♌ ☾ Havanna. May 3, 1808
	h ′ ″	h ′ ″	h ′ ″	h ′ ″
Mean time of immersions.	14 54 32	11 56 07	8 58 14	10 31 26
Longitude west from Paris.	5 38 06	5 38 50	5 38 50	5 38 50
Mean time at Paris.	20 32 38	17 34 57	14 37 04	16 10 06
Apparent longitude of the stars.	94°07 55	130°06 03,6	124 45 10,5	138 52 00
Apparent latitude of the stars.	3 04 48 S.	5 29 34 S.	5 20 48 S.	5 34 07 S.
Latitude——Vertical angle	22 47 52	23 01 13		
Logarithmic radius of the earth.	9.9998036	9.9998000		
Equatorial horiz. parallax of the ☾	57 23,8	58 24,5	57 15	58 05,3
Parallax in Longitude.	—45 36,0	—41 35,9	—35 44,5	—38 52,3
Parallax in latitude.	+13 05,2	+29 17,9	+22 38,3	+31 16,2
Apparent difference of latitude between the moon and stars.	5 03	6 08,0	7 36,0	14 31
Conjunction mean time.	13 59 34			
Havanna west from the plantation	44,3			
Conjunction in Havanna by observ	13 58 49,7	11 09 37	8 18 11	9 34 32
At Paris by the new tables.	19 38 24,0	16 43 51	13 57 11	15 13 40
Havanna west from Paris.	5 39 34,3	5 39 14	5 39 00	5 39 08

Results of observed lunar distances.

	January 11th, 1808 ☾ α ♉	☾ α ♉	January 19th, 1808. ☾ & Antares.	☾ & Antares.
	h ′ ″	h ′ ″	h ′ ″	h ′ ″
Apparent time of the observations.	14 06 43	14 23 18	16 08 31	16 23 02
Apparent distances nearest limb.	26°13 05	26°18 48,2	37 44 45	37 39 55
Altitudes of ☾ calculated { Appt.	43 03 40	39 27 20	47 18 20	48 57 00
Altitudes of ☾ calculated { True.	43 49 31	40 10 30	47 57 34	49 35 01,5
Altitudes of the stars do. { Appt.	16 51 40	13 07 10	13 33 30	16 13 20
Altitudes of the stars do. { True.	16 48 41	13 03 20	13 29 41	16 10 09
Corrected distances.	27 12 22,8	27 21 06,4	38 37 06,1	38 29 02,8
Apparent longitude of the stars.	67 06 52,3		247 05 00,6	
Apparent latitude of ditto.	5 28 47 S.		4 32 30 S.	

True longitude of the moon by observations January 11th, 14^h 15′ 00″,5 } Apparent time at the Plantation. . . . 3^s 04° 21′ 02″,7

January 19th at 16^h 15′ 46″,5 apparent time. . 6 28 30 03,5

			Havanna W from Paris
Longitude of the Plantation W. from Paris	$=5^h$ 38′ 29″,7+44″,3	=	5^h 39′ 14
Ditto from the observation of 19th	. 5 38 18, 5+44, 3	. .	5 39 03

Solar eclipse of June 16th, 1806, in the city of Havanna.

Apparent time. h ′ ″		Dist. of the horns. ′ ″	
8 55 34,6	beginning of the eclipse	0 00,0	Observed by Don Antonio de Robredo, with a Heliometer of Dollond.
8 57 20,2	. . . .	6 12,9	
8 59 22,0	. . . .	8 51,6	
9 02 08,6	. . . .	11 40,0	
9 04 35,8	. . . .	13 31,5	
9 07 44,0	. . . .	15 17,0	
9 11 40,0	. . . .	17 19,3	

	Mean time. h ′ ″
With the elements of page 270 of this Volume, I have calculated the conjunction, by the beginning, June 15th.	22 50 58
By the first observation of distance	22 51 03
By the second.	22 51 07
By the third.	22 51 04
Conjunction June 15th, Astronomical time.	22 51 03
Ditto. in Paris, page 296, June 16th.	4 30 12
Havanna west from Paris.	5 39 09

By the Solar Eclipse (page 162,) observed in the city of Havanna, and at Lancaster in Pennsylvania. U. S.

Havanna west from Lancaster	0^h 24′ 25″
Lancaster west from Paris (page 297.)	5 14 41
Havanna west from Paris.	5 39 06

Longitude of Havanna, by the observations compared with the new tables published at Paris in 1806.

		h ′ ″	
Occultations of stars.	January 11, 1808.	5 39 34	
	April 5.	5 39 14	
	May 2.	5 39 00	
	May 3.	5 39 08	
Distances of moon.	α ♉ January 11.	5 39 14	
	α ♍ January 19.	5 39 03	
Solar eclipse, 1803.		5 38 16	
do. 1806.		5 38 20	
Moon's eclipse, May 9, 1808.		5 38 51	
			5 38 55
By corresponding observations of solar eclipse February 21, 1803		5 39 06	
Ditto June 16, 1806.		5 39 09	
			5 39 07
Havanna inferred from Philadelphia, by the chronometer, No. 63.		5 39 18	
Inferred from Veracruz, page 225.		5 38 37	
Ditto from Porto Rico, page 225.		5 38 34	
			5 38 50
Havanna west from Paris.			5 38 57

Passage of Venus over the disk of the Sun, June 3d, 1769.

Elements from Astronomical tables at	10h 11′ 47″ mean time at Paris.
Longitude of the sun, apparent equinox.	73° 27 18,3
Right ascension of the sun.	72 03 16
Horary motion in ☉'s right ascension.	2 34
Relative horary motion in longitude	3 57,40
Horary motion of Venus in latitude S.	0 35,42
Inclination of the orbit.	8 29 10,00
Apparent obliquity of the ecliptic	23 28 11,5
Radius vector of the earth.	1,0151990
Radius vector of Venus.	0,7262650
☉'s semidiameter.	15′ 47″,07

By a previous calculation of the observations of this passage, I had determined the following elements:—

Sun's parallax at the mean distance from the earth =	8″,62378
Apparent conjunction, mean time at Paris =	10h 11′ 47″
Apparent longitude of Venus.	73 27 18,3
Duration of the passage between the interior contacts =	5h 41′ 54″,5 in mean time.
or	5 41 52,1 in apparent time.
Latitude of Venus at conjunction, north.	10 15,94
The shortest distance of the centers.	10 09,18
Difference of the semidiameters of ☉ and ♀	15 15,89
Sum of the semidiameters.	16 13,27
Difference of Venus and sun's parallaxes at the passage =	21,352

TABLE I.

Reduction of the observations to the center of the earth.

		Appt. time of the observations.	Effect of Parallax	Appt. time of con. center of earth	Long. from Paris.	Contacts at center of earth. Appt. time at merid. of Paris II.	III.	IV.
		h ′ ″	′ ″	h ′ ″	h ′ ″		h ′ ″	h ′ ″
Petersburg.	III	15 24 41	—5 16	15 19 25	—1 51 56		13 27 29	
	IV	15 43 27	—4 58	15 38 29				13 46 33
Cajaneburg.	II	9 20 45	+6 44	9 27 29	—1 41 47	7 45 48		
	IV	15 32 27	—4 36	15 27 51				13 46 10
Wardhus.	II	9 34 10	+6 27	9 40 37	—1 55 07	7 45 30		
	III	15 27 24	—4 33	15 22 51			13 27 44	
	IV	15 45 41	—4 09	15 41 32				13 46 25
Batavia.	III	20 30 13	—4 02	20 26 11	—6 58 15		13 27 56	
	IV	20 48 31	—3 45	20 44 46				13 46 31
Gurief.	III	16 52 25	—6 28	16 45 57	—3 18 24		13 27 33	
	IV	17 11 06	—6 06	17 05 00				13 46 36
Oremburg.	III	17 05 06	—6 12	16 58 24	—3 30 58		13 27 56	
	IV	17 23 24	—5 53	17 17 31				13 46 33
Orsk.	III	17 18 26	—6 09	17 12 17	—3 44 43		13 27 34	
	IV	17 36 57	—5 52	17 31 05				13 46 22
Pekin.	III	21 08 24	—4 27	21 03 57	—7 36 30		13 27 27	
	IV	21 26 54	—3 54	21 23 00				13 46 30
Mean results of the III and IV Contacts							13 27 39,9	16 46 27,5

In the calculation of this and the following tables, the parallax of the sun, at the mean distance of the earth =8″62378, and the difference of parallaxes at the passage =21″,352.

Note. The III contact at Petersburg was observed 13ʰ 28′ 29″ and I subtracted one minute of time, being probably an error committed in setting down the time of the clock.

TABLE II.

Reduction of the observation to the center of the earth.

		Apparent time of observations.	Effect of parallax.	Appt. time at the center of the earth.	Longitudes from Paris.	Appt. time of con. at center of the earth at Paris.
		h ′ ″	′ ″	h ′ ″	h ′ ″	h ′ ″
Paris.	II	7 38 45	+7 03,1			7 45 48,1
Greenwich.		7 29 25	+7 04,2	7 36 29,2	+00 09 21	7 45 50,2
Kew.		7 28 17	+7 04,2	7 35 21,2	+ 10 24	7 45 45,2
Oxford.		7 24 20	+7 02,0	7 31 22	+ 14 23	7 45 45
London.		7 29 16	+7 04,0	7 36 20	+ 9 37	7 45 57
Stockholm.		8 41 46	+6 56,0	8 48 42	— 1 02 55	7 45 47
Upsal.		8 40 12	+6 57,4	8 47 09	— 1 01 15	7 45 54,4
Mean.			+7 01,6		Mean.	7 45 49,5

TABLE III.

		Apparent time observations. h ′ ″	Effect of parallax. ′ ″	Appt. time at the center of the earth h ′ ″
Fort Prince of Wales	II	1 15 23	+4 12,1	1 19 35,1
	III	7 00 47	+0 39,1	7 01 26,1
	IV	7 19 20	+0 49,5	7 20 09,5
St. Joseph.	II	0 17 27	+0 20,3	0 17 47,3
	III	5 54 50	+4 47,9	5 59 37,9
	IV	6 13 19	+4 46,0	6 18 05,0
Taity.	II	21 44 04	—5 33,4	21 38 30,6
	III	3 14 08	+6 17,4	3 20 25,4
Philadelphia.	I	2 13 45	+3 38	2 17 23
	II	2 31 28	+3 54	2 35 22
Cape Francais.	I	2 26 12	+2 23,6	2 28 35,6
	II	2 44 44,5	+2 37,6	2 47 22,1
Cambridge	II	2 47 30,0	+4 19,0	2 51 49,0

TABLE IV.

Difference of time between the interior and exterior contacts at the center of the earth.

	′ ″	
Petersburg	19 04	Egress.
Wardhus.	18 41	
Batavia.	18 35	
Oremburg	18 37	
Gurief.	19 03	
Orsk.	18 48	
Pekin.	19 03	
Fort Prince of Wales.	18 42	
St. Joseph.	18 27	
Greenwich.	18 48	Ingress.
Cape Francais.	18 47	
Oxford.	18 41	
Mean.	18 46,4	

	h ′ ″	
IV contact at Paris, center of the earth, Table I.	13 46 27,5	effect of parallax.
Mean result of Table IV.	—18 46,4	
III contact by the observations of IV contact.	13 27 41,1	—4 54,1
By the mean of direct observations, Table I.	13 27 39,9	—5 18,1
Mean result for the III contact.	13 27 40,5	—5 06,1
II contact by Table II.	7 45 49,5	+7 01,6
Total duration of the interior contacts (n)	5 41 51,0	—12 07,7
By the observations of Wardhus. 5h 42′ 14″,0 / By ditto Cajaneburg. 5 41 35 5	5 41 54,8	—11 10,0
Mean. (a)	5 41 52,9	—11 38,8
By the observations at Taity	5 41 54,8	+11 50,8
By the observations at St. Joseph.	5 41 50,6	+ 4 27,6
By ditto . F. P. Wales.	5 41 51,0	— 3 33,0

Results of sun's parallax at the mean distance of the earth.

By the duration, at Taity and (n)		8″,600
Taity and (a)		8,620
Taity and Wardhus.	8″,731 }	8,623
Taity and Cajaneburg.	8,516 }	
St. Joseph and F. P Wales.		8,62[illegible]
St. Joseph and (a) =	8,645 }	8,616
Taity and F. P. Wales. =	8,588 }	
Mean result.		8,615

Contacts at the center of the earth, for the meridian of Paris; allowing the sun's parallax at the mean distance of the earth=8″,615.

	h ′ ″
I Contact. Apparent time.	7 27 02,5
II	7 45 48,9
III	13 27 41,4
IV	13 46 27,8

Error of the duration of the observations at Wardhus.	+22″,8
Cajaneburg.	−16,0
(n)	− 0,5
Taity.	+ 1,3
St. Joseph.	− 2,3
F. P. Wales.	− 1,7

Determination of the longitude of different places, from Paris, by the observation of the passage of Venus.

			h ′ ″	h ′ ″
Philadelphia, by the	I	exterior contact.	5 09 40,0	= 5 10 03,7 W.
	II	interior contact.	5 10 27,5	
Cape Francais.	I		4 58 27,5	4 58 27,5 W.
	II		4 58 27,4	
Cambridge, N. Eng.	II			4 54 00,5 W.
Taity.	II		10 07 17,9	10 07 17,2 W.
	III		10 07 16,6	
St. Joseph.	II		7 28 01,6	7 28 02,8 W.
	III		7 28 03,9	
F. P. Wales.	II		6 26 13,5	6 26 14,4 W.
	III		6 23 15,3	
Wardhus.	II		1 54 47,6	1 55 01,5 E.
	III		1 55 09,9	
	IV		1 55 07,1	
Cajaneburg.	II		1 41 39,6	1 41 31,5 E.
	IV		1 41 23,6	
Gurief.	III		3 18 15	3 18 23,5 E
	IV		3 18 32	
Oremburg.	III		3 30 42	3 30 52,5 E.
	IV		3 31 03	
Orsk.	III		3 44 35	3 44 36,0 E.
	IV		3 44 37	
Batavia.	III		6 58 30	6 58 24,0 E.
	IV		6 58 18	
Pekin.	III		7 36 16	7 36 24,5 E.
	IV		7 36 33	
Petersburg.	III		1 51 44	1 51 52,5 E.
	IV		1 52 01	

Passage of Mercury over the disk of the Sun, Novr. 12th, 1782.

			h ′ ″	
Philadelphia.	I	contact	9 34 50	Mean time.
	II	. .	9 40 00	
	III	. . .	10 51 30	
	IV	. .	10 57 35	
Paris. . .	I	. .	2 58 04,5	Apparent time.
	II	. .	2 04 30	
	III	. . . .	4 17 40	
Greenwich. .	II	. .	2 54 42	Apparent time
Cambridge in New England.	II	. . .	10 12 10	Apparent time.
	III	. .	11 23 06	
	IV	. .	11 29 14	

Difference of ⊙ and ☿'s semidiameters. . . 16′ 04″,27
Difference of horizontal parallaxes. 4, 01
Horary relative motion in longitude. 3 53, 45
Horary motion of ☿ in latitude, N. 51 91
Appt. conjunction at Paris, by the observ. at Paris and Greenwich = 4h 04′ 09″
Apparent conjunction, by observations at Philadelphia. . . . 22 53 59
Apparent conjunction Cambridge. . . . 23 10 16
Longitude of Philadelphia west from Paris. . 5h 10′ 10″
Cambridge west from Paris . . . 4 53 53

Passage of Mercury over the disk of the sun, Novr. 5th, 1787.

Observations.

			Apparent time h ′ ″
Paris, interior contact at the ingress.			1 19 00
Viviers.		do.	1 28 32
Cadiz.		do.	0 44 30
Marseilles.		do.	1 31 07
Montauban.		do.	1 15 14
Vienna.		do.	2 15 08
Prague.		do.	2 07 26
Philadelphia.	I		20 08 00
	II		20 09 30
	III		00 59 34
	IV		1 01 14
Cambridge in N. England.	I		20 24 04
	II		20 25 52
	III		1 15 44
	IV		1 17 36
Montevideo	III		2 15 11
	IV		2 16 54

Difference of the horizontal parallaxes. . . . = 4″,149
Horary relative motion in longitude between the ingress and conj. 349,55
Between the egress and conjunction. 350,00
Horary motion in latitude, N. 51,40
½ diameter of ⊙—1″,50 irradiation. 969,28

	h ′ ″
Apparent conjunction at Paris, by the observations in Europe =	3 33 16
Philadelphia.	22 33 22
Cambridge	22 39 36
Montevideo.	23 39 01
Longitude of Philadelphia west from Paris.	5 00 54
Cambridge west from Paris.	4 53 40
Montevideo west from Paris.	3 54 15

Annular eclipse, April 3d, 1791.

Elements from the Astronomical tables published at Paris, in the year 1806, by order of the Commissioners of longitude.

	h ′ ″
1791. April 3. Astronomical mean time at Paris.	0 54 40
☉'s longitude from the apparent equinox.	13°41 58
☉'s right ascension in time.	0h 50 25
☉'s semidiameter.	0°16 00,42
Equation of time.	+ 3 17,53
☉'s horary motion in longitude.	2 27,59
Horary motion in ☉'s right ascension in time	9,10
Horary diminution of the equation of time.	0,90
☾'s longitude from the apparent equinox.	13°41 37,8
☾'s north polar distance.	89 15 05,9
☾'s equatorial horizontal parallax.	54 36,1
☉'s equatorial horizontal parallax.	8,6
Apparent obliquity of the ecliptic.	23 27 53,0
Moon's horary motion in longitude.	30 12,97
Moon's horary motion in latitude S.	2 46,72
Horary diminution of ☾'s horizontal parallax.	00,75
Equation of 2d order of the ☾'s horary motion in longitude.	— 00,40
ditto ditto ditto in latitude.	+ 00,11
Proportion of the equatorial horiz. paral. and the ☾'s horiz. diameter.	60 : 32 45,1

Proportion of the equatorial and polar diameters of the earth = 330 : 329

Observations made by the Rev. Nevil Maskelyne, at Greenwich

0h 18′ 40″	Apparent time, beginning of the eclipse.
1 44 51	Least distance of the limbs. 12′ 52″
3 06 47	End of the eclipse.

By the mean result of 8 observations, ☉'s diameter was . 31′ 57″,0

	h ′ ″	h ′ ″	h ′ ″
Apparent time of the observations at Greenwich.	0 18 40	1 44 51	3 06 47
Difference of ☾ and ☉ equatorial parallaxes.	0 54 27,8	54 26,7	54 25,8
Parallax in longitude.	—18 02,4	—29 07,0	—38 05,0
Parallax in latitude.	—34 47,1	—30 18,6	—27 10,4
☾'s apparent semidiameter—2″ inflexion.	15 02,2	15 01,0	14 59,0
☉'s semidiameter—2″ irradiation.	15 58,4	15 58,4	15 58,4

Conjunction at Greenwich by the combination of the beginning and the end of the eclipse. . . apparent time. . . . . 0h 45′ 16″,5

Correction of latitude by the tables. . . . . + 13

By the least distance of the limbs. . . . . + 13,6

Supposing the irradiation of the sun's semidiameter . = 1″,8

The ☉'s diameter was observed . . . . 31′ 57″,0

By the tables. 32 00, 8

The corrected distance of the limbs $= \frac{32' 00''.8 \times 12' 52''}{31,57} = 12' 53'',5$

The double irradiation. . . . . . . — 3, 6

True distance of the limbs. 12 49, 9

And the correction of moon's latitude corrected from the effect of refraction = +11″,5

Conjunction at Paris =(0h 45′ 16″,5+9′ 21″) =00h 54′ 37″,5

Observations at the National Observatory of Paris.

