TRANSACTIONS

OF THE

AMERICAN

PHILOSOPHICAL SOCIETY,

HELD AT

PHILADELPHIA,

FOR PROMOTING

USEFUL KNOWLEDGE.

VOLUME V.

PHILADELPHIA:

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FOR THOMAS DOBSON, AT THE STONE-HOUSE,
Nº 41, SOUTH SECOND-STREET.

1802.

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 prefs, fhould always be the import- "ance or fingularity of the fubjects, or the advantageous "manner of treating them, without pretending to an- "fwer, or to make the fociety anfwerable, for the cer- "tainty of the facts, or propriety of the reafonings, "contained in the feveral papers fo publifhed, which "muft ftill reft on the credit or judgment of their refpec- "tive authors.

Secondly, "That neither the Society, nor the "Committee of the prefs, do ever give their opinion as "a body, upon any paper they may publifh, or upon "any fubject of Art or Nature that comes before "them."

At a ſtated meeting of the Society, held at their Hall, December 19th, 1800, *the following Premiums were propoſed :*

I.

For the moſt ſimple, convenient, and effectual method of ventilating a ſhip at ſea, without manual labour; if ſuperior to any now in uſe, a premium of *one hundred dollars*.

Memoirs to be delivered by the firſt of April, 1802.

II.

For the cheapeſt and moſt effectual method of rendering common oil fit to be burned in the Argand lamp, either by purifying the oil, or by an improvement in the lamp: a premium of *thirty-five dollars.*

Memoirs to be delivered by the firſt of April, 1802.

III.

For any ſimple and effectual method of rendering turpentine, or any other cheap inflammable ſubſtance, a fit fuel for ſtreet or houſe lamps, or a proper material for candles: a premium of *forty dollars.*

Memoirs to be delivered by the firſt of April, 1802.

IV.

For the beſt experimental eſſay on the native red dies of the United States, accompanied with ſmall ſpecimens of the died ſtuffs: a premium of *one hundred and fifty dollars.*

Memoirs to be delivered by the firſt of January, 1804.

General Conditions for the above Premiums:

1. Every candidate, along with his performance, is to ſend to the ſociety a ſealed letter, containing his name and place

place of abode; which letter ſhall never be opened by the ſociety, except in the caſe of a ſucceſsful candidate.

2. No performance, invention or improvement, on any of the ſubjects propoſed, for which a patent or any other reward ſhall have been obtained, before preſenting it to the ſociety, ſhall be conſidered as entitled to the premium.

3. In lieu of the money which ſhall be awarded by the ſociety, as a premium, any ſucceſsful candidate ſhall have it in his option to receive a gold or ſilver medal, or piece of plate, with a ſuitable inſcription of equal value.

4. The ſociety reſerve to themſelves the power of giving, in all caſes, ſuch part only of any premium propoſed, as the performance ſhall be adjudged to deſerve; or of withholding the whole, if it ſhall appear to have no merit above what may have been already publiſhed on the ſubject. The candidates may, however, be aſſured, that the ſociety will always judge liberally of their ſeveral claims.

MR. I. H. DE MAGELLAN, OF LONDON,

Having made a donation, to the ſociety, of *two hundred guineas*, to be veſted in a permanent fund; that the intereſt ariſing therefrom may be diſpoſed of, in annual premiums, to the authors of the beſt diſcoveries or moſt uſeful improvements, relating to Navigation, or to Natural Philoſophy, mere Natural Hiſtory only excepted;—the following are the rules and conditions, adopted by the ſociety, for the diſpoſition of the propoſed premiums, in conformity to the intention of the Donor, viz.

I. The candidate ſhall ſend his diſcovery, invention or improvement, addreſſed to the Preſident or one of the Vice-Preſidents of the ſociety, free of poſtage or other charges; and ſhall diſtinguiſh his performance by ſome motto,

motto, device or other ſignature, at his pleaſure. Together with his diſcovery, invention or improvement, he ſhall alſo ſend a ſealed letter, containing the ſame motto, device or ſignature, and ſubſcribed with the real name and place of reſidence of the author.

II. Perſons of any nation, ſect, or denomination whatever, ſhall be admitted as candidates for this premium.

III. No diſcovery, invention or improvement ſhall be entitled to this premium, which hath been already publiſhed, or for which the author hath been publicly rewarded elſewhere.

IV. The candidate ſhall communicate his diſcovery, invention or improvement, either in the Engliſh, French, German, or Latin language.

V. All ſuch communications ſhall be publicly read or exhibited to the ſociety, at ſome ſtated meeting, not leſs than one month previous to the day of adjudication; and ſhall at all times be open to the inſpection of ſuch members as ſhall deſire it. But no member ſhall carry home with him the communication, deſcription or model, except the officer to whom it ſhall be entruſted: nor ſhall ſuch officer part with the ſame out of his cuſtody, without a ſpecial order of the ſociety for that purpoſe.

VI. The ſociety having previouſly referred the ſeveral communications, from candidates for the premium then depending, to the conſideration of the twelve counſellors and other officers of the Society, and having received 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,

cations, 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.

VII. 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.

VIII. 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.

IX. 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.

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

XI.

XI. In cafe there fhould be a failure, in any year, of any communication worthy of the propofed premium, there will then be two premiums to be awarded in the next year. But no accumulation of premiums fhall entitle an author to more than one premium for any one difcovery, invention or improvement.

XII. The premium fhall confift of an oval plate of folid ftandard gold, of the value of *Ten Guineas.* On one fide thereof fhall be neatly engraved a fhort Latin motto fuited to the occafion——together with thefe words, *The premium of* I. H. De Magellan, *of London, eftablifhed in the year* 1786. And on the other fide of the plate fhall be engraved thefe words, *Awarded by the A. P. S. to*——— ——— for his difcovery of ——— ——— *A. D.*——— *Prefident.* And the feal of the Society fhall be annexed to the faid golden plate, by a ribbon paffing through a fmall hole near the lower edge thereof.

The

The Society having appointed a Committee to collect information respecting the past and present state of this country, the Committee during the last year addressed the following letter to such persons as were likely, in their opinion, to advance the object of the Society.

[CIRCULAR.]

PHILOSOPHICAL HALL, PHILADELPHIA.

SIR,

THE American Philosophical Society have always considered the antiquity, changes, and present state of their own country as primary objects of their research; and with a view to facilitate such discoveries, a permanent committee has been established, among whose duties the following have been recommended as requiring particular attention.

1. To procure one or more entire skeletons of the Mammoth, so called, and of such other unknown animals as either have been, or hereafter may be discovered in America.

2. To obtain accurate plans, drawings and descriptions of whatever is interesting, (where the originals cannot be had) and especially of ancient Fortifications, Tumuli, and other Indian works of art: ascertaining the materials composing them, their contents, the purposes for which they were probably designed, &c.

3. To invite researches into the Natural History of the Earth, the changes it has undergone as to Mountains, Lakes, Rivers, Prairies, &c.

4. To inquire into the Cuſtoms, Manners, Languages and Character of the Indian nations, ancient and modern, and their migrations.

The importance of theſe objects will be acknowledged by every Lover of Science, and, we truſt, ſufficiently apologize for thus troubling you: for without the aid of gentlemen who have taſte and opportunity for ſuch reſearches, our means would be very confined. We therefore ſolicit your communications, now or in future, on theſe ſubjects; which will be at all times thankfully received, and duly noticed in the publications of the Society.

As to the firſt object, the committee ſuggeſt to Gentlemen who may be in the way of inquiries of that kind, that the Great Bone Lick on the Ohio, and other places where there may be mineral ſalt, are the moſt eligible ſpots for the purpoſe; becauſe animals are known to reſort to ſuch places.

With reſpect to the ſecond head, the committee are deſirous that cuts in various directions may be made into many of the Tumuli, to aſcertain their contents; while the diameter of the largeſt tree growing thereon, the number of its annulars and the ſpecies of the tree, may tend to give ſome idea of their antiquity. If the works ſhould be found to be of Maſonry; the length, breadth, and height of the walls ought to be carefully meaſured, the form and nature of the ſtones deſcribed, and ſpecimens of both the cement and ſtones ſent to the committee.

The beſt methods of obtaining information on the other ſubjects will naturally ſuggeſt themſelves to you; and we rely on a diſpoſition favourable to our wiſhes.

The

The Committee consist of the following Gentlemen, viz.

THOMAS JEFFERSON, President of the American Philosophical Society, at Monticello in Virginia.

JAMES WILKINSON, Commander of the Army at Head Quarters.

Dr. CASPAR WISTAR, Vice President of the A. P. S.
Dr. ADAM SEYBERT, Secretary of do.
C. W. PEALE, and
JON. WILLIAMS.
} in Philadel.

Your communications may be addressed to any one of the Committee, but the articles you may think proper to furnish should be sent to this place.

In behalf of the Committee,

I am respectfully,

Sir, your obedient servant,

——— ——— Chairman.

To ——— ———

LIST OF THE OFFICERS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

For the Year 1801.

PATRON. Thomas M'Kean, Esquire, Governor of the Commonwealth of Pennsylvania.

PRESIDENT. Thomas Jefferson, Esquire.

VICE-PRESIDENTS. Caspar Wistar, Robert Patterson, Andrew Ellicott.

SECRETARIES. John Redman Coxe, Adam Seybert, Joseph Clay, Burgiss Allison.

COUNSELLORS for three Years. Jonathan B. Smith, William Currie, Samuel Wheeler, Peter Stephen Duponceau.

CURATORS. Charles Wilson Peale, Robert Leslie, John R. Smith.

TREASURER. John Vaughan.

LIST

LIST of the MEMBERS of the AMERICAN PHILOSOPHICAL SOCIETY, elected ſince January 1799.

AMERICAN MEMBERS.

WILLIAM BOYS, A. M. Philadelphia.
John Redman Coxe, M. D. do.
Thomas Peters Smith, do.
Joſeph Clay, do.
B. Henry Latrobe, Engineer, do.
William Maclure, do.
Samuel Elam, Newport, R. I.
John R. Smith, Philadelphia.
Juſtus Erick Bollman, do.
W. Dunbar, of the Miſſiſſippi Territory.
Samuel Brown, Kentuckey.
Samuel Miller, A. M. New-York.
Robert R. Livingſton, do.
Thomas T. Hewſon, Philadelphia.

FOREIGN MEMBERS.

Robert Liſton, Eſq. his Britannic Majeſty's Envoy Extraordinary and Miniſter Plenipotentiary, near the United States.

M. Dupont de Nemours, late of France, now reſiding in the United States.

Samuel Fhalberg, Phyſician to the Swediſh Government at St. Bartholomews.

Guſtavus Paykul, of Sweden.

Alexander Remerez, firſt Secretary of the Junta at Guatimala.

Francis Blanchet, of Quebec.

William Jones, Mathematical Inſtrument maker, London.

Don Joſeph Joaquin de Ferrer, of Cadiz.

Don Franciſco Peyrolon, Secretary of the Real Sociedad de Amigos del Païs de Valencia.

PRESENTS

PRESENTS

RECEIVED BY THE

American Philoſophical Society,

Since the Publication of their 4th Vol. of Tranſactions,

WITH THE

NAMES OF THE DONORS.

1798. DONORS.	PRESENTS.
Dec. 7. General *James Wilkinſon.*	Various bones of the Mammoth, chiefly of the limbs.
Mr. *Thomas Paſſmore.*	A very fine ſpecimen of Talk, from the back part of New Hampſhire.
1799. March 1. Author,	The Columbian Alphabet, by James Ewing.
April 5. Author,	Facts relative to Natural Hiſtory, by James Edward Smith, M. D.
May 17. Dr. *A. Fothergill*, of Bath.	Rules, Orders and Premiums of the Bath and Weſt of England Society.
Author,	Preſervative plan, or hints for the preſervation of perſons expoſed to thoſe accidents, which ſuddenly

1799. Donors.	Presents.
	ly ſuſpend or extinguiſh vital action, by A. Fothergill, M. D.
May 17. Author,	Plans of the Eclipſes of the Sun and Moon, which are to happen reſpectively, in the years 1805 and 1806, by William Lambert, of Virginia.
Author,	Obſervations on Viſion, by David Hoſack, M. D.
June 21. Author,	Fragments of the Natural Hiſtory of Pennſylvania, by Benjamin Smith Barton.
Author,	An Eſſay on the beſt ſyſtem of Liberal Education, by Samuel Knox, A. M. of Maryland.
Nov. 15, Author,	Lettre—Politico—Theologico—Morale ſur les Juifs par D. Naſs-az, M. D.
John Vaughan, Eſquire.	Nautical Almanac for 1774.
do.	Diſſertation ſur les Thermometres, par J. H. Van Swinden.
do.	Obſervations ſur le Froid Rigoſeux du Mosde Janvier

1799. DONORS.	PRESENTS.
	vier 1776, par S. H. Van Swinden.
Author,	Fifty copies of "Thermometrical Navigation," by Jonathan Williams, to be diſtributed, under directions of the Society.
Dec. 6. *Jonathan Williams*,	A large marine excreſcence.
Author,	Nine numbers of "Recreations in Natural Hiſtory Arts and Miſcellaneous literature," by Dr. James Anderſon, with a promiſe of the ſucceeding numbers.
1800.	
Feb. 21. *Samuel Elam*, Eſq. of New-port, Rhode Iſland,	Five hundred dollars.
March 21. Author,	Nouvelle Voilure propoſée pour les Vaſſeaux de toutes Grandeurs, par David le Roz.
March 21. Author,	Philoſophie de l'Univers, par M. Dupont de Nemours.
April 4. Author,	A Map of the Iſland of St. Bartholemews and its vicinity, by Samuel Fahlberg, Phyſician of the Swediſh

1800. Donors.	Presents.
	Swedish Government in said Island.
Author,	Fauna Suecica Insecta, Gustavi Paikull, Sen. Suec. Reg. Cancellar. a consiliis.
April 18. *William Jones*, Esq. of London.	A pair of eighteen inch globes. (Freight of the above relinquished by Mr. Joseph Sims to the society.)
Author,	The 4th and 5th volumes of the Geography of the United States of America, by D. Ebeling.
Author,	The Naturalist's and Traveller's Companion, by John Coakley Lettsom, M. D. the third edition.
Author,	Natural History of the Tea Tree, by John Coakley Lettsom, M. D.
Dr. *Lettsom.*	Portraits of Dr. Lettsom, and Dr. Sims.
do.	A Synopsis of the Chemical Characters adapted to the new nomenclature, by Messrs Hassenfratz and Adet, systematically arranged

1800. DONORS.	PRESENTS.
	ranged by William Jackſon, Practical Chemiſt.
June 20. Author,	A Memoir on the Analyſis of the Black Vomit, by Iſaac Cathrall.
Andrew Ellicot.	Three ſpecimens of Iceland Chryſtal, found on a ſand bar, in the river Miſſiſſippi.
Author,	A Memoir on Goitre, by Benjamin Smith Barton.
Author,	An Inaugural Diſſertation on the effects of Light in reſpiration, by Joſeph Trent of Virginia.
Author,	An Inaugural Diſſertation on Sedatives, by Robert Berkley, of Virginia.
Aug. 15. Author,	An Inaugural Diſſertation on Abſorption, by John Baptiſte Clement Rouſſeau, of Hiſpaniola.
Jonathan Williams.	A Buſt of Benjamin Franklin, by Houdon.
Sept. 19. Author,	Sobre la excelencia y utilidades del Comercios y las que pueden reſultar a Mallorca

1800. Donors.	Presents.
	lorca del eſtablecimiento de una Compania, diſcurſo por D. Joſef de Jaudenes y Nebot, &c.
Nov. 7. *Jonathan Wiliiams*, Eſq.	A Treatiſe of Artillery, containing a new ſyſtem, or alterations made in the French Artillery, ſince 1765, with tables and plates explanatory, tranſlated from the French, of Monſieur de Scheel, preſented by the tranſlator,
Nov. 21. *William Jones*, Eſq. of London.	Adam's Lectures on Natural Philoſophy, five volumes 8vo.
Author,	An Introductory Diſcourſe on the Science of Nature. Mr. Charles W. Peale.
Dec. 19. Author,	Scriptores Logarithmatici, vol. 38, by Francis Maſeres, Eſq. T. R. S. Curſitor Baron of the Exchequer.
1801. Feb. 6. *Jonathan Williams*.	Elements of Fortification tranſlated from the French with an Appendix.
April 3. Author.	Leçons d'Anatomie Comparée, by G. Cuvier.

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OF

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IX.

XXI.

TRANSACTIONS

TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

No. I.

Experiments on the Tranſmiſſion of Acids, and other Liquors, in the Form of Vapour, over ſeveral Subſtances in a hot earthen Tube. By Dr. Joseph Priestley.

Read, Dec. 20, 1799. I HAVE publiſhed an account of many experiments on the tranſmiſſion of ſteam, and alſo of acids, in the form of vapour, over ſubſtances of various kinds in hot earthen tubes, with an apparatus to receive both the air that was produced in the proceſs, and the liquor that was diſtilled. The following were made at the ſame time, but were then thought leſs worthy of publication. Some of the facts may, however, be of uſe to thoſe who may be diſpoſed to reſume thoſe experiments.

Sending the vapour of ſpirit of nitre over an ounce of *iron turnings*, I got 140 ounce meaſures of air with great rapidity. Of this no part was nitrous, or fixed, but it was ſlightly inflammable. The reſt was phlogiſticated.

In the courſe of the proceſs, the finery cinder that was formed had united to the earth of the tube, and made a hole through it, but I collected 8 dwts. of the iron which had not been much affected.

With *copper* in the ſame proceſs I got pretty pure dephlogiſticated air, from the acid only, while the production was rapid, but when it came ſlowly, it was nitrous. The copper was covered with a peculiar kind of ſcale, and ſome parts were entirely reduced to it. It was brittle, but not black.

Sending the ſame vapour over 240 grains of perfect *charcoal*, I got, with prodigious rapidity, and full of black ſmoke, 900 ounce meaſures of air, ſlightly inflammable, without any fixed air. It was of the ſame ſpecific gravity with common air, and what remained of the charcoal weighed 47 grains.

From about an ounce of the *charcoal of bones*, out of which all air had been expelled by heat, I got, by the tranſmiſſion of the ſame vapour, about an hundred ounce meaſures of air, of which one-fifth was fixed air, and the reſt phlogiſticated. Continuing the proceſs, the air that came afterwards was dephlogiſticated, from the acid only.

From a quantity of melted *lead* I got, in the ſame proceſs, air that came with great rapidity, at firſt dephlogiſticated from the acid, afterwards, what was worſe than common air, as it extinguiſhed a candle. After the proceſs I found in the earthen tube much glaſs of lead covered in part with a white powdery ſubſtance, which was, no doubt, nitrated calx of lead.

The experiment with *tin* in this proceſs was ſimilar to that with lead. After the proceſs there was found a quantity of a white ſubſtance in hard lumps, and the tin that remained was covered with it. This was, no doubt, the nitrated calx of tin.

When this proceſs was gone through with *biſmuth* the air produced was exceedingly turbid, and ſtrongly nitrous. But the

the greateſt part of the acid came over in red vapours, which were imbibed by water, that afterwards gave out nitrous air. The metal was covered with a white powdery ſubſtance, but in ſome places yellow, the nitrated calx of biſmuth. The liquor that was diſtilled was of a blue colour, and the veſſel in which it was received, was filled with red vapours.

Sending the vapour of *marine acid* over a quantity of *copper*, I got about 40 ounce meaſures of air, the greateſt part of which was ſtrongly inflammable, but mixed with common air. For when, after being turbid, it became clear, and the production ſlow, the ſtandard of the air was 1.45.

I then ſent the vapour of this acid through an empty earthen tube glazed on the outſide only, and got about 60 ounce meaſures of air of the ſtandard of 1.4, or 1.35 very turbid. The reſult was the ſame when the tube was glazed both inſide and outſide. This air I ſuſpect had been tranſmitted through the tube, while the vapour of the acid paſſed through in the contrary direction.

With this acid vapour ſent over 10 dwts. of perfect *charcoal* I got about 700 ounce meaſures of air, without any ſenſible quantity of fixed air; but afterwards one tenth of the produce was fixed air, and the reſt inflammable, of which 20 ounce meaſures weighed two grains leſs than the ſame quantity of common air. This air came over white as milk, and the acid that was diſtilled was quite black.

I ſeveral times ſent *cauſtic fixed alkali* in vapour through an earthen tube containing *iron*, when the firſt portion that was diſtilled was ſlightly acid, but not afterwards. I had the ſame reſult in three proceſſes, in which the glaſs worm, and all the apparatus, had remained juſt as it was after the preceding experiments; ſo that nothing acid could well have come to it.

Experiments made with Charcoal, Phoſphorus and Animal Fibres in the Nitrous Acid.

I have formerly given an account of experiments on the ſolution of charcoal in the nitrous acid; and as there is ſome diverſity in the reſults, it may be of uſe to add the following:

Some pieces of pounded charcoal diſſolved with difficulty in nitrous acid, but with heat it conſtantly gave air, of which about one-fifth was at firſt fixed air, and the reſt nitrous; but at laſt it was wholly phlogiſticated. At another time half of the produce was fixed air, and the reſt phlogiſticated.

From 205 grains of perfect charcoal and three ounce meaſures of ſtrong acid of nitre, I got 180 ounce meaſures of air, of which at firſt only one-ſixth, but at laſt one half, was nitrous, and the reſt fixed air. With freſh acid to the remainder of the ſame charcoal I got 82 ounce meaſures of air, of which at firſt only one-ſixth was nitrous, with equal meaſures of common air occupying the ſpace of 1.6. Of the reſt one half was more purely nitrous. The phial in which the ſolution was made becoming dry, and preſently after red hot, I got with great rapidity, and in a very turbid ſtate, 50 ounce meaſures more; and of this one half was fixed, and the remainder phlogiſticated.

Charcoal of copper appeared to differ from that of wood in that, being diſſolved in the nitrous acid, it gave only nitrous air, without any fixed air, and very little phlogiſticated air. From this it may be inferred that charcoal of copper contains no oxygen, which charcoal of wood does, and by which it can give fixed air.

The different reſults of diſſolving copper, phoſphorus, and animal fibres in the ſame quantity of the acid of nitre may give riſe to ſome uſeful obſervations.

Having

Having found that a certain quantity of nitrous acid gave $79\frac{1}{2}$ ounce meaſures of nitrous air by the ſolution of copper, I put into the ſame quantity of the ſame acid as much phoſphorus as it would diſſolve, and found that it yielded 21 ounce meaſures of air, all phlogiſticated; a quantity very nearly to which the nitrous air yielded by the copper would be reduced by heating iron in it, and other phlogiſtic proceſſes. There was a ſtrong acid vapour in this phlogiſticated air, even after being long confined by water.

In the ſame quantity of the ſame nitrous acid, diluted with as much water, I diſſolved one ounce of dry boiled beef, and got from it 82 ounce meaſures of air, all phlogiſticated.

That dephlogiſticated air, or oxygen, enters into the compoſition of fixed air, I think I have proved in various ways, but moſt deciſively by heating charcoal of copper in dephlogiſticated air. From the following experiment on the heating of charcoal of wood in it, it ſeems evident that both fixed and phlogiſticated air are in part compoſed of it.

In 79 ounce meaſures of dephlogiſticated air, which with two equal meaſures of nitrous air occupied the ſpace of 0.93, I diſperſed, by means of a burning lens, $15\frac{1}{2}$ grains of charcoal; when they were increaſed to 91 ounce meaſures, and by waſhing in water reduced to 53, of the ſtandard of 1.92. Again, in 74 ounce meaſures of the dephlogiſticated air, I diſperſed $13\frac{1}{2}$ grains of charcoal, when it was augmented to 80 ounce meaſures, and it was diminiſhed by waſhing in water to 48.

That nitrous air contains oxygen, ſeemed probable from the burning of pyrophorus in it. The ſame may perhaps be inferred from the burning of charcoal of wood. Filling a tall glaſs jar with pure nitrous air, I placed

placed it as quickly as I could over a piece of hot charcoal, and obſerved that it burned with a conſiderable glow, much better than in common air : and the jar was filled with a white cloud. After a few minutes the air was diminiſhed to about one-fourth of its original bulk; but after remaining in this ſituation all night, it was increaſed to about one-third of the original quantity; and being then examined, it appeared to be all phlogiſticated. Dipping the ſame charcoal into water, I got from it $1\frac{1}{2}$ ounce meaſures of air, all phlogiſticated, but with a ſlight mixture of fixed air. This ſubject may deſerve farther inveſtigation. For ſince dephlogiſticated air ſo readily unites with nitrous air, and with it forms nitrous acid, it is not eaſy to account for nitrous air containing any portion of the ſame element, and retaining its aerial form. Alſo the juice of turnſole does not change its colour by ſaturation with nitrous air, which if it contained oxygen, it might be expected to do.

MISCELLANEOUS EXPERIMENTS.

1. *On the colouring of the ſolution of copper in Volatile Alkali, and of various ſubſtances in the marine acid.*

In repeating my former experiments of this kind, a few circumſtances occurred which I did not ſo particularly attend to before; and may be deſerving of notice, and of a farther proſecution. They ſhow that dephlogiſticated air is eſſential to theſe colours, and how they may be given and taken away at pleaſure.

It is well known that the ſolution of copper in cauſtic volatile alkali aſſumes a blue colour if it be made with acceſs of air. Without it, it is perfectly colourleſs; and the colour may be diſcharged by more copper, and reſtored again by means of air, as long as the menſtruum is is capable of diſſolving the metal. The coloured liquor is alſo heavier than that which is without colour; and if a phial of the colourleſs liquor be opened, the colouring will begin at the top, and deſcend in the form of a fine thread in the center of it to the bottom, till the whole be coloured.

By means of this colourleſs ſolution 6 ounce meaſures of air were reduced to 5, completely phlogiſticated, without any fixed or inflammable air in it.

Liver of ſulphur diſcharges this colour:

The ſolution of minium, and alſo that of red precipitate, in the marine acid is attended with much heat, the former with the emiſſion of dephlogiſticated marine acid air, and the latter without it. But when the ſolution of the red precipitate is become cool, and colourleſs, it is afterwards diſſolved in this acid without any generation of heat.

The ſolution of finery cinder in this acid is not attended with heat.

The ſolution of minium has a beautiful yellow colour, but by diſſolving red precipitate it becomes colourleſs. It will alſo diſcharge any other colour made by a ſolution in this acid.

The ſolution of iron in marine acid acquires colour by acceſs of air only, and the ſolution of more iron, even that which is ruſted, will diſcharge the colour.

This coloured acid became colourleſs by diſſolving the black powder of mercury and lead. Much air was produced in this proceſs, and it was pure fixed air, with a ſmall reſiduum that extinguiſhed a candle.

An exceedingly ſmall quantity of pure air is ſufficient to reſtore colour to the ſolution of any ſubſtance in the marine acid.

2. *Of*

2. *Of the production of sulphur by heating water impregnated with vitriolic acid air.*

When I firſt made this experiment it was a long time before any ſulphur appeared; but it is formed much ſooner when the common air is expelled from the tube by heating a little of the impregnated water previouſly to its being hermetically ſealed. By this means the ſulphur will appear the firſt day, and in three or four days the production will have attained its maximum, the whole tube being covered with white cryſtals. After ſome days there will be a little ball of yellow ſulphur ſwimming on the middle of the liquor, and a good deal of ſulphur will be found at the bottom of it, by the cryſtals on the ſides continually ſliding down into the liquor, as others are formed. The tubes I have generally uſed for this purpoſe are ſomething more than three feet long, and more than half an inch wide.

Sulphur is produced in the very ſame manner and in the ſame time by means of water impregnated with hepatic air. The only difference that I obſerved was that I did not ſee the ſame dancing vapour in this proceſs as in that with vitriolic acid air, which is a curious circumſtance in the experiment.

Having evaporated to dryneſs a quantity of water impregnated with hepatic air, there remained a black powder, like ethiops mineral. When this ſaturation is made with water confined by mercury, it has a white colour.

Opening a tube in which ſulphur had been formed from water impregnated with vitriolic acid air under water, I found the air within it of the ſtandard of 1.6, without fixed air, or any thing inflammable in it.

3. *An experiment with Papin's Digeſter.*

Aided by heat in this inſtrument a ſolution of cauſtic alkali made a *liquor ſilicum* with pounded flint glaſs.

4. *Of*

4. *Of Phoſphoric air.*

Phoſphoric air, though confined by mercury, will not always retain its property of taking fire by the admiſſion of atmoſpheric air. A quantity of this air which was made the 18th of November would not take fire on the 22d, but burned with a lambent yellow flame on the approach of a lighted candle, ſmelling ſtrongly of phoſphorus. At other times I have found this air retain its peculiar property much longer; but it was always changed to a lambent inflammable air by keeping, nor would heat reſtore it.

5. *Of the purity or impurity of airs in various circumſtances.*

Some experiments ſeem to indicate that ſomething poſitive is communicated to ſeveral ſubſtances, ſolid and fluid, in conſequence of being expoſed to heat. At leaſt they are diſpoſed after this to attract pure air from the atmoſphere, like other ſubſtances during the emiſſion of phlogiſton. The following obſervations may ſerve to throw ſome light on this ſubject, and perhaps deſerve to be proſecuted farther.

Air from water freſh diſtilled, from rain water, or freſh ſpring water, gave out air ſomething worſe than that which had been expoſed to the atmoſphere.

Air from ſnow water, from a ſolution of blue vitriol, and from water diſtilled from this ſolution, gave air a little worſe than water long expoſed to the atmoſphere. Such alſo was air from river water during a flood from late rains.

Putting a ſmall quantity of ſpirit of wine into a phial, and covering it with a ſmall glaſs veſſel ſtanding in water, I found the air within it conſiderably leſs pure than common air.

Air incumbent on water impregnated with nitrous vapour extinguiſhed a candle.

A phial which had contained aqua regia ſaturated with gold having a very pungent ſmell, I examined the air within it, and found it to be of the ſtandard of 1.65, much worſe than common air.

Air which had been confined with *muſk* was a little worſe than common air. There was no fixed air in it. Air confined in a ſimilar phial, and with a ſimilar cork, about the ſame time was not worſe than common air, nor was air confined with camphor.

Water in which liver of ſulphur was diſſolved did not give out air worſe than before.

6. *Of the proportion of latent heat in ſome kinds of air.*

That heat is neceſſary to the aerial form of ſubſtances is as evident as that it is neceſſary to form the vapour of water. I took the following method to aſcertain the proportional quantity of latent heat in thoſe kinds of air which are readily abſorbed by water, expecting to find a conſiderable difference between them, but I did not find any. I incloſed the bulb of a mercurial thermometer in one end of a glaſs tube, and made the place air-tight with a cork and cement; then filling the tube with mercury, I introduced a certain quantity of water, which, ſurrounding the bulb of the thermometer, would ſoon impart to it whatever heat it received by the abſorption of the air that was thrown up into it.

The quantity of water in all the experiments was 44 grains, and the jar of air that I threw up into it held nearly two ounce meaſures. The kinds of air on which I made the experiment were marine acid air, vitriolic acid air, and alkaline air. In all the caſes the abſorption of the air raiſed the thermometer four degrees of Fahrenheit, which was a ſpace of an inch and a half; ſo that a ſmall difference would eaſily have been perceived. The vitriolic acid air required a little agitation, and on this

this account the heat would not be communicated ſo ſpeedily, and conſequently ſome would be loſt. But the difference in this caſe was only that of 1.6 and 1.5.

7. *Experiments relating to aqua regia and the ſolution of gold and platina in it.*

In impregnating marine acid with nitrous vapour, which makes an aqua regia much ſtronger than that which is made by a mixture of two acids, there dropped from the end of the tube through which the phlogiſticated vapour was conveyed a deep green acid, in the form of balls, which fell to the bottom of the veſſel, and after continuing a ſhort time burſt with the emiſſion of air, the green colour then diſappearing and the acid gradually aſſuming its proper orange colour.

Going to make uſe of a quantity of aqua regia that had been made ſome months, I found its colour changed, and that, by the eſcape of the nitrous vapour, it was become mere marine acid. Impregnating it again with nitrous vapour, it was the ſame as before. Diſtilling the ſolutions of gold and platina in this compound acid, the liquor that came over was marine acid. Platina required more heat to diſſolve it than gold.

8. I made the following experiments to obſerve the different effects of phlogiſticated and dephlogiſticated nitrous acid in the ſolution of mercury.

In the dephlogiſticated acid an ounce of mercury gave leſs of both nitrous and dephlogiſticated air. I diſſolved an ounce of mercury in dephlogiſticated acid of nitre, and without changing the retort, which was cooled, and gradually expoſed to a red heat till nothing more came over, I got about 15 ounce meaſures of nitrous air, and 55 of dephlogiſticated. From the calx that was ſublimed I got 17 ounce meaſures of dephlogiſticated air. In the ſame proceſs with phlogiſticated nitrous acid I got 43 ounce meaſures of nitrous air, and 63 of de-

 phlogiſticated;

phlogiſticated; and from the calx that ſublimed I got 6 ounce meaſures of nitrous air, and 15 of dephlogiſticated.

9. That quicklime gets weight by expoſure to the air is well known. The following experiment will ſhew what that weight is.

An ounce of quicklime expoſed in a ſhallow diſh on the 1ſt of July increaſed in weight till the 14th of Oct. when it had gained 320 grains. Another ounce had gained 300 grains in the ſame time, and after this they gained nothing more. In the ſame time an ounce of quicklime ſaturated with water, and then left to dry, had gained 294 grains: another ounce gained exactly the ſame weight, and a third 325 grains.

10. Pyrophorus is generally made with the charcoal of vegetable or animal ſubſtances mixed with alum, or any thing that contains the acid of vitriol, and the heat by which it takes fire is occaſioned by the eager attraction of this acid for water. I accidentally found that a pyrophorus may be made of ſulphur and iron.

Having kept a cup full of this mixture made up with water in a quantity of common air about two months, I then took it out, and left it in the cup. The next day perceiving the cup to be warm, I emptied it upon a board, when it grew hot, ſmoked very much, gave out a ſtrong ſmell of vitriolic acid air, and at length became red hot. Putting a part of it into another cup confined by common air, the air was rapidly diminiſhed.

11. *Of the abſorption of fixed air by a mixture of iron filings and ſulphur.*

Among ſome of the firſt of my experiments were ſome on the effect of this mixture on fixed air, as well as on that of the atmoſphere. The following relate to the ſame ſubject, and may deſerve to be proſecuted further.

A mixture of this kind which had been ſome time in common air, and was become brown, abſorbed fixed air with great rapidity, without leaving any ſenſible reſiduum. But different portions of it abſorbed this air very differently. Six ounce meaſures of fixed air which had been a long time expoſed to about an ounce of ruſted iron had now a reſiduum of about three-fourths of an ounce meaſure, and it was wholly phlogiſticated.

A bladder containing about 20 ounce meaſures of fixed air was connected with an earthen tube in which were pieces of iron, and at the other end of the tube was another bladder, but empty. The middle part of the tube being made red hot, the bladder was preſſed, ſo as to make the air paſs through the hot iron, and thence it was driven back again, and the proceſs repeated till the air was reduced to 6 ounce meaſures, and by waſhing in water to 5. It was ſlightly inflammable.

No.

No. II.

Experiments relating to the change of Place in different kinds of Air through several interposing Substances. By Dr. JOSEPH PRIESTLEY.

ONE of the most extraordinary circumstances that ever occurred in the course of my experiments is that of the vapour of water, or of mercury, changing places with any kind of air, in vessels through which air could not be made to pass without great force, so that for most purposes they might be considered as air-tight. Of this remarkable fact, and of all the circumstances that led to the complete ascertaining of it, I have given an account in my former publications. I had also observed that different kinds of air capable of forming a chemical union would do it through a bladder that was perfectly air-tight, that in this manner pure air was imbibed by the blood through the membrane of the lungs, while phlogiston was transmitted into the air within them. Since that time I have extended and diversified the experiments, and have observed that what was done by air and water, will be done by any two kinds of air, and whether they have an affinity to one another or not, that this takes place in circumstances of which I was not at all apprized before, and such as experimenters ought to be acquainted with, in order to prevent mistakes of considerable consequence.

Having procured earthen vessels of a very close texture, so as to be apparently impervious to air, containing about an ounce measure, I could fill them with any particular kind of air, and then place them inverted in a large glass jar containing a different kind of air. I then heated the small earthen vessels through the glass jar by means of a burning lens, and I never failed to find after

after the experiment, that the air within the earthen veſſel was the ſame with that which had been on the outſide of it, while that within it was mixed with that on the outſide; but in ſome caſes the mixture was a chemical one, forming a kind of air different from either of them, while at other times they were only diffuſed through one another. It will be neceſſary therefore to recite the circumſtances as I obſerved them, that future experimenters may give more attention to them, and endeavour to aſcertain the cauſe of this difference, which I have not been able to do.

I put one meaſure of dephlogiſticated air into the ſmall earthen veſſel in a large glaſs jar containing inflammable air, and after heating it about half an hour, found the quantity of inflammable air conſiderably diminiſhed, and the air within the earthen veſſel wholly inflammable, and increaſed in quantity one half.

I repeated the proceſs with inflammable air in the earthen veſſel, and dephlogiſticated air in the jar, and then found the dephlogiſticated air ſomething diminiſhed, and the quality of it inferior to what it had been before. The air in the earthen veſſel was wholly dephlogiſticated, hardly diſtinguiſhable from that in the glaſs veſſel. There was no fixed air in either of them.

In both theſe caſes the mixture of the two kinds of air in the glaſs jar was evidently a chemical one, the quantity being diminiſhed; but the air that had been tranſmitted through the earthen veſſel in the contrary direction had undergone no change, being the very ſame with that in the glaſs jar. Of the reaſon of this difference I cannot form any probable conjecture.

When the two kinds of air were ſeparated by a bladder, and no heat was applied, I ſometimes found that the tranſmiſſion had been made both ways, without any chemical union.

Having

Having filled a tanned bladder with dephlogisticated air, and put it into a large jar of inflammable air, I examined them about a month afterwards and found in each of them a mixture of both the kinds of air, and in the same proportions. They both exploded alike; and with equal quantities of nitrous air occupied the space of 1.6. In the bladder there was slight appearance of fixed air, but in the jar none at all.

Reversing this experiment, by putting a bladder filled with inflammable air into a vessel containing dephlogisticated air, and letting them remain from the 12th of Dec. to the 5th of Feb. I found the dephlogisticated air diminished, and of inferior quality. The bladder was air-tight, but much shrunk. There was fixed air in them both, but more within the bladder. They both exploded with violence, but that in the jar seemingly less so than that in the bladder. With equal quantities of nitrous air the standard of that in the jar was 1.1, and that in the bladder 1.3.

That the fixed air in the result of this process did not come from the corruption of the bladder, was evident from the following experiment. On the 20th of June I put a bladder full of inflammable air into a jar containing 90 ounce measures of dephlogisticated air, and on the 23d of the same month another bladder of inflammable air into a jar of the same air, and on the 15th of July I examined them both. The 90 ounce measures of dephlogisticated air were reduced to 47, of the standard of 0.6, whereas it had been of 0.16, and the bladder was found. In the other jar the bladder was almost dissolved, and exceedingly offensive, and there was hardly any appearance of fixed air; whereas in the jar in which the bladder was found there was a great quantity.

The most expeditious manner in which I found the two kinds of air to change places was when a quantity of of any kind of air was confined in an earthen tube clofed at one end, while the open end ftood in a bafon of water or mercury. After this I expofed the clofed end of the tube to a red heat, which I contrived to do by means of a hole purpofely made in the grate of a fmall furnace. In this cafe whatever kind of air was contained in the tube before the procefs, it was in a very fhort time of the fame quality with that on the outfide, which, being in the fire, was fomething worfe than the external air. It made no difference alfo whether the tubes were glazed or not; and yet that they were air-tight appeared from their containing only a certain portion of air after their procefs, as well as before. There was always, however, fome change in the quantity, but on what principle this change was made I could not fatisfy myfelf.

Three and an half ounce meafures of inflammable air treated in this manner came out two ounce meafures, nearly common air, with nothing inflammable in it.

The fame quantity of nitrous air was reduced to $2\frac{3}{4}$ ounce meafures and to the fame ftate. A candle burned very well it. The fame quantity of phlogifticated air came out $2\frac{2}{3}$, of the fame quality with the preceding; but the dephlogifticated air was increafed to 4 ounce meafures, of a ftandard a little better than the reft.

In the preceding experiments the air was confined by water; but the refult was the fame with thofe kinds of air that required to be confined by mercury.

Marine acid air treated in this manner was much increafed, but came out very nearly common air. Vitriolic acid air was neither increafed nor diminifhed, but was not to be diftinguifhed from common air after the procefs. Alkaline air alfo was unchanged in quantity, but in quality it was the fame as the reft.

In order to repeat my former experiment on the tranfmiffion of fteam in this eafy procefs, I filled one of thefe tubes with water; and expoſing the top of it to the fire, I found after ſome time 2½ ounce meaſures of air in it, of the ſame quality with the preceding.

All the preceding experiments having been made with the ſeveral kinds of air unmixed with any other, I was willing to try the effect of a mixture of dephlogiſticated and inflammable air, ſuch as explodes with great violence with the flame of a candle or an electric ſpark. In theſe circumſtances, however, this mixture did not explode at all, the quantity was unchanged, and the quality was, as before, nearly the ſame as that of common air.

To my great ſurpriſe, I found that this mixture of dephlogiſticated and inflammable air did not explode in a red hot gun barrel, a copper tube, or one of ſilver; and though the heat was applied ever ſo ſuddenly. When it was put into a flint glaſs tube, it was alſo heated without exploſion, but the tube became black, by the calx of lead uniting with the inflammable air; but in a tube of green glaſs, in the compoſition of which there is no calx of lead, the mixture exploded. Why it ſhould not explode in the earthen veſſel, the gun barrel, or the copper and ſilver tube, I am unable to ſay; but it is probably owing to the dephlogiſticated air in the mixture uniting with the metal, and forming a calx rather than with the inflammable air, with which it was mixed. In an experiment with the copper tube the quantity of the air came out twice as much as it was when put in. Mixed with an equal quantity of nitrous air, the ſtandard was 1.4, and it exploded like a mixture of common and inflammable air.

To diverſify this courſe of experiments, I put the different kinds of air into earthen retorts ſufficiently air-tight for any common purpoſes, and putting the open ends into baſons of water, I placed the bulbs near to a fire, where the heat was about that of boiling water, and noted the following reſults.

Fourteen

Fourteen and an half ounce meaſures of inflammable air having been expoſed in this manner a good part of a day, was reduced to 8½ ounce meaſures, nearly in the ſame ſtate with common air, without any thing inflammable in it. But 10 ounce meaſures of inflammable air from ſpirit of wine was firſt increaſed to 10½, of the ſtandard of 1.56, then to 12½, of 1.37; and it was ſtill ſlightly inflammable.

Seven ounce meaſures of dephlogiſticated air was increaſed to 12, of the ſtandard of 1.9, and it was afterwards brought to 1.25 with an equal meaſure of nitrous air; ſo that it was in all reſpects atmoſpherical air.

Ten ounce meaſures of phlogiſticated air came out 11, of the ſtandard of 1.8. It was afterwards farther increaſed, and was finally of the ſtandard of 1.38.

In all the preceding caſes the change was produced by means of the fine pores in the earthen veſſel, but I found that in more time the ſame change would be made through a quantity of water in a glaſs retort. For four meaſures of inflammable air having been expoſed to heat in this manner, though it was not changed in its dimenſions, was become of the ſtandard of 1.5, and exploded like a mixture of inflammable and common air.

Inflammable air kept in glaſs jars ſtanding in water does not in general undergo any ſenſible change in many months, except that it preſently ſaturates itſelf with water, and thereby becomes heavier than when freſh made. But, to my great ſurpriſe, I found that, though a glaſs veſſel was perfectly air-tight, yet if it had been broken, and the pieces had been joined with paint, or cement, the air would in time be changed for the external air. At firſt I found that a jar of this kind of air had in it a conſiderable quantity of common air by the manner in which it exploded, and by its being diminiſhed by a mixture of nitrous air. But afterwards I found the inflammable air which had been kept in a glaſs veſſel of this kind all the winter was of the ſtandard of 1.45, and had nothing ſenſibly inflammable in it. I had many reſults of the ſame kind; but in a glaſs veſſel which was only cracked, but was air-tight, the inflammable air was not changed; though when a ſolution of copper in the nitrous acid was put into it, there was an efflroeſcence from every part of the crack on the outſide, which ſhewed that it was not in all reſpects impervious.

No.

No. III.

Experiments relating to the Abſorption of Air by Water. *By* Dr. Joseph Priestley.

By Dr. Joseph Priestley.

IN my attempts to aſcertain the proportion between the phlogiſticated and dephlogiſticated air that conſtitutes the atmoſphere, of which I gave an account in the fourth volume of the *Philoſophical Tranſactions of Philadelphia*, I made one of my computations from the diminution of atmoſpherical air by a mixture of nitrous air, conſidering one-third of the quantity that diſappeared to have been dephlogiſticated air; and ſince by long ſtanding this diminution proceeded much farther than at the firſt, I concluded that this farther diminution was occaſioned by the ſame cauſe as the firſt, only operating more ſlowly, and conſequently that there was in the atmoſphere much more dephlogiſticated air than had been ſuppoſed. Since that time, however, I have found that this ſecond abſorption has ſome different cauſe, though I have not been able to diſcover it; becauſe if ſufficient time be allowed, all kinds of air without diſtinction will be wholly abſorbed by the water with which they are confined.

As this obſervation was made in conſequence of reſuming the experiments of which an account was given before, viz. on mixtures of nitrous and common air, I ſhall firſt recite thoſe which were made with this mixture. In the beginning of May 1798 I ſet by a mixture of this kind, then occupying the ſpace of 1.25, and obſerved that, without agitation, the diminution kept proceeding (though it was ſometimes ſtationary) till on the 18th of October, I examined it, and found it to be

0.34,

0.34, which was conſiderably leſs than I had obſerved before. Replacing it in the ſame veſſel, I found that on the 30th of Nov. it was 0.27; Dec. 2d it was 0.22; Jan. 1ſt it was 0.11; Feb. 12th it was 0.09; Feb. 24th it was 0.06, and on April 3d it was completely abſorbed.

Obſerving this progreſſive diminution, I made other mixtures of the ſame kind, and occaſionally examined them, but I do not think it neceſſary to recite more than two more of the reſults.

Equal quantities of common and nitrous air put together Oct. 5th was on Dec. 2d reduced from 1.25 to 0.83; Jan. 1ſt it was 0.52; Feb. 21ſt 0.31; March 31ſt 0.25; April 3d 0.21; May 25th 0.22; July 1ſt 0.11; and on July 24th it was wholly abſorbed. Another mixture of the ſame kind made Dec. 11th was vaniſhed July 1ſt.

A mixture of equal quantities of common and inflammable air fired together Dec. 13th, and then occupying the ſpace of 1.29, was wholly vaniſhed July 19th.

That this diminution and abſorption depended on the *water* by which it was confined, was evident from a mixture of equal parts of common and nitrous air being kept without any change confined by mercury from October to the April following.

Being now fully ſatisfied that this diminution of air, and its final abſorption, was wholly independent of the action of nitrous air, I expoſed in the ſame manner all kinds of air that could be confined by water to the ſame influence; and I always found that, in more or leſs time, the whole of any quantity would be wholly abſorbed, though a large ſurface of the water in which the veſſels containing them were placed was expoſed to the common atmoſphere, and therefore had an opportunity of ſaturating itſelf with air, and of a purer kind than

than ſeveral of thoſe that were in the jars. And this is the circumſtance which makes the experiment of ſuch difficult ſolution. I always, however, found that when common air was ſubjected to this experiment, the dephlogiſticated part of it was abſorbed in the firſt place. For whenever I examined the air it was always found to be more and more phlogiſticated, till at laſt it was wholly ſo; and this was generally the caſe when about three-fourths of the quantity remained unabſorbed.

Ten ounce meaſures of common air expoſed to rain water from the 28th of July to the 15th of Auguſt, in a glaſs jar about ten inches in diameter, were reduced to 7 ounce meaſures, completely phlogiſticated, as was another quantity of 20 ounce meaſures, when it was reduced to 15.

In order to aſcertain what kind of air would be moſt affected in theſe circumſtances, I expoſed equal quantities of them in the ſame manner on the 19th of Dec. and obſerved them all to be gradually diminiſhed, till July 1ſt; when the dephogiſticated air was reduced to a very ſmall bubble, and on July 6th the inflammable and common air, and an equal mixture of common and nitrous air, were all wholly vaniſhed. Nitrous air was always abſorbed ſooner than any other, till it was reduced to the ſtate of phlogiſticated air, which, if the ſurface expoſed to the action of the water was large, was ſoon effected.

Thinking that the nearer the air on which this experiment was made was to the common atmoſphere, the ſooner this abſorption would be effected, and that the farther it was from it the more time would be requiſite for it, I put a meaſure of common air into a glaſs tube 5 feet in length, placed in a trough of water 18 inches deep, ſo that there were 6½ feet from the confined air to the atmoſphere. But being left in this ſituation from June 5th to July 28th, it was reduced to 0.8, completely

pletely phlogiſticated; ſo that this long ſpace of water had been little or no obſtruction to this proceſs.

On the 21ſt of Jan. I ſet by two quantities of common air, each one meaſure, in two ſimilar glaſs jars, one plunged ſeveral inches under the water, and the other placed on the ſhelf in the ſame trough, thinking that a difference in the *preſſure* to which they were ſubjected might make ſome difference in the abſorption; and till the 26th of March that which was on the ſhelf was more diminiſhed than that which was under the water, and therefore more compreſſed, but on that day they were exactly equal, viz. 0.55. After this that which was ſunk in the water was more diminiſhed than the other. On the 30th of April, that which was ſunk was 0.48, and that on the ſhelf 0.59; but on the 1ſt of July, when I put an end to the experiment, the changes were reverſed again; for that which was ſunk was 0.17, and that on the ſhelf 0.08.

I found, however, that dilatation by an air-pump prevented the abſorption, and compreſſion by a condenſing machine rather promoted it. To determine this I ſubjected one meaſure of common air to the preſſure of about two atmoſpheres a month, in which time I kept another equal meaſure dilated about ſix times, and another in a ſimilar veſſel without dilatation or compreſſion. This was then found to occupy the ſpace of 0.85, the compreſſed air 0.76, and that which had been dilated had undergone no change at all.

I repeated this experiment on nitrous air from the 15th to the 28th of March, when the compreſſed air occupied the ſpace of 0.47, the dilated was 0.91, and that which had been neither compreſſed nor dilated was 0.54. They had all loſt their power of affecting common air nearly in the proportion of their diminution.

The

The laſt ſtate of all theſe kinds of air was phlogiſticated, that of inflammable air as well as the reſt; and ſome idea of its gradual approach to this ſtate may be formed from the following obſervations.

Five ounce meaſures of inflammable air were reduced from Aug. 19th to Sept. 5th to $1\frac{3}{4}$, barely inflammable. In the ſame time 2 ounce meaſures were reduced to 0.35, wholly phlogiſticated; and from the ſame date to Nov. 9th, 3 ounce meaſures were reduced to $\frac{1}{2}$ an ounce meaſure, wholly phlogiſticated.

Having formerly found air much changed by agitation in water, I now repeated theſe experiments with this view, and obſerved that the abſorption went on rapidly to a certain point, but that the agitation impeded the total abſorption, and when the water was warm the quantity was in ſome caſes increaſed. But unleſs the jar in which I agitated the air ſtood in an open trough, a large ſurface of which was expoſed to the atmoſphere, the effect was inconſiderable.

After agitating one meaſure of common air ten minutes it was reduced to 0.36. After five minutes more it was 0.12, but after another five minutes it was 0.16; and though the air was much phlogiſticated, it was never wholly ſo, being never worſe than of the ſtandard of 1.85, when two meaſures were reduced to one.

When one half of any quantity of inflammable air was abſorbed in this proceſs, it was wholly phlogiſticated, though the air given out by the water in which it was agitated was of the ſtandard of common air.

After agitating 2 meaſures of inflammable air, in water which contained air of the ſtandard of 1.6, till it was reduced to leſs than one meaſure, I found it wholly phlogiſticated. The agitation was continued an hour. Meaſuring after every five minutes, I obſerved the quan-

 tity

tity to be as follows: 1.66; 1.43; 1.25; 1.15; 1.05 and .99.

Having agitated 2 meaſures of inflammable air in diſtilled water an hour, I obſerved that, after being diminiſhed, it was increaſed in bulk, and after ſome time it occupied the ſame ſpace as at firſt. Being then examined, it was not at all inflammable, but had no fixed air in it, and it was of the ſtandard of 1.13, when the air in the water was 1.01.

I agitated 5 meaſures of inflammable air in a trough of cold water fifteen minutes, when it was reduced to 2 meaſures, then in warm water, when it began to increaſe. After agitating it 20 minutes in this warm water, it was 5 meaſures; and being then examined it was not at all inflammable, and of the ſtandard of 1.37. The air from the water was common air.

After agitating the ſame quantity of inflammable air the ſame time in cold water it was diminiſhed to 3 meaſures, without any appearance of increaſe. There was then nothing inflammable in it, and it was of the ſtandard of 1.37.

Dephlogiſticated air was ſoon reduced by this proceſs to a much lower ſtandard. After agitating 3 meaſures of this air, of the ſtandard of 0.05 with 2 equal meaſures of nitrous air, the quantity was 1.66 of the ſtandard of 1.17. Three meaſures of this air after five minutes agitation was 1.21. After five minutes more it was 0.96, and being then examined, it was of the ſtandard of 1.7 with equal meaſures of nitrous air.

After agitating a mixture of 2 meaſures of inflammable air and one of dephlogiſticated five minutes, it was reduced to 1.98; after five minutes more to 1.46, and after another five minutes to 1.7, when it extinguiſhed a candle.

Agitation

Agitation had the ſame effect on old and freſh made nitrous air. When both of them were reduced from $3\frac{1}{2}$ meaſures to about 2, they diminiſhed a meaſure of common air to 1.4. The agitation was continued ten minutes.

No. IV.

Miſcellaneous Experiments relating to the Doctrine of Phlogiſton. By Dr. JOSEPH PRIESTLEY.

1. IT has been ſaid that the fixed air which I get by heating iron in dephlogiſticated air, comes from the plumbago contained in the iron, and that when it is found after the union of inflammable and dephlogiſticated air, it was from plumbago diſſolved in the inflammable air. But beſides that there is no evidence of inflammable air containing any plumbago (ſince when iron is diſſolved in any acid the plumbago is left behind) the fixed air contained in this ſubſtance is very inconſiderable, the bulk of the air into which it may be reſolved being inflammable.

From 6 dwts. of the fineſt plumbago from an iron furnace, in the form of a light powder, I got in a glazed earthen tube 40 ounce meaſures of air, one-twelfth part only of which was fixed air, and the reſt inflammable, burning with a blue flame. Then ſending ſteam through it, I got 240 ounce meaſures more, the whole of which was inflammable, of the pureſt kind, exactly reſembling that from iron by the acid of vitriol. The plumbago was concreted into one maſs, reſembling a hard cinder, and weighed $2\frac{1}{2}$ dwts.

Another experiment on plumbago I ſhall mention in this place. Melting one dwt. of it with a burning lens, it threw out ſparks, like caſt iron treated in the ſame manner, but not quite ſo much; after which it was reduced to a ſlag, like finery cinder, weighing 4 grains leſs than it had done. I repeated the experiment with the ſame reſult.