Beginning of the eclipse, apparent time. . . . . = 0h 36′ 55″,4

End of the eclipse. 3 20 52 0

Conj. at Paris by the combination of the beginning and end of the eclipse.		0h	54′	38″,5
Correction of the ☾'s latitude by the new tables	=+		00	09
Palermo, beginning, apparent time.	=	2	10	17, 0
Palermo, end.		3	59	20, 4
Conjunction at Palermo.	=	1	18	45
Conjunction at Paris = 1h 38′ 45″,5——44′ 06″	=	0	54	39, 5
Correction of ☾'s latitude	=+			11, 0
Petersburg apparent time, beginning of the eclipse.		2	56	30
Petersburg end of the eclipse.		5	21	26
By the combination of the beginning and end, conjunction in mean time	=	2	46	37, 6
Conjunction at Paris, mean time = (2h 46′ 37″,6——1h 51′ 56″)	=	0	54	41, 6
Correction of the ☾'s latitude by the tables.	=+			10, 0

			h ′ ″		″
By the observations of Greenwich, conj. at Paris			=0 54 37,5	correction of ☾'s lat.	=+11,5
By	ditto	Paris.	0 54 38,5		+ 9,0
By	ditto	Palermo.	0 54 39,5		+11
By	ditto	Petersburg.	0 54 41,0		+10
Conjunction at Paris, mean time.			0 54 39		+10,5
Correction of ☾'s longitude by the new tables.					=+20,3

Observations at Cambridge, New England.

	h ′ ″	
April 2	18 01 27	Apparent time, beginning of the eclipse
	19 08 07	Annular formation.
	19 12 56	Annular break.
	20 28 26	End of the eclipse.

	h ′ ″	h ′ ″	h ′ ″
Apparent time of observation.	19 08 07	19 12 56	20 28 26
Moon's latitude by tables +10″,3 N.	47 21,7	47 08,4	43 38,7
☾'s equatorial horizontal parallax.	54 28,1	54 28,1	54 27,2
Parallax in longitude.	21 46,4	21 34,6	16 36,1
Parallax in latitude.	47 28,6	47 18,3	43 52,6
Apparent latitude of the ☾ S.	00 06,9	00 09,9	00 13,9
Horizontal ½ diameters of the ☾	14 54,32	14 54,32	14 54,23
Augmentation of the ☾'s ½ diameter.	4,00	4,27	7,22
☾'s apparent semidiameters.	14 58,32	14 58,59	15 01,45
☉'s semidiameter from the tables.	16 00,42	16 00,42	16 00,42
Difference and sum of semidiameters	1 02,10	1 01,83	31 01,87

Horary relative motion in longitude between the formation of the annular and the time of the conjunction.	27′ 45″,8
Between the end of the eclipse and the conjunction.	27 45,2
Results: difference of semidiameter between the formation and the breaking of the annular, by observation.	61,45
By the Tables. $\frac{1' \, 02'',10 + 1' \, 01'',83}{2}$	61,96
Correction of the difference of semidiameters by the tables.	—00,51
Correction of the sum of semidiameters.	— 4,40

	h ′ ″
Conjunction from the annular formation, mean time	20 00 40,8
annular breaking.	20 00 40,8
end of the eclipse.	20 00 40,8

Longitude west from Paris . . . . . . =4h 53′ 38″,2

Observation in the City of Philadelphia.

	h ′ ″		
Formation of annulus.	18 46 11,5	Apparent time	Observed by Mr. Rittenhouse
Break of annulus. . .	18 50 28,5	. .	
End of the eclipse. .	20 03 42	. .	

	h ′ ″	h ′ ″	h ′ ″
Apparent time of the observation. .	18 46 11,5	18 50 28,5	20 03 42
☾'s latitude by the tables + 10″,3 N.	00 47 37,5	00 47 25,5	44 01,9
Parallax in latitude. . . . . —	47 07,1	46 59,3	43 58,5
Apparent latitude of the ☾ . N .	00 30,4	00 26,2	00 03,4
Parallax in longitude.	24 35,3	24 28,3	20 35,4
☾'s apparent semidiameter. . .	14 57,35	14 57,56	15 00,74
Semidiameter of the sun. . . .	16 00,42	16 00,42	16 00,42
Diff. and sum of ☾ and ☉'s semidiameters.	1 03,07	1 02,86	31 01,16

With the corrections—0″,5 for the difference of semidiameters and—4″,4 for the sum of semidiameters, according to the results of the observations at Cambridge, we have the following results:—

Conj. by the formation of the annulus. Mean time.	19h 44′ 37″	19h 44′ 37″,6
By the breaking of the annulus	19 44 38	
By the end of the eclipse.	19 44 38	
Longitude of Philadelphia west from Paris. . .	=	5 10 01, 4

Observations at George Town, Maryland.

	h ′ ″		
Formation of annulus.	18 36 43	Apparent time	Observed by Andrew Ellicott. Esq
Break of annulus. .	18 39 57	. .	
By the end of the eclipse.	19 52 21	. .	

	h ′ ″	
Conjunct. by the formation of annulus, mean time.	19 37 00	19h 36′ 58″,5
By the breaking of ditto. . . .	19 37 00	
By the end of the eclipse. .	19 36 53	
Longitude of George Town west from Paris . . . . . =		5 17 40, 5

Note. I have subtracted 1′ of time from the formation and the breaking of the annulus, from the observations at Philadelphia, and added 1′ of time to the formation of the annulus at George Town, those errors having been discovered by the result of the observations.

By the combination of the observations of the annular eclipse of the sun, April 3, 1791, I have determined the corrections of the

		Irradiation of the ☉'s semidiameter	inflex. of ☾'s semidiameter
	Irradiation of the ☉'s semidiameter	=— 1″,70	=—2″,00
Page 298 of this Volume.	1806. Total eclipse of the ☉	— 1, 87	—1, 93
	1764. Annular eclipse of the ☉	— 2, 15	—1, 35
	1801. Occultation of α ♍ ☉		—1, 82
	1799. Passage of ☿ over the ☉	—1, 50	
	Mean correction of the irradiation . .	—1, 80	inflexion. . . —1, 75

Recapitulation of the results of longitudes of Philadelphia and Cambridge W. from Paris.

	Philadelphia. h ′ ″	Cambridge. h ′ ″
1769. Passage of Venus. , .	5 10 03,7	4 54 00,5
1782. Passage of Mercury. . .	5 10 10	4 53 53,0
1789. Passage of Mercury. . .	5 09 54	4 53 40
1791. ☉'s annular eclipse. . .	5 10 01,4	4 53 58,5
1806. Solar eclipse, page 297. .	5 09 57,0	
Mean results. . .	5 10 01,2	4 53 53

No. LIII.

Notes; with corrections, to be applied to the geographical situations inserted from page 158 to page 164, in the first part of the present volume of Transactions, by J. J. de Ferrer.

Read December 2d, 1808

NOTE I.

THE Longitude of New York (page 297) deduced from the solar eclipse, observed at Kinderhook, and thence transferred by chronometer, is to the west of Paris $5^h\ 05'\ 23''$; and by observations of the solar eclipse the 26th of June 1805, at Lancaster and New York, the result gave the longitude of New York to the eastward of Lancaster (page 296) $9'\ 16''$ in time.

		h ′ ″	
Lancaster west of Paris, (page 297)	=	5 14 41	
Hence New York west of Paris =(5h 14′ 41″—9′ 16″)	=	5 05 25	
By the mean result, New York		5 05 24	
Greenwich west of Paris.		9 21	
New York west of Greenwich		4 56 03	=74° 00′ 45
In page 158.			74 07 45
Correction of longitude to be applied to the places in page 158.			—00 07 00

Thus from the twelve longitudes on the coast, north of Cape May, to New York, subtract $7'\ 00''$ of degree; as the longitudes of those points were transferred by a chronometer from the longitude of New York.

Occultation of stars by the moon, observed at New York.

					h ′ ″
1805.	May	2.	Immersion of a star of the seventh magnitude in π		10 24 25,5
	July	8.	do.	A Ophiuchus	11 55 09,6
1806.	April	26.	do.	d Geminorum.	8 15 49,3
	Septr.	28.	do.	a star of the sixth magnitude in Ophiuchus	7 07 10,8

These immersions took place on the dark limb of the moon, and were observed with an achromatic telescope which magnifies 120 times.

NOTE II.

The longitude of Natchez (page 159) west of Greenwich. .	6 05 54
By page 297 west of Paris 6^h 15′ 01″ or west of Greenwich. .	6 05 40
Correction of the longitudes in page 159	—0 00 14

All the longitudes being transferred from that of Natchez by chronometers, there must therefore be subtracted from each 14″ of time.

NOTE III.

Longitude of La Guira east of Natchez, by correspondent observations of eclipses of the satellites of Jupiter.

	h ′ ″
See the observations of Mr Ellicott Vol. V. page 189.	1 38 07
Natchez west of Paris, page 297.	6 15 01
	4 36 54
Greenwich west of Paris	9 21
La Guira west of Paris.	4 27 33
And reduced to Greenwich. . . .	66°53 15 } Correction =—6′53″
In page 162.	67 0 8 }

From that of La Guira subtract 6′ 53″ of degree.

NOTE IV.

To all the longitudes which follow from C. Bueno to Campeche, pages 163 and 164, add 5′ 35″ of degree, on account of their having been transferred from Havanna, by chronometers; in consequence of the results of the observations, from page 345 to page 357.

NOTE V.

The longitude of Veracruz, page 160, found by the occultation of o Sagittarius was 6^h 33′ 42″,8. I have compared the corresponding observations with the new tables, and have also determined the position of the star from the best catalogues. The result gives,—

Longitude of Veracruz. 6^h 33′ 52″,3 west of Paris, which
Reduced to Greenwich is, 96° 07 50 } Correction=+3′ 30″
In page 164. . . . 96 04 20 }

Hence to all the longitudes from Veracruz to the Bay (which should be called the shoals) of Gallega, page 164, add 3′ 30″ of a degree, they having been transferred from Veracruz by triangles.

NOTE VI.

From all the longitudes on the Ohio and on the Mississippi (page 159) which are expressed in time, subtract 14″ of time, or 3′ 30″ of a degree, also from the longitudes from the Bar of Santander, to the point on the coast, subtract 3′ 30″. The whole having been transferred from Natchez by chronometers; from the longitude of which last place, a like deduction or correction is made, as determined from the last solar eclipse.

Solar eclipse, June 16th, 1806.

After the printing of Nos. XLIII and XLVII, in this Vol. I received the following observations,

			Mean time. h ′ ″
Berlin.	End of the eclipse by Mr. Humbolt.		6 39 40
	By M. M. Bode and Olbers.		6 39 40,5
	By Mr. Tralles.		6 39 42
At Montauban, by Mr Duc la Chapelle, beginning.			4 49 53
Royal Observatory in the Island of Leon.	Beginning.		4 18 42
	Distance of horns 8′ 27″,94		4 21 10
	The clear part of the sun in its greatest obscuration	11′ 51″,81	
	Solar diameter observed.	31 32, 06	

In page 301, from a communication by Mr. Simeon De Witt, it appears that the total darkness was instantaneous, or, continued but a moment,

In latitude	43° 22′	and longitude east of New York.	00° 45′ 00″
In latitude	41 30	do. west of ditto.	00 14 00

These last observations are the most important to determine the latitude of the moon, and the difference of the semidiameters. It may also be noted that though the total darkness should not have been instantaneous, but even of a quarter of a minute's continuance, yet this influence on the result would have been insensible, or not amounting to a single second.

The calculation being applied, it results, that the moment of total darkness was,—

In latitude	43° 22′	and longitude 45′ east of New York at	11h 14′ 07″	mean time
In latitude	41 30	longitude 14 west of do.	11 07 17	ditto.
Correction of moon's latitude by the new tables.			+ 3,3	
Correction of the difference of semidiameters by the tables			= − 1,12	

The observation at Berlin is also very advantageous in ascertaining the latitude of the moon; the north apparent latitude of the moon at the moment of the end of the eclipse, from the tables =30′ 20″, and the sum of the semidiameters(—3″,9 inflexion and irradiation)=32′ 13″,3.

The longitude of Berlin deduced from the comparison of many eclipses and occultations, I make 44′ 09″,5 east of Paris, which differs only half a second from the Connoisance de temps.

	h ′ ″	
The time of conjunction at Paris is known by other observations	=4 30 12,12	mean time.
With these elements there is a correction in the latitude of the ☾	=+ 2,0	
By the distance of centers observed at the Island of Leon at the greatest obscuration.	+ 6,0	
By the determination above.	+ 3,3	
Mean correction to the latitude in the tables.	+ 3,8	
Hence the latitude of the moon at the conjunction was	19 23,1	N.
Conjunction at Paris by the observations at Montauban and the Island of Leon at	4 30 10,8	
By the mean result, page 296.	4 30 12,6	

The longitudes in page 297 are exact, because an error of 6″ in the latitude of the moon, has no influence on the results.

The calculations being applied to the observations of Kinderhook, with the correction of + 3″,8 of the latitude in the tables we have,

Irradiation of the semidiameter of the sun.	=—2″,2
Inflexion of the semidiameter of the moon.	=—1 ,6

By the observations, where the total darkness was momentary, the same results are obtained, which only differ 00″,27 from the determinations in page 298.

With the corrections of the tables, determined as above, I have determined the longitude of Havanna, by the observations of this eclipse = 5^h 39′ 02″ west of Paris.

Note to page 275.

In line 26, for $\odot = \frac{1' \; 48'',16 \times 6'',8 = 2'',6}{4 \; 49 \; 30}$ read $\odot = \frac{1' \; 48'',16 \times 6'',8 = 2'',6}{4 \; 37''}$

I would not pretend to give any importance to the supposition that the illumination of the lunar disk, proceeds from the irradiation of the sun, which undoubtedly is not very probable. Neither can it be attributed to the lunar atmosphere. The eye of the observer is affected by the double horizontal refraction of the moon, and in this case the solar disk would be visible to the observer, before it would illuminate the moon, by a quantity proportional to the product of the horizontal refraction of the moon, and the relative apparent motion of ☽ and ☉.

Appendix to the Memoir XXXVI, *page* 213.

In the observations published at Berlin, are contained the observations of the occultation of γ ♉ the 21st of October, 1793, the same day when the occultation of Aldebaran took place. The combination of these observations appears to me to be very advantageous in determining the parallax of the moon.

Observations of the occultation of γ ♉.

	Immersions. Mean time. h ′ ″	Emersions. Mean time. h ′ ″
At Figueras by Mr. Mechain.	9 24 32	10 28 47,5
At Milan.	9 57 37	11 04 27,1
At Berlin.	10 29 19,3	

Those of Aldebaran are inserted in page 213.

By the comparison of 11 eclipses and occultations of stars,

	′ ″
I determined the longitude of Berlin east of Paris. =	44 09,5
Figueras, by two occultations and a solar eclipse.	2 32,8
Milan, in the Connoisance de temps of 1808.	27,25,0
Marseilles.	12 08,0
Gotha.	33 35,5
Marine Observatory at Paris.	2,5

Comparing the degrees of a meridian measured at Quito, India, Sweden and France, I determined the ellipticity, or the proportion of the equatorial and polar diameters of the earth, to be 317 : 316, which I have made use of in these observations.

Elements by the new tables published at Paris in 1806.

	h ′ ″		h ′ ″
Conjunction at Paris of ☾ with γ ♉	=10 48 39,8	conjunction with α ♉	17 51 06,0
Apparent longitude of γ ♉	62°55 19,63	of α ♉	66 54 37,25
Apparent latitude of γ ♉	5 45 13,0 S.	of α ♉	5 28 52,5
Latitude of ☾ as per tables	5 06 12,0 S.		5 06 03,0
Horizontal equatorial parallax of the ☾	57 57,5		57 42,6
Horary motion of the ☾ in longitude.	34 09,10		34 50,7
Horary motion of the ☾ in lat. towards South.	5,1	towards the North.	7,7

By the result in page 215 we have a difference of latitude at conjunction of Aldebaran $=22' \ 57''$ and the correction of the latitudes of the new tables$=-7'',5$.

Supposing the inflexion of the moon's semidiameter = 1″,5

	h ′ ″
We have the conj. at Paris by the observ. at Figueras of imm. & em.	=10 48 38,3
By the observation at Milan of immersion and emersion.	10 48 37,0
Mean conjunction of ♈ ♉ with ☾ mean time at Paris.	10 48 37,6
Conjunction of Aldebaran by immersion and emersion at Paris, by the observations of M. Mechain at Figueras.	17 51 03,7

Conjunctions deduced from the immersion of both stars, reduced to Paris with the inflexion = 1″,5,

	Conj. m. t. at Paris h ′ ″	For + 10″ in ☾'s paral. ″	Conj. m. t. at Paris. h ′ ″	For + 10″ in ☾'s par. ″
By observations at Figueras.	10 48 34,3	+ 8,88	17 51 02,7	— 14,50
Berlin.	10 48 35,3	+ 5,30		
Milan.	10 48 33,3	+ 7,52		
Marseilles.			17 51 08,7	— 15,40
Gotha.			17 51 59,7	— 23,00
Paris.			17 51 02,8	— 18,10
Mean.	10 48 34,3	+ 7,23	17 51 02,2	— 17,75

By this comparison it appears that the greatest reliance is to be placed on the observations of M. Mechain, and if there should be the least error it cannot exceed half a second.

If the conjunctions calculated by the tables be compared with the conjunctions inferred from the immersions, there results,

Correction of the longitude in the new lunar tables.		= + 2,50
Correction of the parallax in the tables.		+ 0,70
Conj. by the new tables correcting the long. of the ☾ by + 2,5 =	10 48 34,8	17 51 01,0
By the observations supposing a correction of the parallax in the new tables of + 0,7	10 48 34,8	17 51 01,0
Difference	00 00 00,0	00 00 00,0

It is to be observed that if use were made of the parallax in the Nautical Almanack, which supposes the constant equatorial 57′ 11″,0 that is, 10″ more than the tables of Burg, the last results instead of coinciding, would have differed 24″,98 in time.

Second determination of the lunar parallax by the comparison of the two immersions observed by Mechain.

	° ′ ″
Diff. of elongation, by the new lunar tables during the interval of the two imm.	5 17 03,25
Difference of longitudes of the stars.	3 59 17,62
Effect of the parallax.	1 17 45,63
Sum of the elongation calculated by the parallax in the new tables.	1 17 44,24
Difference.	0 00 01,39

The horizontal parallaxes at the immersion of both stars, corresponding to the latitude of Figueras which have been used.	$=\left\{\begin{matrix}57' & 55{,}7''\\ 57 & 35{,}8\end{matrix}\right\}$	From the Tables.
The difference of apparent latitudes at the two immersions.	$=\left\{\begin{matrix}1 & 24\\ 2 & 27{,}5\end{matrix}\right.$	
Error which may be caused by 1″ of uncertainty in the difference of latitudes, in the sum of the elongations.	$=\left\{ 0{,}063\right.$	
By the difference of elongations.	1,39	
There results a correction of the parallax in the tables.	$=+1{,}0$	
By the comb. of the imm. and em. of both stars observed at Figueras	$-0{,}3$	
By the first result.	$+0{,}7$	
Mean correction of the parallax.	$+0{,}5$	

I have calculated the horizontal parallax of the moon in conjunction with Aldebaran by the periodical coefficients of Mr. La Place, supposing the constant equatorial 57′ 01″ and there results +0″,5 more than that deduced from the tables, which agrees with the last result.

Examination of the errors which may influence the result of the parallax deduced from those observations.

The elements which have a direct influence, are the difference of the longitudes of the two stars, and the difference of the longitudes of the moon during the interval of the two occultations deduced from the tables.

I have calculated with all possible care the places of the moon corresponding to the moment of the two immersions observed at Figueras, by the new tables, and I think I have obtained all the accuracy of which the tables are susceptible.

I have calculated also by the tables of the third edition of Lalande, making use of the epochs of mean longitude, anomaly and supplement of the node of the new tables; and the difference of longitudes during the interval of the two immersions, differ but one second. The differences of latitudes agree with the result of the tables of Burg.

I have compared the right ascensions of the different catalogues and the Connoisance des temps for the year 1808, and have moreover calculated various observations made by Mr. Lalande, and the result which I have obtained, ascertains the difference of the longitudes of the two stars within the limits of 0″,8 and the latitudes within 1″.

The difference of latitudes at conjunction of α ♉, in page 215, appears to be within the limits of 1″; supposing the error in the difference of the longitudes of the moon=0″,5; of the stars 0″,8, and the influence of an error of 2″ in the difference of the latitudes of the stars and the moon; the sum of the three errors, supposing it on one side, would influence the result of the horizontal parallax of the moon only 1″,0.

If it should be supposed that the periodical coefficients of La Place represent the motion of the lunar parallax better than the coefficients of the tables of Burg; the constant equatorial will result (from the present observations)=57′ 01″,0 and the constant equatorial of the new tables is the same.

The longitude of Porto-Rico, calculated by these elements, is the same as inserted in page 220.

Errata, on the table of apparent lunar distances, page 348.

Novr. 14.	15 37 40	α ♉ ☾'s nearest limb.		16 45 37	read remote limb.	16 45 37
17.	9 07 30	do.	do.	20 51 04	read remote limb.	21 50 58
	9 24 40	do.	do.	21 00 46	read remote limb.	21 00 46
Decr. 7.	6 14 33	.	.	.	read . .	6 14 54
	6 26 30	.	.	.	read . .	6 26 51

Results of the observations in the table, page 348.

	Appt. time at the Plantation. h ′ ″	Longitudes of the ☾ from Observations. s ° ′ ″	Long. of the Plantation W. from Paris. h ′ ″
1807. Novr. 14.	8 01 12	1 18 37 09,0	5 37 58
	8 26 51	1 18 50 31,0	5 38 31
	15 37 40	1 22 30 35,6	5 38 06
17.	9 16 05	2 26 50 15,3	5 37 56
22.	17 25 27	5 08 45 36,0	5 38 10
24.	17 53 15	6 07 45 11,0	5 38 22
Decr. 7.	6 20 52	11 26 07 43,0	5 38 53
9.	6 33 59	0 19 57 14,0	5 39 00
15.	7 10 37	3 05 07 45,5	3 37 53
20.	12 13 28	5 16 42 36,0	3 58 14
	12 18 16	5 16 45 19,0	5 38 04
	12 31 02	5 16 52 57,0	5 38 19
1808. Jan'y. 11.	14 15 00	3 04 21 03,0	5 38 34
19.	16 5 46	6 28 30 03,0	5 38 18
Mean.			5 38 18,4
Havanna west from the Plantation.			44,3
Havanna west from Paris.			5 39 02,7

NOTE.

The distances of the moon have been corrected from the effects of refraction, parallax and the spheroidal figure of the earth. In calculating the refractions, allowances have been made for the state of the barometer and thermometer.—To deduce the longitude of the moon, use has been made of the longitudes of the stars lately determined by Maskelyne.

No. LIV.

Observations on the Comet of 1807—8. *By William Dunbar.*

Read November 18th, 1808.

THESE observations were made in latitude 31° 27′ 48″ N. and 6^h 5′ 50″ nearly, west of Greenwich. The instrument principally used for taking distances was a circle of reflection by Troughton of London, graduated by the Vernier to ten seconds of a degree, and firmly supported upon a pedestal, adapted to every necessary movement; the observations were made with the most scrupulous care, and as the pedestal afforded every desirable facility, no observation was written down until it had been re-examined several times by the separation and reunion of the images. The clock was regulated to mean time.

This comet was first seen here about the 20th of September 1807, and Seth Pease Esq. Surveyor of the Mississippi Territory, began to make observations on it the 22d of the same month; and as I have the greatest reliance on the correctness of this gentleman (who is an excellent astronomer) I shall here give his observations which preede my own.

Observations by Seth Pease Esq.

	h ′ ″		° ′ ″
1807. Sep. 22. Tuesday at	7 12 16	Comet northerly from Saturn	7 21 15
	7 34 17	ditto. below α Serpentis.	24 16 30
23.	7 20 00	ditto. north of Saturn. .	7 46 7
	7 28 00	ditto. below α Serpentis.	22 41 15
24.	7 2 00	ditto. below α Serpentis.	21 12 30
	7 13 00	ditto. north of Mars. .	19 33 30
25.	6 43 00	ditto. below α Lyræ. .	69 50 25
	6 55 00	ditto. north of Mars. .	20 25 15

This evening I observed an emersion of the 1st satellite of Jupiter, with a six feet Gregorian reflector, power 128, at $8^h\ 27'\ 58\frac{1}{2}''$ mean time; a fine observation; the sky was very serene: from the darting of the first ray from the satellite, it seemed a mere point of light for 15 seconds of time; perhaps with telescopes in general use the satellite might have remained invisible during those 15 seconds, which would affect the longitude resulting from the observation; from the above, the longitude deduced is $6^h\ 5'\ 55\frac{1}{2}''$ west of Greenwich.

The following are my own observations:—

1807, October 2d. The reflecting telescope, power 128, being directed to the comet, shewed the nucleus and coma with tolerable distinctness; the idea produced in the mind of the observer, was that of a round body in combustion, which had produced so much smoke as to obscure the nucleus; the smoke seemed to be emitted in every direction; but, as if it met on one side with a gentle current of air, the smoke seemed to be repelled and bent round the nucleus, escaping on the opposite side, in the direction of the tail. To the naked eye, the comet could not be seen earlier in the evening than a star of the second or third magnitude, although its disk was considerably larger; with the telescope, the nucleus did not seem to be much more than one third, certainly not one half of the planet Mars, which had been lately observed. The Coma seemed to be at least ten times the magnitude of the nucleus; an imperfect measure was taken of the tail, which was about 63′ in length. The coma appeared to be, in a certain degree, illuminated from the nucleus, and the whole was compared by many persons to a distant building on fire. This evening, the following observations were made:—

	h ′		° ′ ″
At	6 40	The comet from Jupiter . .	81 55 55
	6 57	. . below α Lyræ. . .	59 0 20
3d. At	6 33	. . from Arcturus . .	20 40 35
	6 52	. . from Jupiter. . .	81 17 15
	7 3½	. . below α Lyræ. . .	57 32 45

4th. This evening there was an occultation of the planet Mars by the moon, at $7^h\ 2'\ 1''$ mean time: the moon was low, involved in the grosser horizontal atmosphere, and, apparently, almost touching the tops of the forest trees.

			h ′ ″		° ′ ″
1807. Octr.	5.	At	6 39 0	Comet from Arcturus.	20 52 5
			51 30	from α Lyræ.	54 42 10
			7 15 0	from ζ Herculis.	31 32 55
	10.	At	7 0 0	from ζ Herculis.	24 59 20
			13 0	from α Lyræ.	47 53 40
	12.	At	6 31 0	from α Lyræ.	45 20 7
			48 0	from Jupiter.	76 11 8
	14.	At	6 34 0	from α Lyræ.	42 47 20
			53 0	from Jupiter.	75 13 0
	15.	At	6 39 0	from α Lyræ.	41 33 0

The comet was dim this evening, caused by a mist or smoke which obscured the lower parts of the atmosphere, and became invisible before any more observations could be taken.

16th. At 6h 57′ 0″ Comet from α Lyræ. . 40° 17′ 10″

The atmosphere was again so misty, or rather smoky, that no more observations could be taken: the cause of the smoky state of the atmosphere at this season, in our country, is the setting fire to the dry grass of the immense prairies or savannahs, and pine wood forests, in our neighbourhood; the smell of the burning pine, and other resinous aromatick vegetable matters is sometimes very strong, although the conflagrations which occasion it, are not supposed to be nearer than from 50 to 100 miles: dense clouds are frequently formed of the smoky vapour, from whence proceed violent tempests, with thunder and lightning, and torrents of rain of a brownish black colour.

		h ′ ″		° ′ ″
17.	At	6 41 0	Comet from α Lyræ.	39 4 25
		55 0	from Jupiter.	73 55 15
18.	At	6 52 30	β Herculis.	5 46 35
		7 5 30	from α Coronæ.	12 46 45

The apparent length of the comet's tail was this evening about 2° 43′ 30″.

			h ′ ″		° ′ ″
1807. Octr.	23.	At	6 19 30	Comet from α Lyræ.	31 59 20
			38 30	from α Coronæ	14 26 50
			51 30	from β Herculis.	0 47 55
	24.	At	6 26 30	from α Coronæ.	14 58 40
			37 30	from α Lyræ.	30 50 30
			54 30	from β Herculis.	1 30 15
			7 22 30	from Jupiter.	71 17 0
Novr.	5.	At	6 36 0	from α Lyræ.	17 38 50
			49 0	from Jupiter.	67 49 10

The splendor and apparent magnitude of the comet visibly diminish; the nucleus seems reduced to little more than half its first observed magnitude.

		h ′ ″		° ′ ″
17.	At	6 42 0	Comet from α Lyræ. . .	5 20 32
		7 17 0	from α Aquilæ. . .	34 50 48
21.	At	6 30 0	below α Lyræ. . .	1 30 20
		6 45 0	below α Aquilæ. .	33 56 0

December 6th. Indisposition prevented observation for some time past. This evening being fine, I directed the reflecting telescope to the comet; the nucleus is now much diminished in apparent magnitude; I compared it with a star of the sixth magnitude in the Swan, which was within the field of view at the same time, their apparent diameters were nearly equal, but the comet is become so dim, as to be seen by the naked eye only in a pure atmosphere, with favourable circumstances: the weather being cold and damp, my state of health did not permit taking any distances: the coma is yet considerable, but the tail is no longer visible, one would be inclined to say, as the comet recedes from the sun, that the tail is *called in* (as it were) to add to the magnitude of the coma; for certainly the latter is but very little diminished in proportion to the nucleus.

In order to supply my own deficiencies, I shall here introduce the observations of Mr. Pease (on whose correctness I place the greatest reliance) during the time my own were interrupted by ill health.

Observations by Mr. Pease.

			h ′ ″		° ′ ″
1807. Novr.	21.	At	6 51 35	Comet below α Lyræ. .	1 29 30
			58 20	from α Aquilæ. .	33 55 0
	22.	At	6 47 15	from α Aquilæ. .	33 46 15
			7 39 15	from α Cygni. . .	24 15 45
			7 44 15	left of α Lyræ, below.	0 38 25
	24.	At	6 44 42	from α Aquilæ. .	33 31 30
			58 42	above α Lyræ. . .	1 35 30
	30.	At	6 31 7	below α Cygni. .	16 44 45
			36 7	from α Aquilæ. .	33 27 35
Decr.	16.	At	6 44 32	below α Cygni. .	2 44 45
			49 32	to the right of γ Cygni.	5 18 45
	18.	At	7 11 38	to the right of γ Cygni.	6 7 45
			27 38	below α Cygni. .	1 16 30
	19.	At	6 22 0	The Comet was to the right of α Cygni 51′	

			h ′ ″			° ′ ″
1807 Decr.	22	At	6 47 0	Comet above α Cygni.		2 23 15
			59 0	from γ Cygni.	. .	8 26 45
			7 6 0	from ε Cygni.	. .	12 43 45
	24.	At	6 47 44	from α Cygni.	. .	3 54 30
			7 8 44	from Polaris.	. .	42 46 30
	30.	At	7 30 0	from α Cygni.	.	8 21 20
			31 0	from Polaris.	. .	42 9 0
1808. Jany.	1.	At	8 30 0	from Polaris.	. .	41 56 30
			39 0	from α Cygni.	. .	9 50 30

The comet now became too obscure to make any observations upon it, with the sextant, although Mr Pease has given two of the evening of the 22d of January, which he says are true only to five or six minutes, as follows,

22.	about 7h	Comet from α Cygni.	. . .	23° 18′
		from Polaris.	. . .	40 31

The observations which follow are extracted from my own journal.

January 5th. The comet is no longer visible to the naked eye; though having pointed the telescope to its calculated place, I discovered it a little to the S. E. of π 2 Cygni; but this star was not near enough in declination, to take the comparative position of the comet, with the micrometer of the reflecting telescope, in the manner pointed out by Dr. Maskelyne: however, as an approximation is often desirable, I directed to the comet and star, a very good small achromatic telescope, magnifying eleven times, and found that the two objects were distant from each other about two thirds of the diameter of the field of view of the telescope, and having placed the comet and star across the center of the field, and opening the left eye, I found that a line joining the star and comet, produced, would pass through η Pegasi; the angle of the field of view of the telescope having been ascertained to be 2° 18′ 26″, two thirds of which are 1° 32′ 18″ the distance of the comet from π 2 Cygni in the direction η Pegasi; from whence a good approximation of the place of the comet may be deduced. Note, the star π 1 Cygni is marked in Wollaston's catalogue, of the fourth magnitude and π 2 Cygni of the fifth magnitude, but π 2 is now the larger; the stars ought, therefore, to change designations.

The nucleus of the comet is yet to be distinguished by the reflecting telescope, but as small as a star of the seventh magnitude, seen by the naked eye; the coma seems diminished more than half of its appearance, on the 6th of December, and the nucleus is equally surrounded by it on all sides, without any trace of tail, and so faint as very much to resemble some of the nebulæ.

January 15th. Since the fifth instant the weather has been unfavourable for viewing the heavens; this evening is very serene and freezing; after a little search, I found the comet with the telescope, between two small stars in Lacertæ, the position of the comet was again unfavourable for finding its relative place by the micrometer of the reflecting telescope, but having armed my small achromatic telescope with one of Cavallo's pearl micrometers, I took the distance of the comet from two small stars, the angle at the comet being nearly a right one, as follows:

At 7^h 0′ Comet N. easterly from 5 Lacertæ 1° 14′ 12″ of the 4th—5th magnitude,
7 5 Comet S. easterly from 4 Lacertæ 1 24 48 of the 5th magnitude.

The uncertainty may be between one and two minutes.

In the great telescope, the comet is yet sufficiently conspicuous; the nucleus visible like a star of the eighth magnitude, in our purest atmosphere, and the coma but little changed since the 5th instant.

January 17th. The last evening was cloudy and rainy, but the weather cleared up mild this evening, which enabled me to direct the same instrument with the pearl micrometer to the place of the comet, which was very obscure, though I succeeded in making the following observations:

At 7^h 0′ Comet S. easterly from 7 Lacertæ 2° 2′ 58″ of the 4th magnitude,
7 5 Comet N. easterly from 5 Lacertæ 2 5 5.

The uncertainty may be the same as on the 15th.

February 25th. From the 17th of last month the weather continued long unfavourable, and I despaired of again seeing the comet; but thinking it of importance to get a view of it once more, in a more distant part of its orbit, I searched with great diligence and some anxiety, and at length found an object which I had no doubt was the comet, situated between ξ Cassiopeæ and o Cassiopeæ; but as the objects were now descending upon the tops of the forest trees, I had not time to complete my estimate of its place that evening, but marked particularly its position with regard to certain stars both in the field of the large telescope, and in the finder; the comet was not visible in the last, but its position was known by the intersection of the cross-wires, which coincided exactly with the center of the field of the telescope, reserving to myself the ascertainment of its place by the aid of those stars, in case the comet could not be again discovered.

For many days the weather was extremely unfavourable, and when it cleared up, I discovered the stars which had been noted, both in the field of the great telescope, and in the finder, but the comet had removed, and though diligently searched for along its supposed path, was seen no more. I now looked out for some known star, which might pass over the field of view of the telescope after the place of the comet, so as to be enabled to determine their difference in R. A. and declination; but none was to be found which would pass in any convenient space of time, and the place of the comet being now very low in the evening, I was obliged to make haste to approximate in the best manner now in my power; hoping in the course of some months to examine the subject again, when the part of the heavens where the comet disappeared should be conveniently seen in the eastern portion of the hemisphere.

The place where the comet was last seen, is in the line joining the stars ξ and o Cassiopeæ, and the difference of the comet's place in R. A. from o Cassiopeæ was found, from observation, to be 96 seconds in time; from whence we deduce the comet's place on the 25th of February at 8^h to have been $8^\circ\ 7'\ 6''$ in R. A. and $48^\circ\ 30'\ 58''$ north declination. This is given only as an approximation.

No. LV.

A Letter from Captain William Jones, of Philadelphia, to the President of the Society, communicating sundry queries proposed by him to William Jones Esquire, Civil Engineer of Calcutta, relative to the principles and practice of building in India, with his answers to the same.

Read June 17th, 1808.

Philadelphia, June 17*th*, 1808.

Dear Sir,

WHEN in Calcutta, I had the pleasure to become acquainted with Mr. William Jones, whose profession is that of a civil engineer, and who at the time was employed in constructing a dry dock of great capacity, calculated to receive a man of war when the water of the Ganges was at the lowest.

He is distinguished as a man of genius, of much philosophical knowledge, and of great practical experience in all the branches connected with his profession. He regretted that the urgency of his pursuits precluded him from rendering his remarks more perfect and comprehensive than the papers herewith enclosed; and proffered a correspondence with me on any subject which I might deem interesting.

Should the Society desire information, from that quarter, on any subject of philosophy, natural history, or the mechanic arts, I will cheerfully avail myself of his kind offer.

You will perceive that Mr. Jones has said nothing relative to public roads—he did not consider the manner of constructing them in that country as applicable to this.

I know not whether there is any thing in the communication I have to make, that will be new or interesting to the Society; if not, I trust the desire to be useful will constitute my claim to indulgence.

I am, very respectfully, yours,

WILLIAM JONES.

Copy of a letter from William Jones of Philadelphia, to William Jones Esquire, Civil Engineer, of Calcutta.

Calcutta, December 26th, 1807.

MY DEAR SIR,

Your obliging assent to my solicitation for a memorandum of the manner of constructing a *terrace roof* in this country, and a desire to avail myself of such information relative to the arts of other countries, as may be useful in my own, prompts me to ask of you a brief communication of the principles and practice of building in India, with such observations as your experience may suggest.

I look for indulgence, in the liberality of sentiment and love of science and the arts, which general suffrage has attached to your character. A desire of individual information alone, could not have induced me to trespass on time and attention so assiduously and usefully employed, but my intention is, to present your communication to the American Philosophical Society at Philadelphia, which will unite with its associate in a just sense of the obligation.

A knowledge of the composition of cements, and of the quality and combination of materials employed in architecture in India, the excellence of which has been consummated by the lapse of ages, is an object of great interest in America. The structure of public roads is no less so: I am told there are some very excellent in India; any information on that subject, with a view to economy, durability, and a solidity impervious to intense frost, will be highly acceptable.

I beg leave to present a few queries connected with the object in contemplation.—They are suggested by the local circumstance of climate and architecture in America.

1st. What are the materials, and what is the quality of the cement, used in constructing the walls of buildings in India?

2d. Are the walls below the surface, of the same materials?

3d. What is the thickness of the exterior, as well as of the interior walls, in proportion to the elevation?

4th. What are the component parts of the plaister of the exterior and interior walls?

5th. How, and of what materials, is the roof formed?

6th. What is the thickness of the terrace on the roof, the process of laying it, and the composition of the materials?

7th. What are the proportionate dimensions, and what is the relative strength *to oak timber*, of the beams which sustain the roof?