2. The

2. The experiments on the revival of precipitate per ſe in inflammable air being differently reported by different experimenters, and being ſometimes attended with hazard, I ſhall add the following, which were made ſeveral years ago, to thoſe which I have made and repeated ſince.

In 9 ounce meaſures of inflammable air from malleable iron and water I revived part of the precipitate ſent me by Mr. Berthollet, which I had found to contain no fixed air, till not more than one-fourth of the air remained unabſorbed; on examination, I found about one-twentieth part of it fixed air; but mixing nitrous air with it, it appeared that the air diſlodged from the precipitate had not united with the inflammable air; for the ſtandard of equal meaſures of them was 1.71. After the proceſs I miſſed 18 grains of the precipitate. But there are ſeveral cauſes of loſs in this caſe, beſides the quantity of air expelled from the ſubſtance.

In 5.5 ounce meaſures of the ſame inflammable air I revived ſome of the ſame precipitate till it was reduced to 0.77 ounce meaſures. Of this one-ſixth part was fixed air, and the reſiduum of the ſtandard of 1.6. It exploded at once when the flame of a candle was preſented to it.

3. As pyrophorus imbibes pure air when it is expoſed to atmoſpherical air, leaving nothing but phlogiſticated air, (in which it reſembles a mixture of iron filings and ſulphur, which alſo makes a pyrophorus,) the fixed air expelled from it afterwards muſt have been formed by the union of the pure air imbibed by it and the phlogiſton contained in itſelf.

From a quantity of old and ſpoiled pyrophorus I got 180 ounce meaſures of air, of the firſt part of which one half was fixed air, and the reſt phlogiſticated. At the laſt, the one half was fixed air, and the reſt was inflam-

inflammable. In another experiment of this kind I found ſeven-tenths of the air fixed, and the reſt inflammable.

The fixed air that is expelled from lime which has been long expoſed to the atmoſphere cannot have any other origin than the pure air that it has imbibed and ſome phlogiſton which it derived from the fire; for the air to which it is expoſed is always ſomething leſs pure than it was before.

From 15 dwts. of fallen lime I got 45 ounce meaſures of fixed air, and 25 inflammable from the gun barrel in which the experiment was made. Whether quicklime has been expoſed to the atmoſphere, ſo as to become what is called *fallen lime*, or has been ſaturated with water, they come in time to be of the ſame weight, and to have the ſame properties; the former continually gaining weight, and the latter loſing it.

From 15 dwts. of lime ſaturated with water, and then expoſed to the atmoſphere, I got 55 ounce meaſures of fixed air.

4. If any metal be calcined in common air over lime water, a very thick ſcum will be formed on its ſurface, and much of the air will be imbibed by the calx that is formed. I have recited the reſult of this proceſs with ſeveral of the metals, and I ſhall now obſerve that I had the ſame reſult with platina, ſilver, and gold. In the experiment with platina 33 ounce meaſures of air were reduced to $26\frac{1}{2}$, of the ſtandard of 1.75.

5. That phlogiſticated air is ſometimes formed by the union of dephlogiſticated air and phlogiſton is as clearly proved by experiment as that fixed air is formed from the ſame elements. One proof of this is that common air can never be diminiſhed ſo much by the pureſt dephlogiſticated air as it may be by nitrous air, the reſiduum in both the caſes being alike phlogiſticated air. I could

could not by any mixture of dephlogiſticated and inflammable air, fired by an electric ſpark, reduce it to leſs than 2.5; whereas by nitrous air the ſame dephlogiſticated air was diminiſhed to 0.04; ſo that there muſt have been a production of phlogiſticated air when the inflammable air was uſed.

If after any diminutions of common air by phlogiſtic proceſſes more phlogiſticated air is found in ſome of them than there is in others, the additional quantity muſt have been formed in the proceſs; and that there is a great variety in theſe reſults I have obſerved before.

Heating fine needles in common air over mercury till, after its greateſt diminution, it was increaſed to its original bulk, I found that it had nothing ſenſibly inflammable in it, but was wholly phlogiſticated; whereas the addition of one-fourth of inflammable air to three-fourths of phlogiſticated air was eaſily diſtinguiſhable by the flame of a candle. Fixed air will be produced in this proceſs if it be made over lime water, but not with certainty in any other circumſtances.

When ſubſtances that diminiſh air, and leave it phlogiſticated, emit inflammable air before and after the proceſs, it is reaſonable to conclude that they did the ſame during the proceſs; and ſince nothing inflammable is found in the air after it, that it united with the pure part of the air to which it was expoſed, and by that union formed part of the phlogiſticated air; ſo that leſs of this kind of air exiſted in the atmoſphere than has generally been ſuppoſed. This I have obſerved to be the caſe with a mixture of iron filings and ſulphur. It was the ſame with iron that had been partially diſſolved in vitriolic acid. After diminiſhing a quantity of air I immerſed it in mercury, and it gave out a ſmall quantity of inflammable air.

I have

I have recited one caſe of phlogiſticated air being formed by expoſing ruſted iron to inflammable air, which muſt have been formed by the oxygen in the ruſt and the phlogiſton in the air. There is, however, much uncertainty in this reſult, depending on circumſtances which I have not been able to aſcertain. But one clear caſe of the kind is ſufficient proof of the hypotheſis, and I have met with ſeveral.

On the 15th of Auguſt 1799 I examined a quantity of inflammable air which had been confined by mercury with dry iron ruſted in nitrous acid from the 18th of March 1798, and found nothing inflammable in it, though there was no apparent change in the colour of the iron. This was alſo the caſe of another quantity of the ſame kind of air which had been confined in the ſame manner from the 14th of July. At the ſame time, however, another quantity of inflammable air that had been confined the ſame time, and in the ſame manner, with iron ruſted in vitriolic acid was not much changed, though the iron was become black.

Since pure nitrous air wholly vaniſhes when it unites with pure dephlogiſticated air, the phlogiſticated air that is found after heating iron in it muſt have been formed from ſome oxygen contained in the nitrous air and phlogiſton from the iron. After heating turnings of caſt iron in $5\frac{1}{2}$ ounce meaſures of nitrous air from mercury it was reduced to $3\frac{1}{2}$ ounce meaſures, and by waſhing in water to $2\frac{1}{2}$, one ounce meaſure having been fixed air. But when I heated malleable iron in 60 ounce meaſures of the ſame nitrous air it was reduced to 24 ounce meaſures, all phlogiſticated. When I continued this proceſs beyond the point of greateſt diminution, the air produced was inflammable.

Since water contains but a ſmall quantity of air in proportion to its bulk, and generally conſiderably purer than

that

that of the atmofphere, the phlogifticated air that is found by heating fteam in a copper veffel muft have been formed from phlogifton in the copper, and the pure part of the air contained in the water; and whenever I have heated water in this manner and have kept it a confiderable time in the form of fteam, I have found a quantity of air completely phlogifticated, and the longer I kept it in this ftate the more of this air I found.

I have obferved that when metals are calcined in common air over water, the air is always diminifhed, and if it be done over lime water, fixed air is produced. If the calcination be continued after the greateft diminution of the air, it will be increafed by an addition of inflammable air. If this inflammable air came from the decompofition of the water, the water over which the procefs was made would either be acid, or contain pure air, but this is never the cafe. This water is both free from all acidity, and gives out air lefs pure than that of the atmofphere. Alfo the air confined in the fame phial with it is lefs pure than that of the atmofphere. If the oxygen of the water entered into the calx that is formed, hydrogen, or inflammable air, ought, according to the new theory, to be formed, which it is not.

Alfo air from water in which mercury has been agitated is confiderably worfe than common air. A candle went out in it. Had the black powder which is formed in this procefs been owing to the decompofition of the water, fince this powder is mercury fuper-phlogifticated, the remaining water would have been in a ftate of oxygenation; and therefore the air expofed to it would have been purer than that of the atmofphere.

It is faid that metals become calces by imbibing oxygen; but no oxygen has yet been difcovered in finery cinder, and very little, if any, in flowers of zinc. If minium or red precipitate, be diffolved in marine acid, none of the

 dephlo-

dephlogiſticated air which theſe ſubſtances contain is then extricated; but if the ſolutions be evaporated, and the dry reſiduum be heated by a burning lens, the pure air is evolved. For the common air in which they are heated receives an addition of pure air. But the reverſe is the caſe when the ſolutions of finery cinder or flowers of zinc are treated in the ſame manner.

I heated a ſolution of the pureſt flowers of zinc in marine acid in common air, and obſerved that it emitted a denſe white vapour for about an hour after it was evaporated to dryneſs. The air was but little diminiſhed, but worſe than common air, in the proportion of 1.45 to 1.35.

I have obſerved that common air which has been expoſed to hot charcoal is both diminiſhed and phlogiſticated, but that the air which by immerſion in water comes out of this charcoal is likewiſe phlogiſticated. This proves the generation of phlogiſticated air in the proceſs. The water over which this proceſs is made alſo gives out air leſs pure than that of the atmoſphere.

Charcoal that had been expoſed in common air under a receiver ſome days, did not, when immerſed in water, give out more than half as much air as charcoal heated and put into water immediately after it was cold. Both being placed near the fire, ſtill immerſed in water, gave out more air, but in the ſame proportion. Alſo, ſtanding in this ſituation a long time made no difference in this caſe.

6. That finery cinder contains nothing but water and calx of iron, I think I have ſufficiently proved by ſeveral obſervations, eſpecially by its enabling hot charcoal to give out the ſame kind of air that water will do. I had a ſimilar reſult with *terra ponderoſa aerata*, which gives no fixed air with mere heat, but does it when red hot by means of water.

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I mixed a quantity of this ſubſtance pounded with pounded finery cinder; and putting it into a gun barrel, got from it fixed air as copiouſly as if a ſtream of water had paſſed over it. There was a conſiderable reſiduum, which was inflammable air from the iron.

7. Dr. Woodhouſe obſerves that if the manganeze be heated in inflammable air, and much of the air diſappear, the metal is not revived. But not only may the calces of metals imbibe much phlogiſton before their complete revival in a metallic form, but other ſubſtances alſo appear to do the ſame. After heating calcined alum in inflammable air, it became black, and the air was diminiſhed one-fifth. The inſide of the veſſel in which the proceſs was made had alſo a black coating. And brick, which contains iron ore, becomes black in the ſame circumſtances; but it is not even attracted by a magnet afterwards. Pounded flint glaſs becomes black, and abſorbs inflammable air, when it is melted in it with a burning lens; but no lead is formed.

8. I have obſerved that when a mixture of dephlogiſticated and inflammable air is exploded, *acid* is produced if there be any exceſs of the dephlogiſticated air, but only *water with phlogiſticated air* if there be any exceſs of the inflammable air. Theſe proportions I endeavoured to aſcertain, and I found that acid is formed when 100 meaſures of inflammable air are united to 51 meaſures of dephlogiſticated air; but that only water was produced when 100 meaſures of inflammable air were united to 47 meaſures of dephlogiſticated air.

No. V.

Experiments on the Production of Air by the Freezing of Water. *By* Dr. JOSEPH PRIESTLEY.

Read April 18, 1800. IN 1793, when I was in England, I publiſhed a courſe of experiments on *the generation of air from water*, and after my arrival in this country, I reſumed the experiments, and publiſhed a *ſequel* to them. The reſult of the whole was that, after all air had been extracted from any quantity of water, either by heating, or by taking off the preſſure of the atmoſphere, when ever any portion of it was converted into vapour, a bubble of permanent air was formed, and this was always phlogiſticated. The proceſs with the Torricellian vacuum I continued ſome years, and found the production of air equable to the laſt. The neceſſary inference from this experiment is, either that water is convertible into phlogiſticated air, or that it contains more of this air intimately combined with it than can be extracted by theſe proceſſes in any reaſonable time.

Finding that no air is contained in *ice* that is free from viſible bubbles, I thought to aſcertain the truth of one or other of theſe hypotheſes by expoſing to froſt a quantity of water from which I had, by repeated proceſſes with the Torricellian vacuum, expelled all the air that I poſſibly could; thinking, that if it really contained no air, it would appear by the ice being perfectly ſolid; ſo that when it was melted no air would be got from it. This experiment I repeated ſeveral times, but always found that though the outſide of this ice was perfectly tranſparent, and free from air, the central parts were opaque; and though there were no diſtinct air bubbles in it, yet when it was melted a great number of bubbles iſſued from it. The whole quantity, however, was not greater

greater than might have been produced from the ſame water in the other proceſſes in a reaſonable time; and in them the production of air had no limit.

Diſappointed in my expectations of getting by this means ice perfectly free from air, (which when a large quantity of water freezes very ſlowly it is eaſy to do, the air contained in it retiring from that which is frozen to that which remains fluid) I diſſolved ice that was perfectly tranſparent, and therefore free from air, in veſſels containing mercury, and expoſed it to froſt a ſecond time. But I always found that when the whole of it was frozen, though the extreme parts were tranſparent, and therefore free from air, the central parts were opaque, and when diſſolved yielded air. And though I repeated this proceſs ten or a dozen times with the ſame water, always letting out the air that was procured by freezing preſently after it was extricated under mercury, and before it could have been reabſorbed, yet on expoſing it to another freezing, I never failed to get more air; and the harder the froſt was the more air I procured.

As there is an evaporation from ice, no leſs than from water, the interſtices formed by the cryſtallization of the water when it is converted into ice will ſoon be filled with *vapour;* and this vapour, like that which is formed by heat, becomes, I ſuppoſe, the baſis of a quantity of air. Since, however, ice that is the moſt tranſparent ſwims in water, this alſo muſt have interſtices; but they contain no air; being ſuch as exiſt in the moſt ſolid bodies, in which (gold itſelf not excepted) the component particles are not in perfect contact; ſince they are reduced into leſs dimenſions by cold.

As the veſſels I made uſe of in theſe experiments were either cylindrical jars, or conical wine glaſſes, and conſequently the bubbles of air procured by freezing were expoſed to a conſiderable ſurface of water, and would in time

time (though not, I found, in the courſe of a day) have been abſorbed by the water, now free from air, I procured glaſs veſſels of a conical form, terminating in narrow tubes, into which the air diſlodged from the ice might aſcend, and not be ſubject to be abſorbed. I was ſo fortunate as to have ſeveral of ſuch veſſels, and they completely anſwered my purpoſe for five or ſix proceſſes. Theſe veſſels were firſt filled with mercury, and then I introduced into them a quantity of water freed from air by previous freezing; and when, after expoſure to froſt, the ice was melted, the air diſlodged from the ice aſcended into the narrow tubes, and remained without any ſenſible diminution of bulk ſeveral days; and every time that the water was expoſed to the froſt, an addition was made to it. At length, however, though the veſſels were very ſtrong, and contained much mercury, which by its tendency to deſcend would give the water room to expand with the leſs danger of breaking the veſſel, none of them ſerved for more than the number of proceſſes abovementioned.

After the breaking of my glaſs veſſels, I got other cylindrical ones made of *iron*, ſeven or eight inches in height, and near three inches wide at the bottom, the upper orifice cloſed with a cork and cement, in the centre of which was a glaſs tube, the diameter of which was about a fifth of an inch. And as the glaſs tube was in the greateſt danger of breaking by the freezing of the water, and this had happened ſeveral times before, notwithſtanding all my care to guard it from the froſt, I now made uſe of ſnow and ſalt, to freeze the water in the iron veſſel only, placed in a veſſel of mercury, having been previouſly filled as the glaſs veſſels had been.

The water on which I now operated was about three ounces, and it had been made as free as poſſible from air by previous freezing. With this apparatus I repeated the

the procefs of freezing nine times, without changing the water, and the laft portion of air that I procured in this manner was as great as any of the preceding; fo that there remained no reafonable doubt, but that air might be produced from the fame water in this manner *ad libitum*. Having got near two inches of air in the glafs tube, I put an end to the experiment; and examining the air, found it to be wholly *phlogifticated*, not being affected by nitrous air, and having nothing inflammable in it.

During the procefs of freezing the air in the tube was generally compreffed into about one-fifth of its ufual bulk; but, when I began to thaw the ice, which I did by means of hot water in the place of the freezing mixture, it foon expanded to its former dimenfions, and no fenfible portion of it was abforbed during the whole procefs, which was about a week. Sometimes the violence of the preffure, occafioned by the expanfion of the water in freezing, would force a little water out of the veffel between the cork and the glafs tube, or the iron veffel, which prefently became ice. This I always carefully removed, and applied frefh cement to the place, to prevent the introduction of any air from without before I began to melt the ice. And that no external air had entered, was evident both from the manner in which the air was produced as the water recovered its fluidity, and from the quality of it when examined after the procefs.

In the courfe of the experiments with the glafs veffels a phenomenon occurred that was wholly unexpected by me, and which was very amufing. Having left the veffels filled partly with water and partly with mercury in the evening, I generally found them in the morning feemingly quite full of mercury, every part of the ice within the veffel being covered with it. This muft have been occafioned by a vacuum having been formed between the glafs and the ice, and into this the mercury had

had been drawn up on the principle of the capillary tube. When this was not the caſe, the interſtices of the ice towards the centre were filled with thin laminæ of mercury, which alſo exhibited a curious appearance.

Sometimes, when there was no mercury between the glaſs and the ice, an interſtice was made between them when they were placed within the influence of the fire. In theſe circumſtances I have ſeen the mercury drawn up to the height of ſeveral inches. As this ſpace was enlarged by the increaſe of the heat, the laminæ of mercury were contracted, till coming into the form of balls, too heavy to be ſupported, they fell down to the maſs of mercury in the baſon.

The moſt natural inference from theſe experiments is that *water*, when reduced by any means to the ſtate of *vapour*, is in part converted into phlogiſticated air; and that this is one of the methods provided by nature for keeping up the equilibrium of this conſtituent part of the atmoſphere; as the influence of *light on growing vegetables* is the means of recruiting that other part of it; and both of them are ſubject to abſorption and diminution in ſeveral natural proceſſes. Inflammable air I have alſo ſhewn to be convertible into phlogiſticated air; and this is another means of ſupplying the atmoſphere with this ingredient in its compoſition.

That water contains phlogiſton I have ſhewn to be probable from ſeveral conſiderations, eſpecially that of its reſembling metals in their property of being conductors of electricity, for theſe ſubſtances certainly contain phlogiſton, if there be any ſuch thing. Mercury alſo becomes ſuper-phlogiſticated by agitation in water, and this without limit, and without changing either the water or the mercury; and the remaining water contains no more oxygen than before, for the air expelled from it it is not more pure but confiderably lefs fo, and it is perfectly free from acidity.

I would farther obferve that thefe experiments, which prove the converfion of water into phlogifticated air, are inconfiftent with the antiphlogiftic theory, which makes water refolvable into dephlogifticated and inflammable air; but that they are highly favourable to the hypothefis of water being the bafis of every kind of air, the difference between them depending upon the addition of fome principles which we are not able to afcertain by weight. Alfo, if any fpecies of air be entitled to the appellation of *hydrogen*, it is phlogifton, and not inflammable air.

No. VI.

Experiments on Air expofed to Heat in metallic Tubes. By Dr. JOSEPH PRIESTLEY.

Read Aug. 15. 1800.

HAVING lately fent to the fociety an account of fome pretty remarkable experiments upon air heated in *earthen tubes*, I now take the liberty to communicate the refult of fome that I have made on air heated in *metallic tubes*. They are not lefs remarkable than the others; and being unable to explain feveral of them on any known theory, I fhall be glad of the affiftance of the members of the fociety in the inveftigations to which they may lead.

1. *Of a mixture of dephlogifticated and inflammable air not exploding in a red heat.*

One remarkable circumftance attending the heating of air in earthen tubes, and alfo in thofe of metal, is that no mixture of dephlogifticated and inflammable air will explode in them, though it always does in tubes of glafs in which there is no metallic ingredient. With refpect to earthen tubes, the fact may perhaps be explained by the eafy tranfmiffion of air through the heated tube, and even before the tube is red hot. The air in the infide changing places with that on the outfide. In metallic tubes, this is not always the cafe, and when it is, it takes place much more flowly; fo that an explofion might be expected notwithftanding this property.

Since, however, this mixture of dephlogifticated and inflammable air will not explode in tubes of flint glafs, in which there is the calx of lead, and they become black in this procefs, as they do when inflammable air only is heated in them, this air muft be feparated from the dephlogifticated, and unite with the calx of lead. It is therefore

therefore probable that this takes place in the metallic tubes, though the metal is not in the ſtate of a calx, but may be, as it were, ſuper-ſaturated with phlogiſton. When I opened one of the copper tubes in which this experiment had been made, I found the metal exceedingly bright; whereas had any phlogiſton been ſeparated from it, it would have been covered with ſcale, being reduced to the ſtate of calx. Whether the ſame metallic tube would continue to have the ſame effect in this proceſs, or whether, when ſaturated to a maximum with phlogiſton, the mixture of air would have exploded in it, I did not try; ſeveral of the copper tubes, or the ſoder, having melted before this could be aſcertained.

I alſo found that when I threw the focus of a burning lens upon ſome clean filings of copper in inflammable air, much of the air diſappeared; having, no doubt, been imbibed by the metal, which muſt thereby have acquired more phlogiſton than naturally belonged to it.

For the purpoſe of theſe experiments I prepared a mixture of one-third dephlogiſticated and two-thirds inflammable air, each very pure, ſuch as made the loudeſt exploſions when a lighted candle was preſented to any portion of it; but neither in tubes of iron, copper, ſilver, or gold, was there any exploſion at all, though as ſtrong a heat as they would bear without melting was continued ever ſo long. As the quantity and ſtate of the air after the experiments deſerve ſome attention, I ſhall recite ſome of them.

One meaſure of the mixture above mentioned heated in a copper tube was reduced to 0.45, and was wholly phlogiſticated. Another meaſure of the ſame mixture expoſed to heat ten minutes in a tube of ſilver was reduced to 0.73, and then exploded. Another meaſure expoſed in a tube of gold was diminiſhed about one-third, and made a ſlight exploſion afterwards.

2. *Of the tranfmiffion of air through the fubftance of fome metallic tubes.*

When I had difcovered the ready paffage of air through bladders and earthen tubes, I thought the fact a very extraordinary one, and ftill more, that the internal and external air fhould change places, as I obferved in my laft communication to the fociety. But I have fince that obferved that even fome metallic tubes, though perfectly air-tight, admit the tranfmiffion of air through them when they are heated. Of this I had no fufpicion till after heating air in the experiments above mentioned, I fometimes let them remain a confiderable time before I examined the air they contained; not doubting but that whenever it fhould be convenient for me to do this, I fhould always find the air in the fame quantity, and of the fame quality. But I frequently found that it was much increafed, and that in thefe cafes there was always a confiderable proportion of atmofpherical air in them. This, however, was never the cafe with iron tubes, but with thofe of copper, filver, and gold. As the firft copper tubes I made ufe of were made of fheet copper fodered, I had one caft folid; and though I found it to be perfectly air-tight, (as appeared by fetting a fyringe to it, and being unable by that means to force any air through it) it was evident that it was fufficiently porous for the tranfmiffion of air.

Having put $4\frac{1}{2}$ ounce meafures of inflammable air into this copper tube, fodered to a piece of a gun barrel, the end of which was immerfed in a bafon of mercury, I found that two ounce meafures were expelled by the heat when the clofed end was furrounded with hot coals. After continuing fome time in this fituation, I found in it 1.45 ounce meafures, partially phlogifticated, fo that 25 meafures were reduced to 1.45. Afterwards, though the tube continued perfectly air-tight, after a repetition of the

fame

ſame proceſs, there were found in the tube 3.5 ounce meaſures, which though it extinguiſhed a candle, was of the ſtandard of 1.7; ſo that ſome atmoſpherical air muſt have got into it.

One ounce meaſure of inflammable air expoſed to heat ſeveral hours in a *ſilver* tube, and left to cool gradually, came out two ounce meaſures, of the ſtandard of 1.42. The ſame quantity of the ſame air, after continuing only one hour in the heat, and examined immediately after it was taken from the fire; was only 0.72, and wholly phlogiſticated. At another time I kept the ſame quantity of the air three or four hours in the ſame heated tube, and being examined immediately it was only 0.21 wholly phlogiſticated, ſo that the tranſmiſſion of air did not take place while it was hot, but while the tube was cooling, which I thought very extraordinary.

The tube of gold was melted by inadvertently heating it too much before I had made many experiments with it; and ſeeing reaſon to conclude that its effect on the air confined and heated in it was no other than that of thoſe of ſilver, or copper, I did not renew it. I found, however, that a meaſure of inflammable air heated one hour in this tube was ſomething more than a meaſure, and then extinguiſhed a candle. There muſt, therefore, have been an addition to the air within from that without, though I neglected to examine it by the teſt of nitrous air.

It was not neceſſary to expoſe theſe tubes, and the air confined in them, to a red heat, in order to have this effect; for I had a ſimilar reſult when I only placed them near the fire in a degree of heat little greater than that of boiling water.

Air contained in clear water, is, as I have obſerved, ſomething purer than that of the atmoſphere; but when I filled a copper tube with water, and kept it a whole day in the circumſtance above mentioned, the air within

within it was of the ſtandard of 1.4. This, however, might have been tranſmitted through the water, as in ſome former experiments; but to prevent this I placed the open end of the tube (which was a piece of a gun barrel) in a baſon of mercury. Still, however, I found after ſome time the air was conſiderably increaſed in quantity, and almoſt as pure as the air of the atmoſphere. This, therefore, muſt have come through the pores of the veſſel, which, however, when it was examined in every method that I could think of, appeared to be perfectly air-tight.

Experiments relating to Phlogiſticated Air.

There is a peculiar difficulty reſpecting the conſtitution of phlogiſticated air; ſince ſome of my experiments ſeem to ſhew that it contains the principle of acidity, and others that it is intirely free from it; ſo that excepting its baſe (which is like that of all other kinds of air, viz. water) it conſiſts of nothing but ſome modification of phlogiſton.

When dephlogiſticated air is decompoſed together with much inflammable air, phlogiſticated air is produced; and in this caſe there does not appear to be any thing beſides this phlogiſticated air into which the oxygen of the dephlogiſticated air can enter. That the water which is found after this experiment does not contain any oxygen, I think I have ſufficiently demonſtrated; ſince it is not contained in finery cinder, where the new theory lodges it.

Alſo when ruſted iron becomes black by long expoſure to inflammable air, and is thereby converted into phlogiſticated air, the oxygen in the ruſt cannot be found except in this phlogiſticated air.

Notwithſtanding

Notwithſtanding this, in ſeveral other experiments inflammable air becomes phlogiſticated air without any addition of oxygen; as when it is expoſed to heat in copper or ſilver tubes, and probably, therefore, thoſe of other kinds of metal. Inflammable air treated in this manner is generally diminiſhed in quantity, though not always in the ſame proportion.

Three ounce meaſures of inflammable air expoſed half a day to a red heat in a copper tube were reduced to 0.52, completely phlogiſticated. Two ounce meaſures expoſed to the ſame degree of heat only a few hours, came out 1.25. Another equal quantity was reduced to three-fourths of an ounce meaſure; and two ounce meaſures expoſed in this manner twenty minutes came out 1.5, completely phlogiſticated.

I have, however, found a remarkable difference in the reſult of theſe experiments made with two caſt copper tubes, in one of which the metal is much thicker than the other. In the larger and thicker of theſe tubes, the air was always diminiſhed; and though it continually approached to the ſtate of phlogiſticated air, it was very ſlowly; whereas in the thinner tube the inflammable air was always increaſed in quantity, though the whole of it never failed to be phlogiſticated. In this tube phlogiſticated air alſo was always increaſed in quantity; whereas in the larger tube it was neither increaſed nor diminiſhed by the ſame treatment.

When I filled the ſmaller tube with water only, and expoſed the cloſed end to a red heat, I always found much more phlogiſticated air in it than when I uſed the larger tube in the ſame manner. Having filled the ſmaller tube with water, and only kept it in an inclined poſition over the fire, ſo that the heat to which it was expoſed did not much exceed that of boiling water, I found in it the next morning 4 ounce meaſures completely phlogiſticated.

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In order to vary the circumſtances of this experiment, I heated clean filings of copper, and alſo bits of ſilver, in inflammable air, by means of a burning lens; and the reſult was ſimilar, viz. a converſion of the inflammable into phlogiſticated air, for not only was the quantity of air diminiſhed, but the remainder was much leſs inflammable than before. After heating filings of copper in 14 ounce meaſures of inflammable air, till it was reduced to 7 ounce meaſures, I fired a quantity of it together with a quantity of dephlogiſticated air, when the diminution was to 0.77; though when the ſame dephlogiſticated air was exploded together with the ſame quantity of the original inflammable air the diminution was to 0.62. The ſame proceſs being repeated with the remainder of the inflammable air till it was reduced to $3\frac{1}{2}$ ounce meaſures, the diminution, when fired with the ſame quantity of dephlogiſticated air, was only to 1.25. When ſmall bits of ſilver were heated in the ſame manner in inflammable air, the reſult was the ſame, viz. a diminution both of its quantity and its inflammability.

In the following experiments phlogiſticated air was produced from atmoſpherical, dephlogiſticated, and nitrous, air.

Three ounce meaſures of atmoſpherical air expoſed a whole day to a red heat in a copper tube were reduced to $2\frac{1}{2}$, completely phlogiſticated; which is in the proportion of 91.6 of phlogiſticated air in 100. Conſequently, there muſt have been a production of phlogiſticated air in the proceſs.

Two ounce meaſures of dephlogiſticated air, of the ſtandard of 0.64, heated three or four hours in a caſt copper tube were reduced to ſomething leſs than 2 ounce meaſures, wholly phlogiſticated. And 4 ounce meaſures of the ſame dephlogiſticated air were in half a day a day reduced to 1.25. In another tube, two ounce meaſures were in the ſame time reduced to 0.45, both completely phlogiſticated.

Four ounce meaſures of nitrous air were reduced in this proceſs to two completely phlogiſticated; whereas, in any other proceſs, only one-fourth of phlogiſticated air can be found in any given quantity of nitrous air.

Air naturally contained in clear water is ſomething purer than common air; but air produced by expoſing metallic tubes filled with water to a moderate heat, ſo as to be kept ſome time in the ſtate of *ſteam*, is always leſs pure than atmoſpherical air. There muſt, therefore, be a production of phlogiſticated air in this caſe alſo.

Having filled a *ſilver* tube with water, and kept it ſuſpended over the fire a whole day, I found the air within it of the ſtandard of 1.25, when the air expelled from the ſame water was of the ſtandard of 1.0. Uſing a tube of *lead*, in the ſame manner, the air within it was of the ſtandard of 1.6. In both theſe caſes, therefore, there muſt have been a production of phlogiſticated air, and probably from the phlogiſton of the metals.

P. S. Since I wrote the preceding account I have found that inflammable air heated in a gun barrel is ſo far from approaching to the ſtate of phlogiſticated air, that, when it is fired together with dephlogiſticated air, the diminution is greater than with the original inflammable air. This I tried twice, keeping the gun barrel in a red heat the whole day, and not examining the air till the next morning. This difference between the effect of copper or ſilver, and of iron, on inflammable air, in the ſame degree of heat, is not a little remarkable.

To the account of theſe experiments I ſhall add, that pure phlogiſticated air may be procured in the eaſieſt

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and ſureſt manner, by means of iron only, without any mixture of ſulphur. To do this I fill phials with turnings of malleable iron, and having then filled them with water, pour it out, to admit the air of the atmoſphere, and in ſix or ſeven hours it will be diminiſhed in the ſame proportion as by iron filings and ſulphur; and the ſame iron will anſwer this purpoſe I do not know how long, but it will be till all the iron is converted into ruſt. What remains of air in the phial will be the pureſt phlogiſticated air. Iron that is quite dry has no ſuch effect on air.

The *readieſt* method of procuring phlogiſticated air is, no doubt, by means of a mixture of nitrous air with that of the atmoſphere: but it is liable to ſeveral objections; eſpecially that from not knowing the exact quantity of nitrous air to be employed for this purpoſe, on account of the different ſtates of each of thoſe kinds of air; though I have not found that of the atmoſphere to be ſenſibly different, except in circumſtances of which every experimenter is ſufficiently apprized.

Many of the moſt important experiments recited in theſe papers were made with a burning lens of ſixteen inches diameter, with which I was generouſly furniſhed by Mr. Parker, who has ſo much diſtinguiſhed himſelf by his improvements in the art of grinding glaſs. To his liberality in ſupplying me with various veſſels made of glaſs, the public is indebted for a great proportion of my other experiments on air.

No.

No. VII.

Some Account of the Poiſonous and Injurious Honey of North America. By BENJAMIN SMITH BARTON, M. D.

Read July 18, 1794. IN the year 1785, I had an opportunity of obſerving ſome of the diſagreeable effects of our wild honey upon ſeveral perſons who had eaten of it, in the weſtern parts of Pennſylvania, near the river Ohio. From theſe effects I was perſuaded, that a ſubſtance which is generally conſidered as entirely innocent, is capable of doing much injury to the conſtitution. I was, therefore, induced to pay ſome attention to the ſubject. The reſult of my inquiries I now communicate to the Philoſophical Society.

It is not neceſſary to make any remarks on the fabric of honey. It may be ſufficient to obſerve, that the honey will always partake, in a greater or a leſſer degree, of the ſmell, the taſte, and general properties, of the flowers from which it is obtained. This obvious fact ſhould have ſolicited more of the attention of thoſe whoſe employment it is to raiſe large numbers of bees, for the purpoſe of obtaining the valuable product of theſe little inſects. But, in this country at leaſt, hardly any attention has been paid to the ſubject. Perhaps, the following looſe hints, by pointing out ſome of the ſources from which an ill-flavoured or pernicious honey is obtained, may be of ſome ſervice to the new or remote ſettlers of our country.

I muſt obſerve, that in theſe hints I do not mean to include among the diſagreeable conſequences of the eating of honey, the occaſional effect of its purging: for although, as I ſhall preſently obſerve, a purging is one of the common effects of the poiſonous honey, yet the moſt innocent honey will often induce the ſame ſtate of the body, when it is eaten in large quantities, or when it meets with an irritable ſtate of the bowels.

The honey which I call deleterious or poiſonous honey produces, as far as I have learned, the following ſymptoms, or effects: viz. in the beginning, a dimneſs of ſight or vertigo, ſucceeded by a delirium,* which is ſometimes mild and pleaſant, and ſometimes ferocious; ebriety, pain in the ſtomach and inteſtines, convulſions, profuſe perſpiration, foaming at the mouth, vomiting, and purging; and, in a few inſtances, death. In ſome perſons, a vomiting is the firſt effect of the poiſon. When this is the caſe, it is probable, that the perſons ſuffer much leſs from the honey than when no vomiting is induced. Sometimes, the honey has been obſerved to produce a temporary palſy of the limbs; an effect which I have remarked, in animals that have eaten of one of thoſe very vegetables † from whoſe flowers the bees obtain a pernicious honey.

Death is very ſeldom the conſequence of the eating of this kind of honey.‡ The violent impreſſion which it makes upon the ſtomach and inteſtines often induces an early vomiting or purging, which are both favourable to the ſpeedy recovery of the ſufferer. The fever which it excites is frequently relieved, in a ſhort time, by the profuſe perſpiration, and perhaps by the foaming at the mouth. I may add, that as the human conſtitution re-ſiſts,

* An intelligent friend of mine related to me the caſe of a perſon who, for a ſhort time, was ſeverely affected from the eating of wild honey, in Virginia. He imagined that a perſon ſeized him rudely by one arm, and then by the other. After this, he fell into convulſions, from which, however, he recovered, in about an hour. It was imagined that this honey was obtained from a kind of poiſonous muſhroom.

† The Kalmia latifolia.

‡ We ſhall afterwards ſee, that not one of Xenophon's men died from the deleterious honey which they had eaten, in large quantities, on the ſhores of the Euxine-Sea.

ſiſts, to an aſtoniſhing degree, the effects of the narcotick and other poiſonous vegetables that are beſt known to us, ſo we need not wonder, that it alſo reſiſts the effects of the deleterious honey, which is procured from ſuch vegetables.

It deſerves to be mentioned, that the honey which is formed by two different hives of bees in the ſame tree, or at a little diſtance from each other, often poſſeſſes the moſt oppoſite properties. Nay, the honey from the ſame individual comb is ſometimes not leſs different in taſte, in colour, and in its effects. Thus one ſtratum or portion of it may be eaten without the leaſt inconvenience, whilſt that which is immediately adjacent to it ſhall occaſion the ſeveral effects which I have juſt enumerated.

I have taken ſome pains to learn what are the ſigns by which the deleterious honey may, at firſt view, be diſtinguiſhed from innocent honey. I am informed that there is no difficulty in the matter.

The poiſonous honey is ſaid, by ſome, to be of a crimſon-colour: by others, it is ſaid to be of a reddiſh-brown colour, and of a thicker conſiſtence than common innocent honey.

Theſe are the ſigns by which, I am told, the moſt experienced hunters, in the ſouthern parts of North-America, are enabled to diſtinguiſh pernicious from innocent honey.

On a ſubject ſuch as this, I feel every diſpoſition to pay a good deal of deference to the experience of an American hunter. Even philoſophers may obtain much uſeful information from hunters, however wandering their life, however rude their manners. It is in the power of our hunters to enrich natural hiſtory with many important facts. But we ought not, I preſume, to confide implicitly in every thing they tell us.

I have

I have good reaſons for doubting whether the ſigns which I have mentioned will enable us, in every inſtance, to determine whether honey be poiſonous or innocent.

The honey of the bee, undoubtedly ſometimes partakes of the colour of the flowers from which it is gathered. The bees gather honey from many flowers of a crimſon colour, and from many flowers whoſe colour is a reddiſh brown. In theſe caſes, it is probable that the honey will ſometimes borrow, in ſome degree, the colour of the flowers. Yet there are many crimſon-coloured and reddiſh-brown coloured flowers that are perfectly innocent. The honey obtained from them will, I preſume, be innocent alſo. Mr. Bruce ſays he was ſurpriſed to ſee, at Dixan, in Abyſſinia, "the honey red like blood, and nothing," he remarks, "can have an appearance more diſguſting than this, when mixed with melted butter."* Nothing is ſaid, by this author, that can lead us to ſuppoſe that the Dixan honey was poiſonous. From the manner in which it is mentioned, it is pretty evident that it was not poiſonous. Linnæus, informs us that in Sweden the honey, in the autumn, is principally gathered from the flowers of the erica, or heath, and that this honey is of a ſomewhat reddiſh colour; and accordingly, he obſerves, thoſe provinces of the country that are deſtitute of the heath, ſuch as the province of Oelandia, furniſh a white honey.† The great naturaliſt ſays nothing concerning the properties of the heath-honey. However, we may preſume, when we recollect the minute accuracy of Linnæus, that this honey did not poſſeſs any dangerous properties, otherwiſe he would have noticed the circumſtance. Whilſt I reſided in Edinburgh, I had

* Travels to diſcover the ſource of the Nile. Vol. V. or Appendix, p. 151. Quarto edition.

† Fauna Suecica.

I had the honey from the Highlands frequently brought to my table. I often remarked that this honey had a dirty brownifh colour, and I was told that it was chiefly procured from the different fpecies of erica, perhaps principally from the " blooming hather,"* which abound in the Highlands. I never heard the people in Edinburgh, although they confume large quantities of this honey, complain that it poffeffes any noxious property. If it were actively poifonous, or injurious, the quality would have been, long fince, obferved. I well remember, however, that, for two years that I ufed it, it almoft always rendered me drowfy. Sometimes, indeed, it compofed me to fleep as effectually as a moderate dofe of laudanum would have done. A foreigner, who had not been accuftomed to eat anodyne honey, was better capable of remarking the effect which I have mentioned than the natives, who had been in the habit of ufing it, from their infancy. I do not find that this fingular property of the Scots honey has been noticed by any writer.† I have, therefore, related it, though it rather oppofes any objection to the figns employed by our hunters to diftinguifh poifonous from innocent honey. But he who is ftudious of truth, fhould relate ufeful facts, as they are, without regarding what is their connection with a favourite fyftem, or opinion.

The learned Jofeph Acofta fpeaks of a grey-coloured honey comb which he faw, in the province of Charcas, in South-America. The honey of this comb, he fays, is " fharp and black." He fays nothing farther of its properties.‡

An

* Burns.

† Dr. Withering fays bees extract a great deal of honey from the flowers of the erica vulgaris, or common heath, and he remarks that " where heath abounds, the honey has a reddifh caft." A Botanical Arrangement of Britifh plants, &c. Vol. 1ft.

‡ The Naturall and Morall Hiftorie of the Eaft and Weft Indies, &c. p. 303.

An ingenious friend of mine,* to whom the public are indebted for a variety of valuable information concerning the natural productions of various parts of North-America, informs me, that, in the Carolinas, and Floridas, the poisonous honey is often so similar, in colour, taste, and odour, to the common, or innocent honey, that the former cannot be distinguished from the latter. It is owing, he says, to this circumstance, that so many accidents daily happen from the use of the wild honey. He was informed, that it is experience alone which enables the hunters and others to determine, whether the honey which they find in the woods be poisonous or innocent. They have observed that the injurious effects manifest themselves in a short time after the honey is taken into the stomach. They are accustomed, therefore, to eat a small quantity, before they venture to satisfy their appetite. Should this produce *any* disagreeable effects, they do not think it prudent to continue the use of it. But, if in a short time, it should occasion no inconvenience, they think they may, with perfect safety, indulge their appetite to the full

I have been informed that the poisonous honey, by boiling and by straining, may be rendered as innocent as any honey whatever. It is, likewise, said, that by long keeping it becomes harmless.

The honey of which I am treating is poisonous to dogs, as well as to men.

Hitherto, I have not been able to obtain any certain information concerning the means to be pursued in the treatment of persons labouring under the effects of the poisonous honey. It is said that the Indians, and some of the Whites, use cold bathing with advantage. It is probable that this practice has been useful. As the effects produced by this honey are so similar to those produced by

* Mr. William Bartram.

by ſeveral narcotic vegetables that are well known to us, ſuch as opium, henbane,* thorn-apple,† &c. it is probable that the ſame means of treatment will be found uſeful in both caſes. Of thoſe means it is not neceſſary to make particular mention in this place.

It would be curious to aſcertain, whether the bees are ever injured or deſtroyed by the quaffing of the nectar of the flowers from which they prepare the poiſonous honey. It is probable that they are; and, perhaps, ſome of the diſeaſes of theſe little inſects may ariſe from this ſource.‡ It is true, indeed, that there are ſome poiſonous plants the nectar of which the bees will not touch. This is the caſe with the fritillaria imperialis, or crown-imperial.§ I do not remember to have ſeen bees in, or immediately about, the flowers of the common roſebay, or oleander,|| in the tube of which there is a fluid which deſtroys thouſands of the common houſe flies. But what is called inſtinct is not always ſure. The bees may prepare an honey from plants that are very injurious to them. The excellent Mr. Evelyn, ſpeaking of the elm ſays, "but I hear an ill report of this tree for bees, that, ſurfeiting of the blooming ſeeds, they are obnoxious to the laſk,¶ at their firſt going abroad in ſpring, which endangers whole flocks, if remedies be not timely exhibited; therefore, 'tis ſaid, in great elm

* Hyoſcyamus niger.

† Datura ſtramonium.

‡ Dr. James E. Smith aſſerts that the honey or nectar of plants is not poiſonous to bees. *Syllabus to a Courſe of Lectures on Botany*, p. 23. I have ſome good reaſon to believe that, ſometimes at leaſt, the contrary is the caſe.

§ Linnæus, ſpeaking of this plant, ſays, "Nulla, excepto *Melianthο*, copioſiori melle ſcatet planta, quam hæc; ſed apes id non colligunt!" Prælectiones in Ordines Naturales Plantarum. Edidit Giſeke. p. 287. Hamburgi, 1792.

|| Nerium oleander.

¶ This is one of the moſt mortal diſeaſes of bees. It is beautifully deſcribed, and the remedies for it mentioned, by Virgil, Georgic. Lib. iv. l. 251—280.

countries they do not thrive; but the truth of which I am yet to learn."*

In South-Carolina, in Georgia, and in the two Floridas, but more eſpecially in Eaſt-Florida, the inſtances of injuries from the eating of wild-honey are more numerous than in any other parts of North-America, that are known to us.

There is a tract of country included between the rivers St. Illa and St. Mary's, in Eaſt-Florida, that is remarkable for abounding in vaſt numbers of bees. Theſe inſects, which were originally introduced into Florida by the Spaniards,† have encreaſed into innumerable ſwarms, from the facility with which they procure their food, in perhaps the richeſt flowered-country of North-America. In this tract of country, the alarming effects of the wild-honey are often experienced, by the ſettlers, by wandering hunters, and by ſavages.

It is highly probable, that this poiſonous honey is procured from a conſiderable number of the flowers of the countries which I have mentioned. A complete liſt of theſe flowers would be acceptable: but ſuch a liſt it will be difficult to procure at preſent. Perhaps, my hints may induce ſome intelligent native of the country to favour us with his obſervations on the ſubject. Meanwhile, I am happy to have it in my power to mention ſome of the vegetables from whoſe flowers the bees extract a deleterious honey, not only in the country between the St. Illa and St. Mary's, but alſo in ſome other parts of North-America.

Theſe vegetables are the kalmia anguſtifolia and latifolia of Linnæus, the kalmia hirſuta of Walter,‡ the andromeda mariana, and ſome other ſpecies of this genus.

I. Every

* Silva: or a Diſcourſe on Foreſt-trees, &c. p. 133 and 134. Dr. Hunter's edition.

† See Tranſactions of the American Philoſophical Society. Vol. III. No. 31.

‡ Flora Caroliniana, p. 138.

I. Every American has heard of the poiſonous properties of the kalmia anguſtifolia and latifolia. The former of theſe plants is known, in the United States, by the names of dwarf-laurel, ivy, lambkill, &c. It has long been known, that its leaves, when eaten by ſheep, prove fatal to them. The following fact will ſhow that the flowers likewiſe are endued with a poiſonous property.

About twenty years ſince, a party of young men, ſolicited by the proſpect of gain, moved, with a few hives of bees, from Pennſylvania, into the Jerſeys. They were induced to believe that the ſavannas of this latter country were very favourable to the encreaſe of their bees, and, conſequently, to the making of honey. They, accordingly, placed their hives in the midſt of theſe ſavannas, which were finely painted with the flowers of the kalmia anguſtifolia. The bees encreaſed prodigiouſly, and it was evident that the principal part of the honey which they made was obtained from the flowers of the plant which I have juſt mentioned. I cannot learn that there was any thing uncommon in the appearance of the honey: but all the adventurers, who eat of it, became intoxicated, to a great degree. From this experiment, they were ſenſible that it would not be prudent to ſell their honey; but, unwilling to looſe all their labour, they made the honey into the drink well known by the name of metheglin, ſuppoſing that the intoxicating quality which had reſided in the honey would be loſt in the metheglin. In this reſpect, however, they were miſtaken. The drink alſo intoxicated them, after which they removed their hives.

In North-Carolina, this ſpecies of kalmia and the andromeda mariana are ſuppoſed to be the principal vegetables from which the bees prepare the poiſonous honey, that is common in that part of the United States.

II. The kalmia latifolia, known in the United States by the names of laurel, great-laurel, wintergreen, ſpoon-haunch, ſpoon-wood, &c. is alſo a poiſon. Its leaves, indeed, are eaten, with impunity, by the deer,* and by the round-horned elk.† But they are poiſonous to ſheep, to horned-cattle and to horſes. In the former of theſe animals, they produce convulſions, foaming at the mouth, and death. Many of General Bradock's horſes were deſtroyed by eating the leaves and the twigs of this ſhrub, in the month of June 1755, a few days before this unfortunate General's defeat and death. In the ſevere winter of the years 1790 and 1791, there appeared to be ſuch unequivocal reaſons for believing that ſeveral perſons, in Philadelphia, had died in conſequence of their eating our pheaſant,‡ in whoſe crops the leaves and buds of the kalmia latifolia were found, that the mayor of the city thought it prudent and his duty, to warn the people againſt the uſe of this bird, by a publick proclamation. I know that by many perſons, eſpecially by ſome lovers of pheaſant-fleſh, the circumſtance juſt mentioned, was ſuppoſed to be deſtitute of foundation. But the foundation was a ſolid one. This might be ſhown by ſeveral well-authenticated facts. It is ſufficient for my preſent purpoſe to obſerve, that the collection of a deleterious honey from the flowers of this ſpecies of kalmia gives ſome countenance to the opinion, that the fleſh of pheaſants that had eaten of the leaves and buds of this plant may have been impregnated with a pernicious quality.§

I have

* Cervus Virginianus of Gmelin.

† Cervus Wapiti, *mihi*.

‡ Tetrao Cupido of Linnæus.

§ It is not a new ſuſpicion, that the fleſh of animals that have eaten of the leaves, &c. of deleterious vegetables is ſometimes endued with a poiſonous property. Georg. H. Welſchius, a very learned German writer, quoted

I have been informed, that our Indians ſometimes intentionally poiſon themſelves with a decoction of the leaves of this kalmia. The powder of the leaves has been employed (but I ſuſpect with little advantage) in the inflammatory ſtage of certain fevers. From experiments made upon myſelf, I find that this powder is ſternutatory.

To ſome conſtitutions the flowers of the kalmia latifolia, even externally applied, are found to prove injurious.

III. The kalmia hirſuta appears to poſſeſs nearly the ſame properties as the two ſpecies which I have juſt mentioned. This pretty little ſhrub is a native of South-Carolina, Georgia, and Florida.

In Georgia and in Florida, this ſpecies of kalmia is ſuppoſed to be the principal vegetable from which the deleterious honey in thoſe parts of our continent is procured.

IV. The andromeda mariana, or broad leafed moorwort, is a very common plant in many parts of North America. The leaves are poiſonous to ſheep. The petioli, or foot-ſtalks of the leaves and the ſeeds, within the ſeed-veſſel, are covered with a brown powder, ſimilar to that of the kalmiæ. This powder applied to the noſtrils occaſions violent ſneezing.* From the flowers of this plant, the bees extract conſiderable quantities of honey; and it deſerves to be mentioned that this honey, as well as that obtained from ſome other American ſpecies

quoted by Dr. Haller, (See *Hiſtoria Stirpium Indigenarum Helvetiæ Inchoata.* Tom. I. p. 433.) ſays, that the fleſh of a hare which was fed with the leaves of the rhododendron ferrugineum proved mortal to the gueſts. This ſpecies of rhododendron is a native of Switzerland, Siberia, and other parts of the old world.

* For ſome information relative to the properties of the andromeda mariana, ſee Collections for an Eſſay towards a Materia Medica of the United-States, pages 19, 20, 47. Philadelphia, 1798.

ſpecies of andromeda, has frequently the very ſmell of the flowers from which it is obtained.*

I have already obſerved, that it is highly probable, that the American poiſonous honey is procured from the flowers of a conſiderable number of the plants of the country. I have mentioned but a few of them. But there are many others which I have ſome reaſons for ſuſpecting are alſo capable of affording an injurious honey. Indeed, every flower that is poiſonous to man, and is capable of affording honey, may produce an honey injurious to man; ſince the properties of this fluid are ſo dependent upon the properties of the plants from which it is procured. There is, therefore, more poetry than philoſophy in the following lines of Mr. Pope:

> "In the nice bee, what ſenſe ſo ſubtly true,
> "From pois'nous herbs extracts the healing dew."
>
> Essay on Man. Epiſtle I. lines 211 & 212.

I have been informed that in the ſouthern parts of our continent, there is a plant, called hemlock, from the flowers of which the bees prepare a honey that is poiſonous. The flowers are ſaid to be yellow, and the root a deadly poiſon. I do not know what plant this is. Moſt probably, it is ſome umbelliferous plant, perhaps a cicuta, an angelica, or a ſcandix.

Some ſpecies of agaricus, at leaſt ſome fungous vegetables, that grow in the ſouthern ſtates, are extremely

poiſonous.

* In juſtice to the fine genus of andromeda, I muſt obſerve, that all the ſpecies do not furniſh a pernicious honey. The andromeda nitida or lucida of Bartram affords an abundance of nectar, or honey. The flowers of this ſpecies are called by the country people of Carolina and Georgia, "honey-flowers," not, however, merely from the circumſtance juſt mentioned, but from the regular poſition of the flowers on the peduncle, which open like the cells of a honey-comb, and from the odour of theſe flowers, which greatly reſembles that of honey. This ſpecies grows abundantly in the ſwamps called bay-galls. The inhabitants of Carolina are univerſally of opinion, that it affords the greateſt quantity of honey, and that of the beſt quality.

poisonous. As accidents from the use of deleterious honey have happened in the same countries in which these poisonous fungi grow, it has been supposed, and asserted, that the poisonous honey is prepared from a dew that collects upon these fungi. Perhaps, this supposition is not entirely devoid of foundation.*

I shall now mention a few vegetables from the flowers of which, I think, it will be found, that the bees collect a poisonous, or injurious honey. These are:

I. The rhododendron maximum, or Pennsylvania mountain laurel. This belongs to a very active genus of plants. We have already seen, that one of the species, the rhododendron ferrugineum, was, long ago, observed to produce the same effects which have been ascribed to the kalmia latifolia. Another species, the rhododendron crysanthum, has been found a powerful medicine, and has

* If the celebrated author of the *Recherches Philosophiques sur les Americans* be still living, this account of our poisonous and injurious honey (should my memoir fall into his hands) would afford him some entertainment. I would advise him to connect the facts, which I here communicate, with the remarks concerning our insects contained in the first volume of the *Recherches* (see p. 169 and 170). I hope, however, that Mr. De Pauw, who, notwithstanding his love of system and his many errors, is certainly a man of great reading, will recollect, that the Greek and Roman writers (as we shall afterwards see) have said much concerning the poisonous honey of various parts of the old world. And now let me add, that in America there is as good honey as in any other parts of the world; and there is not a scarcity of this good honey. The honey which is collected from the flowers of the tulip-tree (liriodendron tulipifera), the buckwheat (polygonum fagopyrum), the red-maple (acer rubrum), the clover (trifolium), and many other plants is excellent. The Abbe Clavigero says the bee of Yucatan and Chiapa makes "the fine clear honey of Estabentun, of an aromatic flavour, superior to that of all the other kinds of honey with which we are acquainted." (A) *The History of Mexico*, Vol. I. p. 68. Perhaps on some future occasion, I may communicate to the Philosophical Society a list of those indigenous vegetables which, as furnishing an innocent and excellent honey, are worthy of preservation in the neighbourhood of apiaries. The list is an extensive one.

(A) This fine honey, according to the Mexican historian, is "made from a fragrant white flour like jessamine, which blows in September."

has been ufed, in Ruffia, with much advantage, in the ifchias, in chronick rheumatifm, and in other difeafes; and we fhall immediately fee that from another fpecies a poifonous honey has been procured in the neighbourhood of the Euxine-Sea. The footftalks of the leaves, and alfo the feeds, of our rhododendron maximum are covered with the fame brown powder as I obferved covered the leaf-footftalks and the feeds of feveral of the andromedæ, and the kalmiæ. This powder in the rhododendron, as well as in the andromedæ and kalmiæ, excites fneezing, and it is curious to obferve that a fneezing is mentioned by Diofcorides among the fymptoms produced by the honey about Heraclea Pontica. That honey, as will be prefently fhown, is procured from the rhododendron ponticum.