8th. Is the thickness of the walls deemed necessary to sustain the incumbent weight of the roof *alone*, or is it partly to resist heat—or is the extraordinary thickness in consequence of the fragile quality of the brick?

9th. Do you think a roof so constructed capable of resisting the intensity of the frost in North America?

10th. Is a horizontal roof, so constructed, capable of sustaining any great additional weight, such as the superincumbent weight of snow, which, in America, is frequently three or four feet deep?

11th. How, and of what materials are the floors constructed; and what is the quality and thickness of the cement which forms the floor?

12th. What is the proportionate elevation of the ceilings?

13th. What is the quality, and what are the component parts of the *water cement*, used in India, and of the celebrated cement and plaister used at Madrass?

14th. Is shell or stone lime preferred, and does the lime of India possess any intrinsic superiority over the shell or stone lime of Europe or America?

15th. Does sugar, molasses, or animal or vegetable oils, form a part of any of the cements used in India?

16th. I am told that the iron exclusively used in the fastening of all ships built in India, (even that which secures the sheathing boards) is completely protected from the corrosive effects of the copper, by the coat of Chunam [lime and animal or vegetable oil thoroughly amalgamated] one fourth of an inch thick, which is between the main plank and the *sheathing boards*, and also between the latter and the copper sheathing; and that the iron of coppered ships has been found in perfect preservation after ten years' service. Do these facts come within your knowledge?

17th. Is the quantity of manual labour necessarily implied in any of the foregoing queries, such as to forbid the adoption of the practice in America, (where the command of that force is extremely limited and expensive) or can the difficulty be obviated, in any degree, by the employment of other agents?

I will not reiterate my apologies, but assure you of the sincere pleasure I shall derive from any occasion you may find to command my services.

I am very respectfully
and sincerely yours,
WILLIAM JONES.

To WILLIAM JONES Esq.
Seibpore, near Calcutta.

Answers to 17 Queries propounded by William Jones of Philadelphia, to William Jones Esq. Civil Engineer, of Calcutta.

1st. Buildings in Bengal are generally constructed of bricks, formerly nine inches, but now eleven inches in length;—the additional size saves the cement, which is dearer than bricks.

The cement is made of two parts brick dust, one part sand, and one part stone lime—brick dust, alone, would be preferred, but sand being cheaper is used. The mortar is mixed in the common way, but the bricks are laid like what the masons call *grouted work*, which is done by laying the outward courses first, and then filling up the middle space with bricks, small and large, swimming in water and cement, so that no crevice remains open.

Arches, columns, &c. are made with cement, two parts brick dust and one part lime, all sifted fine. The bricks are dipped in water separately as they are laid, for which purpose a vessel of water is placed between every two workmen.

2d. The walls below the surface are of the same materials as those above, but some people, regardless of the expense, lay one course, just above the floor, in lime and oil, the whole thickness of the wall, and afterwards continue the building in the common way—this *forever prevents* damp from rising.

3d. The interior as well as the exterior walls are all of the same thickness, because our houses sink altogether about six inches, or more, and the partition walls in a terrace roof have to sustain their share of the weight with the outer ones. We build the lower story two feet six inches, the second two feet, and the third one foot six inches thick; but you may build your first story two feet, the second one foot nine inches, and the third one foot six inches thick; as you may use *bond timber*, from which we are precluded by the ravages of the white ant.

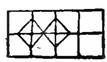
4th. The exterior plaistering is made of three parts washed sand, and one of stone lime, laid on in the common way, but rubbed with a small bit of wood until it sets—the joints are first well opened with a bit of crooked iron.

The inside work is done the same way, and with the same materials, and when dry, coated with shell lime. The shells are cleaned before they are burnt, and when taken from the kiln, the whole are cleaned and picked from the dust (which is a dirty lamina, that falls off in the calcination) and put into a trough, where they are triturated and slacked with a little water, and when mixed to a thick consistence, deposited in earthen jars, or other vessels, for use.

When to be used, a bed of sand or clay is made on the ground, hollow in the middle, and covered with coarse cloth. The lime is strained through a fine cloth that is placed about two or three feet above the bed.—It is mixed with clean water, in order to pass the fine parts in solution through the strainer—the coarse is rejected. It must lie three or four days on this bed to cool, before it is used, or the work will crack. It is mixed with a sufficient proportion of milk that has undergone a fermentation by *leven*, so that the whole is in a curd, without any whey. Of this material the quantity is ascertained by mixing a little and plaistering on a tile.—In fine work, the white of eggs is used in large quantities, and in some cases a small quantity of calcined agate, pulverised—but this kind of work will never answer in your country, as the labour is very expensive. It is the work of many days after the plaister is on, to rub and wipe it; otherwise it would crack on the surface, and so long as a crack appears, the rubbing must be continued.

The wall will sweat for several days; but the water must be constantly wiped off with fine, clean cloths, or the whole work will turn red. A wall finished in this way may be washed with soap and water; but when the plaister breaks, it is not easy to mend it without the patch being visible. Stucco walls will answer much better in America, and would be used here if we had the plaister.

5th. The roof is formed by simply laying beams of wood from wall to wall, in the shortest direction, three feet from centre to centre. Upon these beams are laid transverse pieces of wood, three by two inches thick, to support the tiles or bricks. We use twelve inch tiles, and lay the transverse pieces of wood so that the tiles join in the middle. Our tiles are one and a half inches thick, and are laid in two courses, well bedded. The upper course must break or cover the joints of the lower, thus,



The roof is then ready to receive the terrace. The transverse pieces of wood are not nailed, but the spaces between are filled up with mortar and bits of brick tile &c. so that they cannot shift.

6th. The terrace is six inches thick, when finished, at the middle, and about four inches at the outer walls, independent of the tiles and wood. Wherever it is determined to deliver the water, there must be gentle descents towards those places coming to a narrow focus at the spout. The composition is broken brick, the pieces about four cubic inches, or just as it happens to break; they must not be too small, or the terrace will be liable to crack.

Take the broken bits, dust and all, as they lie for use—measure the whole and count the number of measures of any kind—spread it one foot or thicker, on the ground—level and water it well, turning it over at the same time. This deprives the brick of its over absorbent power.

For every three measures of broken brick, you must use one of the same measure of good stone lime, giving only one third at a time, watering and turning it every day for four days;

the three first days you divide the lime, giving a part each day with a little shell lime mixed with water.—It is now ready to be carried up to the roof, where it is to be expeditiously spread in the shape you want it, and the beating business commences. On a small roof you must employ at least fifty people, women and children will answer, with a few bricklayers, constantly, to see that the materials are laying right. They must all sit down on any thing you find convenient, and continue beating sharply and hard for three days, with a piece of wood about three by two inches thick, and sixteen inches long, handle and all, shaped thus,

The substance must be constantly wetted, taking care that the lime be not washed out. At the end of three days, the hard beating must be abated (as the work is beginning to set) and the watering diminished.

For two days more, the beating must be only a little constant patting, very light, but the fourth day, all the rough face must be filled up with bits of brick, not more than half a cubic inch in size, with the fine dust sifted out; this last must be well mixed with lime, one third its quantity, and rubbed with plenty of water all over the terrace, and a little shell lime added; while this is thin and soft, the beating must be constant, but very light, merely paddling in it with the beaters; as it becomes dry, the beating may be increased to a tolerable sharp blow, constantly filling up every inequality. The sixth day, the surface must be covered with fine brick dust and lime, as before, and the paddling or gentle beating recommenced, adding a little of the juice of the sugar cane, or you may use molasses. At nine days end it ought to be finished, but you had better, in your climate, continue it thirteen days, as patience in this case will afterwards reward you. If it should rain often it will make the business more tedious, and if the rain be heavy you must cover the work with something, or the lime will be washed out. When the beaters rebound from the terrace as if they struck stone, and the sound is clear, you may conclude it is done.

Keep a few people for five or six days, rubbing the surface with water, lime and molasses mixed, so long as a crack appears, and afterwards rub the whole over with any common oil. It is difficult to describe this process, but a little experience will point out what is necessary.

7th. The annexed table of the gravity and strength of wood will inform you.

Result of experiments made on the weight and strength of timber used in Bengal.

The pieces on which the experiments were made, were each square prisms, twenty-four inches long, and one inch on the side; the distance between the props of support was twenty-two inches, and the weight was suspended from the center of the piece.

	Names of the wood	Weight of each piece. oz.	Weight suspended when it broke. ℔	oz.
Native.	Teak.	11	449	13
	Tissoo.	$12\frac{1}{2}$	459	5
	Saul.	13	535	$12\frac{1}{2}$
	Assum, like Saul.	$13\frac{1}{2}$	539	9
	Soondry.	$15\frac{1}{4}$	593	9
	Napaul Fir.	$9\frac{5}{8}$	389	0
European.	Baltic red Fir*	10	346	9
	Ditto white Fir†	7	214	13

* Very dense and full of rosin. † In general use.

N. B. A quantity of pure water, of the same bulk with one of the above pieces of wood would weigh $13\frac{8}{9}$ ounces. Hence they would all float in water except the *Soondry*.

You must not use knotty or curled wood for your beams, and all beams must be rounded or cambered upwards, in the proportion of two inches to twenty feet, as the terrace will bring them down a little.

In a twenty-two feet space, Saul beams, ten by seven or eight inches, are quite sufficient, placed at three feet from centre to centre.

We remove beams when rotten without injury to the terrace. The wall-hold is generally six inches less than the thickness of the wall.

8th. In the thickness of the wall, resistance to heat is not considered. Strength is alone considered. We cannot, as I remarked before, use any bond timber or ties of any kind on account of the destructive vermin.

The bricks contain much sand, salt, alkali, and other fusible matter, and will vitrify before they are well burnt.

You have seen many walls thicker than the dimensions I have given, but those are built with brick and mud, and having no cement require to be thicker.

9th. If you begin your work early, so that it will be completely dry, it will resist any frost, but if any moisture remain within, the frost will rend the work.

10th. Add a little strength to your timber, make the parapet low, take care before a thaw to throw off the snow, keep the spouts open, and it will sustain double (or more) the weight you mention.

11th. The floors the same as the roof, but a little lighter, and not so much cove.

12th. Stick to the common and ancient rules of architecture in all cases; but doors and windows, make them much larger.

13th. Water cement is made of brick dust, lime, and the juice of the sugar cane. The Madrass plaister is as I before described ours.

14th. Stone lime is cheap and used for common purposes, shell lime is dear and only used with fine work; I believe it is no better than your own.

15th. No further than I have before described.

16th. These facts do come within my knowledge, and are true. It forms a crust impervious to water, and must protect any thing it covers. When dry, it will keep a ship afloat after her caulking is perished and loose.

Much oil is saved in making this article by bestowing labour on the beating and mixing of it.

17th. Where manual labour is an objection I have stated it.

No. LVI.

Observations on the foregoing communications, by B. Henry Latrobe, Surveyor of the public buildings of the United States, and one of the Committee to whom it was referred by the Society.

Copying the English standard, the bricks of the United States are very generally made $8\frac{1}{2}$ inches long, $4\frac{1}{4}$ inches broad, and $2\frac{1}{4}$ inches thick; so that in the wall with the joint, they shall take up nine inches in length, and half as much, viz. $4\frac{1}{2}$, in breadth; but the various degrees in which different sorts of clay shrink in drying and burning, occasion here, as well as every where else, variety in the size of the bricks; and I have scarcely ever known bricks, from two different kilns in the same city to work correctly together. The cupidity of the brick-makers contributes also to the diminution of the size of bricks in Philadelphia; a wall two bricks thick seldom measures, with the joint, more than 17 inches; a brick-and-half wall, barely 13 inches, and 5 courses in heighth, with the joints, measure one foot.—This gradual diminution in the size of bricks is rather encouraged, than counteracted, by the interest of the bricklayers:—for, as it is the general practice for individuals, as well as public bodies, to find all their materials, and to pay the mechanic only for the labour, and as it is a very general practice to pay the bricklayer by the 1000 bricks, according to the brick-maker's account; or to count them on the outside of the wall, where they all pass for whole bricks and lie closest, it follows that in a given mass of wall, the small bricks, upon the whole, tell better than the large ones; and in both cases, especially the first, the bricklayer is not interested against admitting small bricks to be made.

On the other hand, the brick-maker in burning his bricks as well as in selling them by count, is benefitted; for small bricks can be burned at less expense of fuel than large bricks, and are less liable to warp and break. I am of opinion that great advantages would result from making our bricks larger than the usual standard; not only in the saving of labour, but of mortar, which here, as in India, is the most expensive part of the wall. The width of a brick should not be greater, than that a man can very easily and conveniently grasp it; and although Mr. William Jones has not given information as to the width of the Calcutta brick, (which is of more importance to the workman than its length) I am of opinion that the best possible size of a brick is the following,

11 inches long as in Calcutta,
$5\frac{1}{4}$ wide } when burned.
$2\frac{1}{4}$ thick.

Such a brick would add $2\frac{1}{2}$ inches to our single brick walls, and in most cases permit them to take the place of walls now built of $1\frac{1}{2}$ bricks. A brick-and-half wall, in the fronts of our middling houses, would give room for the window-dressings and shutters; and, in a two-brick wall, there would be no necessity of making thicker the walls of our best houses for this purpose. This is not the place to enter into further details. Practical builders can easily investigate the results from such a change in the size of our bricks; but it will be difficult to be effected, while the astonishing increase of our buildings gives to the brick-makers such an influence over all our building operations.

1 *Use of brick dust in mortar.*

In his answer to the 8th Query, Mr. William Jones has the following remark:

The bricks contain much sand, salt, alkali, and other fusible matter, and will vitrify before they are well burned.

We might then consider the brick dust, made by pounding the bricks of Calcutta, as so much *sharp sand*, and as having lost that *contractility* which *clay* unvitrified by the admixture of vitrescible substances, and unhardened by fire, universally possesses. In this state, it might be an unobjectionable ingredient in cement in America. But as it is evident from the process of laying on the chunam internally, and also from the beating required upon the materials of their terraces, that their brick dust is not generally in this hardened state, when mixed with the mortar, but that it continues to contract, and to require forcible compression by beating or rubbing until it is quite dry, it becomes, on more than one account, a very noxious as well as a very inconvenient ingredient in all cements, to be used where there is frost, and where labour is dear.

I should be obliged to write a voluminous treatise on this subject, were I to submit to you all that my experience, as well as my reasonings suggest, to counteract the prejudice in favour of the use of brick dust in cements north and south of the tropics. Its utility beyond the reach of frost, I need not examine. It would be useless to establish or to refute it in our region of severe winter. I will therefore only endeavour to comprize, in as small a compass as possible, what may be useful to our own citizens.

Belidor, Blondel, Sturm, Smeaton, Higgins, Adams, and many other French, German, English and Italian writers have all recommended brick dust in some cement or other. I have none of their works at hand, so as to refer to their receipts or their experiments, and no doubt their cements have possessed all the qualities ascribed to them, when the brick dust has been prepared of well burned bricks. I have also seen brick dust employed by engineers and architects whom I have personally known, and have employed it myself; but I do not recollect a single instance of the cement in which it has been used having resisted the effect of moisture and frost. Natural argillaceous stones are more apt to be forced to pieces by frost than any others.* Bricks not sufficiently burned are always destroyed by frost. The effects of frost on the natural clay of the earth is well known,—it renders our roads almost impassable in spring. It seems therefore, to plain sense, a conclusive argument against the use of this material in cements, that wherever we see it present in any natural or artificial production, its dissolution by frost is certain.

* The freestone of Acquia, however, appears to be sand cemented by an alluminous (argillaceous) infusion. Some of it is dissolved by the frost, but the best stone resists it most perfectly. Water oozing through this stone covers the face of the rock with allum I have not been able to detect in this sand stone any particle of calcareous matter. Its smell when moist is strongly earthy. See my memoir in the Philosphical Transactions, on this stone. page 283 of this Volume.

If however the clay be hardened by being converted into a vitrified, or otherwise solid brick, then indeed it ceases to be under the dominion of frost, and is at all events, I should suppose, as good as so much sand. It remains to be enquired by chemical investigation, whether some affinity between clay, thus hardened, and lime does not exist, which expelling in their union their caloric, combines the two substances more intimately and in a smaller compass, than that of lime mixed with sand; and, of course, gives to the compound more hardness, and permanent continuity. If such affinity does exist, which I will not *deny*, such brick dust is so far superior in quality, as an ingredient of cements, to sand. But it is, I think, far counterbalanced by its other quality of infinite contractibility and expansion. Clay, in its purest state, is used in Wedgewood's pyrometer, on account of this very quality, which it appears never to lose; and from thence arises the perfection of this most useful instrument. When the cement, of which brick dust is an ingredient, is laid on in a moist state, it occupies in some cases (for I have last year had much unpleasant experience of the fact in the floors laid in Deniroth's cement at Washington) $\frac{1}{6}$ more space than when dry. On a wall exposed to heat, or upon a timber floor accessible, and at first pervious to the air, there appears to be a limit to the contraction of the cement. But in a heavy vaulted building, like the Capitol of the United States, at least, the moisture of which evaporates slowly, I would reject brick dust altogether as an ingredient of any kind of cement, either for mosaic floors, terraces, or facings. Full justice appeared to be done by the contractor and patentee, in beating his floors both as to time and labour, but after a year's drying they have cracked into innumerable fissures.

From what I have said, it will be evident, that I consider brick dust as an ingredient in cements, inapplicable to our climate and of course useless.

Good clean washed sand, and stone lime, in the proportion of three of sand and one of lime, up to six to one, according to the size of the particles of sand, and the goodness of the lime, is a cement that will never fail, if well mixed and worked, and laid on as soon as possible after being mixed. The lime in slacking should be perfectly drowned in water, and the fluid strained and run into a pit, from whence, after remaining if necessary during a whole winter, or more, it may be cut out hot, as smooth as custard, and capable of receiving a very great proportion of sand without becoming harsh and brittle. All substances containing a quantity of carbon combined with oxygen, are highly useful ingredients; such as *skim-milk, whey,* molasses, skimmings of sugar pans, sugar, vinegar, beer, wine lees, all sorts of washings of breweries, distilleries, and sugar houses. These substances, by giving their carbon to the lime, convert the cement into a calcareous sand stone in a more expeditious manner, than by any process dependent upon attraction from the atmosphere. But though blood, oils, and curds have been recommended, the animal or vegetable mucilage they contain is injurious to their durability. The celebrated cement of Adams, of which oil was a considerable ingredient, after standing with every appearance of permanence for some years, began then to fail, and actions being brought against him by Lord Stanhope (Mahon) and others upon his warrantee, this artist, so deservedly considered as one of the brightest ornaments of the English school, was ruined in fortune, by the damages awarded against him.

Before I close my remarks on this cement, I will add, that all cements of every kind acquire the quality of hardening in proportion to the working and beating they get, and no remark can be more just than that of Mr. Jones, that "the patience bestowed will amply reward you."

2. *and* 3. *Use of Timber in Walls.*

In all professions, there are prejudices of practice, which become national. That of filling their walls with what they call bond timbers is one of those practices, which every English architect receives by inheritance. The white ants have been serviceable to architecture in expelling it from Bengal.

A piece of timber bedded in a wall can be of service, only for the following uses:

1. If it be laid under the joists or timbers of a floor, it serves to spread the weight equally along the wall; or if under the

end of a girder, to give to the girder a broad base or bearing upon the wall.

2. To tie the wall together lengthwise, in order to prevent its spreading at the top.

When the foundation is equal, it is evident that bond timbers become useless, excepting in the first case.—But it has been customary in England to put them regularly into the walls, from the bottom to the top, at the distance of several feet asunder; taking care that one piece shall be laid so as to receive the skirting, another the surbase, &c.—A specimen of this practice might have been seen in the north wing of the Capitol, in which the bond timber had a considerable share in the failure of the work, and in the necessity of a thorough rebuilding of the interior.