II. The azalea nudiflora. This fine fhrub is well known in Pennfylvania, and other parts of the United States, by the name of wild honeyfuckle. Of its properties I know nothing certain. It has, however, too much of the family face, and is too frequently found in company with the rhododendron maximum, and the kalmiæ, not to make me fufpicious that it partakes alfo of the characters of thefe deleterious vegetables. Moreover, a fpecies of this genus, the azalea pontica of Linnæus, is fuppofed to be the ægolethron of Pliny, who mentions it as the plant from which the poifonous honey about Heraclea Pontica is prepared. The tube of the flower of our azalea is perforated by the large bee, called bumble-bee.

III. Datura ftramonium. This plant is known by a variety of names, fuch as Jameftown-weed, gymfin, ftink-weed, French-chefnut. Its active and poifonous properties are now pretty generally known. Children have often been injured by eating the feeds. The tube of the flower contains a confiderable quantity of honey. This

This honey is bitter, and has much of the poiſonous ſmell. Bees quaff it. But admitting that it is of a poiſonous nature, it does not follow that our *cultivated* bees (if I may be allowed to uſe this expreſſion) will collect ſo much of this honey as to prove injurious to thoſe who eat of it. But, in particular places, where this plant has been permitted to increaſe to a great degree, large quantities of honey may be collected from it: and I cannot help ſuſpecting that the uſe of this honey may prove injurious*.

Some of the ancient writers of Greece and Rome have related inſtances of the deleterious properties of the honey of certain countries. The botaniſt Dioſcorides, ſpeaking of the rhododendron ponticum, a ſpecies of the ſame genus to which our mountain laurel belongs, has the following words: "About Heraclea Pontica, at certain ſeaſons of the year, the honey occaſions madneſs in thoſe who eat of it; and this is undoubtedly owing to the quality of the flowers from which the honey is diſtilled. This honey occaſions an abundant ſweating, but the patients are eaſed by giving them rue, ſalt-meats, and metheglin, in proportion as they vomit. This honey," continues the Greek botaniſt, "is very acid, and cauſes ſneezing. It takes away redneſs from the face, when pounded with coſtus. Mixed with ſalt or aloes, it diſperſes the black ſpots which remain after bruiſes. If dogs or ſwine ſwallow the excrements of perſons who have eaten of this honey, they fall into the ſame accidents.†"

Pliny has alſo taken notice of this poiſonous honey. "In ſome years," ſays the Roman naturaliſt, "the honey is very dangerous about Heraclea Pontica. It is not known to

* See the late Dr. Samuel Cooper's Inaugural Diſſertation on the Properties and Effects of the Datura Stramonium. p. 33. Philadelphia, 1797.

† Dioſcorides, as quoted by Mr. Tournefort.

authors from what flowers the bees extract this honey. Here is what we have learned of the matter. In thofe parts, there is a plant called ægolethron, whofe flowers, in a wet fpring acquire a very dangerous quality, when they fade. The honey which the bees make of them is more liquid than ufual, more heavy, and redder. Its fmell caufes fneezing. Thofe who have eaten of it fweat exceffively, lie upon the ground, and call for nothing but cool drinks.*" He then makes the very remarks which I have quoted from Diofcorides, whofe words, indeed, as Mr. Tournefort obferves, he feems to have merely tranflated. The following remark, however, appears to belong to Pliny. "Upon the fame coaft of the Pontus, there is found another fort of honey, which is called mœnomenon†, becaufe thofe who eat of it are rendered mad. It is fuppofed, the bees collect it from the flowers of the rhododendros, which is common among the forefts. The people of thofe parts, although they pay the Romans a part of their tribute in wax, are very cautious how they offer them their honey‡."

The Greeks and the Romans have often defcribed the various plants that were known to them, in fuch dark and obfcure terms, that the botanifts of modern times are frequently at a lofs to determine, not merely the fpecies but alfo the genus the ancient writers have mentioned. With refpect, however, to the plants which I have juft mentioned, the difficulty does not feem to be great. Mr. Tournefort has, I think, fhown, in a very fatisfactory manner, that the ægolethron of Pliny is the chamærhododendros pontica maxima, Mefpili folio, flore luteo of his *Inftitutiones*, a plant fince defcribed by Linnæus, and

* C. Plinii Secundi Naturalis Hiftoriæ Lib. XXI. cap. xiii.

† From the Greek verb, Μαίνομαι, infanio.

‡ Ibid.

and by other botanifts by the name of azalea pontica. Mr. Tournefort has likewife fhown, that the other plant called by Pliny rhododendros is his chamærhododendros pontica maxima, folio laurocerafi, flore cœruleo purpurefcente*. This is the rhododendron ponticum of Linnæus. It is confiderably allied to the azalea pontica.

Xenophon has recorded the remarkable effects of fome poifonous honey, in his celebrated work, called *Memorabilia*.

When the army of the ten thoufand had arrived near Trebifond, on the coaft of the Euxine or Black-Sea, an accident befel the troops, which was a caufe of great confternation. "As there were a great many bee-hives," fay the illuftrious general and hiftorian, "the foldiers did not fpare the honey. They were taken with a vomiting and purging, attended with a delirium, fo that the leaft affected feemed like men drunk, and others like mad men, or people on the point of death. The earth was ftrewed with bodies, as after a battle; not a perfon, however, died, and the diforder ceafed the next day, about the fame hour that it began. On the third and fourth days, the foldiers rofe, but in the condition people are in after taking a ftrong potion.†"

The fame fact is recorded by Diodorus Siculus.

Mr. Tournefort thinks there is every probability that this poifonous honey was fucked from the flowers of fome fpecies of chamærhododendros, or rhododendron. He obferves that all the country about Trebifond is full of the fpecies of this plant, and he remarks that Father Lambert, Theatin miffionary, agrees that the honey which

 the

* Inftitutiones, &c.

† Thefe are nearly the words of Mr. Tournefort's tranflation. I am forry that I have not the original work of Xenophon at hand.

the bees extract from a certain ſhrub in Colchis or Mingrelia, is dangerous, and cauſes vomiting. Lambert calls this ſhrub oleandro giallo, or the yellow roſe-laurel, which Mr. Tournefort ſays is, without diſpute, his chamærhododendros pontica maxima, Meſpili folio, flore luteo*; the azalea pontica, already mentioned.

There are ſeveral paſſages in the Roman poets, which plainly ſhow, that they were no ſtrangers to the poiſonous properties of certain kinds of honey. It is not neceſſary to mention all theſe paſſages. But the following are worthy of notice.

Virgil cautions us not to ſuffer a yew tree to grow about bee-hives:

Neu propius tectis taxum ſine.——————

GEORGIC. Lib. IV. l. 47.

In his 9th Eclogue, the ſame philoſophic poet ſpeaks of the yews of Corſica as being particularly injurious to bees.

Sic tua Cyrnæas fugiant examina taxos. l. 30.

The honey of Corſica was, as Dr. Martyn ſtrongly expreſſes it, "infamous for its evil qualities†."

The

* See Tournefort's Voyage into the Levant. Vol. iii. p. 68. Engliſh tranſlation. London, 1741.

† See his Tranſlation of the Georgics of Virgil, note to line 47, in book IV. Dr. Martyn's criticiſms and annotations always demand attention. I greatly doubt, however, if the taxus of Virgil, be the common yew, or any ſpecies of that genus. Martyn himſelf allows, that "it does not appear from other writers (beſide Virgil), that Corſica abounded in yews." I have been aſſured, that the yew is not an indigenous vegetable in that iſland, and that it is even rare among the foreign vegetables. It may, indeed, be ſaid, perhaps it was common in the time of Virgil. I would obſerve, that the yew is much leſs poiſonous than has been commonly ſuppoſed. I know not that any modern writer has pretended that the bees procure a pernicious honey from its flowers. Theſe facts give riſe to my ſuſpicion, that the taxus of Virgil was not the yew, or taxus of the modern botaniſts. If not the yew, what vegetable was it? Perhaps, the buxus virens, or box. This vegetable abounds in Corſica, where to this day it is known by the name of

The raiſing of bees, for the purpoſes of procuring their honey and their wax, may, at ſome future period, become an object of great importance to the United-States. Surely then, it would be a matter of conſequence to attend to the cultivation or preſervation of thoſe vegetables which furniſh an innocent and a well-flavoured honey, and a good wax. But even in a more limited view of the ſubject, ſome knowledge of theſe vegetables ſeems to be indiſpenſibly neceſſary. And in the new ſettlement, whither the ſettler has carried his bees, where improvements are ſtill very imperfect, it cannot be deemed a trivial taſk to have pointed out ſome of thoſe vegetables from which an injurious honey is obtained.

The ancients, who, in ſome reſpects at leaſt, were equal to the moderns, appear to have paid much attention to this ſubject. Virgil* and Columella have both told us what plants ought to grow about apiaries. It is unneceſſary to repeat, in this place, what the two Roman writers have ſaid on the ſubject. The *Georgics* of the Mantuan poet are in the hands of every man of taſte; and the work of Columella‡ *ſhould* be read, wherever agriculture engages the attention of gentlemen.

The proper management of bees may be conſidered as a ſcience. It is not ſufficient that bees merely make honey and wax. Their honey may be injurious or poiſonous, and their wax may be nearly uſeleſs. To aſſiſt, and to direct the labours of theſe little inſects, the knowledge and the hand of man are required. Let, then, this intereſted

taxo. The gentleman from whom I received this information aſſured me, that the bees of Corſica are very fond of the flowers of the box, and that the honey from this ſource is reputed poiſonous. The box is, unqueſtionably, a poiſonous vegetable. But there is ſtill a difficulty in the caſe. Virgil mentions both taxus and buxus. I think there can be no doubt that his buxus (ſee Georgic. lib. II. l. 449.) is the buxus of the modern botaniſts.

* See Georgicorum, lib. IV. l. 30.—32.

‡ De Re Ruſtica, libri XII.

interested being be at least attentive to his own benefits and pleasures. Let him carefully remove from about the habitations of his bees every fetid or poisonous vegetable, however comely its colour or its form. In particular, let him be careful to remove those vegetables which are noxious to himself. In place of these, let him spread the "marjoram and thyme," and other plants, "the love of bees,*" and his labours will be rewarded. He may, then, furnish his table with an honey not inferior to that of Mount Hermettus, or of Athens; nor to that of Sicily, to which Virgil has so handsomely alluded in the seventh Eclogue:

Nerine Galatea, thymo mihi dulcior Hyblæ,
Candidior cygnis, hederâ formosior albâ.

L. 37, 38.

* Armstrong.

No.

No. VIII.

On the Ephoron Leukon, usually called the White Fly of Passaick River. By Dr. WILLIAMSON.

Read Feb. 1, 1799. THESE insects are of the order called neuroptera. Lin. Syst. Nat.

The eyes are large and prominent.

The stemmata are wanting.

The wings are plain, patent, membranaceous, reticulated. The under wings shorter and narrower than the upper wings by more than one half. They are attached to the body a little behind and below the upper wings and are nearly covered by them.

The antennæ are cetaceous, half an inch long, having six articulations besides the base.

From the tail there are two cetaceous appendices about one inch and a half long. They diverge making an angle of 12 or 14 degrees. Each of them contains 15 or 20 small knots resembling articulations.

The tail, perhaps of the males, is furnished with two small crooked filaments hardly one-tenth of an inch in length, that are inserted below the cetaceous appendices, their points turn inward so as to form pincers.

The length of the insect is half an inch.

The trunk is not thicker than a grain of rye. The abdomen is much smaller.

The wings, abdomen and legs are perfectly white.

The eyes black; the trunk of a brownish colour.

Their flight in speed is nearly equal to that of the dragon flies.

Neither mouth nor feet could be described from the want of a microscope.

They

They begin to riſe out of the river 35 or 40 minutes after the ſun ſets and continue riſing about fifteen minutes.

We have no information concerning the larvæ of thoſe inſects.

The cryſalis, in which form they riſe to the ſurface of the water, is not diſtinguiſhable from the perfect inſect in ſhape or colour.

The cryſalis depoſits a thin white pellicle or ſkin on the ſurface of the water and riſes a perfect inſect. It continues on the wing about an hour and periſhes.

Some of them, not one in a hundred, riſe from the water in the form of a cryſalis. They fly immediately to the ſhore and in leſs than a minute they creep through the white pellicle that covered the trunk, abdomen and appendices, and rejoin their companions on the wing.

In their flight they ſeldom riſe more than ſix or eight feet above the water, but they uſually ſkim or play near the ſurface.

The female drops two cluſters of eggs upon the water and periſhes immediately.

The eggs are yellow. Each cluſter is nearly one quarter of an inch in length and the thickneſs of a common pin, reſembling the roe of a fiſh and containing about 100 eggs. They ſink in the water.

As thoſe inſects are not ſeen to couple on the wing it is preſumed that the male fecundates the eggs when they drop on the water.

Theſe flies are ſo numerous that they appear ſome evenings like thick driven ſnow in a cloud that is hardly tranſparent.

Theſe inſects, who differ in many particulars from the ephemera, are not eaſily reduced to any genus deſcribed by Linnæus, Geoffroy or Scheffer. They muſt be be of the order called neuroptera, but an eighth genus is to be added to that order.

They are natives of the river Paſſaick, but their utmoſt range on that river is not above two miles and a half. They riſe about three quarters of a mile below the bridge at Belville and one mile and a half above that bridge. Within thoſe limits they riſe without number, but no where elſe in the river, though there is a regular tide nine miles above the bridge and there is not any ſalt water within three miles of it. They are not found, as we are told, in any of the neighbouring rivers.

Their firſt appearance every year is about the 20th of July, and they continue riſing every evening more or leſs about three weeks.

They ſeek the light, for they fly in crouds to a lamp or candle, but they are ſuppoſed to be the only genus of winged inſects that never ſee the ſun.

The inſect of an hour, that is never at reſt, might ſerve for a ſtrong figure in the hands of a peeviſh philoſopher.

No. IX.

Remarks on certain Articles found in an Indian Tumulus at Cincinnati, and now depoſited in the Muſeum of the American Philoſophical Society. By GEORGE TURNER.

Philadelphia, November 25th, 1799.

SIR,

Read Dec. 6th, 1799. AS the writer of the paper No. XXII. Vol. IV. p. 179. of the Society's Tranſactions, appears to be under ſome miſconceptions concerning *certain* articles found in an Indian tumulus at Cincinnati, and now depoſited in the Society's muſeum, I beg leave to offer a few remarks on them.

* Fig. 1. and 2. are each deſcribed to be "a ſtone or *compoſition*."

Remark. Both are *natural* ſtones. The former reſembles the greeniſh grey porphyry: the latter is a jaſper [*heliotrope*] marked with blood-coloured veins and ſpots on a green baſis.

Fig. 3. "A *cryſtalline ſubſtance*," &c. "of *conſiderable* tranſparency."

Rem. This is *pure rock cryſtal, perfectly tranſparent.*

Fig. 4. "*As figure* 1. Mixed black and yellow colours."

Rem. This, too, is a *natural* ſtone, a beautiful ſpecimen of granite.

Fig. 5. "Probably a *compoſition*," &c. "ſeems to have been hardened by the *ſun or fire*, and unequally compreſſed by the operation."

Rem.

* See the plate, p. 180.

Rem. This is evidently a *natural* production; a ferruginous ſtone, and perhaps of volcanic origin.

Fig. 6. "A repreſentation of the bill of ſome bird *not now known in this country.*"

Rem. It is a bill or beak by no means unknown in the United States, being common to all rapacious birds, ſuch as the eagle, hawk, vulture, &c. their upper mandible, like that of the preſent ſubject, having a cultrated point, the diſtinguiſhing mark of birds belonging to that claſs. From the ſize and general form of this figure, it appears to have been deſigned to repreſent the beak of an eagle.

Fig. 7. "A regular circular figure, of ruſty black colour, tolerably well poliſhed, and not unlike ebony in appearance, but much leſs ponderous; probably either of coal or a *compoſition.*"

Rem. The former part of the writer's conjecture as to the ſubſtance of this article is right, as far as it goes: it is not the ordinary coal, however, but what is uſually termed Cannel coal [*ampelites*] as the bare inſpection of the ſubject will diſcover.* Col. Sargent ſuppoſes, that the ſmall perforations in the rim were deſigned to ſecure it upon a large axis. But, if a rotatory motion was intended to be given to it, an angular perforation in the centre, inſtead of the circular one there, would have far more efficiently anſwered that purpoſe. It is worthy of remark here, that in the Tranſ-

* Were farther proof neceſſary, I might refer to the ſpecimen of Cannel coal brought from Cincinnati and by me preſented to the Society.

actions of the Scots Antiquaries, vol. i. p. 388, there is a plate of two ancient fibulæ, both formed out of *Cannel* coal. One of them, like this, is of a circular figure, but narrower in the rim, and rather leſs in diameter. Perhaps, both were deſigned for ſimilar purpoſes by their ancient rude owners, though ſeparated by an ocean a thouſand leagues wide! Kindred acts will ſpring from kindred manners.

Fig. 8. "Alſo a ſimilar figure,* yellowiſh colour; appears to have been hardened by the *ſun or fire*, and *glazed*," &c.

Rem. This, which is much ſmaller than the preceding ſubject, has neither been hardened by *art, nor glazed*. It is formed of a fat tenacious argilla, ſuch as conſtitutes the Indian pipe-bowls. This earth is found of various hues, acquires, by expoſure to the air, a pretty firm texture, and is ſuſceptible of a fine poliſh—which, in the preſent inſtance, has been miſtaken for glazing.

I am, with great reſpect,

Sir,

Your moſt obedient,

G. TURNER.

Preſident of the
A. Philo. Soc.

No.

* A third fibula (if I may ſo term it) of nearly the ſame diameter with this, but of copper, was afterwards taken out of the ſame tumulus. It was compoſed of two plates of the metal, united and perforated at the centre.

No. X.

A Drawing and Description of the Clupea Tyrannus and Oniscus Prægustator. By Benjamin Henry Latrobe. F. A. P. S.

The committee to whom was referred Mr. Latrobe's paper on a species of oniscus, called by the author oniscus praegustator, reports, that the same is worthy of publication.

BENJAMIN SMITH BARTON.
February 17th, 1800.

Feb. 21, 1800.

Philadelphia, December 18th, 1799.

To Thomas P. Smith, one of the Secretaries of the American Philosophical Society.

Sir,

Read Feb. 7, 1800. I BEG leave, through your means, to communicate to the American Philosophical Society, an account of an insect, whose mode of habitation, at least during some part of his life, has appeared to me one of the most singular, not to say whimsical, that can be conceived.

In the month of March 1797, illness confined me for several days, at the house of a friend on York river in Virginia, during his absence. My inability to move further than to the shore of the river, gave me leisure to examine carefully, and in more than an hundred instances, the fact I am going to mention.

Among the fish that at this early season of the year resort to the waters of York river, the alewife or oldwife, called

called the *bay-alewife* (clupea *nondefcripta*) arrives in very confiderable fhoals, and in fome feafons their number is almoft incredible. They are fully of the fize of a large herring, and are principally diftinguifhed from the herring, by a *bay* or red fpot above the gill-fin. (fee the drawing) They are, when caught from March to May, full-roed and fat, and are at leaft as good a fifh for the table as the herring.

In this feafon, each of thefe alewives carries in her mouth an infect, about two inches long, hanging with its back downwards, and firmly holding itfelf by its 14 legs to the palate. The fifhermen call this infect *the loufe*. It is with difficulty that it can be feparated, and perhaps never without injury to the jaws of the fifh. The fifhermen therefore confider the infect as effential to the life of the fifh; for when it is taken out, and the fifh is thrown again into the water, he is incapable of fwimming, and foon dies. I endeavoured in numerous inftances to preferve both the infect and the fifh from injury, but was always obliged either to deftroy the one, or to injure the other. I have fometimes fucceeded in taking out the infect in a brifk and lively ftate. As foon as he was fet free from my grafp, he immediately fcrambled nimbly back into the mouth of the fifh, and refumed his pofition. In every inftance he was difguftingly corpulent, and unpleafant to handle; and it feemed, that whether he have obtained his poft, by force, or by favor, whether he be a mere traveller, or a conftant refident, or what elfe may be his bufinefs where he is found; he certainly has a *fat* place of it, and fares fumptuoufly every day.

The drawings annexed to this account were made from the live infect, and from the fifh out of whofe mouth he was taken. I had no books to refer to, then; but examining the Syftema Naturæ of Linnæus, I was furprized to find fo exact a defcription of the infect as follows

follows (ſee Salvii editio, Holmiæ 1763. p. 1060. alſo Trattner's Vienna edition, ſame page).

"*Inſect. apt.* ONISCUS, PEDES XIV.
Antennæ ſetaceæ
Corpus ovale.

O. Phyſodes, abdomine ſubtus nudo, caudâ ovatâ.

Habitat in pelago; corpus præter caput, et caudam ultimam, ex ſeptem ſegmentis trunci, et quinque caudæ. Antennæ utrinque duo, breves. Caudæ folium terminale omnino ovatum; ad latera utrinque ſubtus auctum duobus petiolis diphyllis, foliolis lanceolatis, obtuſis, caudâ brevioribus. Caudæ articuli ſubtus obtecti numeroſis veſiculis longitudine caudæ."

From the particularity with which the oniſcus phyſodes is deſcribed by Linnæus, it is evident that he had the inſect before him, or a deſcription by an attentive obſerver. It appears alſo from the "*Habitat in pelago*," that the O. phyſodes, if this be the inſect, is found detached from his conductor. There are a few points in which the O. phyſodes differs from my inſect. I did not obſerve the antennæ, perhaps for want of ſufficient attention, or of a microſcope. The petioli of the tail were not, to appearance, *two-leaved*, and I am certain that the ſegments of the tail, and the tail itſelf, were without the *veſiculi longitudine caudæ*.

There are many circumſtances, to aſcertain which is eſſential to the natural hiſtory of this inſect. The fiſh whoſe mouth he inhabits comes, about the ſame time with the chad, into the rivers of Virginia from the ocean, and continues to travel upwards from the beginning of March, to the middle of May; as long as they are caught upon their paſſage up the river, they are found fat and full of roe. Every fiſh which I ſaw had the oniſcus in his mouth; and I was aſſured, not only by the more ignorant fiſhermen, but by a very intelligent man who came

came down now and then to divert himſelf with fiſhing, that, in 40 years obſervation, he had never ſeen a bay alewife without the louſe. The chad begin to return from the freſh water lean and *ſhotten*, about the end of May and beginning of June, and continue deſcending during the remaining ſummer months. No one attempts then to catch them, for they are unfit for the table. Whether the bay alewife returns with the chad, I could not learn, but it is certain that after June it is not thought worth the trouble to catch them. No one could tell me *poſitively* whether the oniſcus ſtill continues with them, but it was the opinion of my informant, that, like every other paraſite, he deſerts his protector in his reduced ſtate, for he could not *recollect* that he had ever ſeen him in the mouth of thoſe accidentally caught in the ſeine in July or Auguſt.

I conſider, therefore, the natural hiſtory of the oniſcus, which I now communicate, as very imperfect; and it were to be wiſhed that ſome lover of natural ſcience would follow up the enquiry, by endeavoring to aſcertain whether he continue with, or quit the fiſh before his return to the ocean, and alſo whether he be the oniſcus phyſodes of Linnæus, *qui habitat in pelago.*

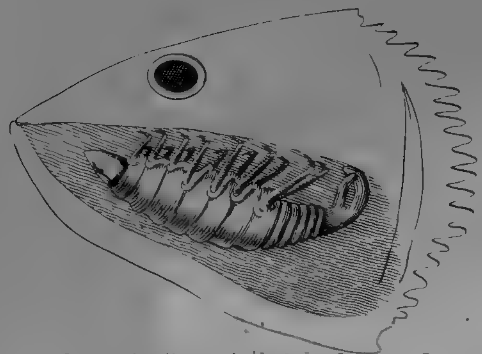
Should he be an inſect hitherto undeſcribed, I think he might be very aptly named *oniſcus prægustator.*

The bay alewife is not accurately deſcribed in any ichthyological work which I have ſeen; nor can I from my drawings, which were made with a very weak hand, venture a deſcription. From his having a regular prægustator, I would ſuggeſt that he ought to be named *clupea tyrannus.*

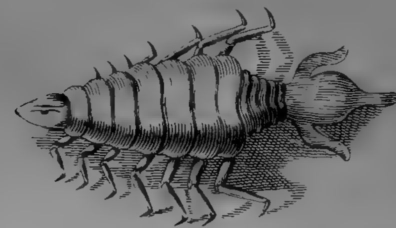
The oniſcus reſembles the minion of a tyrant in other reſpects, for he is not without thoſe who *ſuck* him. Many of thoſe which I caught had two or three leaches on their bodies, adhering ſo cloſely, that their removal coſt them

Plate 1.

The Oniscus praegustator, drawn to its natural size, by measurement.



The Insect, as it places itself in the mouth of the Clupea tyrannus.



Leaches, found upon the Insect.

Outline of the Clupea tyrannus, correctly drawn to its natural size.

Jones sc.

[illegible]

them their heads. Moſt of the marine oniſci appear to be troubleſome to ſome one or other fiſh. The oniſcus ceti is well known as the plague of whales, and many of the reſt are mentioned in Linnæus and Gmelin, as peſtes piſcium.

BENJ[N]. HENRY LATROBE, F. A. P. S.

P. S. A gentleman well ſkilled in entomology informs me that he believes, that in Block's Hiſtory of Fiſhes, a work not to be had in Philadelphia, this oniſcus is mentioned. But, from a late examination of Gmelin and Fabricius, I am convinced that the oniſcus prægustator is a ſpecies not hitherto accurately deſcribed—Gmelin had probably ſeen the Linnæan inſect, having changed the antennæ utrinque duo, to antennis quaternis, and left out moſt of the long deſcription given by Linnæus. Neither he, Linnæus nor Fabricius mention the circumſtance of habitation in the mouth of the fiſh, and the induſtrious and copious Fabricius, who having changed the names of the genera, calls him cymothoa phyſodes, copies the deſcription of Gmelin, excepting the mention of the 4 antennæ, which in his arrangement form a character of the genus.

No. XI.

A Defcription of a newly invented Globe Time-Piece. By the Rev. Burgiss Allison, A. M.

April 4th, 1800.

The committee to whom was referred the communication from Burgifs Allifon, report

That having examined the drawing of his globe time-piece and the references they are of opinion that it difplays confiderable mechanical ingenuity. They think however that too much has been attempted by the inventor. The part intended to exhibit the phafes, &c. of the moon is too little connected with the other parts of the machinery, and is not of great importance, as even were it not liable to objection on account of its detached fituation, it would only fhew the mean and not the true time at which the different phenomena would occur. An error will alfo arife in the apparent place of the fun on account of the equable motion of circle of illumination. This objection is of no great confequence. From the mode which the inventor propofes of making the hours on the *equator* it is evident that the time fhown by the globe will be for that meridian only on which the hour of fix is marked. The committee therefore recommend to the inventor to remove the lunar part entirely; and to have the hours marked on a moveable hoop or circle which may be attached to the globe fo as to fuit any meridian. Upon the whole however the committee deem the communication worthy of publication.

R. PATTERSON,
JOSEPH CLAY.

Briftol,

Briſtol, February 28th, 1800.

RESPECTED SIR,

Read April 4th, 1800. IT is now a conſiderable time ſince I have made ſome improvements in different mathematical inſtruments and machines; which I did not, however, think of ſufficient conſequence to preſent to the ſociety: but having not long ſince ſhewn them to ſome of my friends, they have induced me to preſent the incloſed drawing and deſcription of my globe time-piece. If this ſhould meet with a favourable reception, I ſhall be encouraged to bring forward ſome others which I now have by me. The globe time-piece, I have not actually conſtructed, but have begun it, and when finiſhed will with pleaſure exhibit it to the ſociety.

I remain, Sir,

Reſpectfully your humble ſervant,

BURGISS ALLISON.

THOMAS JEFFERSON, ESQ. Preſident of the American Philoſophical Society.

AA is a terreſtrial globe of any convenient ſize, ſay 8 inches in diameter, then will the hours marked on the equator be about 1 inch aſunder. Within the globe is the movement of a ſpring time piece by which the globe is turned round on its axis once in 24 hours. BB is a flat hoop of braſs in which the globe turns as it does in the brazen meridian of common globes, and which ſerves to point out the hours as they paſs in ſucceſſion under it. CC is a light hoop with the minutes marked on it, and which may be carried round by a ſemicircular wire attached to a cannon moving round the north pole, and thence communicating with the internal movement. But if the lunar part be added, then the minute circle muſt be carried round by ſimilar arms on the inſide of the globe, and an opening left, next the hour circle, between the northern and ſouthern hemiſpheres, for it to move in; the two hemiſpheres being connected by 4, or more ſmall connecting wires, which may be detached at pleaſure to remove the northern hemiſphere when there is occaſion to come at the movement. Or for conveniency the minutes may be ſhown on a circle round the north pole. DD is a braſs circle moving round once in a year on the poles of the ecliptic, ſhowing the different ſeaſons. This being the circle of illumination, one ſide thereof may be made black to diſtinguiſh the dark hemiſphere. It is carried round by the cannon E which turns round a firm ſupporter that ſuſtains the hoop BB, and of courſe the globe, &c. The cannon carries round with it the circular plane FF on the upper part of the foot to which is attached the ſtem G and which riſing as high as the centre of the circle of illumination and at right angles to it, carries on its top a figure of the ſun, whoſe place in the ecliptic is pointed out on the edge of the foot, on which is alſo drawn the ſigns of the zodiac, day of the month, &c. Or if it ſhould be preferred the ſigns, day of month, &c. may be drawn on the circular plane FF which being left at reſt, while the ſtem bearing the ſun, being connected with the cannon G will point out, ut ſupra, the ſun's place in the ecliptic, &c. M repreſents the moon which is carried round the earth in its proper period by the arm L and axis K being connected with the plate P which revolves round the pole of the ecliptic in about 19 years carrying the axis of the moon's orbit with it in an angle of 5½ degrees this is effected in the following manner. The plate P with its wheel O is moved round a cannon fixed to the hoop BB by which the

the wheels a, b, c, are turned, the laſt of which being immoveable on the fixed cannon e turns the wheel b ſince with its axis it move round the ſaid cannon, which is the pole of the ecliptic, once in a year. Again the moon's axis K is turned by a wheel d fixed to an arbor paſſing through the cannon e and on its lower end carrying another wheel, which is turned one tooth per day, by a pin fixed in the globe. If it is required for the moon to turn on its axis ſo as to keep the enlightened ſide to the ſun, it may be done by ſubſtituting for the arc L, the horizontal arm R at the extremity of which let there be the arbor and wheel S of the ſame ſize as the wheel at K and turned by it with its wire W at the lower end of which is the moon. It is obvious from the diſtance of the wheels that they are deſigned to be turned by bands. And here I ſhall avail myſelf of Mr. Hawkins's newly invented ſpiral wire bands, which being elaſtic are applicable to all kinds of machinery without the inconveniency of altering with the weather.

The piece is wound up by a key at the ſouth pole, which pole is a cannon connected with a frame within the globe, containing the wheel work: and the north pole is the ſame being firmly fixed to the hoop BB. The cannon E and circle DD are made to revolve once a year in the following manner. On the poſt within the cannon E is a lever, which once a day is drawn aſide by a pin fixed in the globe near the antarctic circle, and by a wire attached to its lower end, a crank near the edge of the foot is pulled, by which a circle having 365 teeth is moved one tooth per day, which wheel is connected with the plane FF, unleſs that is deſigned to be ſtationary, and in that caſe, the wheel muſt connect with the cannon E by a wire which will ſerve to ſupport the ſun's ſtem, and the movement is effected. From the

the deſcription and drawing it is eaſy to conceive that the following problems may be done by the machine. 1. The hour and minute of the day. 2. The hour and minute of ſun-riſing and ſetting in every part of the world, as the places paſs in ſucceſſion before or behind the circle of illumination. 3. The different ſeaſons, and lengths of day and night. 4. The ſun's place in the ecliptic and day of the month. 5. The phaſes of the moon; her age, place of nodes, eclipſes, riſing, ſetting and ſouthing, in every part of the world, ſhewn by a wire circle of lunar illumination attached to the moon's axis and at right angles to the plane of her orbit; whoſe interſection with the ſolar circle of illumination, will ſhew the height of the ſun, at the riſing or ſetting of the moon.

No.

Plate II.

S
R
K
P
d
o
a
c
b
L
w
M
A
A
C C
XII
XI
X
IX
VIII
VII
VI
V
IIII
III
II
B B
D D
E
F
F
G
April
May
June
July
August

No. XII.

A Defcription of the Pendant Planetarium. By BURGISS ALLISON.

Read May 2d, 1800.

a a a a is a frame fupporting the whole machine. *b b* is a fixed rod or arbor fupporting the fegment *c*, and the fun *s* by a fine wire. *d* is a wheel fixed to the upper part of the cannon *e* carrying round by its lower end the arm *f f* and the planet Mercury fufpended by a fine dark wire. *g g* is an arm fixed by fcrews into the frame *a a* at each end, and alfo to the upper end of the fixed cannon *h h*, which fupports by its lower end the frame *i i*, which, as explained in fig. 2. is an elliptic plane, fupporting by four or more ftuds *l l* the concave piece *k k* forming an elliptic ring. *m m* is a wheel on the moveable cannon *n n* which carries the arm *o o*, fupporting on one end the planet Venus by a fine wire, as above. *p p* as before is a fixed frame attached to the immoveable cannon *q* and the elliptic plane *r r*, fupporting by ftuds the concave ring *s s*, ut fupra; and thus the wires by which the planets are fufpended, and the concave rings are alternately fupported by the moveable and fixed cannons, &c. until the whole forms a concave like the heavens; having the fmall grooves or apertures through which the planets fupporters move round, forming elliptic lines in the concave fegment of a fphere marking out the planets paths, according to their excentricity and fhewing at one view the places of aphelion, perihelion, &c. of all the planets. The concave fegment being painted a dark blue and fpangled with filver ftars in the pofition that fome of the fixed ftars would appear from the centre of the fun, will have a fine

fine effect, especially as the supporting wires of the planets will be dark and so small as to render them almost invisible, the frame being suspended from the ceiling. Their latitude may readily be ascertained by a line drawn from the centre of the sun through that of the planets place to the hoop *t t* encompassing the whole, marked with eight degrees on each side of the ecliptic. The elliptic orbits and inclined planes are obtained by the method shewn in fig. 2. viz.

a a is an elliptic plane fastened to the lower end of each fixed cannon, having its excentricity calculated to that of the planet which is to be affected by it. *b b* is the arm attached to the moveable cannon. *c c* is a slider moving on the arm *b b* by four little friction rollers. *d* is a friction wheel on the under side of *c* turning on a pin which is fastened firm in *c* and moves, with it, through a groove in *b b* which wheel running against the edge of the ellipsis *a a*, forces *c c* out, which is again drawn in by the spring *e*, thus causing the planet to revolve in an elliptic orbit, as it is carried round by the arm *b b*, the moveable cannon, and wheel work.

For the inclined plane, *g* is a wheel turning on a pin fastened into *c c*, and carried round on it by a projecting arm of *b**. On one side of this wheel is a small pin, whose situation and distance from the centre is to be determined by the place of the planet's nodes and the inclination of its plane to that of the ecliptic: to this pin is fastened a small waxed silk cord which passing over the pulley *h* supports the planet by a fine hair wire, as before described and draws it up and lowers it down in its orbit according to its angle of inclination to the plane of the ecliptic. The planets should be made of polished metal to give them weight and brilliancy, or of small glass

* The circumference of the wheel must be commensurate with the distance *c c* moves out.

The Pendant Planetarium. by the Revd. B. Allison.

Fig. 1.

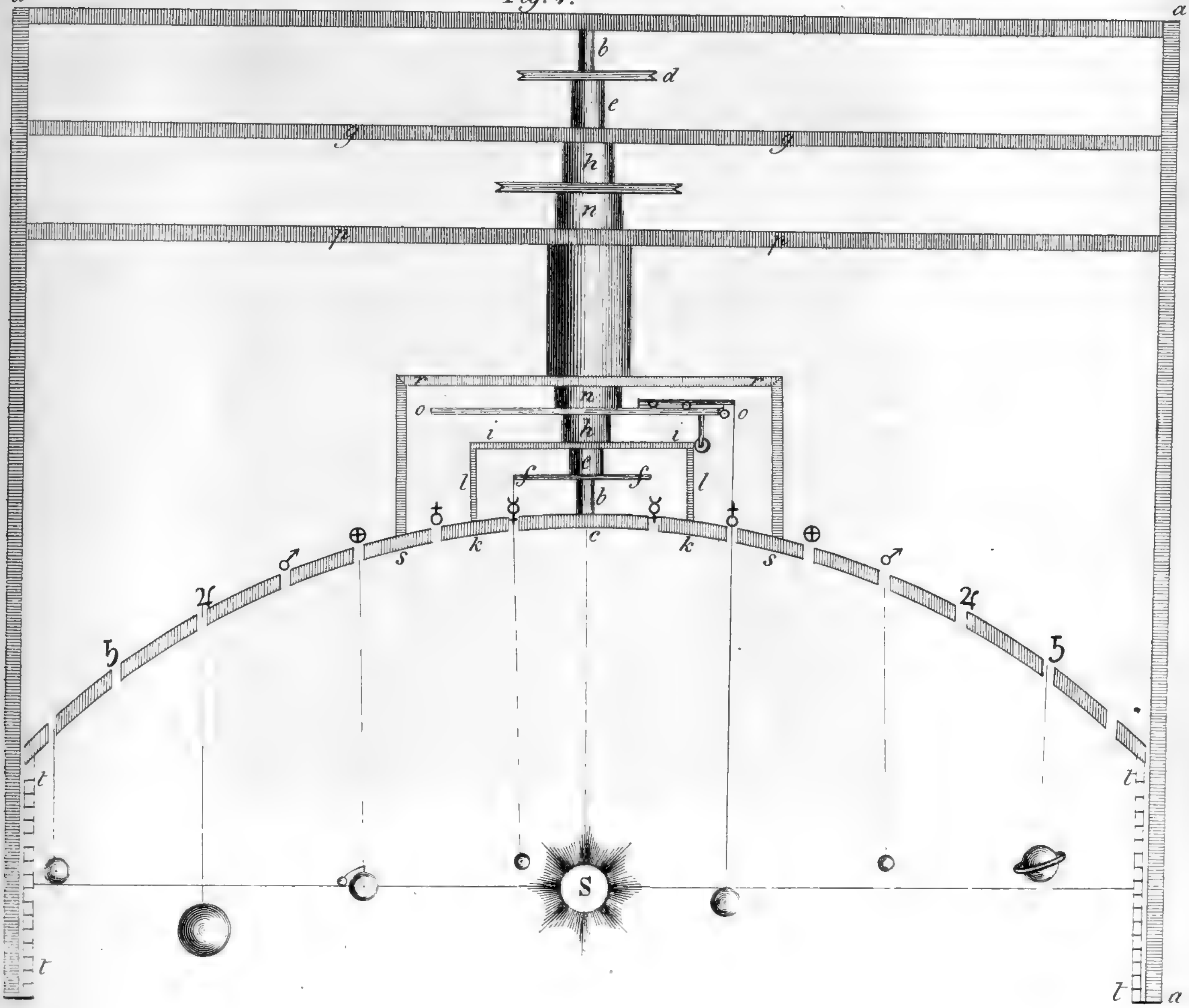
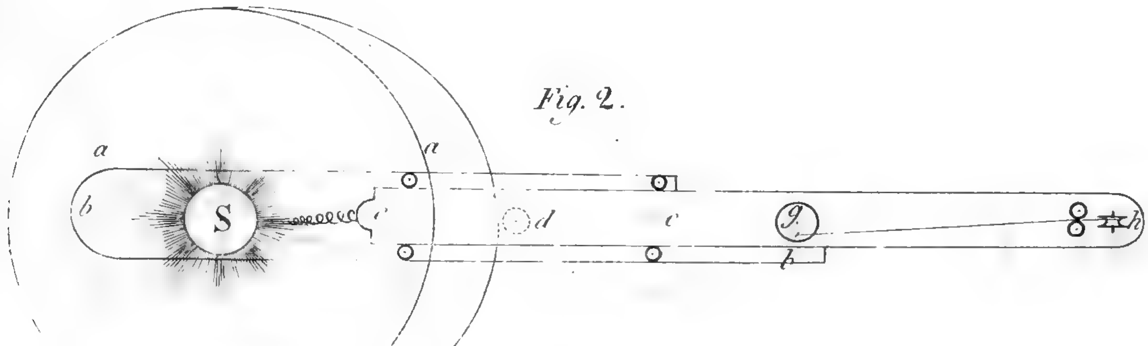


Fig. 2.



Jones sc.

[illegible]

glaſs globes filled with mercury. The ſun may be a globular glaſs fountain-lamp with a cork fitted to the tube, containing a tin pipe for the wick, ſo that the blaze being in the centre of the globe and ſurrounded with oil, will be magnified on every ſide and exhibit a ſplendid ſun. It will be readily underſtood that motion is to be given to the wheels, turning the cannons, &c. by an arbor having as many wheels as the planets have, all firmly fixed to the arbor and calculated to move them in their proper periods. The whole may be made of wood, if required, and the wheels turned by elaſtic wire bands. To the machinery may be attached a ſimple movement whoſe weight may deſcend down the wainſcot of the room in any convenient place. Thus the planets will be ſeen moving round the ſun in the concave above, in elliptic orbits and inclined planes, apparently revolving in the heavens without any ſupport.

It is eaſy to conceive how the ſame principle, as far as it reſpects the excentricity and angles of inclination, may be applied to either vertical or horizontal orreries; by having the wires which ſupport the planets ſufficiently ſtout to bear their weight either in a perpendicular or horizontal poſition, and ſliding in and out of ſmall tubes as they paſs round in the elliptic grooves on the face of the orrery. They may be drawn in by the wheel pin and cord as deſcribed in fig. 2. and forced out by ſmall ſprings. In this caſe their latitude may be marked on the ſupporting wire, and the top of the tube in which they ſlide will ſerve as an index. Or the degrees may be marked on the edge of a groove cut in the tube through which an index, faſtened to the moving wire or ſtem which ſupports the planets, may paſs; and thus give the latitude.

BURGISS ALLISON.

No. XIII.

On the Use of the Thermometer in Navigation. By WILLIAM STRICKLAND.

York, April 1798.

SIR,

Read May 16, 1800.

A SHORT time before I failed from England in 1794, the third volume of the Tranfactions of the American Philofophical Society fell in my way. Being at that time attentive to maritime affairs, I could not but be much ftruck with your maritime obfervations, and on fhewing them to a nautical friend, he recommended me to purfue the fame courfe of obfervations. This advice I followed; and being well fatisfied in having made the experiments in my outward bound voyage, I purfued the fame courfe in my homeward bound voyage; and am about to report the refult of both to you, though the laft appears likely to be of no farther ufe than confirming what has already been faid on the fubject by yourfelf.

The obfervations at large I do not fend you, being too prolix, the thermometer having been recurred to, much more frequently than here ftated; I have noted here only the *changes* which occurred in the temperature of the water, and thereby the table is confiderably abbreviated.

In the outward bound voyage the fubject appearing moft worthy of attention is the probability of a branch ftriking off from the gulf-ftream in a northerly or northeafterly direction, flowing to the eaft of and fomewhat parallel to the banks of Newfoundland. This we appear to have ftruck on the 18th of Aug. P. M. and continued in it till the 23d A. M. except that on the 20th we croffed a cold current probably here running in upon the

the other from the north-weſt. That this is a branch of the gulf-ſtream is rendered probable by the appearance of great quantities of gulf-weed on the 18th A. M. and the circumſtance of the flying-fiſh appearing on the 19th which probably had followed the warm ſtream into an higher latitude than I can, after looking into many voyages, find them to have been previouſly noticed. It will appear alſo from the homeward bound track, that on the 18th of Aug. A. M. we ſtruck a warm current and continued in it ſeveral days, which from the longitude could be no other than the current before noticed in 1794, as after quitting the gulf-ſtream, we had been for ſeveral days in the ſeas cooled by the proximity of the banks of Newfoundland. I have dwelt longer than at firſt ſight may appear neceſſary on this current, becauſe, though it has been ſuppoſed to exiſt to the ſouth-eaſt of the banks of Newfoundland, it has not been traced ſo far north as the latitude of the ſuppoſed Jacquet-Iſle, that is to lat. 47, long. 39. It is probably continued in about a north-eaſt direction, and extends entirely acroſs the Atlantic, till it ultimately ſtrikes the coaſts of Ireland and the Hebrides, after having loſt in its long courſe in thoſe northern latitudes much of its heat and at laſt being reduced to the temperature of the ſeas, through which it flows. That ſuch a current really exiſts through the whole of this extent is rendered highly probable from various productions of the tropical regions being frequently thrown on thoſe ſhores, hitherto ſuppoſed to be the accidental effects of ſtorms and not of the unvarying courſe of nature. The firſt notice of ſuch ſubſtances being caſt on thoſe Iſlands will be found in Vol. III. p. 540, of the Abridgement of the Philoſophical Tranſactions, which abridgement was publiſhed in 1749; but the papers abridged many years before.* We here find the facts

 ſtated

* Phil. Tranſ. Vol. X. p. 396. and Vol. XIX. p. 298.

ſtated but not attempted to be accounted for, except that in conſequence of ſome of theſe having obtained the name of Molucca beans, they are ſuppoſed to have found a way out of the North-Pacific ocean, through the north-weſt paſſage, then ſuppoſed to exiſt. From that time little if any notice was taken of theſe exotic productions, till Mr. Pennant made his tour in the Hebrides in 1772, when he mentions his receiving preſents of them.*

That the exiſtence of ſuch a current never occurred to the inquiſitive and penetrating mind of Mr. Pennant is a ſufficient proof, that at the time no knowledge was had of it, he is content with ſuppoſing theſe things to be drifted upon the coaſts by ſtorms, and the prevailing weſterly winds; but you probably will hold with me that they conſtitute a ſtrong preſumption, if not indubitable proof, of the exiſtence of a regular current; that the courſe of that current has been hitherto unnoticed; but that could it be aſcertained, much advantage would accrue to navigation, by facilitating the voyages from America, through the North-Atlantic, as well as preventing veſſels returning by that track from ſtemming that current, as the Fair-American probably did in her courſe, almoſt the whole of the way to Newfoundland; by ſuch knowledge voyages both ways might be materially ſhortened, as they now are by the like knowledge of the courſe of the gulf-ſtream in its eaſterly and ſouth-eaſterly progreſs towards the coaſts of Europe and Africa. The current in the North-Atlantic might be detected through the greateſt part of the ſpace which it runs by the attentive uſe of the thermometer, until it has approximated the uſual temperature of the ſea in the northern latitudes; it might be thus probably aſcertained to the fiftieth or fifty-fifth degree of north latitude, as the courſe of the gulf-

* Tour to the Hebrides in 1772. Cheſter, printed in 1774, p. 232.

gulf-ſtream has already been determined for an equal or greater diſtance by the ſame means. It is therefore very deſirable that a veſſel ſhould be employed to croſs the Atlantic in an eaſterly and weſterly direction in various latitudes, between latitude 47 and 60, when the direct courſe of this current might be detected, and the torpitude of each ſide of it fixed as far as could be done by the thermometer. Having run into great length on the *probability* of a current, it is now neceſſary to return to facts more immediately connected with our ſubject, the accuracy of the thermometer in aſcertaining our ſituation at ſea.

On the 22d of Auguſt late in the evening the water fell in temperature four degrees to 64; on the next day at noon having fallen to 62 and ſuſpecting that we might be in ſoundings, though no alteration had taken place in the colour of the water, I induced the captain to ſound, but no bottom was found at 140 fathom; on the 24th it will appear by the chart to have fallen to 58, and on the 25th to 56, about which time we were undoubtedly on Jaquet, or Falſe bank, and on the 26th having fallen to 51 at 8 A. M. and aſſumed a green caſt. I was deſirous of ſounding again, but in conſequence of the ill ſucceſs attending our former attempt, and not yet placing any reliance on the thermometer, the captain was unwilling to loſe time in ſounding, ſuppoſing that we were only approaching Jaquet or Falſe bank, but the next day having ſpoke a banker, he informed us that we were on the grand bank, and that Cape Race bore W. N. W. 150 miles. Upon ſounding at noon we ſtruck the ground at 37 fathoms. Here let me remark, that our reckoning as ſhewn on the chart has been well kept, and that the thermometer has with great preciſion indicated our ſituation; on the 21ſt at noon in a ſuppoſed branch of the gulf ſtream 72°.—22d, approaching Jaquet bank and at no great diftance from it, 68°.—23d, ftill nearer 62°.—24th, on the edge of the bank 58°—25th, on Jaquet bank 56°.—26th, on the grand bank 52°.—thus at this feafon of the year is there a difference of 20 degrees of the thermometer between the water on the bank, and in the fame latitude in the ocean, not far to the eaft of it.

Our captain a fenfible and obferving man, as well as very experienced mariner, ftruck with the regular gradation of the thermometer on the approach of the bank, and convinced of its having pointed it out long before he had fufpected his arrival upon it, from this time paid much attention to the thermometer. He found as I had foretold that it would equally fhew by the rife when we had quitted the bank, and obferved that as it would ftill more accurately define the limits of the gulf-ftream, as it was hotter than any other part of the ocean, he might with great advantage make his paffage to New-York by following the northern eddy of the ftream. This eddy he knew to exift, but was unacquainted with the limits of it, and knew not how to afcertain them, except by the thermometer. We purfued this eddy pretty accurately having made good the latitude of New-York in long. 69. in about nine days from quitting the banks, and every day performed nearly equal and good days works. In this courfe from Newfoundland the thermometer indicated every where the approach to danger; on the 5th of September, the vicinity of Sable Ifland banks caufed a fall of 7°; and on the 7th, a bank not marked on any chart I have feen caufed a fall of 11° degrees. Upon founding on this bank the ground was ftruck in 55 fathom, fine white fand, with fome fpecks of red and black. Captain Allyn was fo much pleafed with the accuracy of the thermometer and with the fecurity in which he had failed for fome time in confequence of it, and fo clearly perceived the advantage to be be derived from it in many inſtances, that he declared he would never more go to ſea without one.

The track of the Fair-American appears to have laid very near to Jaquet iſland, which in governor Pownall's chart is marked as very doubtful; a good look out for it was kept for ſeveral days, but with no effect; this may ſo far tend to confirm the ſuſpicion of its non-exiſtence.

The journal from America to England, does little more than confirm the previous obſervations made in this track; the thermometer fell no leſs than 20 degrees on paſſing to the ſouth-eaſt of Newfoundland, and roſe again 9 degrees in the ſame longitudes where in our outward bound voyage, we ſuppoſed ourſelves to be croſſing a branch of the gulf-ſtream. The fall from hence of the thermometer, as the coaſt of Europe is approached is very remarkable and uniform.

WILLIAM STRICKLAND.

To JONA. WILLIAMS, *Eſq.*
Philadelphia.

Thermometrical

Thermometrical Journal of the Temperature of the Atmoſphere and of the Sea on a Paſſage from Hull in England, to New York, on Board the Ship Fair-American of New York, Capt. Ebenezer Allyn, in the year 1794. *Kept by W. Strickland.*

Dates. 1794.	Hour of the Day.	Place at Noon. Lat. N.	Place at Noon. Long. W.	Temperature of Air.	Temperature of Water	Appearance of Water.
July 19,	12	River Humber.				
	4 P. M.			70°	68°	muddy
20,	8 A. M.			67	64	clear
27,	8 A. M.	Cloſe in with the Butt of Lewes,		54	56	dark green
	4 P. M.			56	56	do.
30,	8 A. M.			56	57	bright blue
	4 P. M.	56° 24′	11° 15′	60	58	
31,	8 A. M.			60	57	
	4 P. M.	55 40	13 39	61	58	
Aug. 1,	8 A. M.			57	58	
	4 P. M.	55 2	15 38	63	57	
2,	8 A. M.			58	58	
	4 P. M.	52 57	18 16	66	58	
11,	8 A. M.			63	61	
	4 P. M.	49 1	30 43	65	61	
15,	8 A. M.			63	62	
	4 P. M.	48 36	33 6	64	64	
16,	8 A. M.			60	66	
	4 P. M.	47 41	35 51	66	66	

NOTES AND OBSERVATIONS.

July 19th. Sailed early this morning from Hull roads. At 4 P. M. Spurn lighthouſe E. S. E. 5 miles.

20th Spurn lighthouſe E. by S. 3 miles.

29th at 8 A. M. St. Kilda E. N. E. 4 leagues. Temperature of the water 56°. The water of the river Humber on the 19th was 68° the weather having for ſome time been very hot; on entering the ſea it was 61° our courſe was chiefly in ſight of land till our departure from St. Kilda this day, and the water frequently varied between 61° and 56° influenced probably by the rivers and varying depth of the coaſt; about noon the water changed to a bright blue, OCEAN WATER.

30th at 6 A. M. water 57° acquiring warmth as we recede from land; in the evening 58°.

Auguſt 11th. Eleven days have now paſſed without any alteration in the temperature of the water. 58° may probably be the uſual temperature

Dates. 1794.	Hour of the Day.	Place at Noon. Lat. N.	Long. W.	Temperature of Air.	Water	Appearance of Water.
Aug. 17,	8 A. M.			64°	64°	
	4 P. M.	47° 44′	36° 16′	65	64	
18,	8 A. M.			68	67	
	12	46 47	38 35		68	
	4 P. M.			70	68	
19,	8 A. M.			69	68	
	4 P. M.	46 18	39 41	69	67	
20,	8 A. M.	45 45	41 20	62	64	
	4 P. M.	45 45	41 20	62	62	
21,	6 A. M.			60	70	bright blue
	12	45 18	43 22		72	
	4 P. M.			70	72	
22,	8 A. M.			69	69	
	12	45 28	45 44		68	
	4 P. M.			72	65	
	10 P. M.			62	64	
23,	8 A. M.			62	62	
	4 P. M.	45 28	45 41	65	62	
24,	8 A. M.			59	58	
	4 P. M.	45 41	46 2	61	58	
25,	8 A. M.			60	57	
	4 P. M.	45 15	46 39	64	56	
26,	8 A. M.			57	51	greenish
	12	45 37	48 27		52	
	4 P. M.			60	52	

NOTES AND OBSERVATIONS.

ture of the Atlantic at this season of the year above latitude 50°. This day the water gains three degrees of heat.

15th. This morning it has gained four degrees, in the evening six.

16th. The temperature is 66° and on the

18th 68°. Most of this day much gulf weed floated in the sea, which first led us to suppose ourselves in a branch of the gulf stream, though the thermometer appears to have indicated it since the morning of the 16th by a rise of several degrees; this day at noon according to our reckoning were precisely where Jaquet Isle ought to have been; it is marked as very doubtful in Pownal's Chart of the Atlantic and as we kept a constant look out for it during two days it probably does not exist.

20th. Most of this day the water was found to vary between 64° and 62°. During six hours A. M. and as many P. M. the wind was strong from the N. W. attended with heavy squalls and rain which might have driven before it a current from a colder region, or the thermometer in the air being as low as 62° the air might have had some effect upon it, because on the

21st

Dates. 1794.	Hour of the Day.	Place at Noon. Lat. N.	Place at Noon. Long. W.	Temperature of Air.	Temperature of Water	Appearance of Water.
Aug. 26,	10 P. M.				52°	
27,	8 A. M.			60°	57	
	4 P. M.	45° 41′	48° 40′	64	58	
28,	8 A. M.			60	58	
	4 P. M.	45 12	48 57	63	58	
29,	8 A. M.			63	62	green
	4 P. M.	44 11	49 30	65	64	
30,	8 A. M.			62	65	
	12	43 32	50 52		66	
	4 P. M.			63	66	
31,	8 A. M.			64	70	bright blue
	4 P. M.	42 59	51 48	69	71	
Sept. 1,	8 A. M.			66	69	
	4 P. M.	42 30	53 35	63	68	
2,	8 A. M.			69	70	
	4 P. M.	42 16	55 21	68	71	
3,	8 A. M.			70	73	
	4 P. M.	42 8	57 22	75	73	
4,	8 A. M.			74	73	
	4 P. M.	42 31	58 55	73	70	
	9 P. M.				68	
5,	8 A. M.			70	66	greenifh
	4 P. M.	42 50	61 6	66	66	
6,	8 A. M.			64	68	
	12	42 7	62 38		69	

NOTES AND OBSERVATIONS.

21ft the wind being N. by E. and E. and the thermometer in the air at 60°, the water was at 70° and 72° which indicated our being again in the gulf ftream; vaft bodies of gulf weed floated in the fea all this day; feveral fhoals of flying-fifh alfo made their appearance at different times of the day, which probably had followed the warm current of the ftream, into higher latitudes than they are ufually met with.

23d. The water began to cool the laft evening and this day being at 62°, fufpecting we might be on Jaquet bank, founded but no bottom at 140 fathom.

26th. This day the water was at 51°, and much changed in colour, and we were probably on the eaftern edge of the great Bank having croffed Jaquet bank yefterday, when founding might have been met with; but having failed in finding them on the 23d, our captain not yet confiding in the thermometer, did not choofe to lofe time in trying for them again.

27th. Sounded this day at noon and found a bottom at 37 fathom, when to the furprife of the captain we were undoubtedly on the great Bank. Spoke at 6 P. M. a Banker who informed us that

Dates. 1794.	Hour of the Day.	Place at Noon. Lat. N.	Place at Noon. Long. W.	Temperature of Air.	Temperature of Water	Appearance of Water.
Sept. 6,	4 P. M.			64°	72°	bright blue
7,	8 A. M.			70	71	bright blue
	12				69	greeniſh
	4 P. M.	41° 42′	63° 58′	69	68	
	10 P. M.				64	
8,	8 A. M.			64	62	
	12	44 1	65 52	63	61	muddled green
	4 P. M.			62	70	bright blue
9,	8 A. M.			69	75	
	12	39 36	68 49		78	
	4 P. M.			70	77	
10,	8 A. M.			70	76	
	4 P. M.	39 45	69 37	76	76	
11,	8 A. M.			70	75	
	4 P. M.	40 15	70 24	73	66	bright green
	8 P. M.				63	
12,	8 A. M.			67	66	
	4 P. M.	40 8	70 53	76	68	
13,	8 A. M.			74	68	
	4 P. M.	40 7	71 39	76	68	
14,	8 A. M.			68	67	
	4 P. M.	40 50	72 57	70	67	
15,	8 A. M.			71	68	
	4 P. M.	40 40	73 23	73	68	
20.		At New York.				

NOTES AND OBSERVATIONS.

that Cape Race bore N. N. W. ——— miles, which agrees remarkably with our reckoning.

31ſt. Yeſterday in the afternoon the water began to acquire warmth, being at 66°, and this morning being at 70° and of a bright blue indicated that we had quitted the banks.

September 2d. Short and deep ſwells rolling all this day before a light breeze from W. N. W. we ſuppoſe ourſelves in the northern eddy of the gulf-ſtream, as ſuch a ſwell could not be cauſed by ſuch a breeze unleſs they ran in an oppoſite direction: this was confirmed as the evening advanced, for the breeze getting northward and then to N. N. E. the ſwell entirely abated—while the ſwell laſted the ſhip made only 2½ knots an hour, when it had ſubſided 4 knots. The temperature of the water is now 71, nearly the ſame as on the 21ſt of laſt month, when we ſuppoſed ourſelves in the gulf ſtream.

5th. The water having cooled ſeveral degrees and being at 66°, and having acquired a greeniſh caſt we were undoubtedly in ſoundings but none were attempted; probably on Sable Iſland bank—ſeveral ſmall land birds alighted on the rigging, ſome of which were taken with the hand.

Septem-

September 6th. The ſea becomes again of a bright blue, much gulf weed, and ſome rock weed, was ſeen this evening. The ſame circumſtance occurred on the 2d; a weſterly breeze raiſing the eddy of the ſtream and a N. breeze allaying it.

7th. Becalmed till ſix A. M. during the calm a ſtrong current ſetting to the S. or S. S. W. was very perceptible, ſuppoſed the eddy of the gulf ſtream.

8th. The water having changed colour and fallen in temperature to 61° ſounded at 10 A. M. and found a bottom at 55 fathom, fine white ſand. This bank indicated yeſterday about noon by the fall of the thermometer: whatever bank this may be, it does not appear to be in the Charts, we were juſt 24 hours upon it. At 4 P. M. water 70° and bright blue —no bottom. This day at noon becalmed, the water on the ſurface was at 78°, but in water taken from a depth of 55 fathom, the thermometer ſtood at 63°.

11th. At 3 P. M. the water having changed colour, and fallen 9 degrees, indicated an approach to ſoundings. At 5 P. M. ſoundings 33 fathom green ooze.

15th. At noon Montuck Point in Long-Iſland N. N. E. 12 miles. It will appear by the Chart that the reckoning has been well kept; and that what variation occurs, may be ſuppoſed to have ariſen within the laſt 7 or 8 days in conſequence of currents and calms.

Thermometrical

Thermometrical Journal of the Temperature of the Atmosphere, and of the Sea, on a Passage from Philadelphia to Falmouth on Board the Camilla, Captain George Irwin of Philadelphia, in the Year 1795, kept by William Strickland.

Dates. 1795.	Hour of the Day.	Place at Noon Lat. N.	Place at Noon Long. W.	Temperature of Air.	Temperature of Water.	Appearance of Water.
July, 29,		Embarked at Philadelphia.			80°	very muddy
30,	12	Newcastle, S. W. Dist. 7 M.			80	very muddy
31,	12	Reedy Island close on W.			80	
Aug. 1,	12	At anchor at Bombay Hook.		80°	80	
2,	12	Do. at Do.		85	80	
3,	12	Do. at the Upper Midlings.		84	80	
4,	12	Light House at Cape Henlopen, dist. S. W. 3 mi.		85	76	light green but muddy
5,	6 A. M.				72	bright green
	8 A. M.			76		blue
	10 A. M.				73	
	3 P. M.	38° 1′	73°25′	75	73	
	8 P. M.				74	
6,	8 A. M.			76	79	deep blue
	3 P. M.	38 3	71 4	81	79	
7,	8 A. M.			77	76	deep blue

NOTES AND OBSERVATIONS.

August 4, about noon sailed from Cape Henlopen the water which in the Delaware had been at 80° was now 76 still influenced by the heat of the river.

5th, the water which this morning was at 72, in the evening is at 74 gaining warmth as we recede from the land.

6th, at 8 A. M. in the gulf-stream, temperature of the water 79°.

14th, in the afternoon the water cooled to 73° and 70° and changed to a deep green as if in soundings—we were quitting the gulf-stream.

15th, temperature 61°.

18th, 63°; the sea for the last four days has shown strong marks of our being in soundings; in the chart are marked two rocks near which we probably were on the 15th at noon. Do banks run out from these? or is the great fall in the water no less than 18 degrees to be attributed to the vicinity of the banks of Newfoundland?—the great decrease in the water on the 16th, 17th and 18th, may in part have been caused

Dates. 1795.	Hour of the Day.	Place at Noon. Lat. N.	Long. W.	Temperature of Air.	Water.	Appearance of Water.	Notes and Observations.
Aug. 7,	3 P. M.	38° 58′	68° 7′	81°	74°		caused by the bad weather at this time, the wind having blown with great violence from the N. and E. and the thermometer in the air having varied between 61 and 65. If the cold of the water at this time were not caused by the banks of Newfoundland, but by reefs and shoals surrounding the two rocks, then a branch of the gulf-stream probably passes between those rocks, and the S. E. side of the grand bank in the direction of a current marked by an arrow in Pownal's chart, which branch in our former voyage we crossed to the East of Jaquet bank. Another branch of the gulf-stream appears by our homeward bound voyage to pass off in a northerly or northeasterly direction to the East of the two rocks.
8,	8 A. M.			79	80		
	12	39 34	64 11		78		
	3 P. M.			81	76		
9,	8 A. M.			78	76		
	3 P. M.	39 56	62 35	81	79		
10,	8 A. M.			81	79		
	3 P. M.	40 46	59 10	81	81		
11,	8 A. M.			77	75		
	3 P. M.	40 9	55	79	76		
12,	8 A. M.			79	77		
	3 P. M.	40 29	52	81	81		
13,	8 A. M.			81	79		
	3 P. M.	39 54	50 4	84	81		
14,	8 A. M.			81	79	deep green as if in foundings	
	3 P. M.	41 14	47 41	77	73		
	8 A. M.				70		
15,	3 P. M.	41 37	46 9	61	61		
18,	8 A. M.			65	63		
	3 P. M.	44 3	42 28	67	63		
	10 P. M.				69		
19,	8 A. M.			68	69	blue	19th, the water has again increased its warmth to 69 and 70, the same degree of temperature we observed in our outward bound voyage in the same longitude when we first supposed ourselves
	3 P. M.	45 2	39 26	71	69		
20,	8 A. M.			69	70	deep blue	
	3 P. M.	45 33	36 43	73	69		

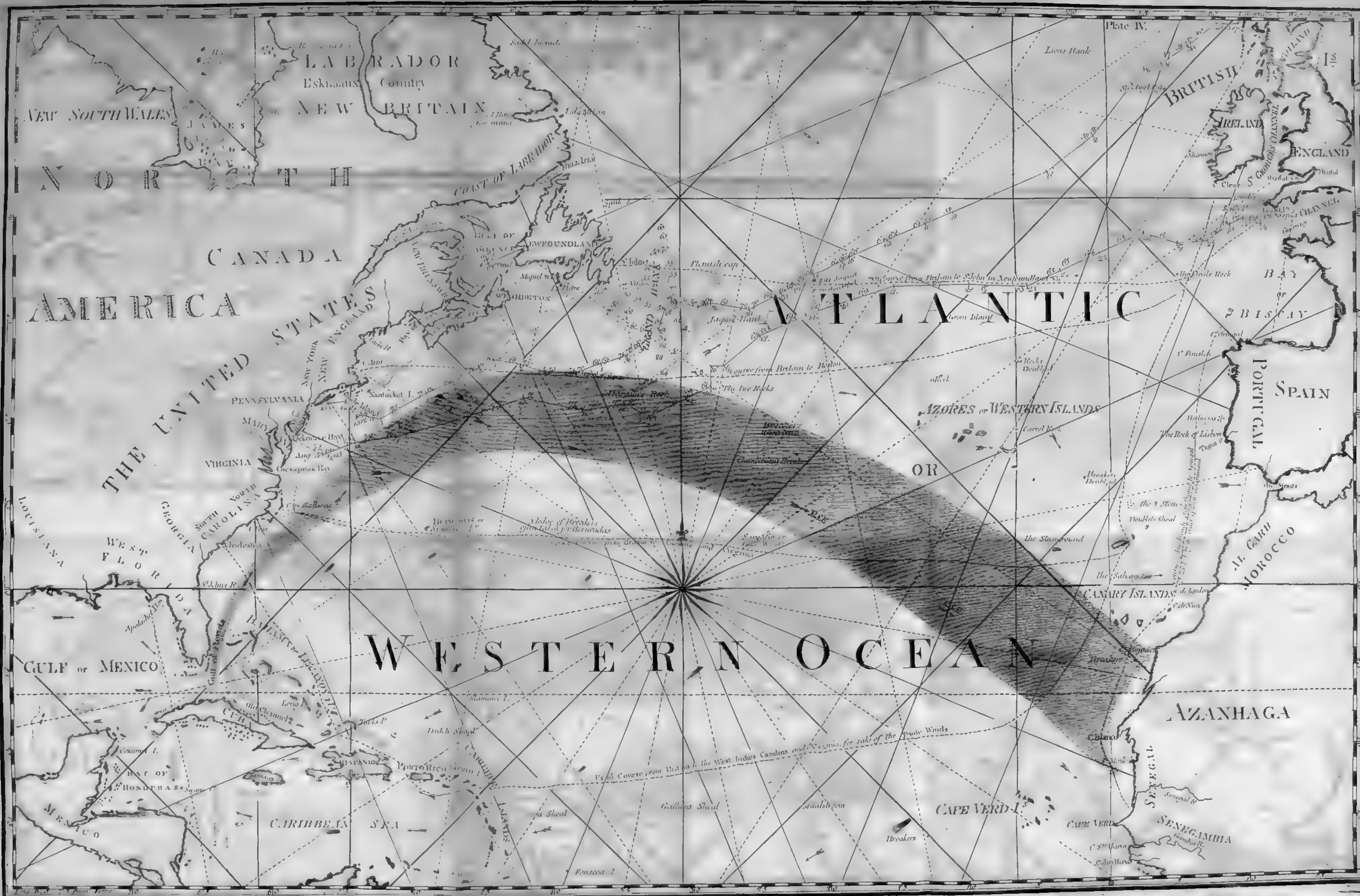


Plate IV.
LABRADOR
Eskimaux Country
NEW BRITAIN
NEW SOUTH WALES
NORTH AMERICA
CANADA
THE UNITED STATES
NEW ENGLAND
NEW YORK
PENNSYLVANIA
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
LOUISIANA
WEST FLORIDA
GULF OF MEXICO
MEXICO
BAY OF HONDURAS
CARIBBEAN SEA
PORTO RICO
COAST OF LABRADOR
NEWFOUNDLAND
Flemish cap
Jaquet Bank
Nantucket I.
Delaware Bay
Chesapeak Bay
The course from Britain to Boston
ATLANTIC OR WESTERN OCEAN
AZORES or WESTERN ISLANDS
CANARY ISLANDS
CAPE VERD Is.
CAPE VERD
AZANHAGA
SENEGAMBIA
SENEGAL
MOROCCO
PORTUGAL
SPAIN
BAY OF BISCAY
BRITISH
IRELAND
ENGLAND
The Rock of Lisbon
Dutch Shoal
Breakers
Gallions Shoal

Dates. 1795.	Hour of the Day.	Place at Noon. Lat. N.	Long. W.	Temperature of Air.	Water.	Appearance of Water.	Notes and Observations.
Aug. 21,	8 A. M.			71°	69°		ſelves to be in a branch of the gulf-ſtream, and in this we continued for two days, when on the 21ſt it cooled to 67, and thence continued gradually and uniformly to loſe warmth in conſequence of our northing till we found it at 61 in the chops of the channel.
	3 P. M.	46° 21′	32° 34′	71	67		
23,	8 A. M.			68	65		
	3 P. M.	46 41	23 38	65	65		
24,	8 A. M.			65	64		
	3 P. M.	47 9	21 22	69	65		
25,	8 A. M.			65	64		
	12	48 3	18 27		63		
	3 P. M.			68	63	dark green	
26,	8 A. M.	48 48	14 57	61	63		
	3 P. M.			63	61	deep blue	
28,	8 A. M.			64	61		
	3 P. M.	48 37	10 2	67	62		
30,	8 A. M.			67	62	muddled green	
31,	8 A. M.			67	63		
	3 P. M.	In foundings.		68	62		
Sept. 1,	8 A. M.	Landſend N. 12 miles.		67	62		

No. XIV.

Sur les Végétaux, les Polypes et les Insectes. By Dupont de Nemours.

Read June 20th, 1800.

Il eſt très facile, et peut-être aſſez naturel, á un animal auſſi ravageur que l'homme de traiter avec peu de conſidération les plantes qui ſe laiſſent dévorer ſi paiſiblement.

Cependant je ne voudrais pas avoir offenſé les Roſes.

Perſonne n'eſt plus diſpoſé que moi a croire, avec les anciens, que tout arbre eſt l'azyle, ou la priſon, d'une nymphe.

Nous ne ſavons pas bien nettement quelle eſt la nature des végétaux, ni s'ils ſont *un règne* dans la nature.

Douter, obſerver attentivement; penſer beaucoup, pour apprendre peu; voila le tot de notre faibleſſe, quand elle eſt ſage.

Nous remarquons dans les végétaux trois ou quatre principaux phénomenes, leur croiſſance, leur ſanté, leurs amours, leur réproduction; et deux eſpèces de vie: celle qui les fait pouſſer, ſe nourrir et s'étendre, qui nous parait purement *végétable:* celle qui les fait aimer, *connubier*, ſe féconder, porter des fruits, des graines qui ont toutes les propriétés des œufs; maniere d'être ſi actîve et ſi voluptueuſe qu'elle touche preſque à *l'anilamité*, ſuppoſé qu'elle ne la ſoit pas.

Tout près des végétaux ſont certainement les Polypes; et peut-être les pucerons, les *volvox*, la plus part des inſectes microſcopiques ſéminaux ou infuſatoires, qui ſemblent ſe multiplier comme les plantes, des deux façons, par la génération et par le bourgeonnement.

Une plante eſt elle une ſorte *d'animal* privé d'yeux, d'oreilles, et de jambes; doué, en compenſation d'une multitude

multitude de bouches, de bras ſupérieurs et inférieurs, de mains, et d'organes réproductifs; chez qui le nombre étonnant de ſes plaiſirs ſupplée à ce qui peut dans chacune de leurs ſenſations, manquer de retour ſur ſoi-même, de ſel, de pointe et d'energie? un pommier porte vingt mille fleurs, cent mille parties ſexuelles du genre feminin et quatre cent mille du genre maſculin, toutes, ou la pluſpart, en amour à la fois: que de félicités!

Une plante eſt elle une famille, une République, une eſpèce de *Buche* VIVANTE dont les habitans, les citoyens, les membres ont en communauté la nutrition, mangent au réfectoire; mais où chaque fleur, et pluſtôt encore chaque etamine, chaque piſtil, eſt un *Indìvidu*, ayant ſon amination, ſes beſoins impérieux et doux, ſes voluptés, ſon bonheur et ſes ſouffrances à part?

Eſt-ce l'un ou l'autre? eſt-ce l'un et l'autre? cela vaut la peine d'y regarder.

Les plantes ont toutes une moëlle épiniere; des myriades de trachées, par leſquelles les racines attirent à elles et conduiſent au tronc, les eaux, les huiles, les ſels qui leur conviennent dans la terre, ou que leur apportent les engrais, et les branches, les feuilles, l'écorce pompent les fluides aqueux ou aëriformes dont elles ſont ſans ceſſe baignées. Elles ſe nourriſſent comme nous mêmes, à la ſeule différence quelles ont leurs *ſuçoirs* en dehors et que nous avons les notres en dedans. Elles digérent. Elles ont un chyle qui leur approprie leurs alimens, et qui, après qu'elles ont évacué par des tranſpirations, par des excrétions régulieres ce qu'il ne leur ferait pas bon de garder, leur fournit une ſêve qui circule comme notre ſang et notre lymphe. Elles ont un *ſuc propre* qui a beaucoup de rapport avec notre fluide nerveux. Elles ont leur veille et leur ſommeil.* Elles ont leurs aſpirations, leurs expirations, leur conſommation, leur combuſtion de l'air atmoſ-

* Voyez *Sennebier* et *Bonnet*.

atmoſpherique qu'elles ont abſorbé, et la ſéparation de ſes élémens divers, des différens gaz qui le compoſent, dont elles s'incorporent les uns et rejettent les autres comme font les animaux, ou avec peu de différence. Elles ont donc des poulmons quoiqu'ils nous ſoient peu viſibles; car où ſe trouvent des effets ſemblables ſont des organes de la même nature, ou ſuſceptibles des mêmes uſages. Leurs poulmons leur ſont encore plus utiles que ne nous ſont les notres. Ils n'ont pas les mêmes répugnances, parce qu'ils leur ſervent en même tems d'eſtomac. Notre eſtomac s'accommode aſſez bien de l'azote que nos poulmons ne peuvent ſupporter. *L'eſtomac-poulmon* des plantes agrée l'azote et l'oxigêne; ſe nourrit du premier, ne conſume qu'une partie de l'autre et en renvoie le ſurplus après l'avoir preſque entirement debarraſſé de moffete. C'eſt ainſi qu'elles rendent aux animaux mobiles l'important ſervice de purifier l'air que les animaux ont beſoins de recevoir plus oxygêné. L'illuſtre et vertueux *La Rochefoucauld*, qui aimait avec une ardeur ſi pure les ſciences et la patrie, et dont l'aſſaſſinat fut un des plus grands crimes de notre révolution, avait fait à cet égard de tres belles et tres inſtructives expériences.

Il y a beaucoup d'apparence que c'eſt la moëlle épiniere qui, communiquant par les utricules horiſontaux et les prolongemens medullaires avec les trachées de l'écorce, remplit dans les plantes la fonction pulmonaire. Nous avons lieu de le préſumer, non pas tant à cauſe de la texture molle et valvuleuſe de cet organe (qui ſerait cependant une ſorte d'indication) que par l'obſervation du fait qui précede la mort naturelle des plantes et qui eſt très remarquable dans les arbres.

Tant que la plante eſt jeune, vigoureuſe, la circulation libre et facile de la ſève l'appelle à grands flots vers la cîme, où la moëlle moins revêtue, plus près de l'écorce, communiquant par un bois plus menu et plus tendre, par des

des trachees et des utricules plus ouverts avec un air plus renouvellé, exerce une respiration mieux déployée éprouve plus fortement l'incendie qui l'accompagne chez tous les êtres respirans. La sêve ascendante y apporte son tribut de l'hydrogêne que lui fournissent l'humidité de la terre et les arrosemens. C'est en se pressant pour s'elever vers le sommet dans les fibres longitudinales serrées l'une contre l'autre, comprimées par l'écorce, et toujours un peu coniques, qu'elle les force presque mécaniquement à pousser en longueur et qu'elle fait croitre la plante. Enfin la sêve arrive au foyer principal: le contact des deux airs qui s'y réunissent dont l'un vient de la terre et l'autre du ciel, et le mouvement respiratoire qui les confond, qui les bat ensemble, opérent la combustion. Celle-ci donne à l'instant comme dans les animaux une *production d'eau* nouvellè.* Cette production de l'eau par la combustion des deux airs pendant la respiration de la plante et au bout de sa tige est démontrée par l'excès de la sêve descendante sur la sève montante: excès que prouve sans replique le bourrelet plus gros qu'elle forme, quand la circulation est artificiellement interrompue,† et remarquons en passant dans cette production de l'eau par le même procédé chez les animaux et chez les plantes, à quel point la nature est uniforme! combien toutes ses loix sont générales, belles et simples!

Par

* Voyez le mémoire ci joint sur la production animale de l'eau.

† La sêve ascendante passe principalement par les fibres longitudinales, fait pousser le bois et les bourgeons à bois, donne à la plante sa hauteur. La sêve descendante revient en plus grande abondance par les fibres corticulaires, développe les bourgeons à fruit, dilate l'écorce, l'attendrit, la rend plus propre à se prêter au nouveau mouvement que produira la sêve montante, et contribue ainsi spécialement à l'accroissement de la plante en grosseur.

Tels sont autant qu'on a pu jusqu'à présent le reconnoitre la marche et les effets de la circulation dans les arbres; d'où l'on peut les inférer dans les autres plantes.

Par la ſuite la grande hauteur de l'arbre, ſon âge avancé, l'endurciſſement, l'engorgement de ſes canaux empêchent la ſêve devenir en même abondance ſe faire bruler avec l'air aſpiré à l'extrêmité du flambeau, au foyer le plus vif de cette *lampe végétale*, comme le ſang et la lymphe des animaux viennent ſe faire bruler avec l'air dans la *lampe animale* qu'on appelle leurs poulmons. Alors cet air dont l'incendie ne ceſſe pas, et devient même plus ardent en raiſon de ce que l'hydrogene y balance moins l'oxigêne, conſume, à la place de la ſêve qui n'arrive qu'en moindre quantité les vaiſſeaux qui devaient la lui fournir. La moëlle moins rafraichie éprouve une *oxidation* qui n'eſt d'abord qu'une eſpece de dartre et qui dégènere bientôt en un véritable état de gangrene. L'arbre ſe couronne: et ſi l'on n'y apporte pas un prompt remède, le ſphacele gagne tout le canal médullaire; puis les couches intérieures: l'arbre ſe creuſe; il meurt. C'eſt lá ſa mort devieilleſſe. Elle eſt três rapprochée de celle qui termine les jours des animaux, lorſque des bleſſures ou des maladies n'ont pas précipité leur derniere heure.

Mais, ô miracle! la plante montre pour la conſervation de ſa vie, plus d'animation, ou du moins une animation plus tenace que les animaux eux-même. La théorie et la pratîque de nos maladies médicales et chirurgicales trouvent chez elle une parfaite application;* et les moyens curatoires ſont plus ſurs, plus efficaces pour elle que pour nous. On peut retarder la mort des plantes, on peut les rajeunir.

Quand l'affreuſe maladie que nous venous de décrire, quand l'impitoyable vieilleſſe attaque leurs poulmons, dévore leur moëlle et parait les conduire au trépas, il ſuffit de leur couper la tête juſqu'au deſſous du point que le germe de la gangrene avait atteint, où la moëlle avait été affectée,

* Voyez l'abbé *Roger Schabol.*

affectée, et de bien garantir la blessure du contact de l'air, pour qu'il repousse à la place de la tête frappée de décrépitude une jeune tête pleine de vigueur.

Si plusieurs branches sont malades, on retranche les branches infortunées et de nouvelles branches se hatent de les suppléer. Le succés est certain si l'on n'a pas trop retardé l'opération, si dans la partie que l'on a conservée la moëlle, qui est le viscére noble des plantes, est demeurée entierement saine et communique avec une écorce qui ne soit ni viciée ni dédieree et dont les pompes aspirantes soient en bon état.—On peut couper le tronc même à fleur de terre; et sur ses debris sur son écorce, de sa sêve, de ses bourgeons, plusieurs arbres nourris d'abord par les mêmes racines, et qui ensuite en poussent qui leur sont personnelles, succédent à l'arbre qu'on a sacrifié. Il leur a transmis une vie qui ne fut point interrompue; rien ne meurt que ce qui a été abattu.

Ce n'est pas un privilege des arbres. Les simples herbes jouissent du même sort. Le jeune gazon fauché de bonne heure, conserve sa verdure immortelle et serre de plus en plus ses nombreux rejetons. Vous le frappez: il souffre, il se rebelle. Fils de la terre, comme *Antée*, il renait sous vos coups, plus fort et plus frais qu'auparavant.

D'où cela vient-il? c'est que, outre la vie générale dont la plante est animée et qu'elle communique à ses branches, chaque branche est une plante semblable à celle dont elle émane, *implantée* sur le tronc comme lui même l'est dans le sol,* ayant sa vie et son particulieres et qui contribue par elles à la bonne constitution du tout dont elle tire sa principale subsistance.

 Cette

* La vie particuliere à chaque branche, et son *implantation* sur le tronc sont démonstrativement prouvés par le phénomène de la graffe qui introduit chez un arbre des branches étrangeres comme un gendre dans une famille. Il devient de la famille sans doute, mais on gardans son individualité, et même son nom; et la race qu'il donne à cette famille est à lui.

Cette partie de l'hiſtoire de la plante l'embraſſe toute entiere à tous ſes âges. Elle préſente une multitude de propriétés viſiblement *animales*, que l'on ne peut conſiderer, ſans être forcé de convenir, non ſeulement que la plante eſt *un animal*, en prenant ce mot dans le ſens le plus générique, mais qu'une plante eſt une *confédération* D'ANIMAUX, tous parens, tous intimement unis, tous s'entr'aidant les uns les autres, travaillant tous au bien de leur ſociété, et toujours prets à réparer les malheurs de la guerre, qu'ils ne peuvent fuir, qu'ils ſavent braver.

Eſt-ce là tout ?—Non, vraiment—ce n'eſt rien encore.

Hâtons nous d'arriver aux FLEURS—chacune d'elles a ſon enfance, ſon épanouiſſement, ſa puberté, ſa paſſion. Chez celles qui ſont *androgynes*, où chaque corolle eſt l'habitation d'un ménage, le château fraternel, amical de quelques aimables princeſſes, ou le palais d'une auguſte et ſenſible impératrice l'œil nud peut quelquefois diſtinguer, et la loupe preſque toujours appercevoir, à des attitudes, à des mouvemens, à des geſtes qui n'ont rien d'équivoque, l'amour, d'abord ſupliant et reſpectueux, puis impitueux des mâles; la reconnoiſſance énivrée des femelles. Il en eſt de timides que leurs amans preſſent et ſemblent violer. Il en eſt de coquettes et de hardies qui vont les chercher, les exciter, les épuiſer l'un après l'autre.

Chez celles où les deux ſexes ſont ſéparés et appartiennent à des fleurs diverſes, ſoit ſur la même plante, ſoit ſur des plantes analogues, mais différentes et qui peuvent être éloignées l'une de l'autre, les mâles ont quelque choſe de l'ardeur mélancolique et ſolitaire des victimes cloitrées, et les femelles qui tiennent tout leur bonheur du zéphir, et qui périſſent en ſtérilité s'il n'a point fait de vent, montrent un peu de cette extâſe des ames tendres et réſignées qui n'eſpérent et ne reçoivent aucun bien que de la bénédiction du ciel.

Tout

Tout cela, je l'avoue, n'eſt que faible et confus; car, qui n'a que peu de ſens, n'a pas beaucoup de ſenſations, ne ſaurait les animer l'une par l'autre, et les raiſonne peu. Mais tout cela *eſt*, et j'ai plutôt adouci qu'éxagèré le tableau.

J'invoque vos reflexions, lecteur philoſophe.—Si les déſirs, ſi les plaiſirs, ſi la ſurabondance de ſanté, ſi la réunion heureuſe, l'action réciproque, la jouiſſance, l'effuſion, le mélange intime, la fecondation enfin, ne ſuppoſent pas ne conſtatent pas *l'individualité*, ſon exerciſe mutuel, la ſéité, la vie, où faudre-t'il les chercher? à quoi pourrons nous les reconnoitre?

Nous avons quelques ſens de plus. Nous avons l'uſage de tous nos ſens dans un degré plus éminent, ce qui tient beaucoup à la combinaiſon de leurs rapports: car il n'y a pas un ſens qui ne ſoit multiplicande et multiplicateur de ſes voiſins: c'eſt ce qui fait que la perfection plus ou moins grande des animaux réſulte du nombre et de la bonté de leurs ſens. Mais le fonds de nos amours, c'eſt-à-dire de l'affaire la plus importante et la plus maitriſante de notre vie, n'eſt-il pas le même que celui de l'amour des plantes? leur effet n'eſt-il pas complettement pareil.—Toutes les fois que je rencontre mon ſemblable, je le ſalue.

Voyons un peu plus loin—Suivons la chaine des ſimilitudes et des analogies.

La plus part des inſectes ont pour chaque individu quatre ſortes de vie: deux endormies, deux actives. Ils ſont œufs; ils ſont chenilles, vers ou larves; ils ſont chryſalides; enſin, ils ſont mouches, ou papillons, ou ſcarabées, ou tipules ou cupreſtes, ou—ou—&c. et ce n'eſt que ſous cette derniere forme qu'ils deviennent productifs.

La plante en miniature eſt d'abord immobile dans ſa graine comme l'inſecte dans ſon œuf.—Elle reçoit par la la germination un premier aliment des cotylédons entre lesquels elle est placée ; et qui, communiquant avec elle par l'insertion de canaux correspondans, lui transmettent l'émulsion, le lait dont ils sont remplis ; de même que l'insecte, et chez les oiseaux le poulet, se nourrissent par leur cordon ombilical des fluides de l'œuf dans lequel ils nagent ; et de la même maniere encore que les petits des quadrupedes, des bipedes, et de tous les vivipares, reçoivent pendant la gestation leur nourriture du *placenta* qui se dévelope et grossit lui même, ainsi que les lobes de la graine transformés en feuilles séminales.

Vers la fin de cette époque le radicule qui a poussé devient remarquable, les véritables feuilles pointent. Alors et la plante est *éclose*. Elle n'a plus besoin de son œuf dont elle a consommé les liqueurs et la substance amylacée, et dont la coquille tombe en lambeaux. Elle vit ; et travaille pour vivre par elle même, comme l'insecte nouveau-né. Elle n'a cependant acquis que sa vie de plante, déja laborieuse et non encore féconde : de même que l'insecte sorti de l'œuf a sa vie de ver, ou de larve, qui cherche sa subsistance et ses commodités, mange, respire, pense, et ne connoit point l'amour, et n'en a ni les organes, ni les idées.

Dans cette seconde vie, la plante éprouve une agitation interne. Elle renouvelle à plusieurs reprises son épiderme, son écorce, ses tuyaux, comme le *bombix* et la plus part des autres chenilles changent leur peau. Elle a, non pas vraisemblablement sans quelque plaisir, des bourgeomemens qui lui font pousser une tige, des branches, des feuilles, un corps, des bras, des mains tellement vivaces que nous avons vu qu'on peut les couper et qu'ils repoussent comme les pattes des ecrevisses et des salamandres, comme la tête des limaçons, comme la queue de quelques serpens, comme les dens venimeuses de toutes les viperes, comme le corps et tous les membres des polypes.

Celles

Celles dont le bois eſt tendre, la moëlle abondante,* le tiſſu ſpongieux, les ſaules, les ſureaux, les menthes, les lianes, la vigne, &c. ont, comme les polypes encore, dans chacune de leurs branches, la poſſibilité, la faculté quand on l'a ſeparée du tronc, et pourvû qu'elle trouve une nourriture convenable, de reformer un nouvel être, ſemblable à ce tronc dont elle a été détachée et à toutes ſes dépendances. Cette propriété leur eſt commune avec un grand nombre de *vers* qui, lorſqu'on les coupe en deux, ou en trois, refont, la partie antérieure une queue, la partie poſtérieure une tête, et celle du milieu tête et queue.

Très pareillement, toutes les plantes privées de leur tête en refont promptement une nouvelle ; et les branches de toutes celles qui ſont propres à la bouture, miſes en terre humide, ſe fabriquent une nouvelle racine. Leur bâton même, renverſé, ſe forme, un peu plus lentement, mais très bien, une tête un gros bout qui répondait aux racines, et des racines au petit bout qui n'avait jamais donné que des branches et du feuillage. Il-y-a revulſion dans toutes ſes liqueurs, renverſement, contournation dans tous ſes bourgeons : ils ſouffrent un tems, mais ils ne meurent pas : ils gueriſſent et s'accoutument à leur nouvel état.

* Il faut répéter que la moëlle tient lieu à la plante de tous nos viſceres majeurs. Ce qui en tient lieu chez les polypes auxquels on ne conteſte pas d'être des animaux eſt encore moins compliqué.

La moëlle eſt donc pour la plante, ſon poulmon, ſon cœur, ſon eſtomac, ſa cervelle, le faiſceau diſtributeur et correſpondant de tous ſes nerfs ou de tous les organes de ſa ſenſibilité. Et c'eſt pourquoi celles qui ont le plus de moëlle ont la vie la plus rapide dans tous ſes mouvemens, et la plus opiniatre. Elles croiſſent plus vite, elles meurent plus vite quand on ne leur porte pas ſecours, parce que cette moëlle plus aminée s'embraſe, ſe gangrene plus aiſément et plutôt. Mais elles ont plus de moyens de ſalut. Elles tracent et ſe marcottent d'elles mêmes. Elles ſe régénerent avec bien plus de facilité.

Lorſqu'on obſerve les compenſations que Dieu a miſes entre le deſtin des différens êtres, on ſe ſent ébloui d'admiration, et l'on ſe proſterne de reconnoiſſance.

état. C'eſt un des rapports de la plante avec le polype qu'on a retourné.

Cette avanture eſt ordinaire aux mangliers; et les ſaules, ſurtout le ſaule pleureur, ſoutiennent la même expérience. Quand une de leurs branches eſt marcottée, ſi on la ſépare de l'arbre en lui laiſſant quelque longueur, la racine qu'elle a pouſſé nourrit deux ſaules : l'un qui finit en pointe, c'eſt la prolongation de la branche : l'autre qui eſt *têtard* et dont la tige reſte long tems plus groſſe par le haut que par le bas. Cette tige renverſée retourne aſſez vite toutes ſes brindilles, tout ſon feuillage; et les branches qui partent de ſa tête, retournées dans leur bourgeon même, prennent ſans difficulté l'attitude naturelle.

Bien là dedans ne reſſemble encore qu'à ce qui arriſe fréquemment à pluſieurs animaux glaireux dont le principe vivifiant eſt répandu toute leur glaire, à différentes eſpeces de vers, et aux polypes ſans amour : mais c'eſt beaucoup pour une plante.

On me demandera incidemment, ſi les polypes connaiſſent l'amour? je n'en ſais rien. J'ai peine à croire qu'il ait été refuſé à perſonne. Les polypes ont viſiblement quelques paſſions animales : la *faim* qui les conduit à une grande activité et au raiſonnement dans le travail, et la *gourmandiſe* qui leur en fait ſavourer le fruit. Les polypes reſſemblent aux plantes par la bouture, le bourgeonnement, les drageons, les cayeux. Nous ne les avons pas encore ſurpris dans des émotions plus tendres ; mais DIEU eſt très bon, la NATURE eſt très généreuſe, et nous ſommes très ignorans.

Quand aux plantes plus faciles à voir et à manier, que les polypes il nous a été poſſible d'apprendre que la bourgeons, les boutures, les graines même, ne produiſent que des végétaux qui demeurent long tems dans leur état que j'appellerais j'appellerais volontiers de *chenilles*, dans leur état d'absence de l'amour.

Mais enfin la plante atteint un âge qui lui fait produire des bourgeons d'une autre espece. Pareils sous plus d'un rapport à des chrysalides, ils renferment des embrions dont la figure n'est plus la même que celle de la tige qui les porte. Ces *bourgeons-chrysalides* rompent leur enveloppe; les *fleurs* déployent, comme des ailes, leurs petales brillantes—ce sont de nouveaux êtres. Elles ont une vie particuliere, plus animée, plus exquise que celle de l'arbre ou de l'herbe qui les soutient, qu'elles décorent. Elles sont plus influencées par l'air ambiant, et réagissent plus fortement sur lui. Elles le décomposent d'une autre maniere et d'une maniere qui ressemble plus parfaitement encore à celle que produit la respiration des animaux dont le jeu des poulmons nous est visible.

La plus part des plantes absorbent l'azote et dégagent une partie de l'oxigêne. Un grand nombre de fleurs s'abreuvent d'oxigêne et repoussent l'azote comme l'homme lui même, et avec une si grande puissance qu'elles balancent et surpassent la consommation que tout le corps de leur plante fait pour sa nourriture de ce fluide irrespirable.

Cet oxigêne dont les fleurs sont si avides, et dont elles se pénétrent si rapidements, en si énorme quantité pour leur petit volume, est *l'air vital* par excellence. Il les embrase, elles aiment, elles jouissent—sont-ce les amours de la plante qu'elles font? sont-ce les leurs? ce sont tous les deux. La mère ne peut être entierement insensible au bonheur de ses enfans, d'enfans qui sont partie de son propre corps.—La plante est devenue papillon; ou pour mieux dire elle s'est converte d'une foule de *papillons-plantes* de l'un et de l'autre sexe, qu'elle a tirés de son sein, et qui semblables presqu'en tout aux autres papillons, ont une vie très courte, la dépensent en voluptés sans

songe

ſonge à l'entretenir, exhalent leur tendreſſe en parfume, s'occupent avec délices et ſans relache de la génération; et ſe fanent des qu'elle eſt conſommée laiſſant, ... au fonds d'un *ovaire* . . . . des *œufs* . . . . fécondés et féconds.

Trouvez vous la parité ſuffiſamment exacte? jugez vous encore que la diſtance ſoit incommenſurable entre la nymphe, ou les nymphes d'une *mimeuſe* et l'ame d'un ciron.

Je ne décide rien. Je ne ſuis qu'un enfant curieux. Je vous apporte les fleurs que j'ai cueillies, et les papillons que j'ai pu attrapper. Savans profeſſeurs dites moi ce que c'eſt?

No. XV.

Memoir on the Analyſis of Black Vomit. By Dr. Isaac Cathrall.

Read June 20th, 1800.

THE inveſtigation of the properties of ſecreted fluids has long engaged the attention of the phyſiologiſt and chemiſt: but, their enquiries have generally been directed to a knowledge of thoſe fluids in a healthy ſtate, while little notice has been taken of the ſecretions of ſome of the moſt important viſcera after a ſtate of diſeaſe. The cauſe of this deficiency, in the examination of morbid ſecretions, and particularly in that denominated the black vomit, muſt be aſcribed to the danger ſuppoſed to attend ſuch an undertaking; though moſt obſervers muſt have been ſtruck with the ſingular appearance of this diſcharge, and much aſtoniſhed with the ſpeedy diſſolution that enſued; yet, none that I have had an opportunity of conſulting, have attempted an analyſis of this fluid. When I firſt contemplated an examination of the black vomit, in 1793 and 1794, I conſidered it as an hazardous undertaking, and limited my views merely to diſtinguiſh that fluid from putrid bile; but, after ſubjecting it to many experiments, and finding that it had no effect on my health, I have been enabled to advance one ſtep farther in the enquiry; and, I have now the ſatisfaction of ſubmitting to the Philoſophical Society, an analyſis of that fluid, together with its effects, when applied to the healthy ſyſtem.

Deſcription of the Black Vomit.

The black matter, or vomit, ſo called, appears to be of two kinds. One, conſiſting of a number of black flaky

 particles,

particles, reſembling the grounds of coffee. The other, of a dark-coloured inſpiſſated mucus: of each of theſe, I ſhall give a ſeparate deſcription.

This flaky diſcharge was always preceded by violent ſickneſs and vomiting; and, as a precurſor to the ejection of this matter, in ſome caſes, the patients vomited a fluid like whey, or muddy water, or one conſiſting of a brown flaky ſubſtance, reſembling chocolate, or ſpoiled porter, mixed with browniſh-coloured mucus.* Theſe ſubſtances were ſometimes of a lighter colour, and were ſuſpended in a glarey yellow-coloured fluid, which became nearly tranſparent when at reſt, by the ſubſiding of a ſmall number of brown particles. This coloured matter was generally vomited in ſmall quantities, and with conſiderable difficulty; but, when the black flaky diſcharge commenced, it was frequently ejected in large quantities, and with ſimilar force to a fluid from the action of an emetic. As the diſeaſe advances, this matter aſſumes a darker colour, and its quantity ſometimes becomes ſo much augmented, that I have known one gallon vomited in 48 hours, beſides a conſiderable quantity, which was of a much thicker conſiſtence, that was diſcharged by the bowels. This black vomit, after ſtanding ſome hours, depoſits a black flaky ſubſtance, from a glarey yellow-coloured fluid, ſimilar, in appearance, to an infuſion of green tea. Theſe depoſitions were ſometimes in diſtinct particles, but, frequently, in a kind of dark powder. The above particles were various in ſize, and of a very irregular figure, not unfrequently mixed with pieces of the villous coat of the ſtomach. Theſe may be diſtinguiſhed by their being longer in ſubſiding

* The chocolate, or coffee ſickneſs, or the black ſickneſs, ſays Dr. de Monchy, is not taken from the blackiſh hue or ſhade of the ſkin, but it is derived from the fœtid, blackiſh matter diſcharged from the firſt paſſages. See Diſeaſes in Voyages to the Weſt-Indies.

fiding to the bottom of the veffel, than the flaky fubftance. There were fome difproportions between the yellow-coloured fluid, and the quantity of flaky fubftance, as in the other appearance of the vomit. The flaky matter was very readily re-incorporated with the yellow-coloured fluid, by the leaft agitation of the veffel; and, when kept in a phial, corked for eight or ten days, affumed rather an agreeable faccharine odour, and was extremely brifk, like fermenting beer. This laft property is not peculiar to this fluid, but common to fome other animal fecretions. When the black vomit was kept for two years in a ftate of reft, the flaky particles became perfectly feparated. On agitating the veffel, the former was immediately incorporated with the latter; and, after remaining at reft fix months, fhowed fcarce any difpofition to feparate. This was the appearance, if I recollect, accurately, of the black vomit, exhibited by Dr. Monro, of Edinburgh, to his clafs, in 1792, and which had been fent to him from the Weft-Indies: yet, as the profeffor did not permit it to go out of his hand, I cannot fpeak correctly as to the fact; but, believe it was not feparated, and confifted of a turbid black-coloured fluid.

The mucus-matter which was fometimes vomited in the yellow fever, and particularly in that which appeared in 1797, was very ropy, and of a black colour. This matter floated on a fluid of a dark colour, which appeared to receive its tinge from the colouring-matter of the mucus. When this matter was agitated in a phial, the mucus fhowed no difpofition to mix with the fluid-part of the vomit, and, when it was repeatedly wafhed, in clear water, became nearly of the colour of the mucus fecreted in the alimentary canal. This black matter was difcharged in large quantities, in the cafes which proved mortal in 1797, and was a very in-

R 2 active

active fluid when applied to the moft fenfible parts of the healthy body, and was effentially different from the coffee-ground vomit.

Analyfis of fluids, ejected a few hours before the commencement of black vomiting.

The fluids, on which the fubfequent experiments were made, were obtained from three patients, from one to fixteen hours previous to the vomiting of the brown-coloured matter, which has been defcribed as generally preceding the black difcharge. In all of thefe cafes, the fick refufed every other drink but plain water. Notwithftanding the fimplicity of the drink, the fluids, which are the fubject of inveftigation, were of the following colours: The firft had nearly the appearance of whey; the fecond was of a yellowifh colour, occafioned by the mucus it contained. The third appeared like muddy water, or refembled water that had been coloured by afhes. Thefe fluids had a difagreeable faccharine tafte, and emitted an odour analogous to that arifing from fluids which had been ejected from debilitated ftomachs, after paroxyfms of indigeftion. They underwent but little change after remaining at reft for twenty-four hours, except that fome part of the mucus-matter affumed a white afpect, and fubfided to the bottom of the veffel.

(*a*) Thefe fluids changed the infufion of turnfole to a red colour; paper ftained yellow with turmerick remained unaltered, but, when previoufly changed by an alkali, was reftored to its priftine colour.

(*b*) Caloric, or diluted acids, would not coagulate this fluid.

C.

(*c*) Lime-water produced no clouds or turbidneſs.

(*d*) Solution of ſulphate of iron, or nitrated mercury, cauſed no precipitation.

(*e*) Muriated barytes occaſioned no alteration ;

(*f*) Nitrated ſilver produced a copious white precipitate ;

(*g*) Sulphate of copper did not ſhow the preſence of ammoniac ;

(*h*) Fixed alkalies occaſioned no alteration ;

(*i*) Oxalic acid produced no change ;

(*k*) Alcohol of galls, or pruſſiate of pot-aſh, did not produce any precipitation.

(*l*) Theſe fluids, when expoſed to cold, were congealed in the temperature in which water freezes; the ice was nearly tranſparent, and, when rendered fluid, had the appearance of water, and taſted like that fluid after being boiled.

The above fluid, therefore, appears to contain an acid in a free ſtate (*a*); but no coagulable matter (*b*), nor carbonic acid, in a diſengaged ſtate, or combined with alkalies or earths (*c* & *d*) ; the acid (*a*) is proved not to be the ſulphuric (*e*). The preſence of the muriatic acid is ſuppoſed, from (*f*) ; no ammoniac is contained in this fluid (*g*), nor earths (*h*), nor lime, or the ſalts formed of lime and acids (*i*) ; no reaſon to ſuſpect metallic matter (*k*) ; but a conſiderable proportion of water (*l*).

Analyſis of black vomit.

We have already obſerved, in the deſcription of the black vomit, that it ſpontaneouſly ſeparated into yellow-coloured fluid, and black flaky ſubſtance.

(No. 1.). The yellow-coloured fluid, and flaky ſubſtance being thrown on a filter of two-folds of paper, four ounces of a fluid paſſed through, which was ſimilar, in appearance, to an infuſion of green-tea. It was

was moderately viſcid, and had a faint ſweetiſh animal odour, and a ſaccharine taſte, perceptibly acrid to the lips. The matter which remained on the filter, was ſimilar, in colour and conſiſtence, to Venice treackle. It was weakly glutinous, and had the ſame odour as the yellow-coloured fluid. When this ſubſtance was dry, it weighed thirty grains. It was friable, and not of ſo black a colour as immediately after being removed from the filter. When this matter was obtained by evaporating the black vomit over a moderate heat, it was brittle and ſhining, but had no peculiar taſte or ſmell; and, when expoſed to a moiſt atmoſphere, became ſoft and glutinous.

(*a*) Eight drachms of the filtered fluid (No. 1.) was evaporated in a ſhallow veſſel, by a gentle heat: the vapour being condenſed, was found to conſiſt of water, which taſted neither acid nor alkaline; but emitted a ſtrong odour of the vomit. The evaporation being continued until an adheſive reſiduum remained of a dark colour, reſembling melted ſugar. This ſubſtance affected the lips in a more obviouſly acrid manner than the fluid did previous to the evaporation. It was highly inflammable when dried, but not entirely ſoluble in water.

(*b*) Six drachms of the filtered fluid (No. 1.) and as many of water, were expoſed in ſeparate phials, cloſely corked, to an atmoſphere, when the mercury, in the thermometer, was as low as 25°. The filtered fluid congealed as ſoon as the water. The two different fluids were examined, after ſtanding a whole night; when the phial, containing the coloured fluid, was found entire, and its contents not quite frozen; as, a part of the fluid, on placing the phial on its ſide, flowed among the ice. The water, in the other phial, was completely frozen, and the veſſel broken in pieces. The ice, in the

the former phial, was of a yellow-colour: The colouring-matter of which could be ſo much diſengaged, by waſhing it with water, as to give it the uſual tranſparency of ice. The aqueous part of the vomit, obtained in this manner, diſſolved ſoap, with facility, but had not the odour of the vomit. This fluid was neither acid nor alkaline. Pruſſiate of pot-aſh, or oxalic acid, did not cauſe any precipitation.

(*c*) Some alcohol was poured on the adheſive reſiduum (*a*), and a conſiderable portion of it was diſſolved, which tinged the menſtruum of a yellowiſh-colour, and gave to it the perceptible taſte of the yellow-coloured fluid. A part of the reſiduum remained inſoluble, which appeared to be of a mucilaginous nature. The menſtruum was poured off, and, by the affuſion of diſtilled water, the fluid became milky, and a reſinous ſubſtance, of a yellowiſh-colour, was precipitated, that had an odour ſimilar to the yellow-coloured fluid.

(*d*) The filtered fluid (No. 1.) betrayed the preſence of an acid to the infuſion of turnſole, as the mixture became manifeſtly reddened. 2. Lime-water, when added to a portion of this fluid, occaſioned no change: 3. Solution of ſulphate of iron cauſed no precipitation, nor did nitrated mercury, or muriated barytes.

(*e*) To ſome of the filtered fluid, I added nitrated ſilver, and a copious white-coloured precipitate was formed. Four drachms of the above fluid was evaporated over a moderate fire, until it was reduced to about one drachm; when ſuffered to remain at reſt, in a cool place, cryſtals, of a cubic figure, were formed. Theſe decrepitated upon coals, and had all the characters of muriate of ſoda, or common ſalt.

(*f*) To ſeparate portions of the filtered fluid (No. 1.) was added oxalic acid, pruſſiate of pot-aſh, infuſion of galls, and a ſolution of ſulphate of copper; but neither of them produced any precipitation.

(*g*)

(*g*) Some diſtilled water being digeſted on ten grains of black flaky ſubſtance (No. 1.) for twelve days, after which it was gently heated and committed to the filter. 1. This liquor immediately changed the vegetable blue to a red colour. 2. Lime-water cauſed no precipitation. 3. Muriated barytes effected no change; but, on the addition of nitrated ſilver, a white-coloured precipitate was produced. Some of the above fluid being cautiouſly evaporated to a certain quantity, on cooling, cryſtals of a cubic figure were formed. Theſe had the properties of muriate of ſoda, or common ſalt.

(*h*) Some marine acid, a little diluted, was poured on ten grains of the black flaky ſubſtance, (No. 1.) a ſlight coagulation was produced, after ſtanding twelve days. The mixture was filtered, and divided into four portions.

The firſt portion was ſaturated with lixivium of mild pot-aſh, but no precipitation enſued; yet, in a few hours, a ſaline ſubſtance appeared at the bottom of the veſſel.

To the ſecond portion was added ſulphuric acid. This threw down a copious flocculated precipitate, of a white colour, which I ſuppoſed to be lime; but, on pouring off the fluid, a thin layer, of a white, fatty ſubſtance, was ſpread over the bottom of the veſſel. This had an unctuous feel, and ſtained paper like oil; and emitted an animal odour when thrown upon coals. This matter, when kept in a phial, corked for two weeks, aſſumed a yellow-colour, and had an odour like rancid ſpermaceti.

To the third portion, pruſſiate of pot-aſh was added, and Pruſſian blue produced.

To the fourth portion, alcohol of galls was added, and the mixture ſaturated with lixivium of mild pot-aſh, which immediately ſtruck a black colour.

I.

(*i*) One hundred and twenty grains of the nitric, and as many of ſulphuric acids, were digeſted on ten grains of dry black flaky ſubſtance (No. 1.) placed in different veſſels, for twelve days. At the expiration of that time, the black ſubſtance was entirely converted, without the application of heat, into the fatty matter before mentioned. That on which the nitric acid was uſed, was of a yellowiſh colour; the acid appearing to have undergone no perceptible change. But the ſulphuric had aſſumed a black colour, and the matter that had precipitated, was as white as ſnow. This, in both acids, roſe to the ſurface, and aſſumed the appearance already deſcribed.

(*k*) Some diſtilled water was boiled on the unctuous matter (*i*). This liquor was filtered; but, on the addition of oxalic acid, no precipitation enſued.

(*l*) Two ounces and a half of black vomit was put into a retort, adapted to a receiver. This was placed in a water bath. Soon after, the fluid began to boil. Two drachms of a browniſh white-coloured fluid, having a ſmall quantity of oil on its ſurface, paſſed into the receiver. This had a ſtrong odour of ammoniac and an oily, diſagreeable taſte. Finding that no more fluid would come over, the retort was placed in a ſand-bath, and a conſiderable quantity of a ſimilar coloured fluid was obtained. The reſiduum, in the retort, conſiſted of a dark-coloured ſpongy coal. This, when expoſed, a ſhort time, in a red hot crucible, gradually aſſumed a grey colour, and, at length, was reduced to aſhes.*

(*m*) Some diſtilled water was ſuffered to ſtand ten days on fifteen grains of aſhes (*l*), after which it was gently heated and filtered. This liquor did not change the co-

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* Many of the preceding experiments, were made in the preſence of a medical gentleman of reſpectability, viz. Dr. Samuel Duffield, conſulting phyſician to the port of Philadelphia.

lour of paper ſtained yellow with turmerick. Muriated barytes produced no alteration; but nitrated ſilver cauſed a copious white precipitate. On the aſhes, which remained undiſſolved, two drachms of nitric acid a little diluted, were digeſted. This mixture being filtered, was divided into two equal parts. To the firſt portion, pruſſiate of pot-aſh was added, which immediately ſtruck a blue colour, and Pruſſian-blue was produced. To the ſecond portion, lixivium of mild pot-aſh was added, and a copious precipitate was formed. This, when collected and dried, had the appearance of lime, and was almoſt entirely ſoluble in diſtilled water. This fluid, when filtered, and oxalic acid added to it, cauſed a copious white ſediment. That this precipitate was lime, was, in ſome meaſure, confirmed, by adding diluted ſulphuric acid to it, with which it formed a ſubſtance like ſelenite, or ſulphate of lime. I found, that, by re-diſſolving this precipitate in ſulphuric acid, and precipitating it again with an alkali, and treating it in the manner mentioned, it gave ſtronger proofs with oxalic acid of the preſence of lime. On the remaining aſhes, which was not diſſolved by the nitric acid, I digeſted ſulphuric acid a little diluted; after which it was boiled on them, notwithſtanding there remained a fixed reſidue. This mixture, when filtered, ſhowed the preſence of lime and iron to chemical teſts.