Bond timbers do injury by the following means: A piece of timber laid along the wall, takes up in its whole length the place of solid materials. It is laid in wet mortar; and the work above, as the moisture descends, keeps it wet for some time. It swells. It is on three sides inaccessible to the air. At last it dries with the wall and shrinks. If the timber occupies less than half the thickness of the wall, the wall will not follow it, the outer part being the heaviest, but the timber occupying less space than before, becomes loose. In heavy buildings, being moist and excluded from the air for a long time, it will probably be rotten before that time. The plaistering that covers it will crack. In fact, if it ever was useful, it ceases entirely to be so.

To prevent these timbers from moving outwards as they get loose, they have some times been made thicker within the wall than on their exterior side, sometimes they have been tied in by short cross pieces. But all this does not remove the evil.

As to the convenience of bond timbers for fastening on the the dressings—the same end may be much better accomplished by driving in very dry oak plugs, after the building is finished and dry.

If however the foundation be unequal, it is evident that the tendency of one part of the wall to sink into a soft place while the rest is supported by a harder part of the foundation can only be resisted by timber strong enough to hold up the wall that is over it. This is very inadequately done by timbers lying at distances from each other only on the inside of the work. Where there is such a foundation, it is infinitely better to combine the strength of all these timbers, and, laying them in the trench, to cover them well from the access of air, and build the wall upon them. But piling is always the best thing that can be done even if no very hard bottom can be reached.—Bond timbers ought never to be depended on.

I have already extended my remarks to a length which I did not intend or foresee—and yet I cannot avoid adding to them what I think necessary to meet the inclination, supported by our Italian prejudices, which the very clear and able manner in which Mr. Jones has described the Hindoo method of constructing terraces might excite, to make further experiments on the construction of flat roofs for our American houses.

In crowded cities, where the court yards are generally small and buried from the light and air by tall houses, terraces on the roofs are almost *necessary*, for the view and enjoyment of the heavens, and for many domestic purposes. But they are every where, excepting beyond the region of frost, the most difficult and precarious part of the construction of the house. Lead, copper, sheet-iron, tarred and sanded paper, calcareous cements, all have been tried, all have had temporary success, all have produced permanent inconvenience. The range of the expansion and contraction of lead, together with the range through 100 degrees of Fahrenheit's thermometer, to which our climate is subject, renders lead an improper metal for the purpose of a terrace. It is liable to be torn to pieces by its own motion.—Copper is very expensive, and is soon corroded by verdigrease. Iron requires constant painting, is sooner corroded by rust, but is otherwise the most convenient material and the cheapest.—Sand, tar, and paper, succeed better to the north-eastward, than in the middle and southern States, but is not easily or securely to be connected with gutters, and is a dirty sort of covering.—Calcareous cements have in no instance as yet succeeded, and the smallest crack, admitting water in winter, during the frost, is fatal to them.

Fortunately, we have no rational use for flat roofs. Our cities are roomy, and our habits and their population will for many centuries keep them so. Our houses are low and our yards airy. I cannot conceive a single argument in favour either of the beauty or utility of terrace roofs in our country. Those that have them scarcely ever use them. The cold in winter and the heat in summer drive us from them. A beautiful prospect may justify the partial use of them, in particular situations, but neither architectural beauty, nor the general wants of our wintry climate call for their introduction.—To the southward beyond the reach of frost, however, the information contained in this paper may be highly useful.

No. LVII.

A general method of finding the roots of numeral equations to any degree of exactness; with the application of Logarithms to shorten the operation: by John Garnett of New Brunswick N. Jersey.

Read January 20th, 1809.

Suppose an equation, $ax+bx^2+cx^3+dx^4+ex^5$ &c. $=v$, to find x.

RULE.

Find, by trial, any near root as x'.

Then, by substitution, $ax'+bx'^2+cx'^3+dx'^4+ex'^5$ &c. $=v'$
Multiply each term by the index of the power of x', and divide by x.
Let the products, $a+2bx'+3cx'^2+4dx3'+5ex4$, &c. $=$ A.
Multiply each term by the power of x', and divide by $2x'$.
Let the products, $b+3cx'+6dx'^2+10ex'3$, &c. $=$ B.
Multiply each term by the power of x', and divide by $3x'$.
Let the products, $c+4dx'+10ex'_2$, &c. $=$ C.
Multiply each term again by its power of x', and divide by $4x'$.
Let the products, $d+5ex'$, &c. $=$D: and so on, continually, until all the powers of x' are destroyed; so that e, &c. $=$E.

Then will $Ax''+Bx''^2+Cx''^3+Dx''^4+Ex''^5$ &c. $=v\text{-}v'$, be a *New Equation* whose roots will all be less by x', and the value, $v-v'$, less by v' than the roots of the original equation. And if the roots and value of this new equation be diminished in the same manner, by another near root, as x''', and so on, continually, the root and value may become less than any assignable quantity, and the sum of all the near roots will be equal to x, the root of the original equation.

This rule will be found virtually the same as that given by Newton, Raphson, Jones, Simpson &c. and, if applied to the extraction of simple powers, will be found the same precisely as the one usually given in common arithmetic, thus for

EXAMPLE I.

Let $x^3 =$	99252847	
$x' = 400$ - - - -	64000000	$= x'^3$ $\quad x' = 400$
By the Rule, $v - v'$	35252847	Resolvend.
divisor		New Equation $x'' = 60$
$3x'^2 = 480000 = A$	28800000	$480000 \times x''$
$3x' = 1200 = B$	4320000	$+1200 \times x''^2$
$1 = 1 = C$	216000	$+1 \times x''^3 = v - v'$
By the Rule,	33336000	Subtrahend
	01916847	Resolvend
$A =$ divisor		New equation $x''' = 3$
$480000 + 2400x'' + 3x''^2 = 634800.$	$1904400 =$	$634800 \times x'''$
$B = 1200 + 3x = 1380.$	$12420 =$	$1380 \times x'''^2$
$C = 1 = 1.$	$27 =$	$1 \times x'''^3$
	1916847	Subtrahend.

Whence $x = x' + x'' + x''' = 463$, the required Root.

This form will serve for all numeral equations, and with nearly the same labour; as for

EXAMPLE II.

$3x^3 + 2x^2 - 5x = v =$	242235792	near root $x' = 400$
$v' =$	192318000	$= 3x'^3 + 2x'^2 - 5x'$
By the Rule, $v - v' =$	49917792	Resolvend.
divisor		New equation $x'' = 30$
$9x'^2 + 4x' - 5 = 1441595 = A$	43247850	$= 1441595 \times x''$
$9x' + 2 = 3602 = B$	3241800	$= + 3602 \times x''^2$
$3 = 3 = C$	81000	$+ 3 \times x''^3 = v - v'$
v''	46570650	Subtrahend.
	3347142	Resolvend.
By the Rule,		$x''' = 2$
divisor		New Equation.
$9x''^2 + 7204x'' + 1441595 = 1665815$	3331630	$1665815 \times x'''$
$9x + 3602 = 3872$	15488	$+ 3872 \times x'''^2$
$3 = 3$	24	$+ 3 \times x'''^3 = v - v' - v''$
	3347142	Subtrahend.
Hence, $x = x' + x'' + x''' = 432.$	000000	

By dividing the original equation by $x - 4{,}32 = 0$, the other roots may be found, but in this case they are imaginary. But, instead of thus approximating to a root by single figures, we can (after the root has been sufficiently diminished) find, by a Table of *Logarithms*, as many places of figures at one operation, as there are places of figures in the logarithms; as in the following

EXAMPLE III.

Suppose $x^3 - 2x = 5$. near Root $x' = 2$

then $x'^3 - 2x' = 4$

By the Rule,

divisor. Resolvend 1

$$\left.\begin{array}{l} 3x'^2 - 2 = 10 \\ 3x' = 6 \\ 1 = 1 \end{array}\right\}$$ near Root $x = ,09$

gives $10x'' + 6x''^2 + x''^3 = 0{,}949329$ Subtrahend.

Resolvend $0{,}050671 = v$.

This being now sufficiently reduced we proceed thus:—

By the Rule,

New Equation.

$3x''^2 + 12x'' + 10 = 11{,}1043$ (A)

$$\left.\begin{array}{l} 3x'' + 6 = 6{,}27 = B \\ 1 = 1 = C \end{array}\right\}$$ $11{,}1043x''' + 6{,}27x'''^2 + x'''^3 = ,050671 = V$ and by reversion of series, $x''' = \frac{V}{A} - \frac{B}{A^3}V^2 + \&c.$

Then, by logarithms,

	$V = ,050671$	Log.	v	8.704760
	$A = 11{,}1043$	Log.	a	1.045492
$v - a$	$\frac{V}{A} = ,00456319$	Log.	d	7.659268
$d - a =$	$\frac{V}{A^2}$		c	6.613776
$6{,}27 =$	B		b	0.797268
$b + c + d =$	$\frac{B}{A^3}V^2 = ,00001176$			5.070312

$\frac{V}{A} - \frac{B}{A^3}V^2 = x''' =$ $,00455143$. whence $x = 2.09455143$

And if $,004551$ be put for x''', in the above new equation, the value and root would be again reduced, so that we should obtain $x'''' = ,0000004815424$, and consequently the root $x = 2{,}0945514815424$, true to the last figure.

No. LVIII.

On the best angles for the sails of a windmill. By John Garnett of New Brunswick, N. Jersey.

Read January 30th, 1809.

The *angle of weather*, or that angle which the section of the vane, at a given distance from the centre of motion, makes with the plane of its motion, will depend on its proportionate velocity to that of the wind; some mean velocity of which is generally assumed, to which the interior mechanism of the mill is adapted; supposing this at $12\frac{1}{2}$ feet per second, which would be called a *fresh gale*, the Dutch mills, with the sails of 30 feet radius, make about 13 revolutions per minute; in this case, the extremity of the vane moves with nearly three times the velocity of the wind, and consequently, at 10 feet distance with the same velocity as the wind; at 20 feet with twice the velocity, being in a direct proportion to the distance from the centre.

As different *angles of weather* have been given by several writers, as Parent, De Moivre, Maclaurin and Simpson, Smeaton &c. and lately by Mr. Hall Gower, which have been copied in the modern treatises on mechanics, as Gregory, Grey &c. where errors may be of considerable consequence, I will endeavour to shew the true principles, and give a very simple construction which will give the *angle of weather* on either hypothesis.

Let the line WV represent the wind's direction and velocity; SV, the direction and velocity of any section of the vane whose *angle of weather* is required; then WS will be the *relative direction and velocity* of the wind to that part of the sail; and the angle WSV, will be the *limit of the angle of weather;* for, at this angle, the wind's relative direction being parallel to WS, can have no effect, and at any greater angle the vane would be a back sail; the *angle of weather* therefore must be less than WSV; suppose it CSV; then WSC will be the *relative angle of incidence* of the wind on the plane SC; from W draw WC perpendicular to the plane SC, and from C draw CM perpendicular to WV; then WC will be the relative velocity and proportionate force with which the wind strikes the vane perpendicular to its plane, which force being resolved into two forces WC and cC, the first perpendicular to the plane of motion and therefore of no effect, the last parallel to it and therefore represents the effective force of every particle of wind to turn the vane, when the force perpendicular to the plane is CW; now let any other *angles of weather* as VSB, VSA, be taken, then will WSB, WSA be the *relative angles of incidence;* BW, AW the relative velocity and proportionate force perpendicular to the plane of the sail; and Bb, Aa the effective forces to turn the vanes SB, SA; whence it appears that these forces are ordinates to the chord WV, and if the force of the wind on the vane were in the simple ratio of its relative velocity, or the number of impinging particles were invariable, as is the case in undershot water wheels, as observed by Mr. Waring, in the third volume of the Philosophical Transactions; then the greatest force would be SB, where the *angle of weather* VSB equally divides the *angle of limit* WSV, which agrees with the theorem given by Maclaurin and Simpson, on the above supposition, which to distinguish we may call "*Waring's hypothesis.*" But if the force be as the *square* of the relative velocity; describe a semicircle on SW, and with the radius SD describe the arc DRE cutting the plane SC in R from which draw RF, RG perpendicular to SW, SV. Then the proportionate force on any point C perpendicular to the plane SS will be $\frac{WC^2}{RF^2}$; or (since RF, SN are halves of CW, WV,) $\frac{WV^2}{SN^2}$; and as WC : cC or SR : RG :: (the force perpendicular to SC,) $\frac{RF^2}{SN^2} : \frac{RF^2 \times RG}{SN^2 \times SR}$ the whole *effective force* on each point of the plane SC, which is the same as given by Maclaurin and Simpson, and *agrees with their hypothesis.*

But the same breadth of sail inclined to different angles of weather will not intercept an equal current of wind; the relative current being the parallelogram WZCP to the plane CS, the particles intercepted will be as CP; or Rp on the plane SR, so that $Rp \times \frac{RF^2 \times RG}{SN^2 \times SR}$ will represent the force on the plane SR, but SN : SD (= SR) : : RF : $Rp = RF \times \frac{SR}{SN}$ therefore the whole effective force on the section SR will be $\frac{RF^3 \times RG}{SN^3}$ which by Simpson's fluxions vol. 2, Prob. 5 page 503, will be a maximum when $MN = \frac{1}{2} SN$. But if the whole effective force according to *Maclaurin and Simpson* be as $RF^2 \times RG$, (SR and SN being constant) the maximum will then be when MN $\frac{1}{3} = SN$.

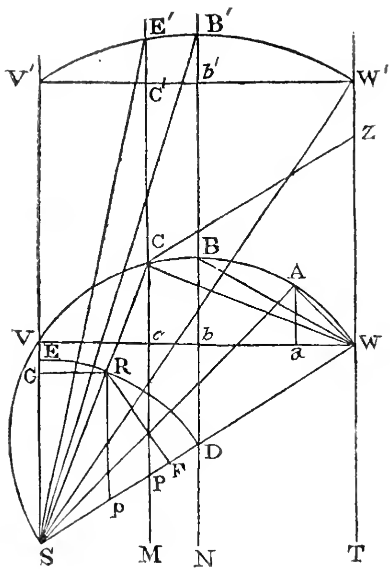
But supposing the angle of weather known for every proportionate velocity of the sail to the wind, it still remains to be determined what that proportion ought to be at the extremity of the sail, as was justly observed by Mr. Smeaton; who, in putting Maclaurin's theory to the test of experiment, *assumed it* as two to one, but he found that by increasing the *angle of weather* three and six degrees, the effect or product was still increasing, although by increasing the *angles of weather* at every part equally they became no longer the angles of Maclaurin; to have made it decisive he should also have taken it as one and an half to one; and as one to one, the forces from the theory continually increasing, as these ratios diminish. Mr. Smeaton also appears to have made an error by estimating the mean velocity of the wind from the distance of the axis of his rotary machine from the centre of his sails; the force being as the squares of the velocities, the mean should have been taken at a greater distance; if this error be corrected, his conclusion that the extremity of the sail should move with 2,7 times the velocity of the wind, will probably be altered to less than double, and from theory a slower motion of the sails appears to be highly advantageous.

The angle of weather on either of these hypotheses is very easily laid down by the following construction, from whence some useful conclusions may be drawn.

Let WV represent the direction and velocity of the wind; SV, SV′ &c. that of the sail at those distances from the centre of motion, and perpendicular to WV; draw the parallel TW′, also NB′ in the middle and MC′ either at $\frac{1}{3}$ the distance between N and S, according to Maclaurin's, or at $\frac{1}{2}$ the distance, by the last hypothesis. Then to find the *angle of weather* corresponding to any velocity or distance TW, draw SW, on which describe a semicircle SVBW, and draw SC, SB, to where it meets the parallels MC′, NB′; then will CSV, be the *angle of weather* according to Maclaurin, if at $\frac{1}{3}$ distance; or according to the last hypothesis, if MC′ be at $\frac{1}{2}$ the distance between N and S; and BSV, equal to *half the angle of limit* WSV, will be the angle of weather according to Waring, if any constant portion of wind could be intercepted; and for Mr. Hall Gower's hypothesis, take TW′, as the whole length of the vane, and *assuming* any angle at the extremity as most advantageous, suppose TW′H = 10 degrees, then any other line drawn from H, to any other distance on TW′, will shew the corresponding *angle of weather*; but this principle will be found evidently erroneous.

The calculation of the different *angles of weather* is also much easier from this construction, than from Maclaurin's theorem for that purpose; for taking WV = 1, as the winds velocity; then the sails' velocity TW is = contangent of the angle of limit = twice the angle of weather according to Waring; and either $\frac{1}{3}$ or $\frac{1}{2}$ the sine of the angle of limit SN, will give the sine of the arc BC, which arc subtracted from the angle of limit (BW =) BV will give the arc VC = twice the *angle of weather* according to either of the two hypotheses.—By this method, the following table is calculated shewing the different angles of weather, and the effective force of the wind to turn the sail; but it must be understood that the proportionate velocity of the extreme part of the sail to the wind can be assumed at pleasure, if the interior mechanism be adapted to it; the greater the angle of weather the less will be the sails' velocity, but the force greater; and also, on either hypothesis, if the same *angle of weather* be assumed at the extremity, the difference of all the other angles would in practice be imperceptible, until we approach towards the centre, where they approximate to either 30°, 35° 16′, 45° or 90°; the last, evidently erroneous.

Velocity of Sail V. Wind=100	ANGLES OF WEATHER. M N = $\frac{1}{3}$ S N.	Maclaurin M N = 1-3 S N	Waring = $\frac{1}{2}$ angle of limit.	Gower	Smeaton.	EFFECTIVE FORCE. $R F^3 \times R G \div S N^3$ M N = $\frac{1}{3}$ S N.	Maclaurin.	Waring.	Gower.
	° ′	° ′	° ′	° ′	° ′				
0	30 0	35 16	45 0	90 0		,3248	,3142	,2500	,0000
25	24 20	28 33	38 59	63 26		,2300	,2238	,1674	,0151
50	18 26	23 4	31 43	45 0	18 0	,1563	,1488	,1067	,0305
75	14 46	18 50	26 34	33 41		,1190	,1128	,0781	,0400
100	12 10	15 41	22 30	26 34	19 0	,0950	,0897	,0607	,0503
125	10 14	13 15	19 20	21 48		,0786	,0758	,0492	,0371
150	8 48	11 31	16 51	18 26	18 0	,0668	,0629	,0413	,0338
175	7 42	9 46	14 53	15 57		,0581	,0556	,0356	,0306
200	6 48	9 0	13 15	14 2	16 0	,0511	,0479	,0311	,0275
250	5 33	7 21	10 54	11 18	12 30	,0414	,0388	,0250	,0229
300	4 40	6 12	9 13	9 28	7	,0346	,0325	,0208	,0197



REMARKS.

1st. The most material consequence to be derived from the above table is the great diminution of the effective force of the wind, as the velocity of the sail increases; which shews, that the sail-cloth should be placed as near the centre as possible, only observing that the *wind must have a free escapement;* for a square foot of sail, moving with half the velocity of the wind, appears to have three times the effective power as when moving with double the wind's velocity; for *the power of the lever when time is considered must be out of the calculation;* this also agrees with Mr. Smeaton's experiments, who found, that by enlarging the breadth of his sails, he gained more than by increasing the radius. Probably the extremity of the sail should not exceed the velocity of the wind; and as this will increase the *angle of weather*, the wind will have a more free escapement, and its reflections be less liable to impede the following sail: the angle of reflection is easily seen from the relative angle of incidence, DSR.

2dly. That Mr. Hall Gower's hypothesis is highly disadvantageous; for by approximating to 90° at the centre it has the least power, where it should have the most.

3dly. It appears evident from theory, and all Mr. Smeaton's experiments, that the greater the angle of weather the slower will be the motion; therefore if by *any simple contrivance* the *angles of weather* could be occasionally altered, it would be the best mode of making the revolutions more uniform, and even of stopping them altogether: I am now making an experiment at large on this method.

4thly. Although the forces appear greatest in the first column, from taking $RF^3 \times RG \div SN^3$ as the measure, yet if the measure had been taken $\frac{RF^2 \times RG}{SN^2 \times SR}$ according to Maclaurin, then the second column had shewn the greatest forces, and the third column, if Bb was the true measure—but on no hypothesis could Gower have any competition.

N. B. $RF^2 \times RG$ is a maximum when $WC \times cC$ is a maximum, and $RF^3 \times RG$ is a maximum, when $cW \times cC$ is a maxium—the first when Wc is $\frac{2}{3}$ of Wv, the last when Wc is $\frac{3}{4}$ of Wv; the greatest right-angled triangle in the segment VBW.

No. LVIII.

Extract from a paper on the Meteoric Stones, written by F. R. Hassler Esq. Mathematical Professor in the Military School at West Point.

Read June 17th, 1808.

THE first thing to be considered on the supposition that these bodies are projected from the moon, is, whether the power exerted by any lunar volcano can be sufficient to throw a heavy body beyond the sphere of its predominant attraction, and of course enter that of the earth. This may be made a subject of calculation on the following principles.

Heavenly bodies exercise an attractive power in the direct ratio of their masses, and inverse ratio of the squares of their distances. Let A, M, and D, represent the attraction, mass, and distance of the earth; a, m, d, those of the moon; then the whole force exerted by the two bodies will be $A : a :: \frac{M}{D^2} : \frac{m}{d^2}$.

A body placed in circumstances most favourable to the hypothesis would of course be between the two bodies, and in a right line with the centers of both; and in order to be merely suspended in equilibrio between them, the two first terms of this proportion must be equal to each other, and the two last must also be equal, that is, $\frac{M}{D^2} = \frac{m}{d^2}$.

Now, taking M to be, in round numbers, equal to 70m, and D+d equal to the distance of the moon from the earth=D, the equation transformed becomes $\frac{70m}{\overline{D-d}|^2} = \frac{m}{d^2}$, from which d is found $= \frac{D}{1+\sqrt{70}}$; but D=60×the radius of the earth, which is, in round numbers, equal to the mean distance of the moon;

therefore $\frac{D}{1+\sqrt{70}} = \frac{60 \text{ rad. earth}}{9.366} = 6.406 \times$ the radius of the earth; and multiplying by 3.67, the ratio of the radius of the earth to that of the moon, $d = 23.5 \times$ radius of the moon, which diminished by one radius of the moon, leaves $22\frac{1}{2}$ times the radius of the moon, or 24310.4 miles for the distance to which a heavy body must be thrown by some internal power of the moon, in order to remain suspended between the moon and earth.

According to the ratio of the quantity of matter in the moon and earth, and the observed rate of falling of a heavy body at the surface of the earth in the first second of time, the rate of falling at the surface of the moon is equal to 3.018 feet. Now, let g=this rate=3.018, s=the distance to which the body must be thrown=24310.4 miles; V=the initial velocity, or the velocity which the body must have at leaving the surface of the moon, then $V=2\sqrt{gs}=39364.3$ feet, or about $7\frac{1}{2}$ miles per second, or more than ten times the velocity of the moon in its orbit. Can we believe that there exists in the moon any internal power, capable of producing this effect? When we consider how small the attraction of gravitation is at the moon, would not the existence of such a projectile force prove in the lapse of ages, destructive to that body? And when centuries, and even thousands of years have passed away without any diminution of its magnitude, are we not irresistibly led to deny that there is in the moon any power of projecting a part of itself beyond the sphere of its own attraction?

No. LIX.

Extract of a letter from a member of the Society, relative to the great cold in January, 1807, *at the town of Hallowell, in the district of Maine, Massachusetts, Head of tide-water on Kennebeck River. Communicated by John Vaughan.*

Hallowell, January 29, 1807,

THE cold here on the night of the 22d—23d, brought the thermometer, for a short time, to 33° (Fahrenheit) below the zero; and again, on the 26th—27th, for a much longer time. But the sky, on the last occasion, became cloudy at 3 A. M. and stopped short our career, or I should have frozen quicksilver by a natural process, for the first time in the United States, and for the first time any where in so low a latitude as 44° 16′ by the side of tide waters; that is, at the level of the sea. Quicksilver, by Mr. Hutchins' experiments at Hudson's Bay, as explained by Mr. Cavendish, and confirmed by various others, freezes at—$38\frac{2}{3}$°; and I had the thermometer at—36° or—37° on the surface of the snow; consequently, had darkness continued without clouds, by day break I should have had my requisite temperature at the surface of the snow, though I did not expect more than—36° in the air. I had prepared diminutive cups of fine writing paper, of a size to hold each a globule of quicksilver; and tools were ready cooled to strike, in order to obtain a proof of malleability.—In all this cold weather our female invalids were riding about the country, and our stages and town patroles (of which in my turn I am one) by night. On the two coldest nights, I sat up with my son, and wore neither hat, nor gloves, nor great coat, nor boots. I observed with three thermometers made by Blunt, the king's instrument-maker in London, a fourth by Jones, and a fifth by an Englishman (who supplies some Italians at Boston) and which proved my third best instrument. At mid-day on the 26th we had a violent wind, with the thermometer 7° below the zero; against which our ladies rode, without inconvenience, in a sleigh; other thermometers in the neighbourhood, including one by Adams, corroborated the above. This winter, till lately, has not differed from any common cold winter in Europe.

No. LX.

Statement of Deaths, with the diseases and ages, in the City and Liberties of Philadelphia, from the 2d of January 1807, to the 1st of January 1809. Communicated by the Board of Health.

From the 2d of January 1807 to the 1st of January 1808.

DISEASES.	Under 2 years.	From 2 to 5.	From 5 to 10.	From 10 to 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	From 70 to 80.	From 80 to 90	From 90 to 100.	From 100 to 110.	Ages unknown.	TOTAL.
ABSCESS,	2	0	0	1	0	2	2	2	0	0	0			3	12
Apoplexy,	0	0	0	0	3	3	8	5	2	4	0			5	30
Aphthæ or Thrush,	2	0	0	0	0	0	0	0	0	0	0				2
Asthma,	2	0	0	1	1	3	1	1	3	2	1	1			16
Atrophy,	17	1	0	1	0	1	1	1	1	1	1				25
Burns,	3	1	0	0	0	0	0	1	0	0				1	6
Cachexy,	0	1	0	1	0	0	1	0	0	0				0	3
Cancer,	0	1	0	0	0	1	2	1	1	1	1			1	9
Casualties,	3	1	0	0	0	1	0	1	2	1				2	11
Catarrh,	1	0	0	0	0	0	2	1	1	0		1		1	7
Cholera,	181	2	0	0	0	2	2	0	0	0				2	189
Cholic,	2	0	0	0	0	1	4	7	2	3				2	21
Compression of the Brain,	0	0	0	0	0	0	1	0	0	0				0	1
Consumption of the Lungs,	6	3	6	21	51	86	54	23	17	6	2			31	306
Convulsions,	91	5	2	0	6	9	2	2	0	1	1			8	127
Contusion,	0	0	1	0	1	0	0	0	0	0		1			3
Curved Spine,	0	0	0	0	0	1	0	0	0	0					1
Debility,	1	0	0	0	0	0	0	3	1	0					5
Decay,	15	4	5	3	5	6	14	8	9	5	4	2		4	84
Diabetes,	0	0	0	0	0	0	0	0	1	0				0	1
Diarrhoea,	21	4	3	0	2	8	3	9	7	5	5	1		7	75
Dropsy,	1	2	1	2	5	10	6	7	5	4	5			4	54
Dropsy of the Brain,	27	13	2	2	3	0	0	1	0	0				0	48
Dropsy in the Chest,	1	1	1	1	2	2	2	3	1	4	1			1	20
Drowned,	0	0	4	2	0	1	3	0	0	0				16	26
Dislocations,	0	0	0	1	0	0	0	0	0	0				0	1
Drunkenness,	0	0	0	0	0	3	4	0	0	1				6	14
Dysentery,	26	9	6	4	4	2	6	3	1	1	1	1		6	70
Dyspepsia,	0	0	0	0	0	0	0	0	0	0		1		1	2
Epilepsy,	1	0	0	1	0	1	0	0	0	0				2	5
Erysipelas,	2	0	0	0	0	1	0	0	0	0					3
Fever,	6	3	3	5	2	6	2	3	3	2	1				36
Fever, Intermittent,	2	1	0	1	0	0	0	0	0	0					4
Remittent,	2	1	1	2	2	2	4	2	1	1				2	20
Bilious,	1	0	1	0	4	1	2	0	1	1				0	11
Malignant Bilious,	0	0	0	1	1	0	0	0	0	0				1	3
Hectic,	1	0	0	1	1	1	0	0	0	0					4
Nervous,	0	0	1	3	1	1	2	2	0	0					10
Putrid,	1	0	0	0	0	0	0	0	0	0					1
Carried forward,	418	53	37	54	94	155	128	86	59	43	23	8	0	106,	1266

DISEASES.	*Under 2 years.*	*From 2 to 5.*	*From 5 to 10.*	*From 10 to 20.*	*From 20 to 30.*	*From 30 to 40.*	*From 40 to 50.*	*From 50 to 60.*	*From 60 to 70.*	*From 70 to 80.*	*From 80 to 90.*	*From 90 to 100.*	*From 100 to 110.*	*Ages unknown.*	*TOTAL.*
Brought forward,	418	53	37	54	94	155	128	86	59	43	23	8	0	106	1266
Fever, Scarlet,	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
Inflammatory,	0	0	0	0	1	1	0	2	1	0	0	0	0	0	5
Puerperal,	0	0	0	0	4	2	0	0	0	0	0	0	0	1	7
Typhus,	0	0	3	3	8	8	7	0	1	0	0	0	0	4	34
Fracture,	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Fungus Hæmatodes.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Gangrene,	3	2	0	2	2	1	3	1	2	1	1	0	0	2	20
Gout,	0	0	0	0	0	1	0	2	2	0	0	0	0	1	6
Gravel,	0	0	0	0	0	0	0	0	1	0	1	1	0	0	3
Hernia,	0	0	0	0	0	1	1	2	2	0	0	0	0	1	7
Hives or Croup,	41	9	4	0	1	0	0	0	0	0	0	0	0	0	55
Hysteria,	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2
Hooping Cough,	15	1	1	0	0	0	0	0	0	0	0	0	0	0	17
Hæmorrhage,	0	0	0	2	1	1	2	1	0	0	0	0	0	0	7
Inflammation of the Brain,	2	1	1	0	0	3	1	0	0	0	0	0	0	4	12
Lungs,	14	2	0	0	7	8	6	2	2	1	0	0	0	6	48
Liver,	1	0	0	0	1	0	2	2	0	0	0	0	0	2	8
Breast,	2	1	0	1	0	0	0	1	0	0	0	0	0	2	7
Stomach,	1	1	0	2	0	0	0	1	1	0	0	0	0	0	6
Bowels,	10	3	2	3	1	2	0	0	0	1	0	0	0	1	23
Bladder	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2
Influenza.	3	0	0	2	1	3	3	6	3	4	3	0	0	2	30
Insanity,	0	0	0	0	6	8	3	8	2	0	0	0	0	4	31
Lethargy,	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
Locked Jaw,	1	1	1	3	0	1	1	0	0	0	0	0	0	1	9
Jaundice,	0	0	0	0	0	1	0	1	0	0	0	0	0	1	3
Murdered,	1	0	0	0	0	0	0	1	1	0	0	0	0	0	3
Old Age.	0	0	0	0	0	0	0	0	1	22	31	2	4	5	65
Palsy,	0	0	0	0	0	0	2	9	3	1	0	0	0	3	18
Parturition,	0	0	0	0	2	7	0	0	0	0	0	0	0	3	12
Pleurisy,	2	0	2	0	2	9	7	5	3	1	0	0	0	7	38
Prolapsus, Uteri,	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Rheumatism,	0	0	1	0	0	0	0	0	0	1	0	0	0	2	4
Schirrus of the Liver,	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Scrofula,	1	2	0	0	0	0	0	0	0	0	0	0	0	0	3
Small Pox, Natural,	7	6	2	0	6	1	0	0	0	0	0	0	0	8	30
Inoculated.	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Sore-throat,	2	2	1	0	0	0	0	0	0	0	0	0	0	2	7
Still-born,	84	0	0	0	0	0	0	0	0	0	0	0	0	0	84
Sudden,	3	1	1	1	0	4	4	3	2	1	0	0	0	11	31
Suicide,	0	0	0	1	1	5	0	1	0	0	0	0	0	1	9
Stone,	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Suffocation,	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Syphilis,	0	0	0	1	5	5	1	1	1	0	0	0	0	1	15
Teething,	0	10	0	0	0	0	0	0	0	0	0	0	0	0	10
Tic Douloureux,	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Tumors,	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Ulcers,	0	2	0	0	0	1	0	2	0	0	0	0	0	0	5
Worms,	0	24	9	4	0	0	0	0	0	0	0	0	0	0	37
Diseases Unknown.	0	0	0	4	0	0	0	0	0	0	0	0	0	51	51
TOTAL.	614	121	65	79	144	236	172	139	88	79	60	11	4	233,	2[illegible]45

Deaths in each Month, of the foregoing period.

	Adults.	Children.	Total.
January,	92	58	150
February,	73	45	118
March,	109	45	154
April,	111	46	157
May,	90	43	133
June,	91	68	159
July,	101	136	237
August,	117	151	268
September,	140	97	237
October,	108	54	162
November,	101	54	155
December,	71	44	115
Total	1204	841	2045

From the 2d of January 1808 *to the* 1*st of January* 1809.

DISEASES.	*Under 1 year.*	*From 1 to 2.*	*From 2 to 5.*	*From 5 to 10.*	*From 10 to 20.*	*From 20 to 30.*	*From 30 to 40.*	*From 40 to 50.*	*From 50 to 60.*	*From 60 to 70.*	*From 70 to 80.*	*From 80 to 90.*	*From 90 to 100.*	*From 100 to 110.*	*Ages Unknown.*	*TOTAL.*
Abortion,	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Abscess,	0	0	2	3	0	0	0	0	1	1	0	0	0	0	1	8
Angina Pectoris,	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
Aneurism,	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Anthrax,	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Apoplexy,	0	0	0	0	1	5	4	6	3	9	3	1	0	0	2	34
Asthma,	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	4
Atrophy or Marasmus,	13	7	1	1	0	0	0	3	1	2	0	1	0	0	0	29
Burns,	0	4	4	2	0	0	1	1	0	0	0	0	1	0	2	15
Cancer,	0	0	0	0	0	0	1	5	1	1	1	0	0	0	0	9
Casualties,	1	0	0	0	0	1	2	5	1	1	0	0	0	0	1	12
Catarrh,	17	2	0	0	0	0	0	2	0	0	1	0	0	0	1	23
Cachexy,	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Caries of the Spine,	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Chlorosis,	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Constipation,	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Cholera Morbus,	116	76	20	4	1	0	1	1	1	0	0	0	0	0	10	230
Cholic,	3	0	0	0	1	3	1	2	1	1	3	1	0	0	1	17
Consumption of the Lungs,	6	6	10	10	21	67	73	41	33	12	1	1	0	0	20	301
Convulsions,	82	18	12	6	0	8	6	4	1	2	0	0	0	0	6	145
Contusion,	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	4
Debility,	10	0	1	0	1	1	0	1	0	0	0	1	0	0	0	15
Decay,	13	6	4	2	4	4	6	9	9	6	5	2	1	0	1	72
Diabetes,	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Diarrhœa,	10	10	10	1	4	2	6	8	8	9	4	2	0	0	0	74
Dropsy,	1	0	3	1	2	7	16	11	9	8	5	2	0	0	2	67
Dropsy of the Brain,	20	11	8	3	2	3	4	0	1	0	0	0	0	0	0	52
Dropsy in the Chest,	0	0	0	0	0	2	2	4	3	2	2	1	0	0	2	18
Drowned,	0	0	0	1	5	5	3	6	1	2	0	0	0	0	5	28
Carried forward,	293	140	75	34	43	110	132	111	78	56	27	12	2	0	55,	1168

DISEASES.	*Under 1 year.*	*From 1 to 2.*	*From 2 to 5.*	*From 5 to 10.*	*From 10 to 20.*	*From 20 to 30.*	*From 30 to 40*	*From 40 to 50.*	*From 50 to 60.*	*From 60 to 70*	*From 70 to 80.*	*From 80 to 90.*	*From 90 to 100.*	*From 100 to 110*	*Ages unknown.*	*TOTAL.*
Brought forward,	293	140	75	34	43	116	132	111	78	56	27	12	2	0	55	1168
Disease of the Heart,	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Hip Joint,	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Drunkenness,	0	0	0	0	0	0	3	0	0	1	0	0	0	0	1	5
Dysentery,	11	10	8	2	2	0	1	1	0	2	1	0	0	0	2	40
Dyspepsia,	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2
Dyspnœa,	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	3
Eruptions,	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	3
Epilepsy,	1	0	1	0	2	1	0	3	4	0	0	0	0	0	0	12
Erysipelas,	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	4
Executed,	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Fever, Type not mentioned,	1	3	0	2	3	2	3	4	0	1	2	0	0	0	2	22
Bilious, Remittent and Intermittent,	2	3	0	1	4	13	7	7	2	3	1	0	0	0	0	45
Typhus, Nervous and Putrid,	0	0	0	3	7	13	7	3	1	1	0	0	0	0	0	35
Inflammatory, Phrenitic & Cephalic,	0	1	0	2	2	0	2	3	0	0	0	0	0	0	0	10
Scarlet,	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Hectic,	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	4
Puerperal,	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2
Fracture,	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	3
Gout,	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	4
Gravel,	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Hives,	23	15	10	3	0	0	0	0	0	0	0	0	0	0	2	53
Hæmorrhage, Hæmorrhoids & Hæmoptysis,	0	0	1	0	0	4	1	2	1	1	0	0	0	0	1	11
Hooping Cough,	3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	11
Inflammation of the Brain,	2	3	2	2	0	3	2	3	2	8	0	0	0	0	0	22
Lungs,	10	14	5	4	0	10	4	5	3	5	4	0	0	0	2	66
Liver,	3	1	1	2	0	1	7	1	4	2	1	0	0	0	2	25
Stomach and Bowels,	8	5	0	0	3	1	3	5	1	3	2	0	0	0	2	33
Peritoneum,	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Insanity,	0	0	0	0	0	7	8	2	3	2	1	0	0	0	2	25
Jaundice,	1	1	0	0	0	0	1	3	1	1	1	0	0	0	0	9
Lethargy,	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	3
Locked-Jaw,	1	0	1	3	0	0	0	3	0	0	0	0	0	0	0	8
Measles,	23	27	13	8	0	0	0	0	0	0	0	0	0	0	2	73
Mortification and Gangrene,	3	2	3	1	0	0	0	4	3	1	1	0	0	0	2	20
Old age,	0	0	0	0	0	0	0	0	0	0	16	15	5	2	0	38
Overlaid,	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Palsy,	0	0	0	0	1	0	0	4	6	2	1	1	0	0	1	17
Parturition,	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	4
Pleurisy,	2	2	0	1	4	6	6	6	3	3	1	0	0	0	1	35
Quinsy,	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
Rickets,	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Rheumatism,	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	3
Scrofula,	0	0	1	0	0	3	0	0	0	1	0	0	0	0	1	6
Small-Pox, Natural,	13	23	32	26	15	12	10	2	1	0	0	0	0	0	7	141
Inoculated,	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	4
Sore Throat,	3	1	1	0	1	0	0	1	0	1	0	0	0	0	0	8
Still-born,	126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126
Suicide,	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2	4
Sudden Death,	4	0	0	4	0	6	15	6	7	4	0	0	0	0	4	46
Syphilis,	1	1	1	0	1	9	0	2	1	0	0	0	0	0	0	16
Teething,	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Thrush,	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Tumors,	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2
Ulcers,	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
Visceral Obstructions,	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Worms,	3	8	5	2	0	0	0	0	0	0	0	0	0	0	2	20
Wounds,	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Diseases unknown,	26	5	2	1	1	1	2	0	1	1	0	0	0	0	3	43
TOTAL,	583	284	167	98	95	212	219	186	128	98	61	30	7	2	101	2271

Deaths in each Month, of the foregoing period.