(*n*) Three ounces of black vomit were put into a retort, and the pneumatic apparatus being affixed, the retort was placed in a ſand-bath, which was gently heated, after exhauſting the air in the neck of the retort. The firſt meaſure of air that was obtained, did not appear to burn when a lighted taper was preſented to it. The ſecond meaſure of air was incorporated with water, and ſome iron-filings inſerted in the phial, which was ſuffered to remain for 24 hours. This mixture

was

was found to precipitate lime from lime-water. Alcohol of galls produced a violet tinge. The vomit which remained in the retort, after the air had been extracted, from being of a very black colour, was changed, by the application of heat, to a light brown.

From reviewing the preceding analysis, the black vomit appears to be composed of the following ingredients:

(*a* & *b*) Prove it to contain a considerable proportion of water;

(*c*) A resinous and mucilaginous substance;

(*d*) Proves a predominant acid which is not the carbonic, phosphoric, or sulphuric acids; but, in all probability, an acid analogous to the one contained in the fluids, ejected previous to the commencement of black vomiting. In repeating this experiment, on the same coloured fluid, taken from twenty different patients, during several seasons of the prevailing yellow-fever, I always found a similar acid to predominate. May not the incessant vomiting and the ejection of black matter, itself, which has been said to be stopped by the exhibition of lixivium of mild pot-ash, or lime-water, accomplish that end, by combining with this acid, and forming a substance less irritating to the stomach, than the acid in an uncombined state?

(*e*) That it contains muriate of soda, or common salt;

(*f*) Proves it to contain neither lime, metallic matter, nor ammoniac.

(*g*) Proves the black flaky substance (No. 1.) to contain an acid, in a disengaged state, probably analogous to the one predominant in the filtered fluid. This experiment likewise shows it to contain muriate of soda, or common salt.

(*h* & *i*) Prove an unctuous animal substance, and a considerable quantity of iron. The former resembled in some respects, spermaceti. How far this substance is analogous to that analysed by the masterly talents of Fourcroy, I cannot determine; as I had not a sufficient quantity of it, to enable me to endeavour to imitate his analysis. From the black flaky substance being entirely converted into the fatty matter (*i*), it is probable that it resembles the fatty substance, described by Dr. Gibbs:*

(*k*) Shows the unctuous substance to contain no lime:

(*l*) The black vomit yielded, on distillation, a brownish white-coloured fluid, and a quantity of dark-coloured oily matter.

(*m*) The carbonaceous matter (*l*) appeared to contain muriatic acid in a combined state; likewise lime and iron:

(*n*) Proves carbonic acid gas.†

The proportion of the different substances which constitute the black vomit, I had not an opportunity of estimating, as I could not obtain a sufficient number of grains, of the black flaky matter, to subject it to a more regular analysis.

Experiments to ascertain the effects of black vomit on the living system.

From the internal surface of the stomach and intestinal canal appearing, on dissection, inflamed and sphacelated, particularly in some patients who had vomited black, it has been believed that the black vomit was corrosive, and had

* See Transactions of the Royal Society of London, for 1794.

† When the foregoing experiments were committed to paper, and during the period of the late yellow-fever, I submitted them to the perusal of Dr. Adam Seybert, whose chemical accuracy is well known to this Society. This gentleman obligingly favored me with his company on the 22d of November, when most of the experiments were shown to him, made on the black vomit, reserved for that purpose, and the result nearly corresponded with what has been already described.

had a power of acting on parts it came in contact with.* This power has likewife been inferred from fome patients complaining of a forenefs in their throats, immediately after the ejection of this black matter.

To determine how far it was capable of acting on the healthy body, it was fubmitted to the following experiments:

1ft. In October, 1794, immediately after a quantity of black vomit was taken out of the ftomach, after death, I applied fome of it to my tongue and lips; to the latter it gave, a fhort time after application, the fenfation of a fluid perceptibly acrid. This experiment was, the next day, feveral times repeated, with the fame refult.

2d. A friend of mine applied it to his lips, and it produced a fimilar fenfation; but would not affect his tongue.

3d. Finding the effects of this matter fo different from what was expected, I began to believe that this difcharge varied materially in point of activity, in different patients; but, on fubjecting the black vomit, procured from a number of perfons, to the fame teft, it produced the fame effect.

4th. Two ounces of a fluid, refembling chocolate, was obtained, which was vomited a few hours before death. This was applied in the fame manner; but, there could not be perceived any difference in the refult.

5th. In the beginning of October, 1799, Mr. Jofeph Parker, an active and intrepid member of the board of health, obligingly prefented me with five ounces of black vomit, obtained from the phyficians of the City-Hofpital. Some of this I applied to my tongue, in his prefence, but could not perceive the leaft corrofive effect. When this fluid was applied to the fkin on different parts of the body, it produced no other effect, than what water did of the

* See Defportes, on difeafes of St. Domingo, p. 203, vol. 1.

the ſame temperature. I have often immerſed my hand in black vomit, immediately after it was diſcharged from the ſtomach, and whilſt it was warm, without exciting the leaſt uneaſy ſenſation in the ſkin.

(*a*) October 4th, 1799, three cats were confined in a room, and fed with beef, which had a conſiderable quantity of the flaky ſubſtance of the vomit inſerted into it. This manner of feeding was continued until they had eaten one drachm and a half of the flaky ſubſtance, and had drank ſeveral ounces of the black vomit. On the 5th, the excretions of the bowels were of a dark colour; yet there could not be diſcovered any difference in their health; but, from their being ſtrangers to each other, they had a conſtant propenſity to combat. This malicious ſpirit continued until the 20th, when they were diſmiſſed in good health.

(*b*) A large dog was confined in a room, and, by an aſſiſtant, his jaws were forced aſunder, and he was compelled to ſwallow an half pint of black vomit. The following day, the excretions by the bowels were fluid and of a black colour; but there could not be obſerved the leaſt alteration in his health, from the time of making the experiment, until he was diſmiſſed; which was about three weeks after.

(*c*) Two full-grown fowls were confined, and fed with bread, ſteeped in black vomit for twelve days. This, Mr. Parker, as well as myſelf, obſerved, they ate with great avidity; but it had no evident bad effect upon their health; for they continued as well after as they were before the experiment, and ſeemed to [give the preference to that kind of food] to every other which was preſented to them, and they appeared to thrive equally as well as if they had been fed upon corn.

(*d*) On the 3d of October, 1799, in a ſmall yard adjoining the houſe in which I live, ſeveral ounces of the black

black vomit, recently obtained, were evaporated over a moderate heat, in order to obtain the flaky ſubſtance. During this experiment, Mr. Parker held his head over the veſſel for ſome minutes, ſo as to inhale the ſteam of black vomit; after which, we continued within two yards of the veſſel, without experiencing any unpleaſant effect.

(*e*) The following day, I cauſed the windows and doors of a room to be cloſed, and the ſame experiment was repeated on a ſand-bath, conſtructed in the middle of a room. The fluid was evaporated until the atmoſphere was ſo impregnated with the effluvia of the vomit, as to render the apartment extremely unpleaſant, not only from the odour of the vomit, but the warmth of the room. In this atmoſphere, I remained one hour; during which, I had a conſtant propenſity to cough, and had, at times, nauſea and inclination to vomit; but, after walking out in the air, theſe effects gradually ſubſided. I experienced, however, a ſenſe of wearineſs at my cheſt for many hours after.

From the above experiments, it appears that the black vomit, when applied to the moſt ſenſible parts of the body, produced little or no effect.

Secondly, It appears that large quantities of this fluid, may paſs through the ſtomach and bowels of quadrupeds and other animals, without apparently diſturbing digeſtion, or affecting their health. This fact inconteſtibly proves the inactivity of this fluid; and renders it probable, that the ſpeedy death which enſues, after this diſcharge in yellow-fever, is not from the deſtructive effects of this matter on the ſtomach and bowels; but, moſt likely from the great degree of direct or indirect debility, which had been previouſly induced, on which the black vomit is ſometimes an attendant, and ſtrongly expreſſes the great danger to be apprehended from the enervated ſtate of the ſyſtem.

Laſtly,

Laſtly, The experiments (*d & e*) tend, in ſome meaſure to prove, that an atmoſphere highly impregnated with the odour of black vomit recently obtained, would not produce fever, apparently under the moſt favourable circumſtances.

Of the opinions of authors concerning the black vomit.

The opinions of authors concerning the properties of the black vomit, from the days of Hippocrates, until the preſent period, may be reduced to four heads. Firſt, that it conſiſted of putrid bile. Secondly, that it was putrid blood, or, according to ſome writers, a mixture of blood and bile. Thirdly, that it was the villous coat of the ſtomach in a ſtate of diſſolution, produced by inflammation, terminating in mortification. Fourthly, it is conjectured to be bile changed to a black colour, in conſequence of meeting with the ſeptic acid, which is ſuppoſed, by profeſſor Mitchell, of New-York, to be generated in the ſtomach and inteſtinal canal. The firſt of theſe opinions, viz. that the black vomit is putrid bile, I believe has been adopted merely from its being found, on diſſection, in the gall-bladder; for their properties are very diſſimilar. The black flaky ſubſtance, which is the only part of the vomit bearing the leaſt analogy to bile, is generally of a darker colour, of a thicker conſiſtence, and is compoſed of a number of flaky particles. This fluid gives a black or brown tinge to linen; whereas, bile, even after becoming highly putrid, and after being retained in veſſels for months, and even years, imparts a yellow colour to water and linen, and has an intenſely bitter taſte. This property and colour of bile is not deſtroyed by a high degree of putrefaction. The experiments made on theſe ſecreted matters, render the diſſimilarity of properties ſtill more obvious. The black flaky ſubſtance, by digeſtion with ſulphuric acid, may be entirely

entirely converted into the fatty matter before-mentioned : but, ſulphuric acid, when digeſted on putrid bile, ſoon diſſolved into a blackiſh green liquor. This colour was rendered more apparent by the addition of water; and the mixture had an extremely bitter taſte. When diluted acids were added to putrid bile, they afforded a much larger quantity of coagulable matter, than when mixed with the flaky ſubſtance of the vomit. Moreover, theſe fluids differ, in their ſpecific gravity; for, that of the black vomit, compared with diſtilled water, is as 1 is to 1-025, whereas, that of putrid bile is as 1 is to 0125.

Theſe eſſential differences make it evident, that the black flaky ſubſtance is not bile of any deſcription, or it ſhould poſſeſs ſome of the diſtinguiſhing properties of that fluid.

The ſecond opinion is, that the black vomit conſiſts of putrid blood. With reſpect to this opinion, ſimilar objections may be made, to what we have already advanced, againſt its being putrid bile. Blood, after becoming highly putrid, and kept for ſix months, will impart a red colour to water. This property, like that in bile, is not deſtroyed by an high degree of putrefaction. Blood farther differs from black vomit, in not conſiſting of flaky particles, likewiſe by ſhowing no proof of containing an acid in a diſengaged ſtate. It farther differs from black flaky ſubſtance, in not being converted into the fatty matter, by digeſtion with the mineral acids. And, likewiſe, in its ſpecific gravity; for, that of the black vomit, compared with diſtilled water, is as 1 is to 1-025, whereas, that of putrid blood is as 1 is to 0417.

Viewing putrid blood in its ſimple ſtate, it certainly bears but little analogy to the flaky matter of the vomit, either in colour, odour or taſte; but, when it is combined with the muriatic, nitric, or ſulphuric acids, and the mixture diluted with an infuſion of green tea, it reſembles, in

 many

many reſpects, the black vomit. The odour, ariſing from this combination, ſo much reſembles that ariſing from black vomit, which had been kept for ſeveral years, that I could hardly diſtinguiſh one from the other. The cloſe analogy of this compound to black vomit, would incline one to believe, that the latter was nothing more than blood combined with a diluted mineral acid; but, as the preſence of theſe acids, in the black vomit, in a diſengaged ſtate, could not be detected by the beſt teſts that we are acquainted with, and, as it is not probable that they are ſecreted by the liver, which we ſhall ſhortly endeavour to prove is the viſcus that ſecretes the colouring-matter of the vomit, this idea of its formation, muſt, of courſe, fall to the ground.

The black vomit has been ſaid to conſiſt of a mixture of putrid blood and bile. Equal quantities of theſe fluids, when ſuffered to become putrid, in a combined ſtate, had a ſtrong, bitter taſte, imparted a red tinge to water, and, in other properties, had not the leaſt reſemblance to the black flaky ſubſtance of the vomit.

With reſpect to the third opinion, viz. that the black vomit conſiſts of the villous coat of the ſtomach, in a ſtate of diſſolution, produced in conſequence of inflammation, terminating in mortification: That black vomiting may be induced by gangrenous termination of inflammation, few will be diſpoſed to deny; but, that the black vomit, in yellow-fever, and that from mortification of the ſtomach, are the ſame, the reſult of almoſt every diſſection muſt oppoſe. The former of theſe ſubſtances appears to come from the liver, while the latter conſiſts, principally, and particularly its flaky portion, of the villous coat of the ſtomach. Beſides, the black vomit is frequently thrown up in large quantities, when the ſtomach, after death, has not been found much inflamed or ſphacelated. In theſe caſes, it certainly could not conſiſt of the villous coat of the

the ſtomach in a ſtate of diſſolution, but muſt be derived from ſome other ſource. This opinion is ſtrongly countenanced by the diſſections of Dr. Jackſon, and other writers, on the ſubject of yellow-fever. That experienced phyſician remarks, that the black colour of the vomited matter was evidently owing to a mixture of vitiated bile; the paſſage of which might be eaſily traced from the gall-duct into the pylorus*. Dr. Lining, of Charleſton, obſerves, that the black flaky ſubſtances are, the bile mixed or adhering to the mucus of the ſtomach; for, upon diſſecting thoſe who died of this diſeaſe, not only in this, but in former years, I always obſerved, ſays this accurate phyſician, that the mucus of the ſtomach was abraded, and the bile, in its cyſtis, was black, and ſometimes very viſcid; and, in ſome caſes, had the conſiſtence of Venice turpentine, and was extremely tough.† Mr. Deſportes, of St. Domingo, remarks, that they found, on diſſection, the gall-bladder full of black bile, the colour of ſtrong coffee‡. This circumſtance of the colouring-matter of the vomit being derived from the gall-bladder, is ſtill farther corroborated by ſome diſſections made by Dr. Phyſick and myſelf, at the hoſpital, at Buſh-hill, during the prevalence of the diſeaſe in 1793. In two perſons who died at an advanced period of the diſeaſe, the ſtomach contained, as did alſo the inteſtines, a black liquor, ſimilar to what had been vomited, and purged, before death. This liquor appeared to be a fluid, in all reſpects, of the ſame quality with that which was found in the gall-bladder.§ Theſe diſſections, without adducing any other of a ſimilar nature, muſt, no doubt, convince every impartial obſerver, that the black matter of the vomit is derived from the liver, and does not conſiſt of a diſſolution of the villous

* See Treatiſe on the Fever of Jamaica, p. 173, and 174.
† See Obſervations, Phyſical and Literary, vol. ii.
‡ See Diſeaſes of St. Domingo, p. 202, vol. i.
§ See a medical ſketch of the Yellow-Fever, publiſhed in 1794.

coat of the ſtomach. The difference in the ejected matter being now eſtabliſhed, and, in a manner, proved to be the effect of different cauſes, I ſhall proceed to conſider the fourth and laſt opinion, viz. that the black vomit is bile, changed to a black colour by meeting with the ſeptic acid in the ſtomach, and inteſtinal canal. The preceding diſſections clearly prove this opinion to be erroneous, as they evidently ſhow, that the black flaky particles, or colouring-matter of the vomit, come from the gall-bladder; therefore, it could not receive its brown or black colour from meeting with the ſeptic acid, ſuppoſed to be generated in the ſtomach and inteſtinal canal.

The black vomit conſidered as an altered ſecretion from the liver.

The colouring matter of the vomit appears, from the authors already quoted, to be generally traced, after death, to the gall-bladder. This poſition being incontrovertibly eſtabliſhed by diſſections, the power of the liver to ſecrete that ſubſtance will be admitted, of courſe, as it could not be ſecreted by the gall-bladder, or tranſmitted into that viſcus through any other paſſage, but by the hepatic duct. If this view of the ſubject be, in any meaſure, juſt, it is a fact aſcertained, beyond the ſhadow of a doubt, that the black flaky ſubſtance of the vomit is an altered ſecretion from the liver. This matter, being ſecreted by the liver, and depoſited by the hepatic duct in the gall-bladder, in the laſt hours of this diſeaſe, is from thence forced, by the contractions of the gall-bladder, and cyſtic duct, in conjunction with the violent action of vomiting into the ſtomach. It there receives the addition of the yellow-coloured fluid, which is almoſt always ejected with the flaky ſubſtance. That this fluid is combined with the flaky matter in the ſtomach, and not in the gall-bladder, every

every enquiry into the appearances, after death, fully confirm. This circumſtance renders the yellow-coloured fluid ſubject to ſome difference in its properties, according to the nature of the fluids received into the ſtomach a ſhort time before vomiting; but, all that I have had an opportunity of examining, have nearly the appearance we have already deſcribed. That the ſecretory œconomy of the liver may be ſo far arreſted in its healthy action, by the progreſs of diſeaſe, as to aſſimulate a fluid having not the leaſt analogy to bile, every work, on morbid diſſections, certainly prove. Lieutaud mentions a caſe from Rivalerius, in conſequence of a diſeaſed liver, where the fluid, in the gall-bladder, reſembled milk; and Storke relates a caſe of dropſy ſucceeding an intermitting fever, where the fluid, in the gall-bladder, reſembled the white of an egg. To theſe, I may add one, that came under my own obſervation, of a gentleman who died dropſical, in conſequence of an enlarged liver. The gall-bladder contained a fluid, of a dark-colour, having not the leaſt reſemblance to bile. Theſe, and many more caſes, could be adduced to prove the power of the liver, under certain circumſtances, to ſecrete a fluid diſſimilar to bile; but, it would be needleſs to recite them, as the inſtances already quoted, are, no doubt, ſufficient to eſtabliſh the fact. This peculiar condition of the ſecretory veſſels, in the yellow-fever, is not confined ſolely to the liver; for, we find that other ſecretory functions are ſometimes affected in a ſimilar manner, during the ſame diſeaſe, and nearly at the ſame period of time. In confirmation of theſe obſervations, I believe moſt phyſicians muſt have remarked, that, in ſome caſes, the kidnies, during the period of black vomiting, ſecretes a fluid of a dark-colour, which has a thick pellicle on its ſurface, and appears almoſt as different from urine, as the black vomit does from bile. This diſcharge is frequently a precurſor to a ſymptom, which never fails

fails to predict a speedy dissolution, viz. a paralysis of the secretory functions of the kidnies.

The more I consider the material change produced in the different secreting vessels, during the last stage of this disease, the more this theory appears to be supported by reason and the plausibility of truth. But, though a morbid condition of the glandular œconomy of the liver may produce the coffee-ground coloured vomit, it does not seem probable that the black inspissated mucus-matter which was ejected in the cases that proved mortal in 1797, is derived from the same source; for, the liver, under no condition of diseased action, that we are acquainted with, is capable of secreting mucus of such an appearance; therefore, we think it most reasonable to refer it to the surfaces, which are destined, in a state of health, to secrete mucus. Now, admitting the axiom, "that similar causes produce similar effects, under similar circumstances," why may not the glandular structure of the stomach be affected in a similar manner to that of the liver and kidnies, so as to enable it to secrete the mucus-matter above mentioned? This opinion, I think may be affirmed by other analogies, not only in the sthenic, but in the asthenic condition of secreting surfaces, in which there are equally as great a deviation from healthy secretion as the one alluded to. This we have clearly exemplified in vessels destined to secrete mucus in a state of health; but, when labouring under inflammation, evidently secrete pus. Other cases, of a similar nature, might be adduced to prove this power in secreting vessels. But, it would be taking up the time of the society to little purpose, to recite other instances to establish a fact which appears to be already fully confirmed.

ISAAC CATHRALL.

May 23, 1800.

No.

No. XVI.

Obſervations on the Soda, Magneſia, and Lime, contained in the Water of the Ocean; ſhewing that they operate advantageouſly there by neutralizing Acids, and among others the Septic Acid, and that Sea-Water may be rendered fit for waſhing Clothes without the Aid of Soap. By SAMUEL L. MITCHILL, *of New-York.*

Read July 18, 1800.

MANY attempts have been made to render the water of the ocean fit for the purpoſes of *drinking* and *cooking*, and ſome of theſe have been attended with flattering proſpects of utility. By a cheap and eaſy proceſs, water tolerably freſh may be diſtilled from common ſalt-water, ſo as to help materially in a caſe of ſcarcity or want, on board a ſhip of good equipment. The names of Hales, Lind and Irvine, are remembered to their honour, for their exertions in this work.

To furniſh needy men with the means of *eating* and *drinking*, is certainly a noble diſcovery. But there is another operation ſcarcely leſs neceſſary to the preſervation of health than eating and drinking, and that is *waſhing* as applied to the human body, and more particularly to the clothing which it befouls. In a communication to profeſſor Duncan, which has been publiſhed in the Edinburgh Annals of Medicine for 1799, and in the third volume of the New-York Medical Repoſitory, I have endeavoured to ſtate the facts in detail concerning the matters ſecreted from the ſkin and wiped off by the clothes, and to ſhew how ſome of theſe became unwholeſome, or infectious and peſtilential, as they grew naſty. It was there ſtated that *ſoaps* and *alkalies* would render foul clothing clean, and both prevent and deſtroy animal poiſon if it was engendering there. And in in a letter I wrote to Timothy Pickering, late Secretary of State to the American Government, in November 1799, I recommended barilla or ſoda as a ſubſtance by which the ſalt-water of the ocean could be ſo ſoftened and altered in its qualities as to become fit for waſhing the clothes of ſeamen.

A ſea-veſſel is peculiarly fitted for concentering foul and corrupting things, and for converting them into peſtilence and poiſon. This is one of the moſt common accidents in ſailing to the latitudes where there is heat enough to promote corruption and to exalt ſeptic ſubſtances into vapour.

One of the moſt diſguſting ſights during a voyage is the perſonal naſtineſs of many of the crew. It is pretended that much of this is neceſſarily connected with the ſervice, that the work is dirty, and eſpecially that freſh water cannot be ſpared from the veſſel's ſtores to waſh the company's clothing; that ſoap cannot be uſed with ocean-water, that ſalt-water alone will not get them clean, and that therefore they are under a neceſſity of being uncomfortably naſty on long voyages, eſpecially toward the latter part of them. Now, naſtineſs of a man's perſon and garments is neceſſarily connected with a ſimilar condition of his bed, bedding, hammock and berth, and moſt commonly of every thing he handles or has ought to do with. If a ſeaman has ſtrength of conſtitution to keep about and do duty, his feelings are nevertheleſs very uncomfortable, he is thereby prediſpoſed to diſeaſe and in danger every moment of becoming ſick; and if this ſhould really happen, his chance of recovery is exceedingly leſſened by the filth with which every thing that touches him is impregnated, and the venom into which that filth is inceſſantly changing.

Thus, the great difficulties with which a ſeaman has to ſtruggle, are, 1ſt, the unfitneſs of ocean-water to waſh with;

with; and 2d, the inutility of ſoap to aid that fluid in cleanſing his clothes. If theſe can be ſurmounted, he will have no excuſe for his uncleanneſs. If after this he becomes uncomfortable or ſickly from that cauſe, it will be owing to his own lazineſs or negligence.

Few ſubjects have been diſcuſſed with more ſolicitude than the one, How did the ocean acquire its ſaltneſs? Whether that maſs of waters derived its briny quality gradually by diſſolving ſtrata of ſalt, or whether it was furniſhed by its Creator with a due quantity of that material from the beginning, are queſtions not neceſſary now to be anſwered. It is ſufficient to obſerve that it is kept ſweet and guarded againſt offenſiveneſs and corruption by the great quantity of ALKALINE matter it contains. The ocean may indeed be conſidered as containing ſome portion of every thing which water is capable of containing or diſſolving, and its water is therefore found to furniſh different reſults on analyſis, when taken up from different depths and in different latitudes.

Yet various as the compoſition of ocean-water is, it always contains *ſoda*, *magneſia* and *lime*, in quantity conſiderable enough to be eaſily detected. Of theſe *ſoda* is the moſt abundant. *Magneſia* is next in quantity. And *lime*, though plentiful, is believed to exiſt in ſmaller proportion than either.

The *alkaline matter* ſo plentifully diſperſed through the water of the ocean, exerts its cuſtomary neutralizing power after the ſame manner and according to the ſame laws which govern its ſeveral kinds on the land and in other places.

The acids commonly preſent in ocean-water are the *ſulphuric*, the *ſeptic* and the *muriatic*. The former of theſe exiſts apparently in ſmall quantity, and is only mentioned becauſe in ſome experiments it has been ſaid to have been obtained from it in the form of a ſulphate of

 lime,

lime, though according to the law of attractions, we might expect to find in it sulphate of soda. The vast amount of animal matter existing in the sea, would lead one à priori to a persuasion that in certain cases, particularly along marshes and shores where the stagnating water was much heated, putrefaction would engender *septic* acid, and that this would in some measure mingle with the water in its vicinity, and not fly away wholly in vapour. The quantity of this acid is so considerable in some coves and bays where salt works have been established, that a quantity of it adheres to the muriate of soda or common salt and vitiates its quality. And this happens in some situations to so high a degree, that Neumman (Chemical Works by Lewis, p. 392,) takes notice of it, observing "that sea water often contains a *nitrous* matter, the ACID SPIRIT DISTILLED FROM SEA SALT PROVING A MENSTRUUM FOR GOLD, which the marine acid by itself never does, and which nothing but the nitrous will enable it to do. Though however this is frequently the case, it is not always: I have examined marine salt whose acid had no action upon gold."—As to the *muriatic* acid, whether it is as some of the older chemists suppose a modification of the sulphuric and the nitrous, or as certain of the moderns believe, but a compound basis of sulphuric and hydrogene, there is evidence enough of its existence in the ocean, in very great plenty.—On the whole, it may be concluded that sea-water *always* contains *muriatic* acid, *frequently septic* and *sometimes sulphuric*.

There are thus three predominating *alkalies* and as many *acids* in the ocean; and by the intervention of water they are liquefied and put in a condition to act each upon the other. Consequently the soda in the first place, as the stronger alkali, attaches and neutralizes the acids in the order of chemical affinity, and forms sulphate, septate and muriate of soda. But as the *two* former are comparatively

paratively rare or ſcarce, the latter is the predominating compound. When there is any acid in the water beyond the capacity of the ſoda exiſting there to neutralize, that part is attracted by the *two* earths, and according to the force of their reſpective combinations, forms ſulphates, ſeptates and muriates of lime and magneſia. Theſe ſalts with earthy baſes, in which the muriatic acid is by far more abundant than the other two acids, conſtitute the *bittern* and *ſcratch* or *ſlack* of the ſalt makers. Theſe ſalited earths attract water ſo ſtrongly that it is difficult or impoſſible to make them cryſtallize; but wherever they are they keep up a dampneſs and refuſe to dry.

When chemiſts ſpeak of ſea ſalt they wiſh to be underſtood as meaning "the pure muriate of ſoda." This neutral compound however in its *pure* ſtate is a great rarity. Perhaps indeed there is no ſuch thing. Experience ſhews it is always mingled with greater or leſs quantities of the *deliqueſcent ſalts with earthy baſes.* And theſe are ſo abundant in ſome ſorts of ſalt that they render it unfit for the preſervation of animal proviſions. Beef and even pork, are not guarded by ſalt ſo adulterated, from becoming tainted and putrid. That ſea ſalt of this impure quality ſhould be fit for curing proviſions, it ought to undergo a particular refining operation to rid it of its foreign admixtures. For want of ſuch a proceſs, ſome ſorts of ſea ſalt, though fair to the eye, do not poſſeſs an intire and undivided antiſeptic power, but ſo far as the muriate of ſoda in the maſs is alloyed by the middle ſalts of magneſian and calcarious compoſition, thoſe parcels of common ſalt ſo vitiated become unfit for oppoſing completely the proceſs of putrefaction. And ſo far they make a departure from the antiſeptic power of pure muriate of ſoda, the manner of whoſe action, I endeavoured to inveſtigate in a Memoir addreſſed to professor Woodhouse and published in the second volume of the New York Medical Repository.

By reason of these foreign and adventitious matters, it happened in Sir John Pringle's experiments, that the common salt employed by him, instead of preventing the corruption of meat, when added in small quantity, rather promoted its decay. (Paper III. Exp. 24.) His trials he observes were made with the white or *boiled* salt kept here (in London I suppose he means) for domestic uses. (Appendix to Observations on Diseases of the Army, &c. p. 345, Note.). This kind of salt is known to abound with the *earthy* salts with which ocean water is charged.

Dr. Percival's experiments on sea salt have a tendency to shew that the septic quality ascribed by the learned Baronet to small quantities of common salt is owing to the mixture of *bitter salt* with it. A quantity of this, he observes, adheres to all the common salt used for culinary and dietetic purposes, and as far as its influence goes, it counteracts the wholesome and preservative powers of the clean and unmixed muriate of soda (1 Essays Medical, &c. p. 344,) and that this *septic* quality of the sea salt depended upon the presence of some heterogeneous substance was the opinion of Pringle himself. (Ibid. p. 347.)

Such then being the composition of ocean water, it is easy to explain wherefore it is not fit *by itself*, for washing garments and making them clean. It has a deficiency of *alkaline salt* in it; and alkaline salts are well known to be the most excellent and complete detergents. And it is quite as easy to assign a reason why it will not answer to employ *soap* with ocean water. The acids united to the lime and magnesia being more strongly attracted by the alkali of the soap, quit their connection with those earths, which fall to the bottom, while the lighter and deserted oil rises to the top. The activity of the alkali of the soap thus

thus overcome by the neutralizing acid of the water, can be of little ſervice, and the diſengaged greaſe immediately thereafter becomes a real impediment.

The baſis of all *hard* ſoap is *ſoda.* The alkaline matter of *ſoft* ſoap is *potaſh.* This probably happens becauſe the former is prone to *effloreſce*, the latter to *deliqueſce* in the air. The reaſon of mingling oil, turpentine and tallow with potaſh is that this ſalt is too corroſive to be handled naked or alone. By its cauſticity *potaſh* deſtroys the ſkin and fleſh of the waſher, and unleſs carefully employed, will deſtroy the goods too. But this is not the caſe with ſoda; which in conjunction with carbonic acid may be diſſolved in water without exerciſing any cauſtic effect upon the arms and fingers of the perſon who uſes it. By virtue of this convenient and excellent quality, the carbonate of ſoda can not only be uſed in a lixivial form to cleanſe goods, but may be employed to alkalize or ſoften ocean water and to render it fit for waſhing with.

It has been aſcertained long ago by Profeſſor Home in his experiments on bleaching, that neither ſea ſalt, nor any other of the *perfectly* neutral ſalts compoſed of an acid and an *alkali* give any *hardneſs* to water; that the common ſorts of ſea ſalt make water *hard* by means only of the heterogeneous ſalts they retain from the *bittern;* and that *alkalies* by precipitating the earth of ſalts with an earthy baſis and by neutralizing their acids, will *ſoften* water.

Ocean water, it has been ſhewn, beſides a *perfect* neutral ſalt, contains a quantity of ſaline matter with *earthy* baſes. To theſe latter, it owes its *hardneſs*, or quality to decompound ſoap. But carbonate of ſoda decompoſes theſe *terrene* ſalts and forms with their acids reſpectively *perfect* neutral ſalts. The water thereupon becomes *ſoft*, or in other words, fit for waſhing goods.

I find

I find on experiment that carbonate of ſoda thrown into ocean water, immediately renders it turbid, the lime and magneſia inſtantly turning milky on their diſengagement from their reſpective portions of acid. To make the water fit for waſhing, ſo much ſoda muſt be added as not only to effect a complete precipitation of theſe earths, but to render the water ſufficiently lixivial or alkaline. It will then exert its detergent and purifying powers.

Having entertained doubts at firſt, whether the water ought not to be decanted off after the lime and magneſia had ſettled to the bottom, or whether it would not require ſtraining or filtering to render it fit for uſe, I convinced myſelf by experiment that foul linen could be rendered clean and white by being waſhed in alkalized ocean water which contained its whole quantity of precipitated earth diffuſed through it. I rather think the ſmall quantity of thoſe impalpable and white particles which adhere to the linen worn upon the body will be advantageous and wholeſome, as the ſhirts and other garments will thereby be enabled to neutralize a portion of the acid and oftentimes noxious matter formed from the ſweat and other excretions of the ſkin, &c. Thus they will be rather ſerviceable than otherwiſe, and as both are in their carbonated ſtate (having borrowed fixed air from the ſoda) they cannot do any harm.

The general inferences from the whole of the preceding reaſoning are theſe: 1. Alkaline ſubſtances, ſuch as magneſia and more powerfully lime and ſoda, are plentifully diſtributed through the ocean, to keep it from becoming foul, unhealthy and uninhabitable, which doubtleſs would be the caſe if the ſulphuric, ſeptic and muriatic acids abounding in it were not neutralized. 2. Where either of theſe acids is but imperfectly ſaturated, as happens when they are united to magneſia and lime, they decompound

pound ſoap, let looſe its greaſe, and become unfit for waſhing by aid of that material. 3. If ſoda or barilla is added to ocean water in ſufficient quantity and the water lixiviated or alkalized, the earths will of courſe be precipitated and the acids neutralized. 4. In this ſtate, dirty linen may be cleanſed in it; and men at ſea be thus enabled to have their clothes waſhed without the aid either of ſoap or of *freſh* water. 5. For this purpoſe, a quantity of barilla or ſoda ſhould always be provided as an article of the ſhip's ſtores, and iſſued to the men on waſhing days. 6. Thus by the operation of this alkaline ſalt, a great proportion of the naſtineſs and infection bred in the clothes, bedding and berths of perſons at ſea might be prevented, and the crews and paſſengers ſo far forth preſerved from fevers and dyſenteries. 7. No more room would be occupied by water caſks in the holds of veſſels, than at preſent. 8. The ſmall quantity of magneſia and lime adhering to clothes waſhed in this way, is an advantage over and above what takes place in uſing freſh water. And 9. A broad and noble view is opened of the economy of Providence in diſtributing alkaline ſalts and earths, ſo liberally throughout the terraqueous globe.

Eaſt Rutger's Street, *July* 4, 1800.

No.

No. XVII.

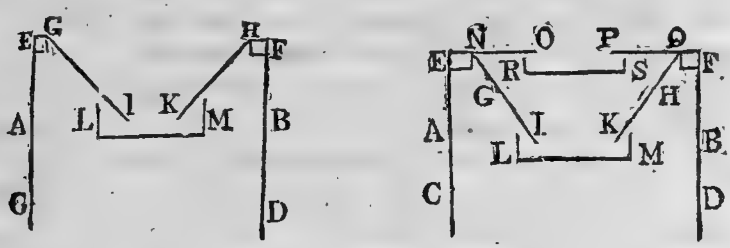
Deſcription of a Stopper for the Openings by which the Sewers of Cities receive the Water of their Drains. By Mr. JOHN FRASER, *of Chelſea, London.*

Read, Sept. 19, 1800.

THE parts of this ſtopper reſemble ſo much the hopper and ſhoe of a griſt-mill, that they may be called by thoſe names. The opening by which the water from the drains paſſes down into the common ſewer, is generally ſecured at its orifice by a curb or frame of wood, and by an iron grating which prevents large bodies from falling in. Let the iron grating open on a hinge, then ſet into the curb a hopper of wood, ſheet or caſt-iron, ſo cloſely fitted at its top to the curb as to prevent the paſſage of air between them. Under this hopper ſuſpend a ſhoe or box, cloſe except at top, within which the lower opening of the hopper may empty itſelf, and the water flow off over the brim of the ſhoe, into the ſewer. When the water ceaſes to flow, the ſhoe remaining full, keeps the lower opening of the hopper cloſed, ſo that no air can paſs up through it. The iron grating is ſhut down on the hopper to keep bodies from falling into it.

In Charleſton and Savannah, where the ſtreets are not paved, and are very ſandy, ſuch quantities of ſand are carried by currents of air down through the drain holes into the ſewer, as to choke that entirely. To prevent this, lay a lid on the hopper, fitted to it, and having an aperture in its centre of half its own diameter. Under this aperture, and very near to it, and conſequently within the hopper, ſuſpend a pan or other veſſel ſomewhat larger than the aperture, but leſs than the lid itſelf. The ſand

ſand conveyed by the wind will fall through the aperture of the lid into the pan, and will ſoon fill it and cloſe the aperture, ſo that all the ſand which follows will blow over and paſs off. When it becomes neceſſary that the aperture ſhould be re-opened to let the water of the drains paſs through, that water will itſelf very quickly work its own way through the ſand in the pan, waſh it over the brim, and down through the hopper and ſhoe into the ſewer, and reſtore the water paſſage; and thus the wind and water will alternately perform the functions of cloſing the paſſage againſt ſand, or opening it for water as ſhall be neceſſary.



In the two ſections here repreſented
A B C D is the opening of the ſewer into the ſtreet.
E F the curb at its orifice.
G H I K the hopper.
L M the ſhoe.

In the ſecond figure N O P Q is the ſand-lid of the orifice, and O P the aperture in that lid. R S the pan ſuſpended under it.

No. XVIII.

TRANSLATION.

A Memoir on Animal Cotton, *or the Insect* Fly-Carrier. *By* M. Baudry des Lozieres, *Member of several Academies, and Founder of the Society of Sciences and Arts, at Cape François.*

Gentlemen,

BEFORE I enter upon the subject of this memoir, I ought to pay the tribute of praise which is due to your useful labours. But the style of eulogy is ill suited to the plainness of an American farmer, and while you are constantly employed in *deserving* praise, you cannot spare time to *hear* it.

I am now going to communicate to you, with some observations upon it, a fact of entomology which I have myself witnessed during my residence at St. Domingo, and which, if I am not mistaken, deserves your greatest attention, because it may introduce a new branch of commerce with the West India colonies, and render very useful an animal which has hitherto been known only by the mischief which it occasions.

Every inhabitant of the West Indies knows and dreads the greedy worm which devours their indigo and cassada plantations. But people have hitherto turned their attention more to the means of destroying it than of rendering it useful. It is indeed very natural to endeavour to destroy our enemy, but to compel him to be of service to us is by far the greater triumph.

Its

Its Birth, Growth, and Death.

The caſſada worm is produced like the ſilk worm, that is to ſay, from the eggs which the mother ſcatters every where, after ſhe has undergone her metamorphoſis into a whitiſh butterfly, or of a light pearl colour.

The egg is hatched about the latter end of July. Its developement is quick, for in September the worm is changed into a butterfly.

This month of September is the ſeaſon of his loves. The conſtant motion of his wings ſhews the ardency of his paſſion which he indulges day and night and even while feeding. The exceſs of this indulgence ſoon deſtroys him, he dies in the ſame month after violent convulſions.

I have ſaid that his life begins at the end of July. He is decked at his birth with a robe of the moſt brilliant variegated colours. This elegant livery, which nature ſeems to have delighted in forming, renders him always agreeable to the eye, which always dwells upon it with pleaſure.

Its Affinities.

It has appeared to me to be a ſmooth caterpillar whoſe external ſhape is exactly like that of the ſilk worm.

It differs however from it, by its ſize, by its thickneſs, and by the beauty of its colours.

It again differs from the ſilk worm, becauſe it does not itſelf work the cone which I am going to ſpeak of.

I leave it to the learned to delineate its external configuration, and to determine upon the family of inſects to which it belongs. I ſhall only ſay that I do not believe it has, like the ſilk-worm, an inteſtine going in a direct line from the mouth to the anus, becauſe it appears to me that this cauſe of elaboration would not have the ſame deſtination.

Its Food.

It feeds on caſſada leaves, of which it is extremely greedy. It feeds at all hours, day and night. It alſo nibbles the leaves of the potatoe, this is however but a tranſitory taſte, it ſoon returns to the caſſada leaf.

I have to obſerve that after it has taken its food, when the time of its metamorphoſis arrives, it does not purge itſelf by diet, like the ſilk worm, but continues to eat to the laſt moment.

The Approach of its Metamorphoſis.

In the month of Auguſt, and when on the point of undergoing its metamorphoſis, it ſtrips off its ſuperb robe, and puts on one of an admirable ſea-green, this fundamental colour reflects all its various ſhades, according to the different undulations of the animal, and the different accidents of light.

The Sting of the Ichneumon Fly.

This new decoration is the ſignal of its tortures. Immediately a ſwarm of ichneumon flies aſſail it. I think I am not miſtaken when I aſſert that there is not one of its pores that has not one of thoſe flies faſtened to it. There is even no neceſſity of making uſe of the microſcope to ſee that he is covered with them.

In vain he ſtruggles with all his might, raiſes himſelf upright to get rid of his cruel tormentors—He muſt ſubmit. Thoſe flies, of the ſmalleſt ſpecies, and which can only be ſtudied by means of the microſcope, drive their ſtings

ſtings into the ſkin of their victim, over the whole extent of his back and ſides. Afterwards, and all at the ſame time, they ſlip their eggs into the bottom of the wounds which they have made.

After having performed this dreadful operation, the ichneumon flies diſappear, and the patient remains for an hour, in a drowzy and even motionleſs ſtate, out of which he awakens to feed with his former voracity. Then he appears much larger, and his ſize increaſes every day. His green colour aſſumes a deeper hue, and the tints produced by the reflection of the light are more ſtrongly marked. The animal in this ſtate of factitious pregnancy, if I may ſo expreſs myſelf, is worthy of all the attention of the obſerver of nature.

I ſhall not undertake the deſcription of the ichneumon fly, it is well deſcribed in the books. If I have obſerved a difference, it is the ſame which exiſts between the European *gnat* and the *muſquitoe* of hot regions, that is to ſay, that our Weſt-India flies are of a leſſer ſize.

I have now to deſcribe the operation which the ichneumon flies, which are extremely ſmall, perform at the very moment of their coming into the world; you will judge, gentlemen, whether this expreſſion is accurate.

Animal Cotton.

A fortnight after the ichneumon flies have thus cruelly depoſited their eggs by perforating the unfortunate caſſada-worm, that is to ſay, ſome time in the month of Auguſt, thoſe eggs may be ſeen by the help of a microſcope, hatching on the body of that animal.

Thoſe eggs are all hatched at the ſame moment, and it is impoſſible to catch the moral point of time which may intervene between the birth of one and that of another.

ther. At one glance, the caſſada-worm is ſeen covered with all the little worms that have juſt been hatched. They iſſue out of him at every pore, and that *animated robe* covers him ſo entirely, that nothing can be perceived but the top of his head. He then turns to a dirty white, the little worms appear black to the eye, but their true colour is a deep brown.

This operation laſts hardly more than an hour, and is followed by another which is not much larger but which is much more curious.

As ſoon as the worms are hatched, and without quitting the ſpot where the egg is which they have broke through, they yield a liquid gum, which by coming into contact with the air, becomes ſolid and ſlimy.

At the ſame time, and by a ſimultaneous motion, they raiſe themſelves on their lower extremity, ſhake their heads and one half of their bodies, and ſwing themſelves in every direction. Now is going to begin an operation which will afford the greateſt delight to the admirer of nature.

Each of thoſe *animalculæ* works himſelf a ſmall and almoſt imperceptible cocoon in the ſhape of an egg, in which he wraps himſelf up. Thus, they make, as it were, their winding ſheet. They ſeem to be born but to die.

Thoſe millions and millions of cocoons, all cloſe to each other, and the formation of which has not taken two hours, form a white robe in which the caſſada-worm appears elegantly clothed. While they are thus decking him, he remains in a ſtate of almoſt lethargic torpidity.

As ſoon as this covering is woven, and the little workmen who have made it have retired and hid themſelves in their cells, the worm endeavours to rid himſelf of thoſe barbarous gueſts, and of the robe which contains them,

them, but he does not ſucceed in this attempt without the greateſt efforts.

He comes out of this kind of encloſure, entirely flaccid and dull, inſtead of his former fat and ſhining appearance, his ſkin now appears flabby, wrinkled and dirty, and gives him the appearance of decrepitude. He is now an exhauſted, ſuffering being, threatened with approaching death.

He will ſtill gnaw a few leaves, but he no longer eats with that voracious appetite, which indicated an active and vigorous conſtitution. Shortly afterwards he paſſes to the ſtate of a chryſalis, and after giving life to thouſands of eggs, he ſuddenly loſes his own, leaving to the cultivator who has not yet bethought himſelf of calculating the advantage that he may draw from him, an advantage which may be ſo improved as to much more than compenſate the ravages which he occaſions.

Shell of the Ichneumon Fly.

I had imagined that the thouſands of little worms which this ſhell contains in the cocoons of which it is compoſed, would be hatched ſome day. I ſhut it up therefore in a box cloſed with great caution. Every morning, and very often in the courſe of the day, I examined it, in order to catch the moment when thoſe little animals were to be born a ſecond time.

In fact, at the expiration of about eight days, I found the inſide of the box lined with a cloud of little flies. I made myſelf certain that they iſſued out of the little cocoon. Several which iſſued out of them before my eyes, left me no doubt as to the fact.

I then took up ſome of thoſe flies, and putting them on a pincer, I examined them with a microſcope.

They

They are bold and lively: they have four wings. Their antennæ are long and vibrating, their belly hangs by a very fine thread: there are ſome that have a tail, and others that do not ſhew it. Afterwards I ſatisfied myſelf that they feed upon ſmall inſects that appear to be of the family of *Acarus*. Thoſe indications appeared to me ſufficient to be ſatisfied that they belong to the family of the ichneumon.

Obſervations on Animal Cotton.

I have often held in my hand that cotton ſhell or wrapper. Its whiteneſs is dazzling. As ſoon as the flies have quitted the cocoon, it may be uſed without any preparatory precaution. It is made up of the pureſt and fineſt cotton.

I call it *cotton* becauſe it is *idio-electric* and is pervious to the electric fluid.

I add to this denomination the epithet *animal*, in contra-diſtinction to common cotton, which may henceforth be called *vegetable cotton*, ſo that the two ſpecies may be diſtinguiſhed from each other by their names, as they are by their origin, although they are very nearly related to each other in their effects.

It is to be obſerved, that what might be called *cob-web* in the covering of the fly-carrier, or ſmall flocks of ſilk which are probably intended to ſhelter the animal from the rain, is far ſuperior to what is called *ferrit* before, and *ſleet ſilk* after the preparation of the finer ſilk. There is no refuſe, no inferior quality in animal-cotton. Every thing in it is as fine and beautiful as can be imagined.

It is poſſible, if we may form a judgment by analogy, that medicine, which has extracted from ſilk what is called *Engliſh drops*, a remedy to which the greateſt efficacy is is attributed, may derive a ſimilar advantage, perhaps for the cure of other diſorders, from an extract of the animal cotton, which might be called the *St. Domingo drops.*

In ſhort there is no need here of any of the precautions which the ſilk-worm requires. The robe which covers the fly-carrier, is worked every where, and every where perfectly well.

I ſhall only obſerve that as the rain ſpeedily deſtroys the caſſada-worm, the inſtant might be ſeized on when the ichneumon fly has depoſited her eggs, to put the fly-carrier under ſhelter. His natural food might be procured for him, as is done with the ſilk-worm.

The ichneumon fly never fails thus to come and depoſite her eggs. I have never ſeen a fly-carrier that was not covered with the robe or ſhell that I have ſpoken of. I have continued this obſervation for many years, and the crop was ſo abundant, that I alone, could collect in leſs than two hours, the quantity of one hundred pints, French meaſure.

I repeat it, animal cotton is attended with none of the difficulties which occur in the preparation of vegetable cotton. It is ſo pure, that as ſoon as the ichneumons have left it, which happens 8 or 10 days after their recluſion, it may be carded and ſpun.

If it ſhould want any preparation, it could be only in caſe it ſhould not have been ſufficiently guarded againſt duſt and rain.

Vegetable cotton, beſides the ſeeds that produce it and with which it is charged, is filled with extraneous matter, of which it cannot be freed, but with a minute attention, many hands and much time, or with the help of machines which have not yet been brought to perfection.

In every point of view, animal cotton appears to me to have a great ſuperiority over that of the vegetable kind.

It will, perhaps, be wondered at, that experience has not long ago aſcertained this fact, but let it be conſidered that the ſilk-worm and its uſe, were known long before any uſe was made of them, and that we are now carefully repairing the loſſes that we have ſuffered by the careleſs indifference of our fore-fathers.

The fly-carrier may experience the ſame fate, becauſe it is leſs difficult to reaſon than to make experiments, but I dare hope that as ſoon as it ſhall have prevailed over the ſophiſtry of indolence, it will ſtand the competition with ſilk and vegetable cotton. It is more abundant than either. It requires leſs time and leſs trouble to procure it.

I have but one word more to add. Silk and vegetable cotton ſerve only to envenom and inflame wounds, which is attributed to the aſperities of their filaments; I have frequently employed animal cotton as lint in the hoſpital of my plantation, it has always ſupplied the want of that made of flaxen linen, and I have not obſerved the ſmalleſt inconvenience to ariſe from the uſe that I have made of it.

Had it not been for the troubles that have laid our colony waſte, and which have prevented the neceſſary communication, I ſhould have brought to you a fly-carrier in every one of the periods of his life. You would have ſeen the eggs, the magnificent robe with which he is decked at his birth, the kind of food that he is fond of, the ſimple but noble veſtment in which he wraps himſelf up on the approach of his tormentors, you would have ſeen thoſe covering his whole body as it were with points, you would have ſeen him covered with his ſhell, and that ſame ſhell carded, ſpun and ready for the weaver. I had in a great degree already executed this deſign.

But it is too well known that I have not been able to ſave any thing in my flight from home, you will, however, be able at a future day to aſcertain the truth of the fact

fact that I have ſtated to you. I thought that a fact of this nature deſerved to be depoſited among your archives, and I may perhaps requeſt of you the permiſſion of depoſiting there ſome other ſtill more curious facts.

BY. DES LOZIERES.

Philadelphia, 3d Feb. 1797.

No. XIX.

Note concerning a Vegetable found under Ground. In a Letter from COLONEL BULL.

DEAR SIR,

Read Nov. 21ſt, 1800. THE incloſed is a copy of a letter from Colonel Bull, a gentleman of reſpectable information and veracity, to the late Mr. Rittenhouſe. It records a curious fact, which appears to me to be worthy of preſervation. You are at liberty to make any uſe of it you may think proper. I ſee no good reaſon to doubt the accuracy of the obſervation. We have abundant proofs, that many ſpecies of animals are capable of ſubſiſting, for a long time, in the *bowels* of the earth, though the *ſurface* of the earth appears to be, and no doubt is, the natural place of reſidence of theſe very animals. Why, then, ſhould we doubt, that the ſame ſpecies of vegetables are capable of accommodating themſelves to theſe two ſituations? It is never ſafe, nor right, to draw extenſive inferences from ſolitary facts, eſpecially when thoſe facts are ſomewhat equivocally related. But in ſome ſciences (I mean thoſe which are merely ſpeculative) conjectures, however improbable or feeble, cannot do much harm. Perhaps many of thoſe impreſſions of vegetables upon ſlate, free-ſtone, coal, and other ſtony matters, which are ſo abundantly diffuſed through the earth, are the impreſſions of vegetables *which have paſſed through all the ſtages of their exiſtence in the bowels of the earth.*

I am, dear Sir,
Your ſincere friend,
BENJAMIN SMITH BARTON.

MR. ANDREW ELLICOTT.
Philad. Sept. 27*th*, 1800.

" I

"I TAKE the pleaſure of giving you an account of a ſingular bloſſom, which I diſcovered laſt May,* in digging of a mill-race, on Opeckon creek,† through a rich bottom of low ground, covered, in general, with well grown large timber, of various kinds, particularly oak, poplar, and walnut, ſeveral of which trees are from three to four feet through, ſtanding on the ground through which the race was dug. The curioſity is this, that between five and ſix feet under ground, chiefly a loomy, ſolid clay, one of the diggers diſcovered a bloſſom, not in full bloom, nearly of the colour of the lilac, which ſtruck his attention. He called me to ſee it, not knowing what it could be. Upon viewing it, I recollected the form, and told the diggers it was the ſame kind of blue flower, which had grown upon the ſurface of the ground adjacent, and was then faded. In order to prove it, I deſired one of the men to dig up the root of the one under ground, and the one upon the ſurface, which, upon examination, proved to be the very ſame kind. The body of earth where the plant was found muſt have been formed perhaps ſome centuries, by reaſon of the uncommon ſize of the timber which it contained, and from which the moſt heavy part of the mill-timber was procured."

* The year is not mentioned.

† A branch of the river Potomak, in Virginia.

No. XX.

Philadelphia, Auguſt 4th, 1800.

DEAR SIR,

Read Aug. 15, 1800.

WITH this you will receive my aſtronomical, and thermometrical obſervations, made at the confluence of the Miſſiſſippi, and Ohio rivers, in Dec. 1796, and Jan. 1797, at Natchez in the years 1797 and 1798—likewiſe at the city of New Orleans, in Jan. and Feb. 1799, to which are added the obſervations on the tranſit of ☿ made at Miller's plantation on the Coenecuch, commonly, (though erroneouſly), called the Eſcambia.—The aſtronomical obſervations made at the confluence of the Miſſiſſippi, and Ohio rivers, the equal altitudes of the ſun at Natchez, with the obſervations made at New Orleans, are entered according to the civil account, for the purpoſe of bringing the thermometrical obſervations into the journal, in the manner they are generally regiſtered.

The obſervations made on the boundary between the United States, and his Catholic Majeſty, will conſtitute a ſeparate paper, and of very conſiderable length, in which the longitudes, of a number of points in the line are determined, both by lunar obſervations, and the eclipſes of ♃'s ſatellites. This work, will probably be ready for the ſociety ſome time the enſuing winter.

Aſtronomical,

Aſtronomical, and Thermometrical Obſervations, made at the Confluence of the Miſſiſſippi, and Ohio Rivers.

1796.

Dec. 18th. Arrived at the confluence of the Miſſiſſippi, and Ohio rivers about 2 o'clock in the afternoon.—Cloudy all day.—Thermometer 24° in the air at ſun ſet, and 34° in the water.

19th. Pitched a tent, and ſet the clock up in it.—Cloudy all day, except a ſhort time about noon.—Thermometer by Fahrenheit's ſcale 9° at ſun riſe, roſe to 19°; fell to 12° at ſun ſet, and to 11° at 9^h P. M.