	Adults.	Child.		Adults.	Child.	
January,	91	45	July,	111	263	
February,	73	50	August,	109	188	
March,	91	63	September,	88	97	
April,	96	73	October,	71	83	
May,	81	98	November,	81	71	
June,	95	132	December,	59	62	
	527	461		519	764	TOTAL....2271

The foregoing Statements were drawn up with as much accuracy as possible, from the Returns given to the Board, from Physicians and others. Any suggestions, for future improvements, will be thankfully received.

By reference to the Census taken by order of Congress, we find the population of the City and Liberties of Philadelphia, and that part of the county connected with the preceding Bills of Mortality, to have been as follows:

Census.	City.	Suburbs.	County.	Total.
1790	28522	13998	3657	46177
1800	41299	26641	4201	72141

A new Census will be taken in 1810.—The present population may be safely estimated at 100000, or upwards.

The population of the State of Pennsylvania, by the same Census, appears to have kept pace with that of the City &c.

1790....434373 1800....602373

No. LXI.

An Account of Experiments made on Palladium, found in combination with pure Gold. By Joseph Cloud, an Officer in the Mint of the United States.

Read June 23d, 1809.

NOTWITHSTANDING the numerous experiments that have been made by several eminent chemists, on a metallic substance, discovered by Doctor Wollaston, in combination with crude platinum, and by him called palladium; there still remains much doubt with respect to the existence of such a simple substance. Professor Murray, one of the latest writers on chemistry, in speaking of palladium, and other metals found in combination with crude platinum, says; "It is not impossible that they may be alloys of others; or that the peculiar properties which they appear to exhibit, may arise from combinations which analysis has not detected. The peculiarity of their association in one natural production, while there are no traces of them in any other, perhaps lends force to this supposition." It has been my fortune, however, to obtain it from a different source; which enables me to point out some of its characters, that will throw such light on the subject, as to remove all doubts respecting the existence of this simple metal.

On the 15th of May, 1807, a deposit of gold bullion, from Brazil, in South America, was made at the Mint of the United States, weighing 797 ounces, 4 dwts., gross, equal to 819 oz. 11 dwts. 11 grs. standard. It was composed of about 120 small ingots, differing in weight; each of them was stamped on one side with the arms of Portugal, and the inscription of "Rio das Mortes." The other side was stamped with a globe. They were also marked with their respective qualities. Among them were two or three ingots, so remarkably different in colour from any of the common native alloys of gold, that I was induced to reserve one, weighing 3 ounces, 11 dwts. 12 grains, for examination, and which was subjected to the following experiments.

Experiment 1st. A portion of the reserved bar was examined for silver, by solution in the nitro-muriatic acid; but no trace of that metal was indicated.

Exp. 2d. 24 carats of this bar were combined with 48 carats of fine silver, and cupeled with pure lead, for the purpose of destroying any of the base metals that might be in combination; but there was no loss of weight produced: consequently, there were none of the easily-oxidable metals in the compound.

Exp. 3d. The pure metals from experiment 2d were reduced to a thin lamina by rollers, and subjected to the action of pure nitric acid: the silver, together with the native alloy of the gold, were dissolved by the acid, which was tinged of a high brownish-red colour. The metals remaining undissolved, after being well washed with pure water, and ignited, weighed 22 carats $1\frac{1}{2}$ grain; and had every appearance of pure gold.

Exp. 4th. The metals remaining undissolved in the last experiment, were submitted to the action of nitro-muriatic acid. The whole was dissolved, except a small portion of silver that had escaped the action of the nitric acid: the solution was tested for platinum, by muriate of ammoniac and other reagents, without any indications of the presence of that metal. The gold was precipitated, and found to have been pure to $\frac{1}{384}$ part.

Exp. 5th. To the metallic solution from experiment 3d, I added some pure muriatic acid, until the silver was precipitated, and the acid was in considerable excess: there was no precipitation of the colouring matter of the solution, which still retained its red colour, and did not appear to have undergone any change by the precipitation of the silver.

By these preliminary experiments I discovered, that the alloy was a compound of gold, and a metal that would resist the cupel, and was soluble in the nitric and nitro-muriatic acids. I therefore adopted the following mode of analysis, as the easiest, and at the same time a satisfactory evidence of the existence of a metal possessing the properties of palladium; by which name I shall call it in future.

Process 1st. The whole ingot was combined with double its weight of fine silver, and cupeled with a quantity of lead, equal to the weight of the compound.

Pro. 2d. The cupeled metals were reduced to thin plates, and submitted to the action of boiling nitric acid, until the silver and palladium were dissolved. The solution, which was of a high brownish-red colour, was decanted, and the residual gold washed with pure water, which was added to the decanted solution.

Pro. 3d. Pure muriatic acid was added to the metallic solution of process 2d, until no further precipitation took place, and the acid was in excess. The silver being completely precipitated, the fluid, which retained its red colour, was decanted; and the precipitate washed with pure water: the washings were added to the decanted fluid, now holding nothing but palladium in solution.

Pro. 4th. A saturated solution of pure pot-ash (carbonate of pot-ash did not succeed so well, part of the palladium being held in solution by the carbonic acid) was added to the metallic solution from process 3d, until the whole of the palladium was thrown down in form of a floculent orange-coloured precipitate. The precipitate was collected on a filtre;—was well washed with pure water, and dried.

Pro. 5th. A portion of the precipitate from the last process was put into a crucible, without addition, and subjected to a heat of about 60° of Wedgewood; and thus, a metallic button of palladium was obtained.

Pro. 6th. Another portion of the precipitate from process 4th was combined with black flux, and submitted to a degree of heat equal to that excited in process 5th, and similar results were obtained.

Having thus obtained a metal, which I supposed to be palladium, from a source heretofore unknown; in order still farther to satisfy myself, I separated that metal from crude platinum, and subjected them both to a number of comparative experiments, with prussiate of mercury, recent muriate of tin, and other re-agents, without discovering the least shade of difference.

Palladium is of a greyish-white colour; so closely resembling that of platinum, that they cannot be distinguished by their complexion. It is malleable, and very ductile; so that by the rolling-mill it can be reduced into thin plates. In hardness it is nearly equal to wrought iron. Its specific gravity, at 64° Fahrenheit, is $11\frac{4}{99}$. It may be alloyed with a number of the metals. With gold, silver, and platinum, it forms ductile alloys, and very much debases the colour of the two former.

It would be useless here to go into a further detail of the characters and properties of palladium, as Dr. Wollaston and Mr. Chenevix have fully explained them, in the Philosophical Transactions of the Royal Society of London, for 1803-4 and 5. It is enough for me to have shown, I trust satisfactorily, that palladium has a real existence; that it is one of the pure or inoxidable metals; and, in this respect, on a par with gold, silver, and platinum; and that it has been found in a native combination with gold; without the presence of platinum, or any other metal.

Gold has never been found pure in nature; it has hitherto always been found alloyed with silver or copper; mostly a combination of both, and frequently other metals. The gold which was the subject of my experiments, appears to have been alloyed with palladium only; if any of the other known metals had been present, except silver and platinum, they would have been indicated by preliminary experiment 2d.—Silver would have been discovered by experiment 1st; and platinum by experiment 4th. It is self-evident, that this alloy was *native;* for no man would have been at the trouble and expense to purify the gold and separate the palladium from platinum, the only source from whence palladium had been heretofore obtained; and where it exists only (agreeably to Doctor Wollaston's experiments, confirmed by my own,) in the proportion of one half of one per cent., merely for the purpose of combining them with an intention of fraud; as none of the metals injures the colour of gold so much, and renders it so suspicious as palladium; and which would necessarily lead to a detection of the imposition. If fraud therefore had been intended, platinum would have answered the purpose much better; as it is not separated from gold by the usual process of assaying.

No. LXII.

Observations on the Geology of the United States, explanatory of a Geological Map. By William Maclure.

Read January 20th, 1809.

NECESSITY dictates the adoption of some system, so far as respects the classification and arrangement of names the Wernerian appears to be the most suitable, First, Because it is the most perfect and extensive in its general outlines, and secondly, The nature and relative situation of the minerals in the United States, whilst they are certainly the most extensive of any field yet examined, may perhaps be found to be the most correct elucidation of the general exactitude of that theory, as respects the relative position of the different series of rocks.

Without entering into any investigation of the origin or first formation of the various substances, the following nomenclature will be used.

Class 1st. Primitive Rocks.

1. Granite,
2. Gneiss,
3. Mica slate,
4. Clay slate,
5. Primitive Limestone,
6. Primitive Trap,
7. Serpentine,
8. Porphyry,
9. Sienite,
10. Topaz-Rock,
11. Quartz-Rock,
12. Primitive Flinty-Slate,
13. Primitive Gypsum,
14. White-Stone.

Class 2d. Transition Rocks.

1. Transition Limestone,
2. Transition Trap,
3. Grey Wacke.
4. Transition Flinty-Slate,
5. Transition Gypsum.

Class 3d. Flœtz or Secondary Rocks.

1. Old Red Sandstone or 1st Sandstone Formation,
2. First or Oldest Flœtz-Limestone,
3. First or Oldest Flœtz-Gypsum,
4. 2d or Variegated Sandstone,
5. 2d Flœtz-Gypsum,
6. 2d Flœtz-Limestone,
7. Third Flœtz-Sandstone,
8. Rock-Salt Formation,
9. Chalk Formation,
10. Flœtz-Trap Formation,
11. Independent Coal Formation,
12. Newest Flœtz-Trap Formation.

Class 4th. Alluvial Rocks.

1. Peat,
2. Sand and gravel,
3. Loam,
4. Bog iron ore,
5. Nagel fluh,
6. Calc-tuff,
7. Calc-sinter.

To the east of Hudson's river, the primitive class prevails, both in the mountains and the low lands, decreasing gradually as it proceeds south; it is bounded on the side of the ocean by the vast tracts of alluvial formation which skirt the great granite ridge, while it serves as a foundation to that immense superstructure of transition and secondary rocks, forming the great chain of mountains that occupy the interior of the continent to the westward.

The primitive to the eastward of Hudson's river constitutes the highest mountains, while the little transition and secondary that is found, occupies the low grounds. To the south of the Delaware, the primitive is the first rock, after the alluvial formation of the ocean, the lowest step of the stair, that mounts gradually through the different formations to the top of the Alleghanys.

To the eastward of the State of New-York, the stratification runs nearly north and south, and generally dips to the east, looking up to the White Hills, the most elevated ground; in New-York State, and to the southward and westward, the stratification runs nearly N. E. and S. W. and still dips generally to the east. All the rivers east of the Delaware, run nearly north and south, following the stratification, while the southern rivers incline to the S. E. and N. W. direction.

Throughout the greatest part of the eastern and northern States, the sea washes the foot of the primitive rock; commences the deposition of that extensive alluvial formation at Long-Island, increasing in breadth to the south, forming a great part of both the Carolinas and Georgia, and almost the whole of the two Floridas and Lower Louisiana. The coincidence of the Gulf-stream, with all its attendant eddies, depositions, &c. &c. rolling along this whole extent, from the Gulf of Mexico to Nantucket, may create speculative ideas on the origin of this vast alluvial formation, while the constant supply of caloric,* brought by that sweeping current from the tropics, may perhaps account for the sudden and great change in the temperature of the climate, within the reach of the Atlantic.

*About 100 miles S. E. of Nantucket, in the month of September, Fahrenheit's thermometer in the sea stood at 78°, while the air was only 66, and the sea in soundings 61.

The great distance occupied by the same, or similar substances, in the direction of the stratification, must strike the observer; as in the primitive rocks, the beds of primitive limestone and Dolomite (containing in some places crystallized felspar and tremolite) which are found alternating with Gneiss, for ten miles between Dover, State of New-York, and Kent, State of Connecticut, appear forty miles north, at Stockbridge, Connecticut, and eighty miles south, between Singsing and Kingsbridge, New-York; where, after crossing the Hudson river and dipping under the trap and sandstone formation in New-Jersey, they most probably re-appear in the marble quarries, distant from twelve to fourteen miles N. W. of Philadelphia,—a range of nearly 300 miles.

There is a bed of magnetic iron ore, from eight to twelve feet thick, wrought in Franconia, near the White Hills, New-Hampshire; a similar bed in the direction of the stratification, six miles N. E. of Phillipstown, on the Hudson river; and still following the direction of the stratification, the same ore occupies a bed of nearly the same thickness at Ringwood, Mount-Pleasant, and Suckasunny, in New-Jersey, losing itself as it approaches the end of the primitive ridge, near Blackwater,—a range of nearly 300 miles.

Instances of the same occur in the transition and secondary rocks; as the Blue ridge from the Hudson river to Dan river, consists of rocks of much the same nature, and included in the same formation.

That no volcanic productions have yet been found east of the Mississippi, is not the least of the many prominent features of distinction between the geology of this country and that of Europe, and may perhaps be the reason why the Wernerian system, so nearly accords with the general structure and stratification of this continent.

It is scarce necessary to observe, that the country must be considered of the nature of the *first* rock that is found in place, even should that rock be covered with thirty or forty feet of sand or gravel, on the banks of rivers, or in valleys; for example, the city of Philadelphia stands on primitive rock, though at the Centre-square, thirty or forty feet of sand and gravel must be penetrated, before the Gneiss rock, which ascertains the formation, is found.

Beginning at the bay of Penobscot (to the northward and eastward of which most probably the primitive descends through a gradual transition to the secondary, and thus into the Independent coal formation, found in such abundance in Nova Scotia;) and proceeding south, the sea coast is primitive to Boston, where the transition covers it as far as Rhode-Island.

ALLUVIAL FORMATION.

On the south east side of Long-Island the alluvial begins, occupying more than the half of that island; its western and northern boundaries are marked by a line passing near Amboy, Trenton, Philadelphia, Baltimore, Washington, Fredericksburg, Richmond, and Petersburg in Virginia, a little to the westward of Halifax, Smithfield, Aversborough and Parker's Ford on Pedee river, in North Carolina, west of Cambden near Columbia, Augusta on the Savannah river, Rocky Landing on the Oconee river, Fort Hawkins on the Oakmulgee river, Hawkinstown on Flint river, and running west, a little southerly, across the Chatahouchee, Alabama and Tombigby rivers, it joins the great alluvial bason of the Mississippi a little below the Natchez.

The ocean marks the eastern and southern limits of this extensive alluvial formation, above the level of which it rises considerably in the southern States, and falls to near the level of the sea, as it approaches the north.

Tide water in all the rivers from the Mississippi to the Roanoke stops at a distance from thirty to one hundred and twenty miles short of the western limits of the alluvial; from the Appomatox to the Delaware, the tide penetrates through the alluvial, and is only stopped by the primitive ridge.

The Hudson is the only river in the United States where the tide passes through the alluvial, primitive, transition, and into the secondary, in all the northern and eastern rivers, the tide runs a small distance into the primitive formation.

Through the whole of this alluvial formation, considerable deposits of shells are found; and a bank of shell limestone beginning in North Carolina, and running parallel to, and within the distance of from twenty to thirty miles of the edge of the primitive through South Carolina, Georgia, and part of the Mississippi Territory; in some places this bank is soft, with a large proportion of clay, in others, hard, with a sufficiency of the calcareous matter to be burned for lime, large fields of the same formation are found near cape Florida, and extending some distance along the coast of the bay of Mexico; in some situations, the calcareous matter of the shells has been washed away, and a deposit of silicious flint has taken their place, forming a porous flinty rock, which is used with advantage for mill-stones.

Considerable deposits of bog iron ore. occupying the lower situations, and many of the more elevated and dividing ridges between the rivers are crowned with a sandstone and puddingstone, the cement of which is bog iron ore.

Quantities of ochre, from bright yellow to dark brown are found in abundance in this formation, in flat horizontal beds alternating with other earths in some places; in others in kidney form masses from the size of an egg to that of a man's head, in form resembling much the flint found frequently in chalk formations.

PRIMITIVE FORMATION.

The south east limit of the great primitive formation is covered by the north western boundary of the alluvial formation from the Alabama river in the Mississippi Territory, (near which it is succeeded by the transition and secondary formations) to the east end of Long-Island, with two small exceptions; the first near Augusta on the Savannah river, and near Cambden in South Carolina, where a stratum of transition clay-slate intervenes, and from Trenton to Amboy, where the oldest sandstone formation covers the primitive along the edge of the alluvial.

From Rhode-Island (the greatest part of which is transition rock) to Boston, the primitive touches a transition formation, which most probably extends to the eastward, until it meets the alluvial along the sea coast by Elizabeth island, cape Cod

&c. &c. the eastern edge of the primitive from Boston to the bay of Penobscot is bounded by the ocean.

The north western boundary of this extensive range is marked by a line running to the eastward of lake Champlain, twenty or thirty miles westward of Connecticut river, to the westward of Stockbridge, twelve miles east of Poukepsy, skirting the high lands, then crossing the Hudson river at Philipstown, by Sparta about ten or fifteen miles east of Eastown, on the Delaware, three miles east of Reading on the Schuylkill, and a little west of Middletown on the Susquehannah, where it joins the blue ridge, and continues along it to Magotty Gap; from thence to four miles east of the lead mines at Austinville, and following a south western direction, by the stoney and iron mountains, six miles S. E. of the warm springs in Buncomb county, North Carolina, to the eastward of Hightown on the Cousee river, and a little to the westward of the Talapousee river, it meets the alluvial near the Alabama river, which runs into the bay of Mexico at Mobile.

In general the strata of this primitive rock run from a north and south to a north east and south west direction, and dip almost universally to the south east at an angle of more than 45 degrees from the horizon; the highest elevation is towards the north western limits, which gradually descends to the south east where it is covered by the alluvial, and the greatest mass, as well as the highest mountains, are found towards the northern and southern extremities of the north western boundaries.

The outline of the mountains of this formation is generally circular waving, in detached masses, with rounded flat tops, as the white hills to the north, or conically waving in small pyramidal tops, as the peaks of Otter, and the ranges of hills to the south; (has the climate any agency in the forms of the northern and southern mountains?) their height does not appear to exceed six thousand feet above the level of the sea, except perhaps the white hills, it is even probable that those mountains are not much higher.

Within the limits prescribed to this primitive formation, there is a range of secondary, extending with some intervals from the Connecticut to the Rappahannock rivers, in width generally from fifteen to twenty five miles, bounded on the north east from Connecticut river to New-Haven, by the sea, where it ends, to recommence on the south side of Hudson river; from Elizabeth town to Trenton, it touches the alluvial. From a little above Morrisville on the Delaware to Norristown, Maytown on the Susquehannah, passing three miles west of York, Hanover, and one mile west of Fredericktown, it is bounded by, or rather appears to cover a tongue of transition, which occupies progressively a diminishing width as far south as Dan river.