20th. *Equal altitudes of the Sun.*

A. M. $10^h\ 23'\ 54''$. P. M. $1^h\ 37'\ 37''$.

Cloudy, except about 1½ hours before and after noon, which accounts for the equal altitudes not being taken farther from the meridian.—Cleared off in the evening.—Thermometer 11° at ſun riſe, roſe in the afternoon to 22°, fell to 11° at 9^h P. M.

Immerſion of the 3d ſatellite of ♃ obſerved at $9^h\ 8'\ 47''$ P. M. Magnifying power of the teleſcope 120—♃ being very low, and attended with an uncommon tremour, which rendered the obſervation ſomewhat doubtful.

21ſt. Flying clouds all day, but diſappeared in the evening.—Thermometer 11° at ſun riſe, fell to 8° at 10^h A. M. roſe to 9° at noon, fell to 3° at 7^h P. M.

Emerſion of the 1ſt ſatellite of ♃ obſerved at $6^h\ 56'\ 0''$ P. M. Atmoſphere a little hazy.—Magnifying power of the teleſcope 120.

The

1796. The weather was ſo intenſely cold, that although a pot of live coals was kept in the tent near the clock, the thermometer which was fixed to the caſe, fell to 4°, and the clock ſtopped at 5^h the next morning.

22d. Keen north wind; with ſqualls of light ſnow.—Clear in the evening.—Thermometer 5° below o at 8 o'clock A. M.—roſe to 1° above o at 2^h P. M.—fell 5° below o at 9^h P. M.—Both rivers on account of the vaſt bodies of ice, thrown up in a variety of poſitions, make a romantic, and to us (on account of our boats) an alarming appearance.

23d. Clear day. Wind from the N. W. Thermometer $7\frac{1}{2}$° below o at 8^h A. M. 6° below o at 10^h A. M. 1° above o at noon, 8° at 2^h P. M. and at 8^h P. M. 7°.

24th. Clear day. Thermometer 7° at 9^h A. M.—17° at 1^h P. M.—and 7° at 8^h P. M.

Traced a meridian by the circum-polar ſtars.

25th. Clear day. Thermometer 7° at ſun riſe, roſe in the afternoon to 17°. Applied the magnetic needle to the meridian, and found the variation to be 7° 15′ eaſt.

Set up a ſmall zenith ſector of about 19 inches radius. Face to the eaſt.

26th. Cloudy in the afternoon. Thermometer 10° in the morning, roſe to 17°.

☉'s preceding limb on the meridian at .	11^h	59′	45″
Subſequent do. at	12	2	9
Centre at	12	0	57

27th.

Dec. 27th. Clear day. Thermometer 3° at ſun riſe, roſe to 33° in the afternoon.

☉'s preceding limb on the meridian at	12ʰ	0′	33″
Subſequent do. at	12	2	57
Centre at	12	1	45

28th. Clear day. Thermometer 8° at ſun riſe, roſe in the afternoon to 33°.

Equal altitudes of the Sun.
A. M. 9ʰ 40′ 2″. P. M. 2ʰ 24′ 56″.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 8ʰ 48′ 38″ P. M. ♃ very low, the atmoſphere hazy, and the belts ſcarcely diſcernible. Magnifying power of the teleſcope 120.

29th. Clear a ſhort time about noon. Thermometer 17° at ſun riſe, roſe in the afternoon to 45°.

30th. Cloudy with light ſnow during the day.—Clear in the evening. Thermometer 32° in the morning, roſe to 35° in the afternoon.

31ſt. Cloudy in the evening and night. Thermometer 21° at ſun riſe, roſe in the afternoon to 45°.

Equal altitudes of the Sun.
A. M. 9ʰ 53′ 7″. P. M. 2ʰ 16′ 25″.

Obſerved zenith diſtance of α Lyræ . 1° 37′ 23″ N.

1797. Jan. 1ſt. Clear and calm in the morning, flying clouds in the afternoon.—From 10ʰ A. M. till noon, three fine luminous circles appeared in the atmoſphere, ſimilar to thoſe deſcribed by by Dr. Smith in his opticks*. Thermometer 21° at ſun riſe, roſe in the afternoon to 40°.

2d. Cloudy with ſnow the whole day.—Thermometer 16° at ſun riſe, roſe in the afternoon to 28°, and fell to 19° at ſun ſet.

3d. Cloudy till noon, clear in the afternoon and evening. Thermometer 6° at ſun riſe, roſe in the afternoon to 18°, fell to 10° at 8^h P. M.

Obſerved zenith diſtance of	α Cygni	7°	35′	32″	N.
do.	β Andromedæ	2	25	38	S.
do.	β Meduſæ	3	11	46	N.

4th. Cloudy in the morning, the remainder of the day clear. Thermometer 12° at ſun riſe, roſe in the afternoon to 37°, fell to 16° at ſun ſet.

Equal altitudes of the Sun.

A. M. 9^h 26′ 36″. P. M. 2^h 47′ 6.5″.

Obſerved zenith diſtance of	α Cygni	7°	35′	29″	N.

Turned the face of the Sector to the weſt.

Obſerved zenith diſtance of	β Andromedæ	2°	30′	24″	S.
do.	β Meduſæ	3	7	5	N.

5th. Clear all day. Thermometer 23° at ſun riſe, roſe in the afternoon to 42°, fell to 30° at ſun ſet.

Equal altitudes of the Sun.

A. M. 9^h 42′ 21″. P. M. 2^h 32′ 31″.

Obſerved

* Book Second, Chap. 11th.

Obferved the times, and diftances of the ☽'s neareft limb from that of the ☉ as follows:

	Times.			Diftances.			
	h	′	″	°	′	″	
P. M.	2	50	53	84	15	20	
	2	52	56	84	16	0	Error of Sextant + 7″.
	2	54	40	84	16	30	
	2	58	43	84	18	20	
Means	2	54	18	84	16	32	

Obferved zenith diftance of	α Lyræ .	1°	33′	28″	N.
do. . . .	α Cygni .	7	31	19	N.
do. . .	β Medufæ	3	7	5	N.

6th. Cloudy in the morning, clear in the afternoon.—Thermometer 24° at fun rife, rofe in the afternoon to 34°, fell to 12° at fun fet.

Obferved zenith diftance of β Medufæ . 3° 7′ 17″ N.

7th. Clear day, wind N. W.—Thermometer 7° below 0 at fun rife, 5° below 0, at 9^h A. M. rofe to 19° in the afternoon, fell to 0 at fun fet.

Obferved zenith diftance of	α Lyræ .	1°	33′	37″	N.
do. . . .	α Cygni .	7	31	27	N.
do. . . .	β Andromedæ	2	30	6	S.
do. . . .	β Medufæ .	3	7	17	N.

Turned the face of the Sector eaft.

8th. Clear day. Thermometer 7° below 0 at fun rife, rofe in the afternoon to 29° above 0, fell to 10° at 7^h P. M.

Obferved zenith diftance of	α Lyræ .	1°	37′	40″	N.
do. . . .	β Andromedæ	2	25	47	S.
do. . . .	β Medufæ .	3	11	49	N.

9th. Clear day. Thermometer 3° below 0 at ſun riſe, roſe in the afternoon to 42°, fell to 32° at ſun down.

Obſerved zenith diſtance of α Lyræ .	1°	37′	40″	N.
do. . . β Andromedæ	2	25	56	S.
do. . . . β Meduſæ .	3	11	27	N.

Latitude

Latitude deduced from the Zenith Distances.

Face of the Sector East. Observed Zenith Distances.

	β Andromedæ. ° ′ ″	β Medusæ. ° ′ ″	α Lyræ. ° ′ ″	α Cygni. ° ′ ″
1796. Dec. 31st.	....	....	1 37 23 N.	....
1797. Jan. 3d.	2 25 38 s.	3 11 46 N.	....	7 35 32 N.
4th.	....	....	....	7 35 29 N.
8th.	2 25 47 s.	3 11 49 N.	1 37 40 N.	....
9th.	2 25 56 s.	3 11 27 N.	1 37 40 N.	....
Means	2 25 47 s.	3 11 41 N.	1 37 34 N.	7 35 30.5 N.
4th. .... Face of the Sector West.				
4th.	2 30 24 s.	3 7 5 N.	....	....
5th.	....	3 7 5 N.	1 33 28 N.	7 31 19 N.
6th.	....	3 7 17 N.	....	....
7th.	2 30 6 s.	3 7 19 N.	1 33 37 N.	7 31 27 N.
Means	2 30 15 s.	3 7 11 N.	1 33 32.5 N.	7 31 23 N.
Mean. Face of the sector east ..	2 25 47 s.	3 11 41 N.	1 37 34 N.	7 35 30.5 N.
Correct observed zenith distances .	2 28 1 s.	3 9 26 N.	1 35 33.2 N.	7 33 26.7 N.
Refractions	+ 2.5	+ 3	+ 1.5	+ 7.5
Correct zenith distances	2 28 3.5 s.	3 9 29 N.	1 35 34.7 N.	7 33 34.2 N.
Mean declinations Jan. 4th 1797	34 32 26.7 N.	40 09 55.9 N.	38 36 1.2 N.	44 33 41.5 N.
Aberration	+ 7.2	+ 9.7	—3.1	+ 4.3
Nutation	— 7.1	—5.2	—0.9	—4.1
Correct declinations	34 32 26.8 s.	40 10 0.4 N.	38 35 57.2 N	44 33 41.7 N.
Correct zenith distances applied ..	+2 28 3.5 s.	−3 9 29 N.	−1 35 34.7 N.	−7 33 34.2 N
Latitudes	37 0 30.3 N.	37 0 31.4 N.	37 0 22.5 N.	37 0 7.5 N.

	°	′	″	
Latitude by β Andromedæ . .	37	0	30.3	
do. . β Meduſæ . .	37	0	31.4	
do. . α Lyræ . .	37	0	22.5	
do. . α Cygni . .	37	0	7.5	
Mean Latitude	37	0	22.9	North.

Longitude deduced from the eclipſes of ♃'s ſatellites and one lunar obſervation.

		′	″	Daily gain. ′	″
1796. Dec. 20th.	Clock too faſt mean time .	2	10		
	Stopped on the 23d by the extreme cold.				
26th.	Clock too ſlow mean time .	0	38	0	18.5
27th.	do.	0	19.5	0	12
28th.	do.	0	7.5	0	15.3
31ſt.	Clock too faſt mean time .	0	38.5	0	4
1797. Jan. 4th.	do.	0	54.5	0	7.5
5th.	do.	1	2.0		

The immerſion of the 3d ſatellite of ♃ was obſerved on the 20th of December at 9^h 8′ 47″ P. M. as before noted: The clock by equal altitudes of the ſun taken on that day appeared to be too faſt 2′ 10″ mean time, and gained by ſubſequent obſervations at a mean rate about 10″ per diem. The clock was therefore too faſt at the time of the obſervation 2′ 14″, the obſervation was of courſe made at 9^h 6′ 37″ P. M. mean time, to which add 1′ 13″ the equation of time, the ſum 9^h 7′ 50″ will be the apparent time of the immerſion, which taken from 15^h 2′ 34″ the apparent time at Greenwich by the theory, will leave 5^h 54′ 44″ for the difference of meridians.

An emerſion of the firſt ſatellite of ♃ was obſerved on the 21ſt of December at 6^h 56′ 00″ P. M. The clock at that time by admitting the mean daily gain to be 10″ was too faſt 2′ 25″ mean time, the obſervation was therefore made at 6^h 53′ 35″ mean time, to which add 0′ 46″ the equation of time, and the ſum 6^h 54′ 21″ will be the apparent time of the obſervation, which deducted from 12^h 49′ 29″ the apparent time at Greenwich by the theory, will give 5^h 55′ 8″ for the difference of meridians.

Another emerſion of the 1ſt ſatellite of ♃ was obſerved on the 28th of December at 8^h 48′ 38″ P. M. The clock at that time was about 1″ too ſlow mean time. The obſervation was therefore made at 8^h 48′ 39″ mean time, from which deduct 2′ 44″ the equation of time, and the remainder 8^h 45′ 55″ will be the apparent time of the obſervation, which deducted from 14^h 41′ 53″ the apparent time at Greenwich by the theory, will give 5^h 55′ 58″ for the difference of meridians.

On the 5th of January 1797, at 2^h 54′ 18″ P. M. by the clock, the diſtance between the neareſt limbs of the ☉ and ☽ was obſerved to be 84° 16′ 39″ the clock at the time of obſervation was 1′ 2″ too faſt mean time, the obſervation was therefore made at 2^h 53′ 16″ mean time, from which deduct

deduct 6′ 15″, the equation of time, and the remainder 2^h 47′ 1″ will be the apparent time of the observation. The observed distance corrected for parallax refraction, &c. will answer to about 8^h 42′ 22″ at Greenwich, by which the difference of meridians appears to be about 5^h 55′ 21″.

By supposing the observation on the 3d satellite of ♃, with the lunar observation to be equivalent to either of those on the 1st satellite, the mean longitude will be had as below.

	h	′	″
Longitude by the 3d satellite .	5	54	44
do. by the lunar observation	5	55	21
Mean	5	55	2.5
do. by the 1st satellite on the 21st of December	5	55	8
do. by do. on the 28th of December	5	55	58
Mean	5	55	22.8 = 88° 50′

42″ west from Greenwich, or 0^h 54′ 47.8″ = 13° 41′ 57″ west from the city of Philadelphia.

The foregoing observations were made under very unfavourable circumstances, the weather intensely cold, and not a sufficient number of tents to secure our instruments, and cover our men: our store-boat having been left behind, and was frozen up near the mouth of the Wabash river till about the 20th of January. The spirits in the vessel in which the plummet of the sector was suspended were frequently congealed, and what appeared somewhat singular, was that the spirits began to freeze on the outside of the vessel very near to the upper edge, from which it extended in prongs, like bucks-horns, and did not congeal within till the spirits fell about $\frac{4}{10}$ of an inch below the upper edge.—The vessel was $1\frac{1}{2}$ inches in diameter.—The ice on the outside did not appear to contain a full proportion of spirit. Although the observations were made under unfavourable circumstances, I have no reason to suppose them liable to any material objection, and therefore presume that the determinations of the latitude, and longitude, of the confluence of the two rivers are sufficiently correct for geographical purposes, notwithstanding

ſtanding a difference of about 2 degrees in longitude, and 14 minutes in latitude, from Mr. Hutchins's map.

1797.
Feb. 24th. Arrived at Natchez.
27th. Encamped at the north end of the village.
28th. Set up the clock.
March 1ſt. Set up the large zenith ſector, with the face to the eaſt.

3d. *Equal altitudes of the Sun.*
A. M. 9h 50′ 11″. P. M. 2h 9′ 11″.

The obſerved times, and diſtances of the ☉'s and ☽'s neareſt limbs.

	Times. h	′	″	Diſtances. °	′	″	
	2	54	35*	59	46	0	
	2	56	18	59	46	40	
	2	59	20	59	47	0	Error of the Sextant 0″.
	3	0	38	59	47	20	
	3	3	53	59	47	50	
Means .	2	58	58	59	46	58	

Repeated.

	h	′	″	°	′	″	
	3	45	6	60	2	10	
	3	48	18	60	2	30	
	3	51	22	60	2	40	
	3	52	45	60	3	0	Error of the Sextant 0″.
	3	54	37	60	4	40	
	3	56	39	60	4	50	
	3	58	47	60	5	20	
	4	0	34	60	5	40	
Means . .	3	54	16	60	3	51	

Repeated.

* All the obſervations connected *with*, or dependent upon *time*, are entered as obſerved by the clock, and will therefore require a correction to reduce them to mean ſolar time, which may readily be done from the *ſtatement* of the errors of the clock, with its rate of going, to be found at the end of each courſe of obſervations.

Repeated.

	h	′	″	°	′	″	
	4	24	18	60	11	55	
	4	26	15	60	12	30	
	4	28	14	60	13	20	Error of the Sextant o″.
	4	29	50	60	13	35	
	4	32	5	60	14	20	
Means .	4	28	10	60	13	8	

4th. The obferved times, and diftances of the ☉'s and ☽'s neareft limbs.

	Times.			Diftances.			
	h	′	″	°	′	″	
	2	6	22	72	5	30	
	2	7	34	72	5	50	
	2	8	29	72	6	30	Error of the Sextant o″.
	2	9	29	72	6	40	
	2	10	23	72	7	0	
	2	11	44	72	7	30	
Means .	2	9	0	72	6	29	

Repeated.

	h	′	″	°	′	″	
	4	47	45	72	57	0	
	4	49	26	72	57	30	
	4	51	10	72	57	40	
	4	52	16	72	58	20	Error of the Sextant o″.
	4	53	31	72	58	20	
	4	54	30	72	58	40	
	4	55	19	72	58	40	
	4	56	21	72	59	0	
Means .	4	52	17	72	58	9	

5th.

		°	′	″	
Obferved zenith diftance of	Pollux .	3	2	58	S.
do. . .	Caftor .	0	45	56	N.
do. . . .	Pollux .	3	03	1	S.
do. . .	β Tauri .	3	7	59	S.

6th. *Equal altitudes of the Sun.*
A. M. 9h 37′ 57″. P. M. 2h 18′ 54″.

The obſerved times, and diſtances of the ☉'s and ☽'s neareſt limbs.

	Times. h	′	″	Diſtances. °	′	″	
	2	32	57	98	11	20	
	2	34	2	98	11	40	
	2	35	10	98	12	0	
	2	36	4	98	12	0	Error of the Sextant 0″.
	2	36	49	98	12	30	
	2	37	38	98	12	50	
	2	38	33	98	13	20	
Means	2	35	53	98	12	14	

			°	′	″	
7th.	Obſerved zenith diſtance of	β Tauri	3	7	57	S.
	do.	Caſtor	0	45	55	N.
	do.	Pollux	3	2	58	S.

8th. *Equal altitudes of the Sun.*
A. M. 9h 23′ 42″. P. M. 2h 31′ 26″.

		°	′	″	
Obſerved zenith diſtance of	β Tauri	3	8	0	S.
do.	Caſtor	0	45	56	N.
do.	Pollux	3	2	56	

9th. Turned the face of the ſector weſt.

			°	′	″	
	Obſerved zenith diſtance of	Pollux	3	4	0	S.
10th.	do.	Caſtor	0	44	55	N.
	do.	Pollux	3	3	59	S.

11th, 12th, and 13th. Cloudy with conſtant, but not heavy thunder.

14th. Cleared off very early in the morning with a violent gale of wind which blew down a number of the tents, and puſhed in the ſide of the one we uſed for the obſervatory againſt the clock, where it reſted till the gale was over, which did not exceed 15 minutes.

Equal

Equal altitudes of the Sun.
A. M. 9ʰ 41′ 58″. P. M. 2ʰ 7′ 36″.

		°	′	″	
Obſerved zenith diſtance of β Tauri	. .	3	8	58	S.

15th, and 16th. Cloudy with ſome thunder and a little rain.

			°	′	″	
17th.	Obſerved zenith diſtance of β Tauri	. .	3	8	58	S.
	do. . . . . Caſtor	.	0	44	57	N.
	do. . . . . Pollux	.	3	3	56	

The obſerved times, and diſtances of the ☉'s and ☽'s neareſt limbs.

	Times. h	′	″	Diſtances. °	′	″	
	20	57	41	109	43	40	
	20	59	55	109	42	30	
	21	1	44	109	41	20	Error of the Sextant 0″.
	21	2	51	109	40	30	
	21	4	35	109	39	30	
	21	5	49	109	39	00	
Means .	9	1	49	109	41	5	

18th. *Equal altitudes of the Sun.*
A. M. 9ʰ 13′ 10″. P. M. 2ʰ 31′ 38″.

			°	′	″	
19th.	Obſerved zenith diſtance of β Tauri	.	3	8	54	S.
	do. . . Caſtor	.	0	44	50	N.
20th.	do. . . . . β Tauri	.	3	8	55	S.

21ſt. Stopped the clock and ſet it forward about 9 minutes.—Screwed up the pendulum bob.

Equal altitudes of the Sun.
A. M. 9ʰ 53′ 24″. P. M. 2ʰ 3′ 43″.

The obſerved times, and diſtances of the ☉'s and ☽'s neareſt limbs.

	Times.			Diſtances.			
	h	′	″	°	′	″	
	21	18	5	65	50	30	
	21	21	28	65	50	0	
	21	23	29	65	50	0	
	21	24	12	65	49	20	Error of the Sextant 0″.
	21	25	7	65	48	40	
	21	26	17	65	48	0	
	21	29	17	65	47	30	
Means .	9	23	55	65	49	9	

Repeated.

	h	′	″	°	′	″	
	21	30	35	65	46	40	
	21	31	40	65	46	30	
	21	33	19	65	46	50	
	21	34	41	65	46	0	Error of the Sextant 0′.
	21	36	10	65	45	30	
	21	37	43	65	45	20	
	21	39	14	65	45	0	
Means .	21	34	46	65	45	56	

22d. Obſerved zenith diſtance of β Tauri . 3° 8′ 57″ s.

The obſerved times, and diſtances of the ☉'s and ☽'s neareſt limbs.

	Times.			Diſtances.			
	h	′	″	°	′	″	
	21	42	32	54	49	20	
	21	43	35	54	48	50	
	21	44	28	54	48	20	Error of the Sextant 0″.
	21	45	40	54	48	10	
	21	46	32	54	48	00	
Means .	21	44	33	54	48	32	

23d. Obſerved zenith diſtance of β Tauri . 3° 8′ 56″ s.

The

The obferved times, and diftances of the ☉'s and ☽'s neareft limbs.

	Times.			Diftances.			
	h	′	″	°	′	″	
	21	21	16	43	53	10	
	21	23	7	43	52	40	
	21	24	13	43	52	20	Error of the Sextant 0″.
	21	25	15	43	52	10	
	21	26	52	43	52	00	
Means	21	24	9	43	52	28	

From this time I was too much occupied in other concerns, occafioned by the different commotions in the country, to attend to a regular feries of obfervations till October; there are therefore but few entered till that time.

28th. *Equal altitudes of the Sun.*
A. M. 9^h 28′ 32″. P. M. 2^h 26′ 43″.

April 7th. Obferved zenith diftance of Caftor . 0° 44′ 56″ N.

From this time, till the 4th of June no attention was paid to the clock, it ran down feveral times.

June 12th. *Equal altitudes of the Sun.*
A. M. 8^h 58′ 4″. P. M. 3^h 8′ 50″.

Immerfion of the 1ft fatellite of ♃ obferved at 15^h 28′ 25″.—Belts tolerably diftinct, magnifying power of the telefcope 120.

17th. *Equal altitudes of the Sun.*
A. M. 8^h 54′ 41″. P. M. 3^h 13′ 49″.

26th. Clock removed from the tent, into a houfe where I went to refide myfelf, but on account of the ficknefs which prevailed on the river, I removed in July with my people about feven miles into the country and encamped, where

where I remained till the 27th of September, and then returned to the village of Natchez.

28th. Cleaned the clock and set it a-going.

Immersion of the 1st satellite of ♃ observed at 14^h 30′ 10″.—Belts distinct, magnifying power 120.

29th. *Equal altitudes of the Sun.*

A. M. 8^h 53′ 21.5″. P. M. 3^h 5′ 17.5″.
Doubtful 2 or 3 seconds.

30th. *Equal altitudes of the Sun.*

A. M. 8^h 59′ 44″. P. M. 2^h 58′ 35″.

Immersion of the 1st satellite of ♃ observed at 8^h 59′ 19″. Belts distinct, magnifying power 120.

Oct. 2d. Prepared to observe an eclipse of the 4th satellite of ♃. The satellite was not eclipsed, neither am I convinced that it touched the shadow of ♃, it was very distinct, and appeared when nearest, to be its full diameter from the body of the planet.

7th. *Equal altitudes of the Sun.*

A. M. 9^h 2′ 10″. P. M. 2^h 54′ 14″.

From this time, till the beginning of January following, it was with difficulty I could sit up long enough to make an observation, owing to a severe fever.

18th. *Equal altitudes of the Sun.*

A. M. 8^h 58′ 41″. P. M. 2^h 56′ 52″.

25th. *Emersion* of the 1st satellite of ♃ observed at 5^h 55′ 12″. —Belts distinct, magnifying power 120.

26th. *Equal altitudes of the Sun.*

A. M. 9^h 9′ 25″. P. M. 2^h 47′ 5″.

Nov. 22d. Clock ran down, wound it up, set it a-going, and lowered the pendulum bob.

24th.

24th. *Equal altitudes of the Sun.*
A. M. 9^h 28′ 26″. P. M. 2^h 38′ 35″.

Emersion of the 1st satellite of ♃ observed at 8^h 7′ 33″. —Belts distinct, magnifying power 120.

26th. *Equal altitudes of the Sun.*
A. M. 9^h 30′ 44″. P. M. 2^h 37′ 48″.

Dec. 1st. Thermometer rose to 78°.—Musquitoes very troublesome at night.

2d. Thermometer 50° at sun rise, fell to 47°.—Cloudy.

3d. Thermometer 22° at sun rise, rose to 35°. —Snow and hail without intermission till 6^h P. M. when it cleared away with a strong N. W. wind.

Observations on a lunar eclipse.

	h	′	″
Beginning	8	38	34
Beginning of total darkness	9	37	35
End of total darkness	11	18	59
End of the eclipse	12	18	12

During the above observation the thermometer was at 20°.

4th. Thermometer 18° at sun rise, rose to 33°. —Mr. Dunbar's thermometer was at 17° in the morning.

Equal altitudes of the Sun.
A. M. 9^h 17′ 7″. P. M. 2^h 57′ 35″.

5th. Thermometer 20° at sun rise, rose to 37°.
6th. Thermometer 18° at sun rise, rose to 39°.

Equal altitudes of the Sun.
A. M. 9h 25′ 15.5″. P. M. 2h 51′ 24.5″.

7th. Thermometer 30° at sun rise, rose to 49°.

Emersion

Emerfion of the 2d fatellite of ♃ obferved at $7^h\ 56'\ 31''$.—Belts diftinct, magnifying power 120.

8th. Thermometer 33° at fun rife, rofe to 51°.

Equal altitudes of the Sun.
A. M. $9^h\ 56'\ 15''$. P. M. $2^h\ 22'\ 19''$.

9th. Thermometer 30° at fun rife, rofe to 47°. —Cloudy.

10th. Thermometer 28° at fun rife, rofe to 56°.

11th. Thermometer 40° at fun rife, rofe to 60°.

12th. Thermometer 52° at fun rife, rofe to 75°. —Cloudy part of the day.

13th. Thermometer 60° at fun rife, rofe to 75°. —Flying clouds.

14th. Thermometer 63° at fun rife, rofe to 75°. —It was 74° at 9^h in the evening, a thunder guft at midnight.

15th. Thermometer 46° at fun rife, rofe to 50°. —Flying clouds.

16th. Thermometer 30° at fun rife, rofe to 51°.

Equal altitudes of the Sun.
A. M. $9^h\ 28'\ 0''$. P. M. $2^h\ 58'\ 15''$.

17th. Thermometer 50° at fun rife, rofe to 55°.

Emerfion of the 1ft fatellite of ♃ obferved at $8^h\ 24'\ 30''$. —A little hazy, but the belts were middling diftinct, magnifying power 120.

18th. Thermometer 43° at fun rife, rofe to 54°.

Equal altitudes of the Sun.
A. M. $9^h\ 50'\ 14''$. P. M. $2^h\ 38'\ 8''$.

19th. Thermometer 30° at fun rife, rofe to 53°. —Cloudy with fome cold rain.

20th.

20th. Thermometer 34° at ſun riſe, roſe to 51°. —Cloudy with cold rain.—Cleared off at night with a N. W. wind.

21ſt. Thermometer $17\frac{1}{2}$° at ſun riſe, roſe to 37°.

Equal altitudes of the Sun.

A. M. $9^h\ 46'\ 43''.5$. P. M. $2^h\ 44'\ 58''.5$.

22d. Thermometer 23° at ſun riſe, roſe to 41°. —Cloudy.

23d. Thermometer 28° at ſun riſe, roſe to 37°. —Flying clouds.

24th. Thermometer 41° at ſun riſe, roſe to 50°.

Emerſion of the 1ſt ſatellite of ♃ obſerved at $10^h\ 21'\ 1''$. —A little hazy, belts middling diſtinct, magnifying power 120.

25th. Thermometer 55° at ſun riſe, roſe to 60°. —Cloudy with a little rain.

26th. Thermometer 64° at ſun riſe, fell to 40°. —Cloudy with a N. E. wind.

27th. Thermometer 22° at ſun riſe, roſe to 39°. —Wind N. W.

28th. Thermometer 28° at ſun riſe, roſe to 54°.

29th. Thermometer 31° at ſun riſe, roſe to 52°.

30th. Thermometer 53° at ſun riſe, roſe to 65°. —Heavy rain.

31ſt. Thermometer 55° at ſun riſe, roſe to 57°. —Heavy rain.

1798.

Jan. 1ſt. Thermometer 31° at ſun riſe, roſe to 67°.

Equal altitudes of the Sun.

A. M. $9^h\ 50'\ 10''$. P. M. $2^h\ 53'\ 43''$.

2d. Thermometer 48° at ſun riſe, roſe to 61°. —Cloudy.

At 15 minutes after 8 o'clock A. M. ſtopped the clock about 19 minutes by my watch, and lowered the pendulum bob a ſmall matter, but ſcarcely diſcernible with a magnifying glaſs.

3d. Thermometer 45° at ſun riſe, roſe to 52°.

4th. Thermometer 47° at ſun riſe, roſe to 63°. —Cloudy great part of the day.

Immerſion of the 3d ſatellite of ♃ obſerved at . $6^h\ 36'\ 51''$. *Emerſion* do. at . 8 36 23. } Belts diſtinct, magnifying power 120.

5th. Thermometer 27° at ſun riſe, roſe to 67°.

Equal altitudes of the Sun.
A. M. $9^h\ 33'\ 5''$. P. M. $2^h\ 36'\ 44''$.

6th. Thermometer 37° at ſun riſe, roſe to 61°. —Cloudy.

7th. Thermometer 55° at ſun riſe, roſe to 72°. —Rain.

8th. Thermometer 55° at ſun riſe, roſe to 73°.

Equal altitudes of the Sun.
A. M. $9^h\ 41'\ 30''$. P. M. $2^h\ 30'\ 55''$.

Emerſion of the 2d ſatellite of ♃ obſerved at $7^h\ 22'\ 12''$. —Belts diſtinct, magnifying power 120.

9th. Thermometer 35° at ſun riſe, roſe to 62°.

Equal altitudes of the Sun.
A. M. $9^h\ 40'\ 21''$. P. M. $2^h\ 32'\ 52''$.

Emerſion of the 1ſt ſatellite of ♃ obſerved at $8^h\ 23'\ 10''$. —Belts diſtinct, magnifying power 120.

10th. Thermometer 24° at ſun riſe, roſe to 66°. —Cloudy.

11th.

11th. Thermometer 23° at ſun riſe, roſe to 61°. —Cloudy with ſome rain.

12th. Thermometer 27° at ſun riſe, roſe to 57°. —Cloudy.

13th. Thermometer 50° at ſun riſe, roſe to 65°. —Cloudy part of the day with rain.

14th. Thermometer 62° at ſun riſe, fell to 55°.—Heavy rain.

15th. Thermometer 37° at ſun riſe, roſe to 60°.

Equal altitudes of the Sun.

A. M. $9^h\ 29'\ 10.5''$. P. M. $2^h\ 48'\ 20''$.
Doubtful 3 or 4 ſeconds.

Emerſion of the 2d ſatellite of ♃ obſerved at $9^h\ 58'\ 28''$. —Belts obſcure, the planet and ſatellites very tremulous.—Magnifying power 120.

16th. Thermometer 32° at ſun riſe, roſe to 69°.

Equal altitudes of the Sun.
A. M. $9^h\ 23'\ 55''$. P. M. $2^h\ 54'\ 20''$.

Emerſion of the 1ſt ſatellite of ♃ obſerved at $10^h\ 19'\ 19''$. —Belts tolerably diſtinct, magnifying power 120.

17th. Thermometer 33° at ſun riſe, roſe to 76°.

18th. Thermometer 34° at ſun riſe, roſe to 64°.

19th. Thermometer 40° at ſun riſe, roſe to 60°. —Cloudy with ſome rain.

20th. Thermometer 54° at ſun riſe, roſe to 71°. —Cloudy.

21ſt. Thermometer 53° at ſun riſe, roſe to 68°. —Cloudy with rain.

22d. Thermometer 67° at ſun riſe, roſe to 76°. —Cleared off with a N. W. wind.

23d. Thermometer 22° at ſun riſe, roſe to 46°.

Equal altitudes of the Sun.
A. M. 9h 13′ 47″. P. M. 3h 8′ 2″.

The obſerved times, and diſtances of the ☉'s and ☽'s neareſt limbs.

	Times. h	′	″	Diſtances. °	′	″	
	3	23	15	74	27	5	
	3	24	36	74	27	15	
	3	26	24	74	27	40	
	3	27	25	74	28	0	
	3	28	34	74	28	10	
	3	29	34	74	28	30	Error of the Sextant 0″.
	3	30	25	74	28	50	
	3	31	16	74	28	55	
	3	32	8	74	29	0	
	3	33	4	74	29	30	
	3	33	46	74	29	40	
	3	34	28	74	30	00	
Means .	3	29	35	74	28	33	

The obſerved times, and diſtances of the ☽'s weſtern limb from Aldebaran.

	Times. h	′	″	Diſtances. °	′	″	
	9	54	11	45	34	0	
	9	55	14	45	33	30	
	9	58	59	45	31	20	
	10	0	6	45	30	40	
	10	1	3	45	30	40	Error of the Sextant 0″.
	10	2	5	45	30	20	
	10	3	10	45	29	10	
	10	4	53	45	28	0	
	10	6	6	45	27	20	
Means .	10	0	39	45	30	33	

24th. Thermometer 18° at ſun riſe, roſe to 49°. —N. W. wind.

Equal altitudes of the Sun.
A. M. 9h 22′ 58″. P. M. 2h 59′ 21″.

25th. Thermometer 48° at ſun riſe, roſe to 60°.

26th.

26th. Thermometer 66° at ſun riſe, roſe to 76°. —Cloudy.
27th. Thermometer 49° at ſun riſe, roſe to 61°.
28th. Thermometer 34° at ſun riſe, roſe to 63°.

Equal altitudes of the Sun.
A. M. 9^h 11′ 52″. P. M. 3^h 11′ 51″.

29th. Thermometer 55° at ſun riſe, roſe to 76°.
30th. Thermometer 66° at ſun riſe, roſe to 82°.
31ſt. Thermometer 67° at ſun riſe, roſe to 81°.
Feb. 1ſt. Thermometer 59° at ſun riſe, roſe to 81°. —Cloudy with ſome rain.
2d. Thermometer 64° at ſun riſe, roſe to 76°.
3d. Thermometer 63° at ſun riſe, roſe to 80°. —Cloudy.
4th. Thermometer 66° at ſun riſe, roſe to 78°. —Flying clouds.
5th. Thermometer 55° at ſun riſe, roſe to 79°.
6th. Thermometer 61° at ſun riſe, roſe to 71°. —Cloudy with a little rain.
7th. Thermometer 54° at ſun riſe, roſe to 80°.

Equal altitudes of the Sun.
A. M. 9^h 30′ 53″. P. M. 2^h 53′ 48″.

8th. Thermometer 51° at ſun riſe, roſe to 66°. —Heavy rain laſt night and this day.
9th. Thermometer 33° at ſun riſe, roſe to 57°. —Wind N. W.

Equal altitudes of the Sun.
A. M. 9^h 4′ 35″. P. M. 3^h 19′ 50″.

Emerſion of the 2d ſatellite of ♃ obſerved at 7° 2′ 52″. —Belts diſtinct, magnifying power 120.

10th. Thermometer 31° at ſun riſe, roſe to 50°.
11th. Thermometer 55° at ſun riſe, roſe to 70°.

12th.

12th. Thermometer 61° at ſun riſe, roſe to 78°.

Equal altitudes of the Sun.
A. M. $9^h\ 1'\ 43''$. P. M. $3^h\ 22'\ 28''$.

13th. Thermometer 64° at ſun riſe, roſe to 80°. —Cloudy with a little rain.
14th. Thermometer 61° at ſun riſe, roſe to 81°.
15th. Thermometer 55° at ſun riſe, fell to 50°. —Some rain.
16th. Thermometer 40° at ſun riſe, roſe to 55°. —Cloudy in the forenoon.

Immerſion of the 3d ſatellite of ♃ obſerved at $6^h\ 51'\ 32''$. —Belts middling well defined, magnifying power 120.

17th. Thermometer 30° at ſun riſe, roſe to 49°. —Cloudy with a heavy rain at night.
18th. Thermometer 50° at ſun riſe, roſe to 56°. —Cloudy.
19th. Thermometer 42° at ſun riſe, roſe to 55°. —Cloudy.
20th. Thermometer 40° at ſun riſe, roſe to 54°. —Cloudy part of the day.
21ſt. Thermometer 41° at ſun riſe, roſe to 66°.

Equal altitudes of the Sun.
A. M. $9^h\ 39'\ 19''$. P. M. $2^h\ 43'\ 4''$.

End of the obſervations at the Town of Natchez.

1797. The rate of the clock's going, at the town or village of Natchez.

		′	″	Daily loſs.
Clock too ſlow mean time March	3d.	12	32.4	
do.	6th.	13	5.5	11.0
do.	8th.	13	26.6	10.5
do.	14th.	14	33.6	11.2
do.	18th.	15	45.3	17.9*
do.	20th.	16	18.0	16.3

* The alteration in the going of the clock after the 14th muſt have been occaſioned by the tent being blown againſt it, as mentioned on the 15th.

Stopped

Stopped the clock and raised the pendulum bob.

			′	″	Daily gain.
do.		21st.	8	40.1	″ 6.6
do.		28th.	7	26.2	

From this time till the 4th of June the clock was but little attended to, and ran down several times.

			′	″	Daily loss.
Clock too fast mean time	June	12th	3	55	″ 2.9
do.		17th	3	40.6	

June 26th. The clock was taken down and removed into a house, where it was not attended to till September 28th.

			′	″	Daily gain.
Clock too fast mean time	Sept.	29th.	9	30.4	″
do.		30th.	9	39.5	9.1
do.	Oct.	7th.	10	47.4	9.7
do.		18th.	12	53.0	11.4
do.		26th.	14	24.3	11.4

Nov. 22d. Clock ran down, wound it up, set it a-going and lowered the pendulum bob.

			′	″	Daily gain.
Clock too fast mean time	Nov.	24th.	16	22	″
do.		26th.	16	28	3
do.	Dec.	4th.	16	30	0.2
do.		6th.	16	37	3.5
do.		8th.	16	38.5	0.7
do.		16th.	16	40.5	0.2
do.		18th.	16	44	1.7
do.		21st.	16	52	2.7
do.	1798. Jan.	1st.	17	31	3.5

1798.

Jan. 2d. Stopped the clock about 19 minutes and lowered the pendulum bob.

			′	″	″	
Clock too slow mean time	Jan.	5th.	1	21		
do.		8th.	1	20	0.3	daily gain.
do.		9th.	1	22	2.0	daily loss.
					1.0	do.

do.

			′	″	″	
do.		15th.	1	28.2	0.8	daily gain.
do.		16th.	1	28	2.3	daily loſs.
do.		23d.	1	44	1.0	daily gain.
do.		24th.	1	43	1.7	daily loſs.
do.		28th.	1	50	3.5	do.
do.	Feb.	7th.	2	24.6	5.5	do.
do.		9th.	2	35.6	2.0	do.
do.		12th.	2	41.6	1.3	do.
do.		21ſt.	2	53.5		

1797.

The reſults of the obſervations made at Natchez for the Longitude.

			h	′	″
March	3d.	Longitude weſt from Greenwich by a lunar obſervation the ☽ from the ☉.	6	6	24
		do.	6	6	41
		do.	6	5	54
	4th.	do.	6	6	33
		do.	6	5	37
	6th.	do.	6	4	27
	17th.	do.	6	5	48
	21ſt.	do.	6	5	2
		do.	6	6	34
	22d.	do.	6	5	34
	23d.	do.	6	6	37
June	12th.	do. by an immerſion of the 1ſt ſatellite of ♃	6	6	5
Sept.	28th.	do.	6	6	23
	30th.	do.	6	6	13
Oct.	25th.	do. by an emerſion of do.	6	6	15
Nov.	24th.	do.	6	5	58
Dec.	3d.	by the beginning of the lunar eclipſe	6	5	36
		do. beginning of total darkneſs	6	6	6
		do. end of total darkneſs	6	5	29
		do end of the eclipſe	6	5	38
	7th.	By an emerſion of the 2d ſatellite of ♃	6	6	5
	17th.	do. 1ſt ſatellite	6	5	58
	24th.	do. do.	6	6	12
1798. Jan.	4th.	By an immerſion of the 3d ſatellite	5	58	11
		do. emerſion do.	6	0	47
		The immerſion of the ſame ſatellite by de Lambre's Tables	6	2	58
		Emerſion of do. by de Lambre's Tables	6	4	57
	8th.	Emerſion of the 2d ſatellite	6	5	43
	9th.	do. 1ſt	6	5	57
	15th.	do. 2d	6	5	27
	16th.	do. 1ſt	6	5	45

23d.

			h	′	″
	23d.	By a lunar observation, the ☽ from the ☉.	6	4	41
		do. the ☽ from Aldebaran.	6	5	6
Feb.	9th.	By an emersion of the 2d satellite	6	5	2
	16th.	By an immersion of the 3d do.	5	59	25
		do. by de Lambre's Tables	6	3	26

The longitude of Natchez is stated in the 4th volume of the Transactions of the American Philosophical Society, page 451, at 16° 15′ 46″ west from Philadelphia, or 91° 29′ 16″ which is equal to 6^h 5′ 57″ west from Greenwich.—That determination includes all the foregoing observations previous to the 10th of January, except the immersion, and emersion of the 3d satellite* on the 4th of that month, which from the imperfection of the theory were omitted.

* I have lately been furnished by Jose Joaquin de Ferrer, an ingenious Spanish gentleman, with a number of valuable astronomical observations, which he has made at different places on this continent: among them there are three on the eclipses of Jupiter's satellites made at la Guaira, which correspond with an equal number of mine made at Natchez.—They are the following:

		Apparent Time. h ′ ″	h ′ ″
1798. Jan. 4th.	*Emersion* of the 3d satellite of ♃ observed by Mr. de Ferrer at la Guaira	10 9 51	
	Observed at Natchez	8 31 51	
	Difference of meridians		1 38 0
do. 8th.	*Emersion* of the 2d satellite of ♃ observed by Mr. de Ferrer at la Guaira	8 54 11	
	Observed at Natchez	7 15 58	
	Difference of meridians		1 38 13
do. 9th.	*Emersion* of the 1st satellite of ♃ observed by Mr. de Ferrer at la Guaira	9 54 40	
	Observed at Natchez	8 16 31	
	Difference of meridians		1 38 9
	Mean		1 38 7.3

The telescopes used by Mr. de Ferrer and myself were both acromatic, and nearly of the same magnifying power, (that is about 120), the difference of the meridians will therefore require no correction on account of the difference of the instruments, and may be safely taken as above stated: by which it appears that the town of Natchez, is 1^h 38′ 7″.3 or 24° 31′ 49″ west of la Guaira.—The latitude of la Guaira as determined by Mr. de Ferrer is 10° 36′ 40″ N.

Refult of the obfervations for the latitude of Natchez.

Obferved Zenith Diftances of the following Stars.

Face of the Sector Eaft.

1797.	β Tauri. ° ′ ″	Caftor. ° ′ ″	Pollux. ° ′ ″
March 4th.	. . . .	. . . .	3 2 58 S.
5th.	3 7 59 S.	0 45 56 N.	3 3 1
7th.	3 7 57	0 45 55	3 2 58
8th.	3 8 0	0 45 56	3 2 56
Means	3 7 58.7	0 45 55.9	3 2 58.2

Face of the Sector Weft.

	β Tauri.	Caftor.	Pollux.
9th.	. . . .	. . . .	3 4 0
10th.	. . . .	0 44 55	3 3 59
14th.	3 8 58	. . . .	. . . .
17th.	3 8 58	0 44 57	3 3 56
18th.	3 8 54	. . . .	. . . .
19th.	. . . .	0 44 50	. . . .
20th.	3 8 55	. . . .	. . . .
22d.	3 8 57	. . . .	. . . .
23d.	3 8 56	. . . .	. . . .
April 7th.	. . . .	0 44 56	. . . .
Means	3 8 56.3	0 44 54.5	3 3 58.3
Means face eaft	3 7 58.7	0 45 55.9	3 2 58.2
Means	3 8 27.5	0 45 25.2	3 3 28.2
Refractions	+3.1	+0.7	+3
True zenith diftance	3 8 30.6	0 45 25.9	3 3 31.2
Mean declinations March 15th.	28 25 20.3 N.	32 19 1.9 N.	28 30 10.7 N.
Aberrations	+1.7	+2.1	+0.8
Nutations	—1.0	+6.9	+3.4
Semi. ann. equations	+0.5	+0.4	+0.3
True declinations	28 25 21.5	32 19 11.3	28 30 15.2
True zenith diftances applied	+3 8 30.6	—0 45 25.9	+3 3 31.2
Latitudes N.	31 33 52.1	31 33 45.4	31 33 46.4

		°	′	″
Lat. by	β Tauri	31	33	52.1
do.	Caftor	31	33	45.4
do.	Pollux	31	33	46.4
Mean lat. N.		31	33	48 nearly.

Astronomical

Astronomical, and Thermometrical Observations, made at the City of New-Orleans on the Mississippi.

1799.

Jan. 10th. Set up the clock, thermometer 70° in the afternoon.

11th. Cloudy all day, thermometer 73° in the afternoon.

12th. Cloudy with mist, thermometer 72° in the morning, fell to 65° in the evening.

13th. Cloudy in the afternoon, thermometer 70° in the morning, fell to 64° in the evening.

14th. Clear, thermometer 62° in the morning, rose to 63° in the afternoon.

Equal altitudes of the Sun.
A. M. 9^h 6′ 42″. P. M. 2^h 53′ 3″.

Emersion of the 1st satellite of ♃ observed at 6^h 10′ 37″ P. M.—Night clear, belts distinct, magnifying power 120.

15th. Clear day, thermometer 61° at sun rise, rose in the afternoon to 68°.

Equal altitudes of the Sun.
A. M. 8^h 52′ 25″. P. M. 3^h 6′ 48″.

Set up the Sector of six feet radius. Face to the east.

Observations on the passage of the ☽ over ♃, and three of his satellites.

	h	′	″	
2d. Satellite immersed at	5	35	26	
1st. do.	5	41	7	
♃ began to immerse at	5	44	5	
♃ immersed at	5	46	22	
4th. Satellite immersed at	5	53	47	P. M.
1st. do. emerged at	7	2	0	
♃ began to emerge at	7	4	42	
♃ emerged at	7	6	50	
4th. Satellite do. at	7	16	48	

The

The 3d ſatellite at the time of its immerſion was obſcured by a ſmall cloud, and as it emerged about the time that ♃ was ⅔ emerged, it was not attended to ſo accurately, as to entitle it to a place among the obſervations.

16th. Cloudy with rain, thermometer 62° at ſun riſe, fell in the afternoon to 59°.

17th. Cloudy with rain, thermometer 58° at ſun riſe, roſe in the afternoon to 67°.

18th. Cloudy, thermometer 59° in the morning, roſe in the afternoon to 61°.

19th. Clear, thermometer 56° at ſun riſe, roſe in the afternoon to 66°.

Equal altitudes of the Sun.

A. M. $9^h\ 10'\ 47''$. P. M. $2^h\ 46'\ 10''$.

		°	′	″	
Obſerved zenith diſtance	β Andromedæ	4	36	28	N.
do.	β Tauri	1	31	6	S.
do.	Caſtor	2	22	15	N.
do.	Pollux	1	26	35.5	S.

20th. Clear in the morning, cloudy in the evening, thermometer 60° at ſun riſe, roſe in the afternoon to 69°.

Obſerved zenith diſtance α Coro. Borealis 2° 32′ 52″ S.

Equal altitudes of the Sun.

A. M. $9^h\ 40'\ 27''$. P. M. $2^h\ 15'\ 49.5''$.

21ſt. Cloudy all day, clear in the evening, thermometer 60° in the morning, roſe to 69° in the afternoon.

Emerſion of the 1ſt ſatellite of ♃ obſerved at $8^h\ 2'\ 9''$ P. M.—Belts diſtinct, magnifying power of the teleſcope 120.

		°	′	″	
Obſerved zenith diſtance	β Tauri	1	31	10	S.
do.	Caſtor	2	22	14	N.
do.	Pollux	1	26	31.5	S.

22d.

22d. Clear day, thermometer 61° at ſun riſe, roſe in the afternoon to 72°.

Equal altitudes of the Sun.
A. M. 9ʰ 36′ 39″. P. M. 2ʰ 18′ 18″.

		°	′	″	
Obſerved zenith diſtance	β Andromedæ	4	36	29	N.
do. . . .	β Tauri .	1	31	9	S.
do. . .	Caſtor .	2	22	12.5	N.
do. . .	Pollux .	1	26	35.5	S.

23d. Clear day, thermometer 66° at ſun riſe, roſe in the afternoon to 74°.

		°	′	″	
Obſerved zenith diſtance	α Coro. Borealis	2	32	51	S.
do. . . .	β Andromedæ	4	36	30	N.

Turned the face of the Sector to the weſt.

Obſerved zenith diſtance of Pollux . 1° 28′ 16″ S.

24th. Clear day, thermometer 68° at ſun riſe, roſe in the afternoon to 77°.

Obſerved zenith diſtance of α Coro. Borealis 2° 34′ 34″ S.

Equal altitudes of the Sun.
A. M. 8ʰ 54′ 0″. P. M. 2ʰ 59′ 33″.

The equal altitudes of this day are doubtful 2 or 3 ſeconds, from the violence of the wind.

Obſerved zenith diſtance β Andromedæ 4° 34′ 49″ N.

The above zenith diſtance is doubtful, from the effect of the wind on the plumb-line.

		°	′	″	
Obſerved zenith diſtance	β Tauri .	1	32	47	S.
do. . . .	Caſtor .	2	20	35	N.
do. . . .	Pollux .	1	28	17	S.

25th. Heavy fog in the morning, thermometer 70° at 6 o'clock A. M. and 79° in the afternoon.

Obſerved

			°	′	″	
	Obſerved zenith diſtance of	β Andromedæ	4	34	46	N.
	do. . .	β Tauri .	1	32	50	S.
26th.	do. .	α Coro. Borealis	2	34	31.5	S.

Clear till 9 o'clock A. M. afterwards flying clouds, thermometer 75° all laſt night, roſe in the afternoon to 79°.

27th. Cloudy with fine rain—the thermometer continued at 77° all laſt night, fell to 68° at 2^h P. M. The wind which had been ſoutherly ſince the 10th, ſhifted to the north, and the mercury fell to 56° in the evening.

Feb. 6th. *Equal altitudes of the Sun.*
A. M. 9^h 18′ 44″. P. M. 2^h 23′ 44″.

7th. and 8th. Heavy rain, accompanied with ſharp lightning, and heavy thunder.

9th. Clear—the thermometer 36° at ſun riſe, roſe in the afternoon to 57°.

10th. Clear—the thermometer 30° at ſun riſe, roſe in the afternoon to 60°.

Emerſion of the 2d ſatellite of ♃ obſerved at 9^h 10′ 26″. —Very clear, belts diſtinct, magnifying power of the teleſcope 120.

11th. Clear—the thermometer 31° at ſun riſe, roſe in the afternoon to 65°.

12th. Clear—hoar froſt—thermometer 38° at ſun riſe, roſe in the afternoon to 71°.

17th. Clear—the thermometer 59° at ſun riſe, roſe in the afternoon to 74°.

Equal altitudes of the Sun.
A. M. 9^h 33′ 16″. P. M. 1^h 57′ 33″.

Latitude

Latitude of the City of New-Orleans deduced from the Zenith Diſtances.

Face of the Sector Eaſt.

1799.	β Andromedæ. ° ′ ″	β Tauri. ° ′ ″	Caſtor. ° ′ ″	Pollux. ° ′ ″	α Coro. Borealis. ° ′ ″
Jan. 19th.	4 36 28 N.	1 31 6 S.	2 22 15 N.	1 26 35.5 S.	. . . .
20th.	. . . .	. . . .	. . . .	. . . .	2 32 52 S.
21ſt.	. . . .	1 31 10 S.	2 22 14 N.	1 26 31.5 S.	. . . .
22d.	4 36 29 N.	1 31 9 S.	2 22 12.5 N.	1 26 35.5 S.	. . . .
23d.	4 36 30 N.	. . . .	. . . .	. . . .	2 32 51 S.
Means	4 36 29 N.	1 31 8.3 S.	2 22 13.8 N.	1 26 34.2 S.	2 32 51.5 S.

Face of the Sector Weſt.

	β Andromedæ.	β Tauri.	Caſtor.	Pollux.	α Coro. Borealis.
	. . . .	. . . .	. . . .	1 28 16 S.	. . . .
24th.	4 34 49 N.	1 32 47 S.	2 20 35 N.	1 28 17 S.	2 34 34 S.
25th.	4 34 46 N.	1 32 50 S.	. . . .	. . . .	. . . .
26th.	. . . .	. . . .	. . . .	. . . .	2 34 31 5 S.
Means	4 34 47.5 N.	1 32 48.5 S.	2 20 35 N.	1 28 16.5 S.	2 34 32 7 S.
Means face weſt	4 36 29 N.	1 31 8.3 S.	2 22 13.8 N.	1 26 34.2 S.	2 32 51 5 S.
Means	4 35 38.2 N.	1 31 58.4 S.	2 21 24.4 N.	1 27 25.3 S.	2 33 42.1 S.
Refractions	+ 4.5	+ 1.5	+ 2.3	+ 1.5	+ 2.5
Correct zenith diſtances . . .	4 35 42.7 N.	1 31 59.9 S.	2 21 26.7 N.	1 27 26.8 S	2 33 44.6 S.
Mean declinations, 23d Jan. 1799. .	34 33 6.8 N.	28 25 23 N.	32 18 49 N.	28 29 53.2 N.	27 23 59.5 N.
Aberrations	+ 7.0	+ 2.5	— 1.6	—2.4	— 11.3
Nutations	— 3.8	+ 4.6	+ 7.6	+7.5	— 1.2
True declinations	34 33 10 N.	28 25 30.1 N.	32 18 55 N.	28 29 58.3 N.	27 23 47 N.
Correct zenith diſtances applied . .	—4 35 42.7 N.	+1 31 59.9 S.	−2 21 26.7 N.	+1 27 26.8 S.	+2 33 44.6 S
Latitudes	29 57 27.3 N.	29 57 30.0 N.	29 57 29.3 N.	29 57 25.1 N.	29 57 31.6 N

Latitude

		°	′	″
Latitude by β Andromedæ	.	29	57	27.3
do. . β Tauri	. .	29	57	30.0
do. . Caſtor	. .	29	57	29.3
do. . Pollux	. .	29	57	25.1
do. . α Coro. Borealis	.	29	57	31.6
Mean Latitude north	. .	29	57	28.7

The above determination differs but 16″.3 from the latitude of New-Orleans as ſtated in the requiſite tables, and which may have ariſen from the obſervations being made in different parts of the city.

Longitude of the city of New-Orleans, deduced from the eclipſes of ♃'s ſatellites.

1799.			′	″	Daily loſs. ′	″
Jan.	14th.	Clock too ſlow mean time . .	9	56		
					0	37
	15th.	. . . do. . . .	10	33		
					0	36.5
	19th.	. . . do.	12	59		
					0	38
	20th.	. . . do. . . .	13	37		
					0	36
	22d.	. . . do.	14	49		
					0	36
	24th.	. . . do. . . .	16	1		
					0	38
Feb.	6th.	. . . do.	24	27		
					0	25.4
	17th.	. . . do. . . .	29	6		

From the 24th of January, till I left New-Orleans, I was engaged in decking, and rigging a ſchooner, to tranſport our baggage, apparatus, and proviſions along the coaſt, and therefore unable to attend conſtantly to the going of the clock, which was ſet up in a place much expoſed, and probably the caſe was by ſome accident ſhifted a ſmall matter between the 6th, and 17th of February, from the poſition it had when ſet up: This appears likely from the rate of the clock's going during that interval.

An emerſion of the 1ſt ſatellite of ♃ was obſerved on the 14th of January at $6^h\ 10'\ 37''$ P. M.—the clock was then too ſlow mean time 10′ 05″, the obſervation was therefore made at $6^h\ 20'\ 42''$ mean time, from which deduct 9′ 48″ the equation of time, and the remainder $6^h\ 10'\ 54''$ will be the apparent time, which deducted from $12^h\ 12'\ 19''$ the apparent time at Greenwich by the theory, the remainder $6^h\ 1'\ 25''$ will be the difference of meridians.

An emerſion of the 1ſt ſatellite of ♃ was obſerved on the 21ſt of January at $8^h\ 2'\ 9''$ P. M. The clock at the time of obſervation was 14′ 34″ too ſlow mean time, the obſervation was of courſe made at $8^h\ 16'\ 43''$ mean time, from which deduct 12′ 0″ the equation of time, and the remainder $8^h\ 4'\ 43''$ will be the apparent time of the obſervation, which deducted from $14^h\ 5'\ 43''$, the apparent time at Greenwich by the theory, the remainder $6^h\ 1'\ 00''$ will be the difference of meridians.

On

On the 10th of February at 9^h 10′ 26″ P. M. an emerſion of the 2d ſatellite of ♃ was obſerved, the clock was then 26′ 26″ too ſlow mean time, the obſervation was therefore made at 9^h 36′ 52″ mean time, from which deduct 14′ 38″ the equation of time, and the remainder 9^h 22′ 14″ will be the apparent time of the obſervation, which taken from 15^h 22′ 5″ the apparent time at Greenwich by the theory, the remainder 5^h 59′ 51″ will be the difference between the meridians.

The longitude given by the 2d ſatellite, does not appear from the theory to be entitled to more than half the weight of either of thoſe by the firſt; this being admitted, the longitude will be had as below.

	Longitude weſt.		
By the emerſion of the 1ſt ſatellite on the 14th of Jan.	6^h	1′	25″
	6	1	25
By do. on the 21ſt of Jan.	6	1	0
	6	1	0
By an emerſion of the 2d ſatellite on the 10th of Feb.	5	59	51
Mean	6	0	56 = 90° 14′ weſt

from Greenwich, or 1^h 0′ 21″ = 15° 5′ 15″ weſt from Philadelphia.

The longitude of the city of New-Orleans is ſet down in Robertſon's Navigation at 89° 54′ 0″ or 5^h 59′ 36″ weſt. In the requiſite tables at 89° 58′ 45″ or 5^h 59′ 55″ W. and by the French academicians* at about 90° or 6^h weſt from Greenwich.—The difference is not conſiderable, and perhaps the reſult of my obſervations may agree with the foregoing authorities ſtill more nearly, when compared with correſponding ones, or others made about the ſame time, at any obſervatory the longitude of which has been accurately ſettled.

The obſervations on the paſſage of the ☽ over ♃, and three of his ſatellites, before mentioned, will be reduced to apparent time, by adding 34″ to each obſervation.

Obſervations made on the tranſit of ☿ in May 1799 at Miller's place on the Coenecuch river, commonly, (though erroneouſly), called the Eſcambia, in lat. 30° 49′ 33″ N. by meaſurement, from the ſouth boundary of the United States, and due ſouth from the end of two hundred and forty-eight miles, and one hundred and eighty-ſix perches eaſt from the Miſſiſſippi, in the parallel of 31° N. lat.

May 2d. The inſtruments arrived in a boat from the head of Penſacola-Bay.

* Expoſition du calcul par de la Lande 1762.

3d. Put up the clock and ſet it to apparent time nearly.

Equal altitudes of the Sun.
$3^d\ 20^h\ 22'\ 34''$. $4^d\ 3^h\ 37'\ 27''$.

4th. *Equal altitudes of the Sun.*
$4^d\ 20^h\ 30'\ 17''$. $5^d\ 3^h\ 29'\ 51''$.

5th. *Equal altitudes of the Sun.*
$5^d\ 20^h\ 22'\ 47''$. $6^d\ 3^h\ 37'\ 45''$.

6th. At 19^h ☿ appeared beautifully defined through a middling heavy fog on the face of the ſun, at 21^h the fog diſappeared.

	h	′	″
The internal contact at the egreſs was obſerved by myſelf at	22	45	24
The external do. at	22	48	29.5

The external contact is certain within the ½ of a ſecond. —Magnifying power of the teleſcope 200.

	h	′	″
The internal contact at the egreſs was obſerved by Capt. Stephen Minor, His Catholic Majeſty's commiſſioner, at	22	46	21
The external do. at	22	48	14

Magnifying power of the teleſcope 35.

The internal contact at the egreſs was obſerved by my aſſiſtant Mr. David Gilliſpie at	22	46	21
The external do. at	22	47	59

Magnifying power of the teleſcope 25.

Equal altitudes of the Sun.
$6^d\ 20^h\ 15'\ 21''$. $7^d\ 3^h\ 45'\ 36''$.

The

The rate of the clock's* going deduced from the equal altitudes.

		′	″	Daily gain. ′	″
May 4th.	Clock too faſt mean time	3	23		
5th.	do.	3	34	0	11
6th.	do.	3	51	0	17
7th.	do.	4	6	0	15

The clock was 4′ 5″ too faſt mean time when the obſervations on the tranſit of ☿ were made, and the equation of time 3′ 44″ additive to the mean time, the difference therefore between 4′ 5″ and 3′ 44″ being deducted from the obſervations will give the apparent times.

A Lunar obſervation made near the mouth of the Chattahocha.

It was my original intention to have taken charts of the ſouthern parts of all the rivers interſected by the 31ſt degree of N. lat. and falling into the gulf of Mexico between the Miſſiſſippi, and St. Marks: But having no buſineſs up or down the Paſkagola, (which is a large river and navigable for boats of burden many miles above the boundary), it was omitted.—The Chattahocha, or as it is ſometimes called the Appalachicola, is a river of more importance than the former, and a map of it from the boundary to its mouth was a deſirable object; but owing to the precipitate manner we had to leave the country in conſequence of the hoſtile diſpoſition of the Indians, and deſcending the river partly in the night, it was impoſſible to take a ſketch of it with any tolerable degree of accuracy.—About 4 minutes of a degree north of the entrance of its weſtern branch into St. George's Sound, I found the latitude to be about 29° 46′ 51″ N.—At the ſame place

Dd 2 on

* The clock was well faſtened to a poſt ſet 3½ feet in the ground, but being neither covered, nor ſurrounded by any building, and ſeveral hundreds of Indians in our camp, ſome individuals of whom were frequently leaning againſt the poſt, (though admoniſhed to the contrary), which circumſtance might produce a ſmall irregularity in the going of the regulator.

on the bank of the weſtern branch, the following obſervations were made to determine the longitude.

	Watch Nº 1.	Watch Nº 2.	Double alt. ⊙'s upper limb.	
1799.	d h ′ ″	d h ′ ″	° ′ ″	
Sept.	22 20 23 17	22 20 23 38	61 3 0	
	22 20 23 46	22 20 24 8	61 47 10	
	22 20 24 11	22 20 24 33	61 57 30	Error of Sextant add 10″.
	22 20 24 49	22 20 25 11	62 12 40	
	22 20 25 19	22 20 25 41	62 24 40	
	22 20 26 19	22 20 26 42	62 49 50	
Means	22 20 24 37	22 20 24 59	62 2 28	

The obſerved times, and diſtances of the ⊙'s and ☽'s neareſt limbs.

			Diſt. of the limbs.	
	d h ′ ″	d h ′ ″	° ′ ″	
	22 21 0 8	22 21 0 34	74 45 0	
	22 21 0 43	22 21 1 9	74 44 30	
	22 21 1 24	22 21 1 49	74 44 30	
	22 21 1 57	22 21 2 23	74 44 20	Error of Sextant add 10″.
	22 21 3 20	22 21 3 49	74 44 0	
	22 21 4 13	22 21 4 40	74 43 50	
	22 21 4 38	22 21 5 6	74 43 40	
Means	22 21 2 20	22 21 2 47	74 44 16	

	Watch Nº 1.	Watch Nº 2.	Double alt. ⊙'s upper limb.	
	d h ′ ″	d h ′ ″	° ′ ″	
	22 21 7 58	22 21 8 26	79 14 0	
	22 21 8 35	22 21 9 3	79 27 30	Error of Sextant add 10″.
	22 21 9 8	22 21 9 37	79 40 30	
	22 21 10 1	22 21 10 30	80 1 0	
Means	22 21 8 55	22 21 9 24	79 35 45	

The firſt and third ſets of obſervations were made to determine the error of the watches and their rate of going. By the firſt ſet of obſervations watch Nº. 1 appeared to be too ſlow 13″ and Nº. 2 too faſt 9″. By the third ſet made about 44½ minutes after the firſt, the watch Nº. 1 was too ſlow 23″ and Nº. 2 too faſt 6″—hence Nº. 1 loſt 10″ in 44½ minutes and Nº. 2 loſt 3″ nearly in ſame time. The errors of the watches reduced to the time of the lunar obſervation and applied to it will give 22ᵈ 21ʰ 2′ 41″ for

for the correct apparent time. The longitude of the place of observation was estimated at $5^h\ 39'$ west from Greenwich. From the latitude of the place, the apparent time of the observation, and the estimated longitude, the true altitude of the ☽'s centre comes out $64^\circ\ 53'\ 52''$ and that of the ☉'s $38^\circ\ 14'\ 50''$—from which the longitude will be had as follows:

	° ′ ″		
☽'s true altitude	64 53 52		
☉'s do.	38 14 50		
Difference true altitudes	26 39 2		
☽'s apparent altitude	64 29 58		
☉'s do.	38 15 56		
Difference apparent altitudes	26 14 2		
Apparent dist. ☽'s and ☉'s centres	75 16 4		
Sum	101 30 6		
Difference	49 2 2		
½ Sum	50 45 3	S	9.8889664
½ Difference	24 31 1	S	9.6180087
☽'s apparent altitude	64 29 58 co. or	c. S	0.3660068
☽'s true altitude	64 53 52	S	9.6276060
☉'s apparent altitude	38 15 56 co. or	c. S	0.1050480
☉'s true altitude	38 14 50	S	9.8950616
			2)39.5006975
Difference true altitudes	26 39 2		19.7503487
½ Difference true altitudes	13 19 31	S	9.3626315
	67 43 46	T^t	10.3877172
	67 43 46	c. S	9.5786170
	37 27 22.5	S	9.7840145
	2		
True distance	74 54 45.0		
Dist. at Greenwich at noon the 23^d 0^h	76 14 17		
Do. 23 3	74 45 57		
Difference between the 1st and 2d	1 19 32	P. L.	3547
Do. between the 2d and 3d	1 28 20	P. L.	3091
			$0456 = 2^h\ 42'\ 4''$

which

which added to 23 days will give for the time at Greenwich	23^d 2^h 42′ 4″
from which deduct the apparent time of the obſervation	22 21 2 41
Longitude of the place of obſervation weſt . .	0 5 39 23

The above determination of the geographical poſition of the place of obſervation, is probably as correct, if not more ſo, than in our beſt charts. From this example it may be ſeen with what eaſe, both the latitudes, and longitudes of places may be determined on land for common geographical purpoſes with a good ſextant, a well made watch with ſeconds, and the artificial horizon, the whole of which may be packed up in a box of 12 inches in length, 8 in width, and 4 in depth.

This paper being now carried to the length intended, and embracing the objects propoſed, I have only to add that

I am with ſincere eſteem,

Your friend, &c.

ANDW. ELLICOTT.

Mr. ROBERT PATTERSON,
V. P. American Philoſophical Society.

No.

No. XXI.

Aſtronomical, and Thermometrical Obſervations, made on the Boundary between the United States and His Catholic Majeſty. By ANDREW ELLICOTT.

Philadelphia, Sept. 23d, 1800.

DEAR SIR,

IT is with real pleaſure, that I embrace this opportunity of preſenting through you to the American Philoſophical Society the following aſtronomical and miſcellaneous obſervations, made on the boundary between the United States, and His Catholic Majeſty.

So far as this addreſs can be conſidered as a mark of reſpect, you are entitled to it from the ſervices you have rendered this country, in the uniform attention, and the judicious manner, in which you have diſcharged the laborious duties, of profeſſor of the mathematicks in the univerſity of Pennſylvania: But excluſive of this, you are entitled to it from me in a more particular manner, as the preceptor of my youth, and at all times ſince, my diſintereſted friend.

I feel a confidence that any errors, or inaccuracies, which may be found in the following work, will not only meet with your indulgence, but with that of every other perſon of ſcience, acquainted with the difficulties under which I laboured.—To William Dunbar, Eſq. of the Miſſiſſippi Territory I feel myſelf under the greateſt obligations, for his aſſiſtance during the ſhort time he was with us; his extenſive ſcientific acquirements, added to a ſingular facility in making mathematical calculations, would have reduced my labour, to a mere amuſement, if he had continued.—To my aſſiſtants Meſſrs. Gilleſpie, Ellicott, junr. and Walker, the former of whom acted as ſurveyor,

veyor, I have likewiſe to acknowledge my obligations, for the promptitude with which they executed the orders, they received, and the aid they gave me in making the obſervations.

An Account of the Apparatus uſed on the Boundary between the United States and His Catholic Majeſty.

On behalf of the United States we had,

1ſtly, One zenith ſector of nearly ſix feet radius ſimilar to the one made by Mr. Graham for Dr. Bradley and Mr. Molyneux, with which the aberration of the ſtars, and nutation of the earth's axis were diſcovered, and the quantities determined.

2dly, Another zenith ſector of 19 inches radius to be uſed when the utmoſt accuracy was not neceſſary, and where the tranſportation of the large one could not be effected without great expenſe and difficulty. Theſe inſtruments were principally executed by my late worthy, and ingenious friend Mr. Rittenhouſe, except ſome additions which I have made myſelf. The plumb lines of both ſectors are ſuſpended from a notch above the axis of the inſtruments, in the manner deſcribed by the Rev. Dr. Maſkelyne the preſent Aſtronomer Royal at Greenwich, in the introduction to the firſt volume of his Aſtronomical Obſervations. A particular deſcription of thoſe inſtruments is rendered unneceſſary, by being accurately done in a number of ſcientific works, particularly by M. de Maupertuis in his account of the meaſurement of a degree of the meridian under the arctic circle. The ſector is of all inſtruments the beſt calculated for meaſuring zenith diſtances which come within its arch. The large

large one above mentioned extends to 5 degrees north, and ſouth of the zenith, and the ſmall one to between 8 and 9 degrees. Stars when ſo near the zenith are inſenſibly affected by the different refractive powers of the atmoſphere ariſing from its different degrees of denſity, add to this that the error of the viſual axis is completely corrected by taking the zenith diſtances of the ſtars with the plane, or face of the inſtrument both eaſt and weſt.

3dly. A large acromatic teleſcope made by Mr. Dolland of London, which excluſive of a terreſtrial eye piece which magnifies about 60 times has three other eye pieces for celeſtial purpoſes, the magnifying powers are 120, 200, and 300, the firſt I generally uſed. This inſtrument for producing a well defined clear image is exceeded but by few reflectors.

4thly. A tranſit and equal altitude inſtrument, which I conſtructed and executed in the year 1789, and uſed in running the weſtern boundary of the ſtate of New York, and afterwards in running the boundaries of the diſtrict of Columbia, and the principal avenues in the city of Waſhington. It is mentioned in the 4th Vol. of the Tranſactions of the American Philoſophical Society, No. 6. page 49.

5thly. Two acromatic teleſcopes for taking ſignals with ſliding tubes, one of them drew out to upwards of 4 feet, and the other to about 15 inches,—the latter for its length is remarkably good, it ſhews the ſatellites of Jupiter very diſtinctly.

6thly. A regulator which I executed in the year 1784.

7thly. An inſtrument of 8 inches radius for taking horizontal angles, made by the late Mr. George Adams of London, and ſimilar to the one deſcribed by M. de Maupertuis in the work already mentioned.

8thly. Three braſs ſextants; one of them executed by Mr. Ramſden in a ſuperior ſtyle. It is 7 inches radius, and by the vernier divides to 20 ſeconds, which may be again ſubdivided with eaſe by the eye, aided with the microſcope. This ſextant I uſed in taking all the lunar diſtances.

9thly. A ſurveying compaſs made by Mr. Benjamin Rittenhouſe upon the neweſt, and moſt approved plan.

10thly. Two excellent ſtop watches, with ſecond hands, to be uſed if any accident ſhould happen to the regulator, or at places to which it could not be taken.

11thly. Two excellent caſes of drawing, and plotting inſtruments.

12thly. Two copper lanterns to be uſed in tracing meridians, and giving the direction of lines when determined in the night by celeſtial obſervation. Thoſe lanterns had four ſides, each ſide about $4\frac{1}{2}$ inches wide, and 8 inches high: in the front of each is a ſlit, or aperture of about 5 inches in length, and 3 tenths of an inch in breadth; through which a lighted candle is to be ſeen in the night. To render this ſlit, or aperture more conſpicuous in day-light, a ſlip of white paper was ſometimes faſtened to the copper on each ſide of it, and at others a piece of white paper was placed behind the lantern, which rendered the aperture very diſtinct, when the door which is on the oppoſite ſide to the aperture was opened. L. L. L. Plate V. are different views of the lanterns.

13thly. An apparatus to ſecure the water in uſing the artificial horizon againſt the effects of the wind: As an accurate knowledge of the time, is of the utmoſt conſequence in aſtronomy, it is abſolutely neceſſary that the obſervations for that purpoſe be made with certainty. On this account I ſhall be more particular in deſcribing the method I have purſued for fifteen years, without finding it liable to any objection of weight. It is well known that equal altitudes of the ſun, or ſtars, afford the readieſt method of obtaining the time for occaſional purpoſes, and at land thoſe equal altitudes muſt be taken from an artificial horizon if a quadrant, or ſextant be uſed. It is therefore

therefore neceſſary that the water, or any other fluid made uſe of ſhould be entirely free from any undulation both fore, and afternoon, when the obſervations are made, which will not be the caſe if the ſurface is expoſed even to a very light breeze, to effect this purpoſe I have made uſe of the following apparatus, viz.

Plate V. Fig. 1. repreſents a tin cup, about 2 inches deep, 5 inches long, and 3 wide; it is well to have the bottom made heavy by fitting ſome lead in it. This cup is to be filled with water and the wind kept from it by covering it with the roof (Fig. 2.) the ends, and lower parts of which are made of tin, and the principal part of the ſides, or inclined planes are of talc or iſinglaſs; which ſhould be of a good quality, and rendered ſufficiently thin by ſeparating, and taking off a number of laminæ with the point of a penknife. The lower part of the roof ſhould be ſo conſtructed, as to go down into the cup about 3 tenths of an inch. The degree of inclination of the planes, forming the two ſides of the roof is of little importance. The planes of the one I have always uſed ſtand nearly at right angles to each other. The lower part of the roof ſhould go eaſily into the cup, becauſe it ſometimes happens that the evaporation from the water, will be ſo abundant as to cover the iſinglaſs, and render the image of the ſun which is reflected from the water obſcure: In that caſe the roof muſt be removed a few ſeconds of time, and the particles of water on the iſinglaſs will diſappear. As the iſinglaſs when properly reduced will be very thin, and conſequently tender and delicate, it is neceſſary that it ſhould be defended againſt accidents when not in uſe, for this purpoſe a caſe of tin ſuch as repreſented by Fig. 3. will be found convenient. The equal altitudes in the following work, with a few exceptions, were taken with ſextants, ſometimes by three perſons following each other as quick as poſſible, the

 corresponding

correſponding forenoon, and afternoon obſervations, were added up in ſeparate ſums, and divided by the number of terms for the means, by which they were reduced to a ſingle expreſſion, as entered in the journal or diary. The three ſextants gave nine obſervations, and it frequently happened that the extremes of the nine obſervations, did not differ more than 1 or 1½ ſeconds. After the forenoon obſervations were made, the ſextants were carefully laid away, care being taken not to touch the indexes till the afternoon obſervations were completed.

14thly. Two two-pole chains of the common conſtruction.

The apparatus on the Spaniſh ſide was much leſs conſiderable: It conſiſted of the following inſtruments.

1ſt. An excellent ſextant, which graduated by the vernier to 10 ſeconds: It was preſented by William Dunbar, Eſq. to Governor Gayoſo, after my arrival in that country.

2dly. An aſtronomical circle executed by Mr. Traughton of London, for the above mentioned William Dunbar, and ſold by him to Governor Gayoſo to be uſed on the boundary. This inſtrument is in itſelf a portable obſervatory, and executed in a maſterly manner;—the different circles are by the vernier divided into 5 ſeconds, and may very eaſily by the eye, aided with the microſcope be again ſubdivided. The graduations appear to be perfect, ſo far as human dexterity extends. This inſtrument was ſent away a few days before the Indians made an attack upon us at the mouth of Flint River.

3dly. An old ſurveying compaſs very ſlightly made, and was for a ſhort time accommodated with a wooden ſight, which was done (with conſiderable dexterity) by Mr. Patrick Taggert, a deputy ſurveyor on the Spaniſh ſide, who was very uſeful in every ſtage of the buſineſs.

Obſervations

Obſervations made with the ſix-feet Zenith Sector on Union Hill near the Miſſiſſippi river, for determining the firſt point in the boundary between the United States, and His Catholic Majeſty's provinces of Eaſt and Weſt Floridas.

Face of the Sector Weſt.

1798.			°	′	″	
May 6th.	Obſerved zenith diſtance of	α Andromedæ	3	2	11	S.
	do.	Caſtor	1	18	33.5	N.
	do.	Pollux	2	30	19	S.
7th.	do.	α Andromedæ	3	2	12.8	S.
	do.	Caſtor	1	18	33.3	N.
	do.	Pollux	2	30	19.5	S.
	do.	β Pegaſi	4	1	15	S.
8th.	do.	α Andromedæ	3	2	12.6	S.
	do.	Pollux	2	30	18.6	S.
	do.	β Pegaſi	4	1	13.5	S.
	do.	α Coro. Borealis	3	36	28.8	S.
9th.	do.	Caſtor	1	18	33.2	N.
	do.	β Pegaſi	4	1	16.3	S.
	do.	α Coro. Borealis	3	36	26.2	S.

Face of the Sector Eaſt

			°	′	″	
10th.	Obſerved zenith diſtance of	β Pegaſi	3	59	37.5	S.
11th.	do.	α Coro. Borealis	3	34	44	S.
12th.	do.	α Andromedæ	3	0	32	S.
	do.	Caſtor	1	20	10	N.
	do.	Pollux	2	28	38	S.
	do.	α Coro. Borealis	3	34	46	S.
13th.	do.	α Andromedæ	3	0	31	S.
	do.	Caſtor	1	20	8.8	N.
	do.	Pollux	2	28	38	S.
	do.	β Pegaſi	3	59	40.5	N.
14th.	do.	α Andromedæ	3	0	34	S.
	do.	α Coro. Borealis	3	34	47	S.
15th.	do.	α Andromedæ	3	0	35	S.
	do.	Caſtor	1	20	12	N.
	do.	Pollux	2	28	40	S.
16th.	do.	β Pegaſi	3	59	40	S.

Reſult

Refult of the foregoing Obfervations.

Face of the Sector Weft.

The foregoing Obferved Zenith Diftances when arranged ftand as below.

1798.	α Andromedæ. ° ′ ″	Caftor. ° ′ ″	Pollux. ° ′ ″	β Pegafi. ° ′ ″	α Coro. Borealis. ° ′ ″
May 6th.	3 2 11 S.	1 18 33.5 N.	2 30 19 S.	....	....
7th.	3 2 12.8	1 18 33.3	2 30 19.5	4 1 15 S.	....
8th.	3 2 12.6	....	2 30 18.6	4 1 13.5	3 36 28.8 S.
9th.	....	1 18 33.2	....	4 1 16.3	3 36 26.2
Means	3 2 12.1 S	1 18 33.3 N.	2 30 19.1 S.	4 1 14.9 S.	3 36 27.5 S.
Face of the Sector Eaft.					
10th.	....	....	....	3 59 37.5 S.	....
11th.	....	....	....	....	3 34 44 S.
12th.	3 0 32 S.	1 20 10 N.	2 28 38 S.	....	3 34 46
13th.	3 0 31	1 20 8.8	2 28 38	3 59 40.5	....
14th.	3 0 34	....	....	....	3 34 47
15th.	3 0 35	1 20 12	2 28 40	....	....
16th.	....	....	....	3 59 40	....
Means	3 0 33 S.	1 20 10.3 N.	2 28 38.7 S.	3 59 39.3 S.	3 34 45.7 S.
Means face of the Sector weft	3 2 12.1 S.	1 18 33.3 N.	2 30 19.1 S.	4 1 14.9 S.	3 36 27.5 S.
Correct obferved zenith diftances	3 1 22.5 S.	1 19 21.8 N.	2 29 28.9 S.	4 0 27.1 S.	3 35 36.6 S.
Refractions	+ 3.0	+ 1.3	+ 2.5	+ 4	+ 3.5
True zenith diftances	3 1 25.5 S.	1 19 23.1 N.	2 29 31.4 S.	4 0 31.1 S.	3 35 40.1 S.
Mean declination, on the 10th May	27 58 38 N.	32 18 54.4 N.	28 30 1.6 N.	26 59 26.5 N.	27 24 8.2 N.
Aberrations	— 13.2	+ 4.4	+ 3.5	— 12.7	— 4.4
Nutations	— 4.1	+ 8.7	+ 8.7	— 6.1	+ 0.8
Semi. ann. equations	— 0.5	....	....	— 0.5	+ 0.4
True declinations	27 58 20.2 N.	32 19 7.5 N.	28 30 13.8 N.	26 59 7.2 N.	27 24 5 N.
True zenith diftances applied	+3 1 25.5 S.	−1 19 23.1 N.	+2 29 31.4 S.	+4 0 31.1 S.	+3 35 40.1 S.
Latitudes	30 59 45.7 N.	30 59 44.4 N.	30 59 45.2 N.	30 59 38.3 N.	30 59 45.1 N.

Latitude

		°	′	″
Latitude by	α Andromedæ .	30	59	45.7
do. .	Caſtor . . .	30	59	44.4
do. .	Pollux . .	30	59	45.2
do. .	β Pegaſi . .	30	59	38.3
do. .	α Coro. Borealis .	30	59	45.1
Mean Latitude north	. . .	30	59	43.74

From the reſult of the above obſervations it appears that the obſervatory was 16″.26 or about one thouſand, ſix hundred and forty-four feet and eight-tenths of a foot Engliſh meaſure too far ſouth, which diſtance was laid off to the north on a meridional line drawn from the obſervatory O to the point A, (ſee Plate V. Fig 4.). The point A is in a deep hollow, or chaſm. —From the point A a viſta was opened both to the eaſt and weſt, and as near at right angles to the meridian as poſſible: but the point A being too low for doing it with certainty, the elevated poſition B eaſt from A, and diſtant thirty-four perches, was pitched upon as the moſt proper place for commencing our operations. The tranſit inſtrument was accordingly put up at B, and the perpendicular or vertical fibre of the teleſcope, was brought to deſcribe the prime vertical by taking equal altitudes of Arcturus. —This was effected in the following manner: a piece of timber T, flatted on the upper ſide, was placed at the point C, diſtant from B ſeventy-one perches, and at right angles to the viſta; on this piece of timber at U, one of the copper lanterns already deſcribed was placed on the 18th in the afternoon; the tranſit inſtrument being previouſly adjuſted, and the vertical fibre which was a ſingle thread of ſpider's web, being brought to biſect the aperture in the front of the lantern.—A few minutes before the ſtar in its aſcent was expected to appear in the field of the teleſcope, it was elevated about forty-one and an half degrees: immediately upon the ſtar's making its appearance, the horizontal fibre of the teleſcope was brought to biſect it, and kept upon it by gradually elevating the inſtrument until the ſtar arrived at the interſection of the fibres, at that inſtant the elevating arc was faſtened, and afterwards the clamp of the perpendicular axis was looſened. On the morning of the 19th, the level of the inſtrument was carefully examined and adjuſted. A ſhort time before the ſtar was expected to appear in the field of the teleſcope, in its deſcent, the teleſcope was directed weſt: as ſoon as the ſtar appeared in the field, the clamp was faſtened and the vertical fibre brought to biſect the ſtar, and kept upon it by the ſcrews which direct the arm of the clamp until it arrived at the interſection of the fibres.—The elevating arc was then looſened, and the teleſcope taken out of the Y's and reverſed; a lighted candle having been previouſly put into another lantern ſimilar to the firſt, and placed on the ſame piece of timber. The aperture of the ſecond lantern was brought into the direction of the vertical fibre (which ſuppoſe to be at *n*) by an aſſiſtant at C, who received the neceſſary ſignals for that purpoſe from the obſerver at B.—In the forenoon of the ſame day the diſtance between the apertures of the two lanterns was carefully biſected, which

which ſuppoſe to be at S. The firſt lantern was then removed and the aperture brought to coincide with the point of biſection. In the afternoon of the ſame day, the vertical fibre of the teleſcope being brought to biſect the aperture of the lantern at S, Arcturus was again obſerved in its aſcent, and the morning following in its deſcent.—The inſtrument was reverſed as in the firſt caſe, and the aperture of the ſecond lantern which was now put on the flatted piece of timber V, placed about 18 inches below the firſt, and brought truly into the direction of the vertical fibre by an aſſiſtant.—The candle in the firſt lantern at S was then lighted, and the flames of both were biſected by the vertical fibre. Being by this obſervation convinced, that the teleſcope moved accurately in the prime vertical, the line was then opened weſt with that direction, the diſtance of two hundred and thirty-five perches to high water mark: as the inſtrument then deſcribed the prime vertical, the offset into the parallel of latitude, (which became a tangent to the arc), was laid off to the north, being two and an half inches, where a hewn poſt was ſet up and ſurrounded by a mound of earth.—At S, the tangent of an angle of 2′ 36″ 45‴ having BC for its baſe was laid off to the north by meaſuring from the middle of the aperture of the lantern, the diſtance of 10.68 inches, at the termination which ſuppoſe to be at *r*, a fine mark was placed, which the verticle fibre was brought to biſect.—This mark gave the direction of an arc, which continued the diſtance of ten miles, would again interſect the parallel of latitude, which would then become a chord to the arc, and the offsets be to the ſouth, and fall within the viſta we were opening: by taking ſo ſmall an arc, the trouble and expence of opening two lines through one of the moſt impenetrable countries in the world was avoided.

	Ft.	In.	
At the termination of the firſt mile which was 85 perches eaſt of the tranſit ſtation at B an offset of	1	0	was laid off to the ſouth.
At the termination of the ſecond mile	4	5	do.
do. of the third	7	0	do.
do. of the fourth	8	9	do.
do. of the fifth	9	9	do.
do. of the ſixth	9	11	do.
do. of the ſeventh	9	4	do.
do. of the eighth	8	8	do.
do. of the ninth	5	9	do.
do. of the tenth	2	9	do.

On the 17th of July, we moved our camp to Big Bayou Sara, about 37″ north of the parallel of 31° and 9.6 perches eaſt of the ten mile poſt. On the 19th ſet up the clock, and prepared to obſerve ſuch of the eclipſes of ♃'s ſatellites as ſhould be viſible while we continued at that ſtation.

Aug.


No. 1
Fig. 1.
The cup with the roof on it
Fig. 2.
Fig. 3.
L
L
L
O Union Hill.
Engrav'd by B. Jones.

[illegible]

Aug. 2d. *Equal altitudes of the Sun.**
A. M. 8^h 9′ 35″. P. M. 3^h 46′ 56″.

Prepared to observe an immersion of the 1st satellite of ♃.—At 13^h 43′ a small cloud began to obscure the moon, but ♃ and his satellites continued very bright till about 13^h 44′ 26″ when the 1st satellite began to lose its lustre; At 13^h 44′ 35″ the cloud which appeared over the moon, extended itself almost instantaneously over the whole hemisphere, and obscured the stars and planets.

5th. *Equal altitudes of the Sun.*
A. M. 8^h 6′ 41″. P. M. 3^h 48′ 19″.

8th. *Equal altitudes of the Sun.*
A. M. 7^h 57′ 19″. P. M. 3^h 56′ 2″.

9th. *Emersion* of the 2d satellite of ♃ observed at 13^h 13′ 9″. The planet and his satellites middling bright. Magnifying power of the telescope 120.

On the 6th and 9th of this month, at the distance of 9 miles and ninety perches from the first transit station B, and distant from the point D Plate VI. 10 miles and 5 perches, equal altitudes of α Delphini were taken in the same manner, as already related with Arcturus, to determine the direction of our arc, which on a base of 212.5 perches, was 31 inches south of the prime vertical, which is equal to an angle of 2′ 31″ 6‴.—This angle ought to have been but 2′ 13″ 59‴, the difference 0′ 17″ 7‴ was therefore the error of the arc to the south. Now suppose this error to have been gradually accumulating, which is very probable, it would at the distance of 9 miles and 90 perches, (the space between the transit stations), have carried the arc about 2 feet too far to the south: But the transit at the distance of 9 miles and 90 perches from the first station, ought to have been 2 feet and 7 inches north of the parallel, the difference therefore of 7 inches is the distance of the transit to the north of the parallel at its second station, and which is included in the offsets for the second arc to the termination of 18 miles, and 118 perches from the point D.—On the 9th another arc for 10 miles was laid off, making an angle of 2′ 36″ 45‴ with the prime vertical. The base was 212.5 perches east, and the perpendicular 32 inches north from the aperture of the lantern.

12th. *Equal altitudes of the Sun.*
A. M. 8^h 6′ 48″. P. M. 3^h 47′ 7″.

* The equal altitudes of the sun, and his passage over the meridian with the thermometrical observations when they occur, are entered according to the civil account, the others according to the mode of astronomers.

15th. *Equal altitudes of the Sun.*
A. M. 8^h 32′ 55″ P. M. 3^h 15′ 55″

16th. *Immersion* of the 2d satellite of ♃ observed at } 13^h 22′ 45″
Emersion . do. . . . 15 48 16
The night clear, Belts distinct, magnifying power 120.

17th. *Equal altitudes of the Sun.*
A. M. 8^h 14′ 57″ P. M. 3^h 32′ 27″

23d. *Equal altitudes of the Sun.*
A. M. 8^h 23′ 8″. P. M. 3^h 19′ 54″.

Immersion of the 2d satellite of ♃ observed at 15^h 58′ 25″.
Belts distinct, magnifying power 120.

30th. *Equal altitudes of the Sun.*
A. M. 8^h 22′ 40″. P. M. 3^h 14′ 34″.

31st. Clock ran down in the morning, wound it up and set it a-going; and took the following

Equal altitudes of the Sun.
A. M. 9^h 42′ 22.5″. P. M. 2^h 26′ 11″.

Sept. 1st. *Equal altitudes of the Sun.*
A. M. 8^h 28′ 47″. P. M. 3^h 38′ 54″.

Immersion of the 1st satellite of ♃ observed at 15^h 58′ 50″.
Belts very distinct, magnifying power 120.

2d. *Equal altitudes of the Sun.*
A. M. 8^h 29′ 15″. P. M. 3^h 37′ 32″.

This was the last observation made at Bayou Sara.

Result

Refult of the equal altitudes of the Sun taken at Bayou Sara.

		′	″	Daily lofs. ″
Clock too flow mean time Aug.	2d.	7	28.3	
do.	5th.	7	57.6	9.8
do.	8th.	8	25.1	9.2
do.	12th.	9	1.7	9.1
do.	15th.	9	31.0	9.5
do.	17th.	9	49.4	9.2
do.	23d.	10	33 9	7.4
do.	30th.	11	27.5	7.7

Clock ran down early in the morning of the 31ft, wound it and fet it a-going.

		′	″	Daily lofs. ″
Clock too faft mean time Aug.	31ft.	4	30	
do. Sept.	1ft.	4	23.3	6.7
do.	2d.	4	15.7	7.6

Longitude deduced from the eclipfes of Jupiter's fatellites, obferevd at Bayou Sara.

				h	′	″	
Auguft	9th.	Emerfion of the 2d fatellite		6	3	17	Weft from Greenwich.
	16th.	Immerfion of	do.	6	3	3	
		Emerfion of	do.	6	3	58	
	23d.	Immerfion	do.	6	4	27	
Sept.	1ft.	Immerfion of the 1ft	do.	6	5	21	

When the firft point of latitude was determined on the Miffiffippi, the annual inundation prevented our approaching the banks of the river: But on the 28th of July, the waters having fubfided it was mutually agreed that William Dunbar, Efq. his Catholic Majefty's aftronomical commiffioner, fhould proceed to the point D at high water mark, and extend the line from that point to the eaftern bank of the river aforefaid, which he completed on the 18th of Auguft, and whofe report is in the following words.

" On the 28th of July, the line then approaching the 10th mile, and learning that the waters of the inundation were retired within the banks of the Miffiffippi, fo that the lands were become fufficiently dry to give firm footing to the labourers, the aftronomer for His Catholic Majefty taking upon himfelf the extending of the line through the river low ground to the eaftern margin of the Miffiffippi. The party allotted for this fervice did accordingly encamp at the point D, pufhing the line forward in continuation of the tangent commencing at the point B. Judging the prefent a convenient pofition for verifying the direction of the line, the aftronomer for His Catholic Majefty eftablifhed his obfervatory near the point D, and made the following obfervations with the circular inftrument* placed in the direction of the tangent, viz.

Ff 2 " On

* The aftronomical circle already mentioned.

"On the aſtronomical 15th of Auguſt were taken equal altitudes of the ſtar τ Pegaſi the eaſtern obſervatory* being made preciſely on the vertical arc correſponding to the line, and the ſecond to the weſtward being completed, and the circle with its teleſcope reverſed, the axis of the inſtrument was found to make an angle to the ſouth of 20″ with the lantern placed carefully in the direction of the line, and conſequently the direction of the line at the obſervatory is 10″ to the north of eaſt. The diſtance of the obſervatory from the point B is 3430 French feet,† therefore by calculation the line paſſing through the obſervatory makes an angle of 21″ 41‴ northerly with due eaſt: But by obſervation this angle is only 10′, hence it would appear that the line inclines too much to the ſouth by the quantity of 11″ 41‴, which in running 100 miles would cauſe a deviation of nearly 28 French feet. So ſmall a difference between the two ſets of obſervations may well ariſe from the imperfection of inſtruments, combined with the unavoidable errors of obſervation.

"The line being extended to the margin of the Miſſiſſippi on the 17th of Auguſt, the meaſurement from the point D was found to be 2 miles and 180 perches Engliſh meaſure, or 2111.42 French toiſes. At the diſtance of 1 and 2 miles at the points *x* and *y*, were erected ſquare poſts ſurrounded by mounds of earth, and at the diſtance of 88 French feet from the margin of the river, and in the parallel of latitude was erected a ſquare poſt 10 feet high ſurrounded by a mound of eight feet in height. On this poſt is inſcribed on the ſouth ſide a crown with the letter R underneath; on the north U. S. and the weſt fronting the river, Agoſto 18th, 1798. Lat. 31° N. In erecting the mile poſts, due regard was paid to the quantity of the offsets to the north of the tangent, and are by calculation as follows,

	Diſtance from the point B.						*Offsets*			*Offsets*		
	French Meaſure.			*Engliſh Meaſure.*			*Engliſh Meaſure*			*French Meaſure.*		
Mounds.	Toiſes.	Feet.	Tenths.	Miles.	Perches.	Feet.	Feet.	Inches.	Tenths.	Feet.	Inches.	Lines.
D	602	3.	2	0	234	0	0	2.6		0	2.5	
x	1426	2.	0	1	234	0	1	2.4		1	1.6	
y	2250	1.	8	2	234	0	2	11.86		2	9.7	
z	2690	0.	7	3	88	4	4	3.6		4	0.4"	

On Monday the 20th of Auguſt, the aſtronomer for His Catholic Majeſty returned with his party to camp at Bayou Sara.

On

* The point B.

† Mr. Dunbar's obſervatory, was a ſhort diſtance eaſt of the point D, which is at the foot of a ſteep hill.

On the first day of September following, William Dunbar, Esq. after making the foregoing report declined any further service and returned home.

Sept. 3d. Moved our camp to Thompson's creek, distant from the point D at high water mark 18.75 miles.

4th. Cleaned the clock, and set it up against the stump of a tree, which was left high, and prepared for that purpose.

7th. *Equal altitudes of the Sun.*

A. M. $8^h\ 25'\ 42''.5$. P. M. $3^h\ 33'\ 19''$.

8th. *Equal altitudes of the Sun.*

A. M. $8^h\ 18'\ 16''.5$ P. M. $3^h\ 40'\ 29''$.

9th. *Equal altitudes of the Sun.*

A. M. $8^h\ 22'\ 50''$. P. M. $3^h\ 35'\ 28''$.

10th. *Equal altitudes of the Sun.*

A. M. $8^h\ 21'\ 27''$. P. M. $3^h\ 36'\ 28''$.

Immersion of the 2d satellite of ♃ observed at $10^h\ 45'\ 8''$
do. . 1st. . do. . 12 19 11
The night remarkably fine, belts very distinct, magnifying power 120.

11th. *Equal altitudes of the Sun.*

A. M. $8^h\ 28'\ 9''$. P. M. $3^h\ 29'\ 20''$.

12th. *Equal altitudes of the Sun.*

A. M. $8^h\ 18'\ 12''$. P. M. $3^h\ 38'\ 45''$.

13th. *Equal altitudes of the Sun.*

A. M. $8^h\ 12'\ 38''.5$. P. M. $3^h\ 43'\ 51''$.

16th.

16th. *Equal altitudes of the Sun.*

A. M. $8^h\ 18'\ 13''.5$. P. M. $3^h\ 36'\ 44''.5$.

17th. *Equal altitudes of the Sun.*

A. M. $8^h\ 47'\ 33''$. P. M. $3^h\ 6'\ 57''.5$.

Immersion of the 2d satellite of ♃ observed at $13^h\ 23'\ 35''$
do. . 1st . do. . 14 14 1
Night clear, belts distinct, magnifying power 120.

19th. *Equal altitudes of the Sun.*

A. M. $9^h\ 3'\ 50''.5$. P. M. $2^h\ 49'\ 39''.5$

23d. *Equal altitudes of the Sun.*
A. M. $9^h\ 4'\ 3''$. P. M. $2^h\ 47'\ 37''$.

24th. *Equal altitudes of the Sun.*

A. M. $8^h\ 49'\ 57''$. P. M. $3^h\ 1'\ 23''.5$.

Immersion of the 2d satellite of ♃ observed at $16^h\ 2'\ 1''$
do. . 1st . do. . 16 8 40
Night clear, belts distinct, magnifying power 120.

25th. *Equal altitudes of the Sun.*

A. M. $8^h\ 46'\ 32''.5$. P. M. $3^h\ 4'\ 22''.5$.

26th. *Equal altitudes of the Sun.*
A. M. $8^h\ 44'\ 54''$. P. M. $3^h\ 5'\ 41''$.

Immersion of the 1st satellite of ♃ observed at $10^h\ 37'\ 10''$
do. . 3d . do. . 11 28 32
Emersion do. . do. . 13 15 40
Night fine, belts distinct, magnifying power 120.

The

The arc being now extended to the weſt ſide of Thompſon's creek, the following offsets into the parallel of latitude were laid off, viz.

				F.	In.	
At the termination of the		11th mile	an offset of	4	2	to the ſouth.
do.	.	12	do.	6	11	do.
do.	.	13	do.	8	11	do.
do.	.	14	do.	10	2	do.
do.	.	15	do.	10	7	do.
do.	.	16	do.	10	3	do.
do.	.	17	do.	9	0	do.
do.	.	18	do.	7	0	do.

Took equal altitudes of τ Pegaſi, to determine the direction of our arc, which at the diſtance of 206 perches eaſt from the tranſit, was 19.35 inches ſouth of the prime vertical, which ſubtends an angle of 1′ 40″ 48‴. The tranſit was 8 miles and 118 perches eaſt from its ſecond ſtation, which diſtance ſhould have given an angle of 1′ 44″ 52‴, hence it appears, that the arc was directed too far north by 4″ 4‴ on a ſuppoſition that this was gradually accumulating, the tranſit was too far north by 6.8 inches, which is accounted for in the offsets for the 19th, 20th, and 21ſt miles.

27th. Re-examined the direction of our arc by taking equal altitudes of the ſame ſtar, the coincidence was leſs than $1\frac{1}{2}''$ which was probably occaſioned by an imperfection inſeparable from obſervations: this ſmall difference was biſected and the diſtance of 20.8 inches was laid off from the point of biſection to the ſouth, and the arc continued through its termination as in the former caſes.

29th. Clock ran down in the night.

30th. Wound up the clock and ſet it a-going.

Oct. 7th. *Equal altitudes of the Sun.*
A. M. 8^h 36′ 1″. P. M. 3^h 21′ 44″.

19th. *Equal altitudes of the Sun.*
A. M. 8^h 27′ 29″. P. M. 3^h 27′ 50″.

Immerſion of the 1ſt ſatellite of ♃ observed at 10^h 55′ 31″
do. . 2d . do. . 13 21 15
Night very fine, belts diſtinct, magnifying power 120.

20th.

20th. *Equal altitudes of the Sun.*

	h	′	″		h	′	″
A. M.	9	30	6.5.	P. M.	2	25	5.

End of the aſtronomical obſervations made at Thompſon's creek.

The following offsets complete the work done with the Tranſit inſtrument, viz.

		F.	In.	
At the termination of the	19th mile an offset of	4	3	was laid off to the S.
do.	20 do.	1	2	do.
do.	21 do.	3	1	to the North.

Reſult of the equal altitudes of the Sun taken at Thompſon's creek.

		′	″	Daily gain. ″
Clock too faſt mean time Sept.	7th.	2	1.8	doubtful 13.0
do.	8th.	2	14.8	6.5
do.	9th.	2	21.3	8.8
do.	10th.	2	30.1	7.8
do.	11th.	2	37.9	4.7
do.	12th.	2	42.6	7.4
do.	13th.	2	50.0	5.7
do.	16th.	3	7.2	7.0
do.	17th.	3	14.2	5.9
do.	19th.	3	26.1	7.1
do.	23d.	3	54.7	11.1
do.	24th.	4	5.8*	8.4
do.	25th.	4	13.2	11.7
do.	26th.	4	24.9	

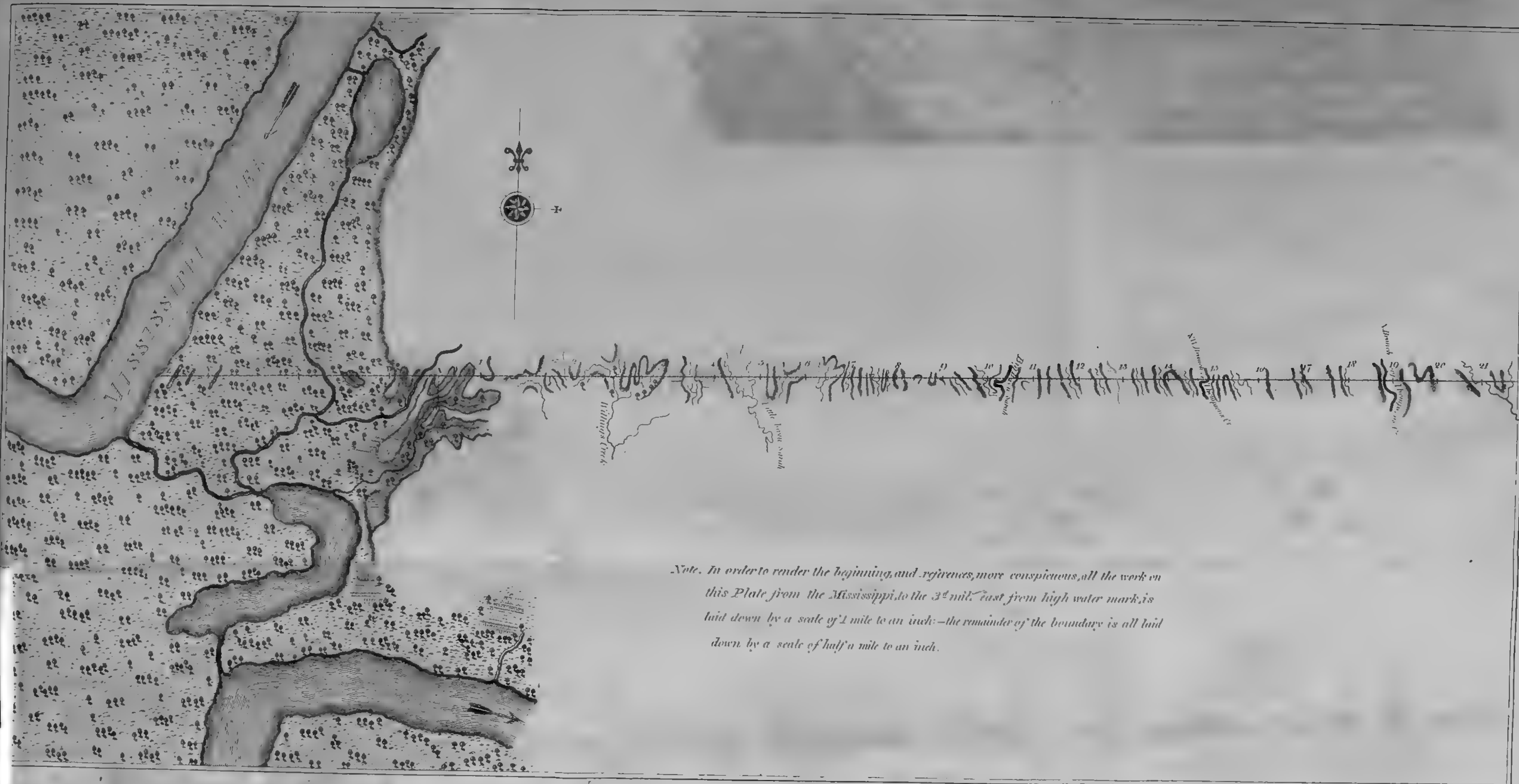
Clock ran down on the 29th, was ſet a-going on the 30th.

		′	″	Daily gain. ″
Clock too faſt mean time Oct.	6th.	11	14.1	9.3
do.	7th.	11	23.4	7.5
do.	19th.	12	53	5.5
do.	20th.	12	58.5	

Longitude

* The night preceding this obſervation, the tent in which the clock was placed was blown down and lodged on the clock till morning, when it was removed.

No 2


Mississippi River
Willings Creek
Note. In order to render the beginning, and references, more conspicuous, all the work on this Plate from the Mississippi, to the 3d mile east from high water mark, is laid down by a scale of 1 mile to an inch:—the remainder of the boundary is all laid down by a scale of half a mile to an inch.

Longitude deduced from the eclipses of ♃'s satellites observed at Thomson's Creek.

		h	′	″	
Sept. 10th.	*Immersion* of the 2d satellite	6	4	14	Longitude west from Greenwich.
	do. . 1st do.	6	5	8	
17th.	do. . 2d do.	6	3	58	
	do. . 1st do.	6	4	45	
24th.	do. . 2d do.	6	3	50	
	do. . 1st do.	6	4	37	
26th.	do. . 1st do.	6	4	41	
	do. . 3d do. {by de Lambre's Tables.}	6	3	4	
	Emersion . do. do. do.	6	6	48	
Oct. 19th.	*Immersion* . 1st do.	6	4	49	
	do. . 2d do.	6	4	52	

At the end of the 21st mile in the line, the land became of a more inferior quality, from which we concluded to pursue a less scientific but a more expeditious method, until the goodness of the soil would justify a greater degree of accuracy: Agreeably to this conclusion, we had a line traced east with a surveying compass, from the end of the 21st mile, from high water mark on the Mississippi, to the east side of Pearl or Half-way river, the distance being 85 miles and 194 perches, at the end of which the following observations were made.

Nov. 19th. Put up the clock and set it to apparent time nearly.

20th. *Equal altitudes of the Sun.*
A. M. 9^h 22′ 40″. P. M. 2^h 37′ 30″.

Emersion of the 1st satellite of ♃ observed at 9^h 43′ 30″. —Belts distinct, magnifying power 120.

21st. *Equal altitudes of the Sun.*
A. M. 9^h 33′ 19″. P. M. 2^h 27′ 6″.

22d. *Equal altitudes of the Sun.*
A. M. 9^h 38′ 34″. P. M. 2^h 22′ 9″.

Obſervations on a Lunar Eclipſe.

At 17^h 10′ the ☽'s limb entered the penumbra, but was not indented till 17^h 11′ 34″.—The earth's ſhadow was not well defined, and the atmoſphere ſmoky.—The ☽ was obſcured by clouds at 17^h 25′.—Magnifying power of the teleſcope about 60.

25th. *Equal altitudes of the Sun.*
A. M. 9^h 34′ 39″. P. M. 2^h 27′ 19″.

28th. *Equal altitudes of the Sun.*
A. M. 9^h 18′ 42″. P. M. 2^h 44′ 55″.

30th. *Equal altitudes of the Sun.*
A. M. 9^h 17′ 11″. P. M. 2^h 44′ 18″.

The ſmall zenith ſector arrived, which we agreed to uſe for the determination of this point in the line.—The large one having been ſent by water by the way of New-Orleans, and we were uncertain when it would come to hand.

Thermometer 84°.

Dec. 1ſt. Poliſhed the reflectors of the eye-piece, of the teleſcope of the ſmall zenith ſector, and ſet it up

With the face to the Weſt.

Cloudy.—Thermometer 60° at ſun riſe, roſe to 83°.

2d. Cloudy.—Thermometer 64° at ſun riſe, roſe to 84°.

3d. *Equal altitudes of the Sun.*

A. M.	9^h 34′ 8.5″.	P. M.	2^h 31′ 45.5″.

Thermo-

Thermometer 54° at ſun riſe, roſe to 70°.

			°	′	″	
Obſerved zenith diſtance	α Lyræ	.	7	34	10	N.
do. . .	β Pegaſi	.	4	2	22	S.
do. . .	α Andromedæ		3	3	19	S.
do. . .	β Andromedæ		3	30	47	N.
do. . .	β Tauri	.	2	36	46	S.
do. . .	Caſtor	. .	1	16	38	N.
do. . .	Pollux	.	2	32	3	S.

4th. *Equal altitudes of the Sun.*
A. M. 9h 30′ 11″. P. M. 2h 36′ 26″.

Thermometer 28° at ſun riſe, roſe 50°.