This secondary formation is interrupted after it passes Fredericktown, but begins again between Monocasy and Seneca creeks, the north eastern boundary crossing the Potomac, by the west of Centerville, touches the primitive near the Rappahannock, where it finishes. On the north west side it is bounded by the primitive, from some distance to the westward of Hartford, passing near Woodbury, and recommencing south of the Hudson, passing by Morristown, Germantown, &c. to the Delaware; after which it continues along the transition, by the east side of Reading, Grub's mines, Middletown, Fairfield, to near the Potomac, and recommencing at Noland's ferry, runs along the edge of the transition to the westward of Leesburg, Haymarket &c. to near the Rappahannock.

All this secondary appears to be the oldest red sandstone formation, though in some places about Leesburg, Reading &c. the red sandstone only serves as cement to a pudding, formed of limestone of transition, and other transition rock pebbles, with some quartz pebbles. Large beds of greenstone trap and wacke of different kinds, cover in many places this sandstone formation, and form the small hills, or long ridges which occur so frequently in it.

The stratification in most places runs from an east and west to a north east and south west course, and dips generally to the N. W. at an angle most frequently under 45 degrees from the horizon, covering both the primitive and transition formations, at every place where their junction could be examined; and in some places, such as the east side of the Hudson (where the action of the water had worn away the sandstone) the smooth water-worn primitive was covered with large rolled masses of greenstone trap to a considerable distance, the hardness and solidity of which had most probably survived the destruction of their sandstone foundation; may not similar derangements be one of the causes of the broken and unconnected state of this formation?

Prehnite and zeolite are found in the trap of this formation; considerable *deposits* of *magnetic iron ore* at Grubb's mines are enveloped, and have their circular layers intersected by greenstone trap, on a ridge of which this extensive cluster of iron ore appears to be placed.

Grey copper ore has been found in the red sandstone formation near Hartford and Washington in Connecticut; at Scheuyler's mines in Jersey, *copper pyrites* and *native copper* have been found. The metallic veins on Perkiomen creek, containing *copper pyrites, blende,* and *galena,* are in the same formation; running nearly north and south, across the east and west direction of the red sandstone; a small bed from an half to three inches thick of *brown* or *tile copper ore* is interspersed and follows the circular form of the iron beds at Grubb's mines.

Besides the sandstone formation, there is included within the described limits of the primitive, a bed of transition rocks, running nearly S. W. from the Delaware, to the Yadkin river, dipping generally to the south east 45 degrees or more from the horizon; its width is from two to fifteen miles, and runs from the west of Morrisville, to the east of Norristown, passes Lancaster, York, Hanover, Fredericktown, Bull run mountain, Milton, foot of Pig river, Martinsville, and finishes near Mount Pilot, between the Delaware and Rappahannock; it is partially covered by the red sandstone formation, and is in the shape of a long wedge, the thick end, touching the Delaware, and the sharp end, terminating at the Yadkin.

This range consists of beds of blue, grey, red and white small grained transition limestone, alternating with beds of *grey wacke* and *grey wacke-slate;* with granular quartzose rocks, and a great variety of transition rocks, not described or named in any treatise yet published; much of this limestone is intimately mixed with *grey wacke-slate,* other portions of it contain so great a quantity of small grained sand, as to resemble *Dolomite,* and perhaps might with propriety be called the *transition Dolomite*, in many places veins and irregular masses of silex, variously coloured (mostly black) run through it, and considerable beds of fine grained white marble, fit for the statuary, occur.

Limestone spar runs in veins and detached masses, through the whole of this formation, both it, and the *grey wacke-slate* contain quantities of *cubic pyrites;* galena has likewise been found near Lancaster, and many veins of the *sulphate* of *barytes* traverse this formation, which runs about 25 to 30 miles south east, and nearly parallel to the great transition formation. A similar formation, about fifteen miles long, and two to three miles wide, occurs on the north fork of the Catabaw river, running along Linville and John's mountains, near to the Blue ridge; a bed of transition rock, commencing on Green pond mountain, Jersey, runs through Suckasunny plains, increasing in width as the primitive range decreases, until it joins the great transition formation between Easton and Reading.— On the west side of this partial transition formation, from the Potomac to the Cataba, between it and the great western transition range, a series of primitive rocks intervenes, something different from the common primitive, having the structure of *gneiss;* with little *mica*, the scales of which are detached and not contiguous; much *felspar*, rather granular than crystallized; *mica-slate*, with small quantities of *scaly mica;* clay-slate, rather soft and without lustre, the whole having a dull earthy fracture, and gritty texture, partaking of transition and primitive, but not properly belonging to either; this rock is always found on the edge of the primitive, before you come upon the transition, but no where in such quantities as in this range; there are many varieties of it, so that it imitates almost every species of the common primitive rocks, but differing from them, by having a dull earthy fracture, gritty texture, and little or no crystallization.

About ten or twelve miles west of Richmond, in Virginia, there is an *independent coal formation*, twenty to twenty five miles long, and about ten miles wide, it appears to be not far distant from the range of the red sandstone formation, it is situated in an oblong bason accompanied by whitish *freestone, slaty clay*, &c.

with *vegetable impressions*, as well as most of the other attendants of that formation; this bason lays upon, and is surrounded by primitive rocks. It is more than probable that within the limits of so large a mass of primitive, more partial formations of secondary rocks may be found.

A great variety of mineral substances is found in this primitive formation, such as *garnets* in the *granite*, from the size of a pin head to the head of a child; *staurotide; andalusite; epidote* in great abundance; *tremolite;* all the varieties of *magnesian rocks; emerald*, touching *graphic granite* and disseminated in the *granite* of a large extent of country; *adularia; tourmaline; hornblende; sulphate* of *barytes; arragonite* &c.

From the number already found, in proportion to the little research that has as yet been employed, there is every reason to suppose, that in so great an extent of crystalline formation, almost every mineral which has been discovered in similar situations on the ancient continents, will be found on this.

The metallic substances which are found in this primitive, are generally extensive like the formation. *Iron pyrites* run through vast fields, principally of *gneiss*, and *mica-slate; magnetic iron ore* forms vast beds, from ten to twelve feet thick, generally in a *hornblende* rock, occupying the higher elevations, as at Franconia, high lands of New-York; the Jerseys; Yellow and Iron mountain, in the west of North Carolina, &c. &c. Black, brown, and red *hematitic iron ores* are found in Connecticut and New-York, &c. *Crystals* of *octahedral iron ore* are disseminated in *granite* (some of which have polarity, as at Brunswick) and in many varieties of the *magnesian genus; black lead* exists in beds from six to twelve feet wide, traversing the States of New-York, Jersey, Virginia, Carolina, &c. *Native* and *grey copper ore* occur near Stanardsville and Nicholson's Gap, disseminated in a *hornblende* and *epidote rock*, bordering on the transition; *molybdena* is found at Brunswick, Maine; Chester, Pennsylvania; Virginia; North Carolina, &c. *Arsenical pyrites* have been discovered in large quantities in the district of Maine; *rutile*, and *menachanite* exist in a large bed, on the edge of the primitive near Sparta, in Jersey, having a large grained marble, with *menachanite* and *negrine* imbeded in it on one side, and *hornblende* rock on the other; this bed contains likewise large quantities of *blende; detached* pieces of *gold* have been found in the beds of some small streams in North Carolina and other places, apparently in a *quartz* rock. *Manganese* has been found in New-York, North Carolina, &c. Near the confines of the red sandstone and primitive formations, a *white ore* of *Cobalt* has been worked above Middletown on the Connecticut river, and it is said near Morristown in New-Jersey.

The general nature of metallic repositories in this formation appears to be in beds, disseminated or lying in masses; when in beds (as the *magnetic iron ore,* and *black lead)* or disseminated as the *iron pyrites, octahedral iron ore, Molybdena,* &c. they occur at intervals through the whole range of the formation; veins to any great extent have not yet been found in this formation.

TRANSITION FORMATION.

This extensive field of transition rocks, is limited on the S. E. side from a little to the eastward of lake Champlain, to near the river Alabama, by the N. W boundary prescribed to the primitive rocks; on the N. W. side it touches the S. E. edge of the great secondary formations, in a line, that passes considerably to the westward of the dividing ridge, in Georgia, North Carolina, and part of Virginia, and runs near it in the northern parts of that State, and to the eastward of it in the States of Pennsylvania and New-York.

This line of demarkation runs between the Alabama and Tombigby rivers, to the westward of the north fork of the Holstein river, until it joins the Alleghany mountains near the sulphur springs, along that dividing ridge to Bedford county in Pennsylvania, and from thence N. E. to the east side of the Catskill mountains on Hudson's river. This line of separation of the transition and secondary formations, is not so regularly and distinctly traced as in the other formations, many large valleys are formed of horizontal secondary limestone, full of shells, while the ridges on each side consist of transition rocks, &c. the two formations interlock, and are mixed in many places, so as to require much time and attention to reduce them to their regular and proper limits. It is however probable, that to the N. W. of the line here described, little or no transition will be found, although to the S. E. of it, partial formations of secondary may occur.

The breadth of this transition formation is generally from 20 to 40 miles, and the stratification runs from a north and south to a north east and south west direction, dipping generally to the N. W. at an angle in most places, under 45 degrees from the horizon. On the edge of the primitive; it, in some places, deviates from this general rule, and dips for a short distance to the south east. The most elevated ground is on the confines of North Carolina, and Georgia, along the S. E. limits to Maggotty Gap, descending towards the N. W. until it meets the secondary; from Maggotty Gap, north easterly, the highest ground is on the north west side, sloping gradually towards the primitive, which ranges along its south east boundary.

The outline of the mountains of this formation, is almost a straight line, with few interruptions, bounding long parallel ridges of nearly the same height, declining gently towards the side, where the stratification dips from the horizon, and more precipitous on the opposite side, where the edge of the strata comes to the surface.

This formation is composed of a small-grained transition limestone, of all the shades of colour from white to dark blue, and in some places it is red, intimately mixed with grains of *grey wacke slate*, also of *lime spar* in veins, and disseminated; *siliceous flinty* veins and irregular masses, in many places there is an intimate mixture of small sand, so as to put on the appearance of *dolomite*, this is in beds from 50 to 5000 feet in width; it alternates with *grey wacke*, and *grey wacke slate*, a siliceous aggregate, having particles of a light blue colour, from the size of a pin head to that of an egg, disseminated, in some places in a cement of a slaty texture, and in others in a quartz cement; a fine sandstone cemented with quartz in large masses, often of a slaty structure, with small detached scales of *mica* intervening, and a great variety of other rocks, not described or named by any author, which from their composition and situation cannot be classed but with the transition.

The limestone, *grey wacke*, and *grey wacke slate*, generally occupy the vallies; the quartzose aggregates, the ridges; amongst which is that called the *millstone grit;* this must not be confounded with another rock, likewise denominated the *millstone grit*, which is a *small grained granite*, with much quartz, found in the primitive formation; there are many and extensive caves in the limestone of this formation, where the bones of many animals are found, as well as the remains of marine insects and shells.

Beds of *coal-blende*, accompanied by *alum slate* and *black chalk*, have been discovered in this formation on Rhode Island; the Leheigh and Susquehannah rivers; (a large body of *alum slate* which occurs on Jackson's river in Virginia is perhaps only a part of a similar formation;) *powerful* veins of the *sulphate* of *barytes* cross it, in many places it is granular, as that near Fincastle; or slaty, as in Buncomb county, North Carolina.

Iron and *lead* have as yet been the principal metals found in this formation; the *lead* in the form of *galena*, in clusters, or what the Germans call *stock-werck*, as at the lead mines on New river, Wythe county, Virginia; the *iron* is disseminated in the form of pyrites; hematitic and *magnetic iron ores*, and considerable quantities of the *sparry iron ore* occur in beds and they are likewise disseminated in the limestone.

SECONDARY FORMATION.

The south east limit of this extensive formation is bounded by the irregular border of the transition, from between the Alabama and Tombigby rivers, to the Catskill mountains. On the north west side it follows the shore of the great lakes, and loses itself in the alluvial of the great bason of the Mississippi, occupying a surface from 200 to 500 miles in breadth.

Its greatest elevation is on the south east boundary, from which it falls down, almost imperceptibly, to the north west and mingles with the alluvial of the Mississippi, having an outline of mountain, straight and regular, bounding long and parallel ranges of a gradually diminishing height as they approach the N. W. limits. An almost horizontal stratification, or the strata waving with the inequalities of the surface, distinguishes this from the two preceding formations.

Immense beds of secondary limestone, of all the shades from light blue to black, intercepted in some places by extensive tracts of sandstone and other secondary aggregates, appear to constitute the foundation of this formation, on which reposes that great and valuable formation, called by Werner the *independent coal formation,* extending from the head waters of the Ohio, with some interruptions, all the way to the waters of the Tombigby, accompanied by its several usual attendants, *slaty clay* and *freestone* with vegetable impressions &c. but *in no instance* that I have seen or heard of, is it *covered* or does it *alternate* with any rock resembling *basalt,* or indeed any of those called the newest *flœtz trap formation.*

Along the S. E. boundary, not far from the transition, a *rock-salt* and *gypsum* formation has been found; on the north fork of Holstein not far from Abington, and on the same line south west from that in Green county and Pidgeon river, State of Tennessee, it is said considerable quantities of *gypsum* have been discovered; from which, and the numerous salt licks and salt springs which are found in the same range, as far north as lake Oneida, it is probable, that this formation is on the same great scale, which is common to all the other formations on this continent: at least rational analogy supports the supposition, and we may hope one day to find, in abundance, those two most useful substances, which are generally found mixed or near each other in all countries that have been carefully examined.

The metallic substances which have been already found in this formation, are *iron pyrites,* disseminated, both in the coal and limestone; *iron ores,* consisting principally of *brown, sparry* and *clay iron stone,* in beds; *galena,* whether in veins or beds is not ascertained. The large deposits of *galena* at St. Louis on the Mississippi, have been described as detached pieces, found covered by the alluvial of the river, of course not in place; all the large specimens which I have seen, were rolled masses, this rather confirms the opinion, that they were not found in their original places.

On the great Kanawa river, near the mouth of Elk river, there is a large mass of black (I suppose vegetable) earth, so soft, as to be penetrated by a pole from 10 to 15 feet deep; out of the hole thus made, a stream of *hydrogene gas* frequently issues, which will burn for some time. In the vicinity of this place there are *constant streams* of that *gas*, which it is said when once lighted will burn for weeks, a careful examination of this place, would probably throw some light on the formation of coal and other combustible substances, found in great abundance in this formation.

From near Kingston on lake Ontario, to some distance below Quebec (as far as I can recollect, not having my note-book here) it is principally primitive; and from all the information I could collect, that great mass of continent, lying to the north of the 46th degree of latitude, for a considerable distance to the west, consists mostly of the same formation; from which it is probable, that on this continent, as well as in Europe and Asia, the northern regions are principally occupied by the primitive formation.

The foregoing observations are the result of many former excursions in the United States, and a knowledge lately acquired by crossing the dividing line of the principal formations, in 15 or 20 different places, from the Hudson to Flint river; as well as from the information of intelligent men, whose situation and experience, make the nature of the place near which they live familiar to them; nor has the information that could be acquired from specimens, when the locality was accurately marked, been neglected, nor the remarks of judicious travellers.

Notwithstanding the various sources of information, much of the accuracy of the outlines of separation between the formations, must depend on rational analogy; for instance, between Maggotty and Rockfish Gaps, a distance of upwards of sixty miles, I found in six different places which were examined, that the summit of the blue ridge divided the primitive and transition formations: I of course concluded, that in places where I had not examined (or which from their nature could not be examined) the blue ridge from Maggotty Gap to Rockfish Gap, was the boundary of the two formations.

The map of the United States on which those divisions are delineated, though I believe the best yet published, is exceedingly defective in the situation and range of mountains, courses and windings of rivers &c. but as the specimens which I collected every half mile, as well as the boundaries of the different formations, are from the positive situations of the different places, the relative arrangement of the map cannot change them, but must become more exact, as the geographical part is made more accurate.

In adopting the nomenclature of Werner, I do not mean to enter into the origin or first creation of the different substances, or into the nature and properties of the agents which may have subsequently modified or changed the appearance and form of those substances; I am equally ignorant of the relative periods of time in which those modifications or changes may have taken place; such speculations are beyond my range, and pass the limits of my inquiries. All that I mean by a formation, is a mass of substances (whether adhesive, as rocks; or separate, as sand and gravel;) uniform and similar in their structure and relative position, occupying extensive ranges, with few or no interpolations of the rocks belonging to another series, class, or formation; and even where such partial mixtures apparently take place, a careful examination will seldom fail to explain the phenomenon without shaking the general principle, or making it a serious exception to the rule.

In the account of the metals and minerals, it is not intended to give a list of the number, extent and riches of the metallic and mineral repositories; the nature of the ore or mineral, with a description of its relative position, in regard to the surrounding substances, is the principal object of geology, which cannot be understood by microscopic investigation, or the minute analysis of isolated rocks and detached masses; this would be like the portrait painter dwelling on the accidental pimple of a fine face: the geologist must endeavour to seize the great and prominent outlines of nature; he should acquaint himself with her general laws, rather than study her accidental deviations, or magnify the number and extent of the supposed exceptions, which most frequently cease to be so when judiciously examined.

Should this hasty and imperfect sketch, call forth the attention of those possessed of more talents and industry for the accurate investigation of this interesting subject, the views of the writer will be fully accomplished.

No. LXIII.

Astronomical Observations made at the Havanna by J. J. de Ferrer, and communicated by him to the Society.

Latitude of the Havanna. . . . . . 23° 08′ 24″ N.

1809. *April 3d, Emersion of Saturn from the* ☾.

	Apparent time. h ′ ″		
Emersion of the ring of Saturn.	11 22 44,5	very exact	From the obscure limb ☾
Exterior contact or total emersion of the planet.	11 23 49,0	Idem.	
Total emersion of the ring.	11 24 19,0	Idem.	
April 29. Eclipse ☾			
Emersion of Tycho, beginning. . . .	8 14 15		
end.	8 14 59		
End of the Eclipse.	8 35 25		
April 29, Occultation of 1a, and 2a ♎ ☾.			
Immersion 1a ♎ illuminated limb. . . .	11 06 25,8	Observations very exact.	
Immersion 2a ♎ illuminated limb. . .	11 13 21,0		
Emersion 2a ♎ obscure limb.	12 31 51,8		
June 23 Occultation of 1a ♎ and 2a ♎ ☾.			
Immersion, obscure limb 1a ♎.	7 42 40,8	very exact.	
Immersion, obscure limb 2a ♎.	7 51 52,8	very exact.	
Emersion, illuminated limb, 2a ♎. . .	9 18 32,0	may be 6″ less on acct. of a (cloud.	
June 28. Occultation of β Capricorn ☾.			
Immersion, illuminated limb, ☾. . . .	15 41 20,4	very exact.	
Emersion, obscure limb, ☾.	16 54 53,5	very exact.	

The times mentioned are apparent.—Magnifying power of the Telescope 100—The accuracy of the above observations may be depended on.

☞ *A model and description of a machine for steering a vessel of any burden, with ease and perfect safety to the steersman, has been laid before the Society, for which an Extra Magellanic-premium of a gold medal of the value of twenty dollars was awarded by the Society to the inventor, Mr. James Humphreys of Philadelphia. But the communication, which cannot be well understood without a plate, came too late to be conveniently inserted in the present volume. It shall, however, appear in the next.*

END OF VOL. VI.

GENERAL INDEX.

TO THE FIFTH AND SIXTH VOLUMES.

☞The Roman numerals signify the volume, and the figures, the page.

A.

B

C

E

G

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I

K

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M.

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