			°	′	″	
Obſerved zenith diſtance of	α Lyræ	.	7	34	9	N.
do. . .	β Pegaſi	.	4	2	22	S.
do. . .	α Andromedæ		3	3	18	S.
do. . .	β Andromedæ		3	30	45	N.
do. . .	β Tauri	. .	2	36	37.5	S.
do. . .	Caſtor	.	1	16	38	N.
do. . .	Pollux	.	2	32	8	S.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 13h 32′ 35″. —Night clear, belts diſtinct, magnifying power 120.

5th. *Equal altitudes of the Sun.*
A. M. 9h 40′ 59″. P. M. 2h 26′ 35″.

Face of the Sector Eaſt.

Thermometer 26° at ſun riſe, roſe to 45° in the afternoon, and to 60° after night.

Obſerved zenith diſtance of α Andromedæ 2° 59′ 0″ S. The ſtar was ſeen but a few times during the obſervation between the clouds as they paſſed.

6th. Cloudy with ſome rain in the morning, and ſo dark that we had to breakfaſt by candle light at 8h A. M.

7th. Cloudy with fome rain.—Thermometer 55° at fun rife, rofe to 70°.

8th. The clouds blew off a few minutes, when the following obfervation was made.

Obferved zenith diftance of α Andromedæ 2° 59′ 6″ s.

Immediately after the above obfervation was made, the hemifphere was covered with dark clouds, which were attended with rain, fharp lightning, and heavy thunder till the next morning.

Thermometer 60° at fun rife, rofe to 82°.

			°	′	″	
9th.	Obferved zenith diftance of	α Lyræ	7	38	0	N.
	do.	β Pegafi	3	58	16	s.
	do.	α Andromedæ	2	59	8	s.
	do.	β Andromedæ	3	35	11	N.

Cloudy the remainder of the night.

Thermometer 51° at fun rife, fell to 31° in the evening.

10th. *Equal altitudes of the Sun.*

A. M. 8h 20′ 21″. P. M. 3h 50′ 33″.

		°	′	″	
Obferved zenith diftance of	α Lyræ	7	38	1	N.
do.	β Pegafi	3	58	19	s.
do.	α Andromedæ	2	59	9	s.
do.	β Tauri	2	32	32	s.

Juft before the obfervation on α Andromedæ was made, a cloud appeared above the horizon and about 30° fouth of weft: From this cloud a number of ftreamers iffued fimilar to an Aurora borealis, but much whiter.—One of them paffed above the fouthern horizon, and terminated in the weft fhoulder of Orion; another paffed over Mars and Jupiter, and extended almoft to the eaftern horizon; a third paffed through the northern part of Andromedæ, and a fourth through Urfa Minor.—Thefe ftreamers in a few

few minutes broke into very minute clouds which moved with great rapidity towards the eaſt, and in leſs than fifteen minutes extended over the whole hemiſphere.—The ſtars appeared and diſappeared almoſt inſtantly; I ſuppoſe that α Andromedæ not leſs than thirty times during the obſervation; β Andromedæ was likewiſe ſeen, but it appeared and diſappeared too rapidly to be obſerved with any degree of certainty. β Tauri was ſeen almoſt as frequently as β Andromedæ, but the obſervation nevertheleſs appeared to be correct. Before Caſtor and Pollux came to the meridian, the clouds became heavy and dark, and obſcured all the ſtars for the remainder of the night. This phenomenon was not attended with any wind.

Thermometer 31° at ſun riſe, roſe to 45°.

11th. *Equal altitudes of the Sun.*

	h	′	″		h	′	″
A. M.	8	37	12.5.	P. M.	3	34	22.

		°	′	″	
Obſerved zenith diſtance of	α Lyræ .	7	38	1	N.
do. . .	β Pegaſi .	3	58	18	S.
do. . .	α Andromedæ	2	59	2	S.
do. . .	β Andromedæ	3	35	7	N.
do. . .	β Tauri .	2	32	28	S.
do. . .	Caſtor .	1	20	59	N.
do. . .	Pollux .	2	27	58	S.

Emerſion of the 1ſt ſatellite of ♃ obſerved at $15^h\ 26'\ 34''$.—The planet was low and tremulous, the belts middling diſtinct, magnifying power of the teleſcope 120.

Thermometer during the three laſt obſervations at 21°.

12th. Cloudy all day.

13th. Cloudy till evening.

Obſerved

		°	′	″	
Obſerved zenith diſtance of	β Pegaſi .	3	58	13	S.
do. . .	β Andromedæ	3	35	4	N.
do. . .	β Tauri .	2	32	34	S.
do. . . .	Caſtor .	1	21	4	N.
do. . .	Pollux .	2	27	58	S.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 9ʰ 54′ 2″. The night clear, belts very diſtinct, magnifying power 120.

Thermometer 22° at ſun riſe, roſe to 57°.

14th. *Immerſion* of the 3d ſatellite of ♃ obſerved at 7ʰ 44′ 6″. —The belts very diſtinct, and the ſatellites remarkably bright, magnifying power 120.

Thermometer 31° at ſun riſe, roſe to 61°.

15th. *Equal altitudes of the Sun.*

A. M. 8ʰ 20′ 34″. P. M. 3ʰ 52′ 42″.

Emerſion of the 2d ſatellite of ♃ obſerved at 12ʰ 50′ 19″. —Belts diſtinct, magnifying power 120.

End of the obſervations made at Pearl river.

Rate of the clock's going deduced from the equal altitudes of the Sun

			′	″	″	
Clock too faſt mean time	Nov.	20th.	14	8.6	8.5	daily loſs.
do. . .		21ſt.	14	0.1	8.2	do.
do. . .		22d.	13	51.9	5.2	do.
do. . .		25th.	13	36.3	4.0	do.
do. . .		28th.	13	24.3	9.1	do.
do. . .		30th.	13	6	9.7	do.
do. .	Dec.	3d.	12	37.1	3.5	do.
do. . .		4th.	12	33.6	2.9	daily gain.
do. . .		5th.*	12	36.5	7.1	daily loſs.
do. . .		10th.	12	1	8.4	do.
do. . .		11th.	11	52.7	16.4	do.
do. . .		15th.	10	47.1		

Reſult

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* Till this time the clock was left expoſed, and people frequently leaning againſt the poſt to which it was faſtened, and the poſt ſtanding in ſand, no better place to be had.

Refult of the obfervations for the longitude.

Nov.	20th.	*Emerfion* of the 1ft fatellite of ♃	6	0	24	West from Greenwich.
Dec.	4th.	do.	5	58	58	
	11th.	do.	5	59	8	
	13th.	do.	5	59	53	
	14th.	*Immerfion* of the 3d do. by de Lambre's Tables.	5	59	43	
	15th.	*Emerfion* of the 2d do.	5	59	5	
		By the lunar eclipfe November 22d.				
		If the ☽'s firft touching the penumbra be confidered as the beginning, the longitude will be	5	59	38	
		If the ☽'s being indented be taken for the beginning, the longitude will be	6	1	12	

Refult

Refult of the obfervations for the latitude.

The foregoing obferved Zenith Diftances when arranged ftand as below.

Face of the Sector Weft.

	α Lyræ. ° ′ ″	β Pegafi. ° ′ ″	α Andromedæ. ° ′ ″	β Andromedæ. ° ′ ″	β Tauri. ° ′ ″	Caftor. ° ′ ″	Pollux. ° ′ ″
December 3d.	7 34 10 N.	4 2 22 S.	3 3 19 S.	3 30 47 N.	2 36 46 S.	1 16 38 N.	2 32 3 S.
4th.	7 34 9	4 2 22	3 3 18	3 30 45	2 36 37.5	1 16 38	2 32 8
Means . .	7 34 9.5	4 2 22	3 3 18.5	3 30 46	2 36 41.7	1 16 38	2 32 5.5
Face of the Sector Eaft.							
5th.	. . . .	. . . .	2 59 0	. . . .	. . . . . .	. . . . . .	. . . . . .
8th.	. . . .	. . . .	2 59 6	. . . .	. . . . . .	. . . . . .	. . . . . .
9th.	7 38 0	3 58 16	2 59 8	3 35 11	. . . . . .	. . . . . .	. . . . . .
10th.	7 38 1	3 58 19	2 59 9	. . . .	2 32 32	. . . . . .	. . . . . .
11th.	7 38 1	3 58 18	2 59 2	3 35 7	2 32 28	1 20 59	2 27 58
13th.	. . . .	3 58 13	. . . .	3 35 4	2 32 34	1 21 4	2 27 58
Means . .	7 38 0.7	3 58 16.5	2 59 5	3 35 7	2 32 31	1 21 1.5	2 27 58
Means face weft . . .	7 34 9.5	4 2 22	3 3 18.5	3 30 46	2 36 41.7	1 16 38	2 32 5.5
True obferved zenith diftances	7 36 5.1	4 0 19.2	3 1 11.7	3 32 56.5	2 34 36.3	1 18 49.7	2 30 1.7
Refractions . . .	+ 7.5	+ 4	+ 3	+ 3.5	+ 2.5	+ 1.2	+ 2.5
Correct zenith diftances	7 36 12.6	4 0 23.2	3 1 14.7	3 33 0	2 34 38.8	1 18 50.9	2 30 4.2
Mean declinations to the 9th .	38 36 11.1 N.	26 59 32.9 N.	27 58 41.6 N.	34 33 4.0 N.	28 25 19.4 N.	32 18 46.5 N.	28 29 57.4 N.
Aberrations	+ 5.7	+ 10.6	+ 10.7	+ 11.5	+ 1.5	— 4.0	— 3.8
Nutations	— 6.4	— 7.0	— 5.7	— 4	+ 4.5	+ 7.3	+ 7.5
True declinations . . .	38 36 10.4	26 59 36.5	27 58 46.6	34 33 11.5	28 25 25.4	32 18 49.8	28 30 1.1
Correct zenith diftances . . .	−7 36 12.6	+4 0 23.2	+3 1 14.7	−3 33 0	+2 34 38.8	−1 18 50.9	+2 30 4.2
Latitudes	30 59 57.8 N.	30 59 59.7 N.	31 0 1.3 N.	31 0 11.5 N.	31 0 4.2 N.	30 59 58.9 N.	31 0 5.2 N.

Latitude

			°	′	″
Latitude by	α Lyræ	. .	30	59	57.8
do.	β Pegaſi	. .	30	59	59.7
do.	α Andromedæ	.	31	0	1.3
do.	β Andromedæ	.	31	0	11.5
do.	β Tauri	. .	31	0	4.2
do.	Caſtor	.	30	59	58.9
do.	Pollux	.	31	0	5.2
Mean latitude North		. . .	31	0	2.7

From the above reſult for the latitude, it appears that the obſervatory was too far north by 2″.7 or about 272 feet, and the guide or compaſs line being 68.8 feet ſouth of the obſervatory, it appears that the guide or compaſs line oppoſite to the obſervatory was too far north by 213.2 feet. This correction of 213.2 feet was carefully laid off to the ſouth, and the guide, or compaſs line corrected back to the 21ſt mile, by laying off to the ſouth from the end of each mile a proportional part of the 213.2 feet —For a chart of this part of the boundary ſee Plate VII.* From the termination of the 213.2 feet, another guide or compaſs line was carried eaſt 99 miles, and 194 perches, to the weſtern bank of the Mobile, or Tombecby river, where the following obſervations were made.

1799.

March 18th. Put up the clock and ſet it to apparent time nearly.

Set up the large Sector with the Face to the Eaſt.

19th. Cloudy with heavy rain at night.

20th. Flying clouds great part of the day, heavy rain in the afternoon, and evening, attended with ſharp lightning, and remarkably loud thunder.

21ſt. Cloudy all day with a little rain and ſtrong north wind, cleared off about midnight with a violent wind from the N. W.

Obſerved zenith diſtance of α Coro. Borealis 3° 36′ 55″ s.

The above obſervation is doubtful owing to the violence of the wind which affected the plumb-line.

* The offsets were too ſmall to be laid down on the chart.

22d. *Equal altitudes of the Sun.*
A. M. 8^h 56′ 16″. P. M. 3^h 3′ 13″.

Obſerved zenith diſtance of	β Tauri .	2° 35′ 0″.5	s.
do. . . .	α Coro. Borealis	3 36 53	s.

Thermometer 40° at ſun riſe, roſe to 51°.

23d. *Equal altitudes of the Sun.*
A. M. 8^h 44′ 36″. P. M. 3^h 13′ 23″.

		° ′ ″	
Obſerved zenith diſtance	β Tauri .	2 34 59.5	s.
do. . .	Caſtor .	1 18 26.7	N.
do. . .	Pollux .	2 30 29	s.
do. .	α Coro. Borealis	3 36 55	s.

Set up the tranſit and equal altitude inſtrument, and took the greateſt elongation of α Urſæ Minor. Weſt.

Thermometer 39° at ſun riſe, roſe to 67° in the afternoon.

24th. *Equal altitudes of the Sun.*
A. M. 9^h 29′ 0″ P. M. 2^h 28′ 2″

Took the greateſt elongation of α Urſæ Minor. Weſt, which did not differ perceptibly from the obſervation of yeſterday.

Obſerved zenith diſtance of	Caſtor	1° 18′ 28″.8	N.
do. . .	Pollux	2 30 30	s.

Took the greateſt elongation of α Urſæ Minor. Eaſt.

The obſervations on α Urſæ Minor. were made for the purpoſe of tracing a meridian, a particular account of which will cloſe the work done at this ſtation.

Thermometer 39° at ſun riſe, roſe to 59°.

25th. *Equal altitudes of the Sun.*
A. M. 9^h 0′ 21″. P. M. 2^h 55′ 49″.

Obſerved zenith diſtance of β Tauri 2° 34′ 57″.5 s.

Took

Took the greateſt elongation of α Urſæ Minor. Weſt.

Obſerved zenith diſtance of	Caſtor	1° 18′ 27″.5	N.
do. . . .	Pollux	2 30 26	S.

Took the greateſt elongation of α Urſæ Minor. Eaſt.

Thermometer 40° at ſun riſe.

26th. Set the clock two minutes forward, and raiſed the pendulum bob.

Turned the face of the Sector Weſt.

Equal altitudes of the Sun.

A. M. 9^h 3′ 52″. P. M. 2^h 55′ 26″.5.

Traced a meridian by biſecting the angle, formed by the greateſt elongations of α Urſæ Minor. Eaſt, and Weſt.

	° ′ ″	
☉'s preceding limb on the meridian at	11 58 26*	A. M.
Subſequent do.	0 0 34	P. M.
Centre at	11 59 30	A. M.

	h ′ ″
Sirius paſſed the firſt fibre of the tranſit inſtrument at .	6 11 41
The meridian at .	6 12 29
The third fibre at .	6 13 24

27th.

	h ′ ″	
☉'s preceding limb on the meridian at	11 58 15	A. M.
Subſequent do. . . .	12 0 23	P. M.
Centre at	11 59 19	A. M.

Obſerved zenith diſtance of β Tauri 2° 36′ 38″.5 S.

* The Sun's paſſage over the meridian when it occurs, is entered according to the civil account.

	h	'	"	
Sirius paſſed the firſt fibre of the tranſit inſtrument at .	6	7	52	
The meridian at .	6	8	41	
The third fibre at .	6	9	36	

		h	'	"	
Obſerved zenith diſtance of	Caſtor .	1	16	47.4	N.
do. .	Pollux .	2	32	3	S.
do. .	α Coro. Borealis	3	38	25	S.

Thermometer 41° in the morning, raiſed to 67°.

		h	'	"	
28th.	⊙'s preceding limb on the meridian at	11	58	5.5	A. M.
	Subſequent do. . .	12	0	14	P. M.
	Centre	11	59	9.7	A. M.

	h	'	"
Sirius paſſed the firſt fibre of the tranſit inſtrument at .	6	4	6
The meridian at .	6	4	55
The third fibre at .	6	5	51

Obſerved zenith diſtance of	Caſtor	1°	16′	48″.6	N.
do. . .	Pollux	2	32	5	S.

Thermometer 49° at ſun riſe.

		h	'	"	
29th.	⊙'s preceding limb on the meridian at	11	57	59	A. M.
	Subſequent do.	12	0	7	P. M.
	Centre do.	11	59	3	A. M.

Obſerved zenith diſtance of	Caſtor	1°	16′	50″.5
do. . . .	Pollux	2	32	3

Thermometer 51° at ſun riſe, roſe to 73°.

30th. Cloudy with rain.

		h	'	"	
31ſt.	⊙'s preceding limb on the meridian at	11	57	41	A. M.
	Subſequent do.	11	59	50	A. M.
	Centre do.	11	58	45.5	A. M.

Obſerved

Obſerved zenith diſtance of β Tauri 2° 36′ 37″.7

		h	′	″
Sirius paſſed the firſt fibre of the tranſit inſtrument at	.	5	52	50
The meridian at	.	5	53	39
The third fibre at	.	5	54	34

			°	′	″	
Obſerved zenith diſtance of	Caſtor	.	1	16	50	N.
do. .	Pollux	.	2	32	1	S.
do. .	α Coro. Borealis		3	38	25.7	S.

Thermometer 84° at 4 o'clock P. M.

		h	′	″	
April 1ſt.	☉'s preceding limb on the meridian at	11	57	31	A. M.
	Subſequent do. . . .	11	59	40	A. M.
	Centre do. . . .	11	58	35.5	A. M.

Cloudy in the afternoon attended with ſharp lightning, heavy thunder, and a great fall of rain.

			h	′	″
2d.	Sirius paſſed the firſt fibre of the tranſit inſtrument at	.	5	45	19
	The meridian at	.	5	46	8
	The third fibre at	.	5	47	2

Obſerved zenith diſtance of α Coro. Borealis 3° 38′ 27″.5 S.

		h	′	″	
3d.	☉'s preceding limb on the meridian at	11	57	15	A. M.
	Subſequent do. . . .	11	59	24	A. M.
	Centre do. . . .	11	58	19	A. M.

♀ paſſed the meridian at . 1h 24′ 32″ centrum.

Obſerved zenith diſtance of β Tauri 2° 36′ 38″.7 S.

		h	′	″
Sirius paſſed the firſt fibre of the tranſit inſtrument at	.	5	41	33
The meridian at	.	5	42	22
The third fibre at	.	5	43	17

4th.

		h	′	″	
4th.	☉'s preceding limb on the meridian at	11	57	9	A. M.
	Subfequent do. . . .	11	59	18	A. M.
	Centre do. . . .	11	58	13.5	A. M.

5th. Cloudy all day.

		h	′	″	
6th.	☉'s fubfequent limb on the meridian at	11	59	10	A. M.
	Deduct the paffage of the femi diameter	—	1	4.5	
	Centre on the meridian at .	11	58	5.5	A. M.

♀ paffed the meridian at . $1^h\ 27'\ 30''$ Centrum.

	h	′	″
Sirius paffed the firft fibre of the tranfit inftrument at .	5	30	22
The meridian at .	5	31	11
The third fibre at .	5	32	6

		h	′	″	
7th.	☉'s preceding limb on the meridian at	11	56	55	A. M.
	Subfequent do. . .	11	59	5	A. M.
	Centre . do. . .	11	58	0	A. M.

	h	′	″
Sirius on the firft fibre of the tranfit inftrument at	5	26	39
The meridian at .	5	27	27
The third fibre at .	5	28	23

8th. Cloudy with a little rain in the evening.
Thermometer 39° in the morning.

Obferved

Obſerved the times, and diſtances, of the neareſt limbs of the ☉ and ☽ as below.

	h	′	″	°	′	″	
	22	51	25	48	2	0	Add 7″ for the error of the Sextant.
	22	52	27	48	2	20	
	22	53	27	48	2	40	
	22	54	12	48	3	0	
	22	54	55	48	3	20	
	22	55	43	48	4	0	
Means	22	53	41	48	2	53	

Taken again as follows.

	h	′	″	°	′	″	
	23	34	21	48	18	10	Add 7″ for the error of the Sextant.
	23	35	48	48	18	40	
	23	37	1	48	19	20	
	23	37	49	48	19	40	
	23	38	30	48	20	10	
	23	39	15	48	20	20	
Means	23	37	7	48	19	23	

9th. ☉'s preceding limb on the meridian at $11^h\ 56'\ 47''$ A. M.
Subſequent . do. . 11 58 56 A. M.

Centre at . . 11 57 51.5 A. M.

♀ paſſed the meridian at . $1^h\ 30'\ 38''$ Centrum.

Equal altitudes of the Sun.
A. M. $8^h\ 47'\ 50''$. P. M. $3^h\ 8'\ 9''$.

	h	′	″
Sirius paſſed the firſt fibre of the tranſit inſtrument	5	19	12
The meridian at	5	20	1
The third fibre at	5	20	56

10th.

10th. Took down and packed up the inftruments.

During my employ on the boundary I made it a point to multiply my aftronomical obfervations as much as poffible when it did not interfere with my other bufinefs: in this I had two views; *firft*, becaufe obfervations accurately made never become obfolete, and may at fome future day be found effentially ufeful, and *fecondly*, to determine by experiment, what reliance might be placed in obfervations made at temporary ftations, without any of the conveniences annexed to permanent obfervatories.—The meridian being traced upon accurate principles, furnifhed an opportunity of comparing equal altitudes of the fun, with the tranfits of his centre over the meridian. The foregoing obfervations made at this ftation, furnifh the two following comparifons.

On the 26th of March the ☉'s centre paffed the meridian at } $11^h\ 59'\ 30''$ A. M.

Equal altitudes of the ☉ on that day.

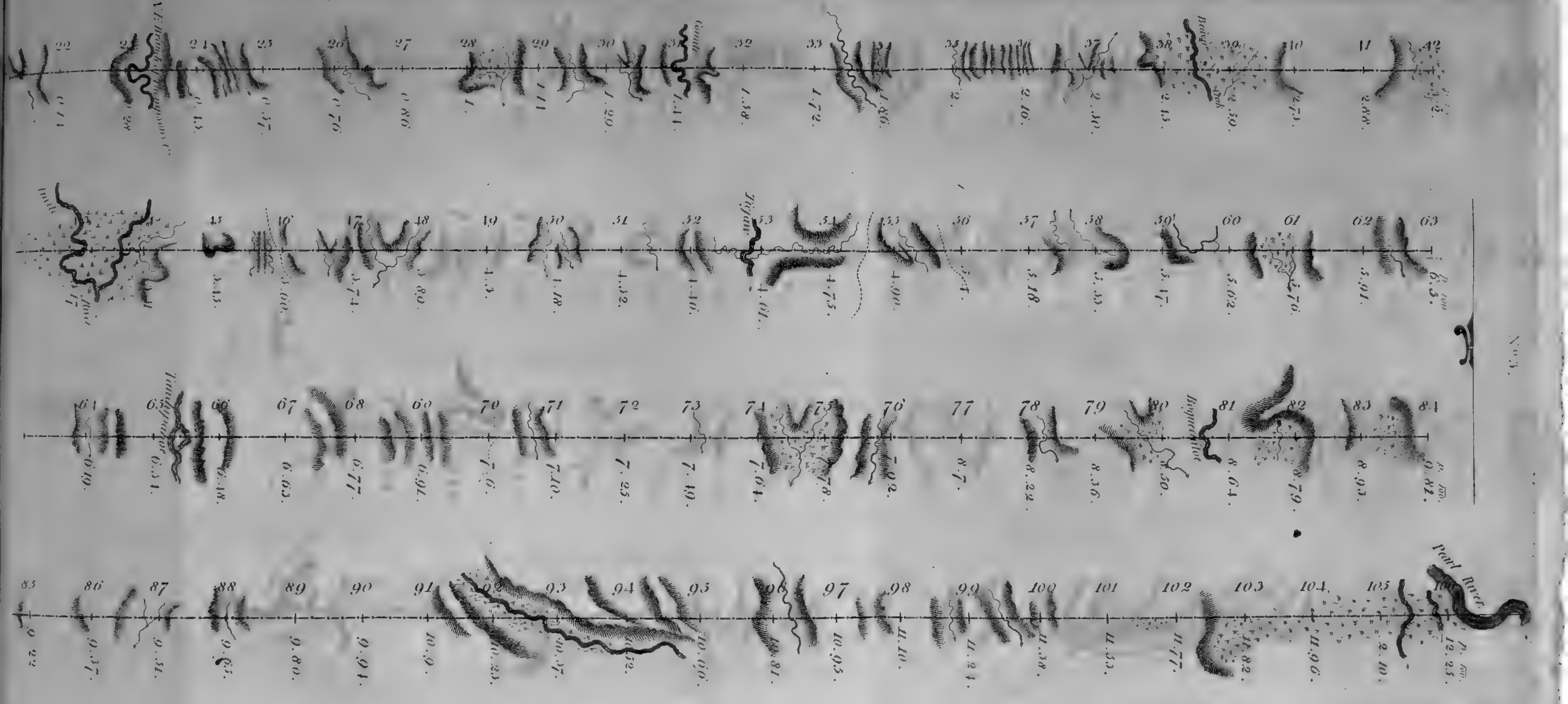
		h	'	"
A. M. 9 3 52.	P. M.	2	55	26.5
Add		12		
		14	55	26.5
Deduct forenoon's obfervation		9	3	52
	2)	5	51	34.5
Half		2	55	47.2
Add forenoon's obfervation		9	3	52
		11	59	39.2
Deduct for change of ☉'s declination . .			—	9.6
☉'s centre paffed the meridian by equal altitudes		11	59	29.6

Which differs but $\frac{4}{10}$ths of a fecond from his paffage over the meridian by obfervation.

On the 9th of April the ☉'s centre paffed the meridian at } $11^h\ 57'\ 51''.5$ A. M.

Equal

Note. The offsets between the guide line and parallel of latitude were too small to be laid down on this part of the boundary.



[illegible]

Equal altitudes of the Sun on that day.

	h ′ ″		h	′	″
	A. M. 8 47 50.	P. M.	3	8	9
Add			12		
			15	8	9
Deduct forenoon's obſervation			8	47	50
		2)	6	20	19
Half			3	10	9.5
Add the forenoon's obſervation			8	47	50
			11	57	59.5
Deduct for change of the ⊙'s declination .				—	8.6
⊙'s centre paſſed the meridian by equal altitudes at			11	57	50.9

Which differs from the obſerved time but $\frac{6}{10}$ths of a ſecond.

The paſſage of the ſtars over the meridian afford an eaſy, and accurate method of determining the rate of the going of a clock, as is well known to all aſtronomers; and when the right aſcenſion of a ſtar is well ſettled, the error of a clock can be determined by it with great preciſion,—as for example, take the paſſage of Sirius on the 27th of March.

	h	′	″
Right aſcenſion of Sirius the beginning of 1800 according to De Zach*	6	36	19.9
Deduct ann. preceſſion for one year		—	2.6
Right aſcenſion the beginning of 1799 . . .	6	36	17.3
Aberration and preceſſion on the 27th of March .		+	0.6
Nutation . do.		—	0.7
True right aſcenſion of Sirius	6	36	17.2
⊙'s right aſcenſion by the Nautical Almanac at the time Sirius paſſed the meridian, deduct	0	26	53.5
Sirius paſſed the meridian apparent time at	6	9	23.7
Do. . . by obſervation	6	8	41
Clock too ſlow apparent time	0	0	42.7

* Vide Obſervationibus Aſtronomicis Annis 1787, 1788, 1789, 1790.

	h	′	″
☉'s centre paſſed the meridian on the 27th of March at	11	59	19 A. M.
Equation of time + 5′ 20″.8	12	5	20.8
Clock too ſlow mean time	0	6	1.8
By the paſſage of Sirius over the meridian on the 27th and 28th the clock gained on mean ſolar time, about 10″ per diem, which is equal to about 2″.5 when Sirius was obſerved, which is to be deducted		—	2.5
Clock too ſlow mean time when Sirius paſſed the meridian	0	5	59.3
Equation of time . . do. . . .	0	5	16.1
Clock too ſlow apparent time, which differs but ½ a ſecond from the error given by Sirius	0	0	43.2

The neareſt diſtances of the limbs of the ☉, and ☽, were taken twice at this ſtation, (as entered in the journal), and may ſerve as examples of the accuracy of that method of determining the longitude.—As their altitudes were not taken at the time of the obſervations, they were determined by calculation: The latitude and time being known from obſervation, and the declinations deduced from the Nautical Almanac upon a ſuppoſition that the longitude was about 5 hours, and 52 minutes, weſt from Greenwich.—The method of calculating an altitude; the latitude, time, and declination being given, may be found in moſt books of ſpherical trigonometry, and a very eaſy one, particularly adapted to this purpoſe, in the requiſite tables problems 5, 6 and 7; but to prevent any errors which might ariſe from this ſource, and affect the determination of the longitude, I would recommend that the altitudes be determined both ways, as checks upon each other.—Either of the methods bring out the true altitude of the ☉'s, or ☽'s centre; but as the apparent is generally wanted, it will be had by ſubſtracting the parallax in altitude, and adding the refraction.

	h	′	″
The firſt obſervation was made by the clock April 8th at .	22	53	41
Clock too ſlow apparent time		2	6
The apparent time of the obſervation was therefore at .	22	55	47

	°	′	″
Obſerved diſtance of the limbs . .	48	2	53
☉'s ſemi-diameter	+	16	0
☽'s do.	+	14	59
Error of the Sextant	+	0	7
☽'s increaſed ſemi-diameter for her altitude	+	0	8
Obſerved diſtance of the centres . .	48	34	7

☉'s true

		° ′ ″			
⊙'s true altitude		62 19 20			
☽'s do.		33 55 58			
Difference true altitudes		28 23 22			
⊙'s apparent altitude		62 19 48			
☽'s do.		33 11 25			
Difference apparent altitudes		29 8 23			
Obſerved diſtance of the centres		48 34 7			
Sum		77 42 30			
Difference		19 25 44			
½ Sum		38 51 15		S	9.7975032
½ Difference		9 42 52		S	9.2272126
☽'s apparent altitude		33 11 25	co. ar.	c. S	0.0773486
☽'s true altitude		33 55 58		c. S	9.9189175
⊙'s apparent altitude		62 19 48	co. ar.	c. S	0.3331280
⊙'s true altitude		62 19 20		c. S	9.6669844
					2)39.0210943
Difference true altitudes		28 23 22			
					19.5105471
½ Difference		14 11 41		S	9.3895525
Tangent					10.1209946
Correſponding c. S	(To be deducted from the 2d line above increaſed by 10.)				9.7806675
		23 58 29.5 / 2		S	9.6088850
True diſtance		47 56 59			
Diſt. at Greenwich	9ᵈ 3ʰ	47 6 51			
Do.	9 6	48 30 30			
Difference between 1ſt and 2d		0 50 8	P. L. 5551		
Do. between 2d and 3d		1 23 39	P. L. 3328		h ′ ″
			2223	=	1 47 46
Add					9ᵈ 3 0 0
Time at Greenwich					9 4 47 46
Time of the obſervation on the Mobile					8 22 55 47
Longitude weſt from Greenwich					0 5 51 59

The

The fecond obfervation was made April 8th by the clock at	23^h	$37'$	$7''$
Clock too flow apparent time		2	7
The apparent time of the obfervation was therefore at .	23	39	14

	°	′	″
Obferved diftance of the limbs	48	19	23
☉'s femi-diameter	+	16	0
☽'s femi-diameter	+	14	59
Error of the Sextant	+	0	7
☽'s increafed femi-diameter from her altitude	+	0	10
Obferved diftance of the centres	48	50	39

	°	′	″			
☉'s true altitude	66	6	20			
☽'s do.	42	54	46			
Difference true altitudes . .	23	21	34			
☉'s apparent altitude	66	16	42			
☽'s do.	42	15	7			
Difference apparent altitudes	24	1	35			
Obferved diftance of the centres . .	48	50	39			
Sum	72	52	14			
Difference	24	49	4			
½ Sum	36	26	7	. .	S	9.7737238
½ Difference	12	24	32	.	S	9.3322098
☽'s apparent altitude	42	15	7	co. ar.	c. S	0.1306537
☽'s true altitude	42	54	46	.	c. S	9.8647430
☉'s apparent altitude	66	16	42	co. ar.	c. S	0.3954564
☉'s true altitude	66	16	20	.	c. S	9.6046490
						2)39.1014357
Difference true altitudes	23	21	34			
						19.5507178
½ Difference	11	40	47	. .	S	9.3062979
				Tangent .		10.2444199
Correfponding log. cofine	(To be deducted from the 2d line above increafed by 10.)					9.6945605
	24	8	34.5	.	S	9.6117374
			2			
True diftance	48	17	9			
Diftance at Greenwich 9^d 3^h . .	47	6	51			
do. . . 9 6 . .	48	30	30			

Difference

Difference between 1ſt and 2d	1 10 18 P. L. 4083				
do. 2d and 3d	1 23 39 P. L. 3328	h	′	″	
	755 =	2	31	16	
Add	9^d	3			
Time at Greenwich	9	5	31	16	
Time of the obſervation on Mobile	8	23	39	14	
Longitude weſt from Greenwich	0	5	52	2	
do. by the firſt obſervation	0	5	51	59	
Mean	0	5	52	0.5	

	h ′ ″	
The longitude of our camp on Thompſon's creek by the mean of five immerſions of ♃'s firſt ſatellite was	6 4 48	Weſt from Greenwich.
The diſtance from Thomſon's creek on the parallel of 31°, to the obſervatory on the Mobile was by meaſurement 184.46 miles eaſt, which in time is equal to	—0 12 17	
Longitude of the camp on the Mobile	5 52 31	
do. by the two lunar obſervations	5 52 0.5	
Difference	0 0 30.5	

Reſult

Refult of the Obfervations made on the Mobile river for afcertaining the Latitude.

The Zenith Diftances ftand as below.

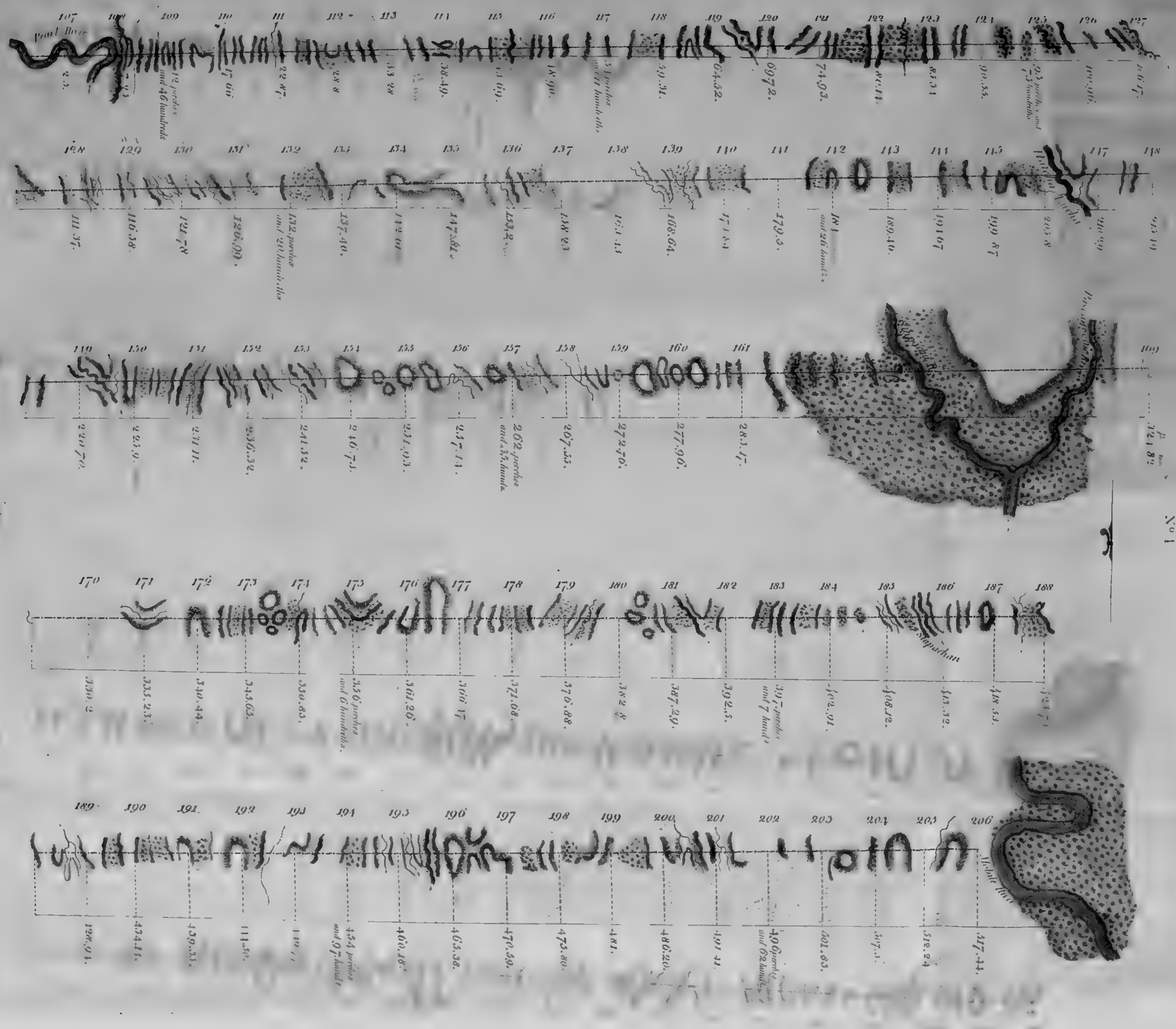
Face of the Sector Eaft.

	β Tauri. ° ′ ″	Caftor. ° ′ ″	Polhux. ° ′ ″	α Coro. Borealis. ° ′ ″
March 21ft.	....	....	....	3 36 55 s.
22d.	2 35 0.5 s.	....	....	3 36 53
23d.	2 34 59.5	1 18 26.7 N.	2 30 29 s.	3 36 55
24th.	....	1 18 28.8	2 30 30	....
25th.	2 34 57.5	1 18 27.5	2 30 26	....
Means	2 34 59.2	1 18 27.5	2 30 28	3 36 54.3

Face of the Sector Weft.

	β Tauri.	Caftor.	Polhux.	α Coro. Borealis.
27th.	2 36 38.5	1 16 47.4	2 32 3	3 38 25
28th.	....	1 16 48.6	2 32 5	....
29th.	....	1 16 50.5	2 32 3	....
31ft.	2 36 37.7	1 16 50	2 32 1	3 38 25
April 2d.	....	....	....	3 38 27.5
3d.	2 36 38.7	....	....	....
Means	2 36 38.3	1 16 49.1	2 32 3	3 38 26.1
Means with the face eaft	2 34 59.2	1 18 27.5	2 30 28	3 36 54.3
Means	2 35 48.7	1 17 38.3	2 31 15.5	3 37 40.2
Refractions	+ 2.5	+ 1.3	+ 2.5	+ 3.6
Correct zenith diftances	2 35 51.2	1 17 39.6	2 31 18	3 37 43.8
Mean declinations to the 26th March	28 25 28.6 N.	32 18 48.3 N.	28 29 54.6 N.	27 23 57.6 N.
Aberrations	+ 1.3	+ 2.8	+ 1.3	− 13.3
Nutations	+ 5	+ 7.5	+ 7.9	− 1.6
Semi. ann. equations	+ 0.4	+ 0.5	+ 0.5	+ 0.3
True declinations	28 25 35.3	32 18 59.1	28 30 4.8	27 23 42.4
Correct zenith diftances applied	+2 35 51.2	−1 17 39.6	+2 31 18	+3 37 43.8
Latitudes	31 1 26.5 N.	31 1 19.5 N.	31 1 22.8 N.	31 1 26.2 N.

Latitude



	°	′	″
Latitude by β Tauri . .	31	1	26.5
do. by Caſtor . .	31	1	19.5
do. . Pollux . .	31	1	22.8
do. by α Coro. Borealis .	31	1	26.2
Mean Latitude north . .	31	1	23.7

From the reſult of the above obſervations, the compaſs line was too far north by 1′ 23″.7, or 518.55 perches, which diſtance was carefully laid off to the ſouth, and a ſtone ſet up at the termination, marked on the north ſide U. S. Lat. 31° 1799,—and on the ſouth ſide DOMINOS de S. M. C. CAROLUS IV. Lat. 31° 1799.—From this ſtone, the line was corrected back as in the foregoing caſe, agreeably to plate VIII.

On our arrival at the end of the compaſs line on the Mobile river, one ſerious difficulty preſented itſelf, that was the continuation of the line through the ſwamp, which is at all times almoſt impenetrable; but at that ſeaſon of the year abſolutely ſo: being wholly inundated :—But fortunately we found in the neighbourhood of our camp a ſmall hill, the ſummit of which was juſt elevated above the tops of the trees in the ſwamp. From the top of this hill, we could plainly diſcover the pine trees on the high land, on the eaſt ſide. Upon aſcertaining this fact, we ſent a party through to the other ſide, (along the water courſes, by which the ſwamp is interſected in various directions), with orders to make a large fire in the night with light-wood; the ſame was likewiſe to be done on the hill before mentioned, to obtain nearly the direction from one place to the other.—The atmoſphere was too much filled with ſmoke, to diſcern a flag, or other ſignal,—the woods being on fire on both ſides of the ſwamp.—It happened unfortunately that the day before our fires were to be lighted, the fires in the woods had extended over almoſt the whole of the highlands, on both ſides of the ſwamp; by which ſo many dead trees were ſet on fire, that there was no poſſibility of diſcriminating between them, and our fires.—It was then agreed that the parties ſhould light up, and extinguiſh their fires a certain number of times; making ſtated intervals.—This ſucceeded ſo well, that we became certain of not taking a wrong fire in determining the angles.—Contrary to our expectation, a heavy rain fell on the ſame night, a ſhort time after we had finiſhed the experiment, and extinguiſhed all the fires in the woods.—The ſtorm cleared off with a ſtrong north-weſt wind, which carried off all the ſmoke, and enabled us to determine the angles in the day, by erecting ſignals, which was accompliſhed on the ſecond day of April.—This work was connected with the obſervatory in the following manner. At the obſervatory A (ſee Fig. G, plate IX.) a meridional line was traced, by taking the greateſt elongations of α Urſæ Minoris, both eaſt, and weſt, with the tranſit and equal altitude inſtrument :—equal diſtances were carefully meaſured in each direction, and a fine mark placed at the termination of each meaſurement,—the diſtance between thoſe marks was accurately biſected, and a fine mark placed at the point of biſection for the meridian.

meridian. The ſame operation was performed a ſecond time, and although the difference in the reſults, appeared too trifling to need any attention, it was nevertheleſs biſected, and that point of biſection taken for the meridian,—which is deſignated by AE and terminated by a parallel of latitude drawn through B.—From the point A, a viſta was opened to the ſummit of the hill at B: from B, to C, another viſta was opened, which formed the baſe: the baſe was too ſhort if it could have been avoided; but the hill would not admit of its being any longer.—D the ſignal on the eaſt ſide of the ſwamp.—The angles were meaſured on the horizontal arc of the aſtronomical circle already mentioned.—This inſtrument by means of a vernier is graduated to 5″, which by the help of a microſcope may be eaſily ſubdivided by the eye, into 1½, or 2 ſeconds.—The meaſurements, and angles ſtand as below.

AB = 310.8 perches.
BC = 70.356 perches.

∠ BAE =	37°	58′	48″
∠ ABD =	57	43	21
∠ BCD =	139	23	58
∠ DBC =	39	47	1
∠ CDB =	0	49	1

From theſe data, AE is found to be equal to 244.9 perches, BE to 191.26 perches, BD to 3211.65 perches, EF to 2987.44 perches, and DF to 316.7 perches. DB being conſidered as an arc of a great circle, forming with the prime vertical an angle of 5° 42′ 9″ to the north, being the exceſs of the angles BAE, and ABD above 90.—From the reſult of the obſervations for the latitude, the obſervatory appeared to be too far north by 518.55 perches, which is deſignated by AH. It therefore follows, that the ſignal at D, was too far north by the ſum of the diſtances DF, EA and AH, which is equal to 1080.15 perches: this diſtance was meaſured due ſouth from the point D, and would interſect the paralell of 31°, at the end of 215 miles and 169.6 perches from high water mark on the Miſſiſſippi.

From the termination of the above mentioned 1080.15 perches, another guide, or compaſs line was continued eaſt, to the eaſt ſide of the Coenecuch; but the termination of the compaſs line, not being in a proper place for a courſe of obſervations, the obſervatory was erected north of it, in the meridian of the termination of the 257th mile; where the following obſervations were made.

1799.

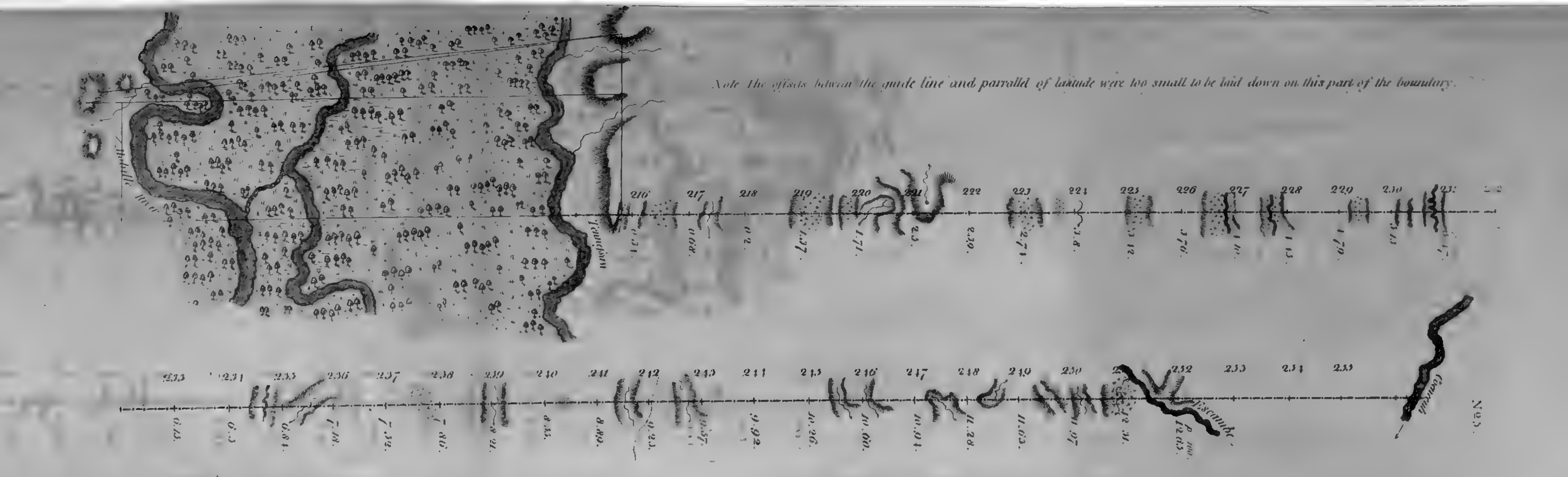
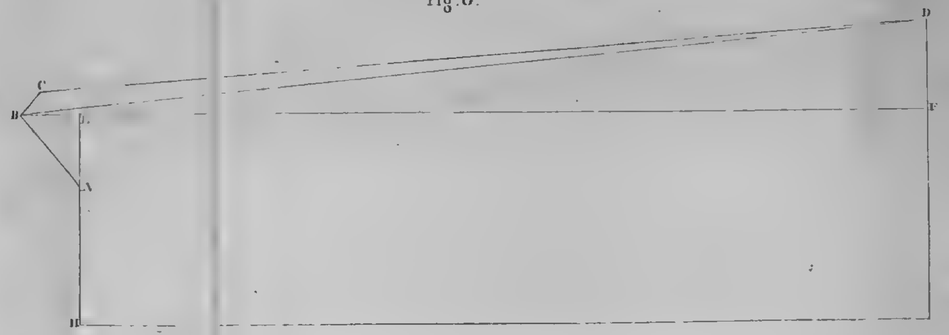


Fig. G.



Scale of 500 Perches to an inch

1799.
May 9th. The inſtruments arrived, ſet up the clock, and both ſectors, the ſmall one was uſed by the commiſſioner for His Catholic Majeſty, at this ſtation, on the Chatahocha river, the mouth of Flint river, and at our ſtation up the St. Mary's.

Faces of the Sectors to the Eaſt.

				°	′	″	
9th.	Obſerved zenith diſtance of		ε Bootes	3	4	8	S.
	do.		α Coro. Borealis	3	35	53	S.
	do.	Small ſector	α Lyræ	7	36	43	N.
10th.	do.		ε Bootes	3	4	9.5	S.
	do.	Small ſector	do.	3	3	20	S.
	do.		α Coro. Borealis	3	35	55	S.
	do.	Small ſector	α Lyræ	7	36	48	N.
	do.		β Pegaſi	4	0	12	S.
11th.	do.		Caſtor	1	19	12	N.
	do.		Pollux	2	29	41	S.
	do.		ε Bootes	3	4	6.5	S.
	do.	Small ſector	do.	3	3	8	S.
	do.		α Coro. Borealis	3	35	52	S.
	do.	Small ſector	do.	3	35	9	S.
	do.	Small ſector	α Lyræ	7	37	1	N.
	do.		α Andromedæ	3	0	59.5	S.
12th.	do.		Pollux	2	29	43	S.
	do.	Small ſector	ε Bootes	3	3	21	S.
	do.	Small ſector	α Coro. Borealis	3	35	7	S.
	do.	Small ſector	α Lyræ	7	36	52	N.

13th. Turned the face of the Small Sector Weſt.

Cloudy with rain.

14th. Cloudy all day with heavy ſhowers of rain.

15th. Cloudy with rain till after dark, then clear.

			°	′	″	
Obſerved zenith diſtance of	ε Bootes	ſmall ſector	3	6	47	S.
do.	α Coro. Borealis	ſmall ſector	3	38	34	S.
do.	α Lyræ	ſmall ſector	7	33	30	N.

16th. Cloudy with heavy ſhowers of rain great part of the day.

				°	′	″	
	Obſerved zenith diſtance of		α Andromedæ	3	0	58.5	S.
17th.	do.		Caſtor	1	19	20	N.
	do.		Pollux	2	29	45	S.
	do.	Small ſector	ε Bootes	3	6	58	S.
	do.	Small ſector	α Coro. Borealis	3	38	34	S.
	do.		β Pegaſi	4	0	13	S.
	Face of the large Sector Weſt.						
	do.		α Andromedæ	3	2	41.5	S.
18th.	do.		Caſtor	1	17	30.5	N.
	do.		Pollux	2	31	24	S.
	do.		ε Bootes	3	5	48.5	S.
	do.	Small ſector	do.	3	6	45	S.
	do.		α Coro. Borealis	3	37	27.7	S.
	do.	Small ſector	do.	3	38	22	S.
	do.	do.	α Lyræ	7	33	30	N.
	do.		β Pegaſi	4	1	52.5	S.
	do.		α Andromedæ	3	2	40	S.
19th.	do.		Caſtor	1	17	29.5	N.
	do.		Pollux	2	31	25	S.
	do.		ε Bootes	3	5	47.5	S.
	do.		α Coro. Borealis	3	37	31.8	S.
	do.		β Pegaſi	4	1	52.5	S.
	do.		α Andromedæ	3	2	41.5	S.
20th.	do.		Caſtor	1	17	27	N.
	do.		Pollux	2	31	26	S.
	do.		ε Bootes	3	5	48	S.
	do.		α Coro. Borealis	3	7	29.7	S.
	do.		β Pegaſi	4	1	54	S.
	do.	Small ſector	α Lyræ	7	33	40	N.

At this ſtation, no obſervations but for the determination of the latitude were made,—the eclipſes of Jupiter's ſatellites not being viſible, the planet being too near the ſun.—The clock was put up to advertiſe us of the time a ſtar would appear in the field of the teleſcopes, which is at all times of importance; but at this place particularly ſo, on account of the flies, and muſquitoes, which were ſo numerous, and troubleſome, that an obſervation which would not require more than one minute, could not be made without great pain.

Reſult

Refult of the Obfervations made with the large Sector on the Coenecuch, to determine the Latitude.

The Zenith diftances ftand as below.

Face of the Sector Eaft.

	Caftor.	Pollux.	ε Bootes.	α Coro. Borealis.	β Pegafi.	α Andromedæ.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
May 9th.	. . . . . .	. . . . . .	3 4 8 S.	3 35 53.5 S.	. . . . . .	. . . . . .
10th.	. . . . . .	. . . . . .	3 4 9.5	3 35 55	4 0 12 S.	. . . . . .
11th.	1 19 12 N.	2 29 41 S.	3 4 6.5	3 35 52	. . . . . .	3 0 59.5 S
12th.	. . . . . .	2 29 43	. . . . . .	. . . . . .	. . . . . .	. . . . . .
16th.	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	3 0 58.5
17th.	1 19 10	2 29 45	. . . . . .	. . . . . .	4 0 13	. . . . . .
Means	1 19 11	2 29 43	3 4 8	3 35 53.5	4 0 12.5	3 0 59

Face of the Sector Weft.

	Caftor.	Pollux.	ε Bootes.	α Coro. Borealis.	β Pegafi.	α Andromedæ.
	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	3 2 41.5
18th.	1 17 30.5	2 31 24	3 5 48.5	3 37 27.7	4 1 52.5	3 2 40
19th.	1 17 29.5	2 31 25	3 5 47.5	3 37 31.8	4 1 52.5	3 2 41.5
20th.	1 17 27	2 31 26	3 5 48	3 37 29 7	4 1 54	. . . . . .
Means	1 17 29	2 31 25	3 5 48	3 37 29.7	4 1 53	3 2 41
Means face eaft	1 19 11	2 29 43	3 4 8	3 35 53.5	4 0 12.5	3 0 59
Means	1 18 20	2 30 34	3 4 58	3 36 41.6	4 1 2.7	3 1 50
Refractions	+ 1.3	+ 2.5	+ 3	+ 3.5	+ 4	+ 3
Correct zenith diftances	1 18 21.3	2 30 36.5	3 5 1	3 36 45.1	4 1 6.7	3 1 53
Mean declinations to the 15th.	32 18 47.5 N.	28 29 49.7 N.	27 55 38 N.	27 23 54.1 N.	26 59 58 N.	27 59 3 5 N.
Aberrations	+ 4.4	+ 3.6	— 0.7	— 3.2	— 12 5	— 11.7
Nutations	+ 8.0	+ 8.2	— 0.7	— 2.1	— 6.7	— 5.0
Semi-annual equations	0.0	0.0	+ 0.4	+ 0 4	— 0.5	— 0.4
True declinations	32 18 59.9	28 30 1.5	27 55 37	27 23 49.2	26 59 32.3	27 58 46.4
True zenith diftances applied	—1 18 21.3	+2 30 36.5	+3 5 1	+3 36 45.1	+4 1 6.7	+3 1 53
Latitudes	31 0 38.6	31 0 38	31 0 38	31 0 34.3	31 0 39	31 0 39.4

		°	′	″
Latitude by	Caſtor	31	0	38.6
do.	Pollux	31	0	38.0
do.	ε Bootes	31	0	38.0
do.	α Coro. Borealis	31	0	34.3
do.	β Pegaſi	31	0	39.0
do.	α Andromedæ	31	0	39.4
Mean Latitude north		31	0	37.9

Reſult of the Obſervations made with the ſmall Sector on the Coenecuch to determine the Latitude.

The Zenith diſtances ſtand as below.

Face of the Sector Eaſt.

	ε Bootes. ° ′ ″	α Coro. Borealis. ° ′ ″	α Lyræ. ° ′ ″
May 9th.	....	....	7 36 43 N.
10th.	3 3 20 S.	3 35 2 S.	7 36 48
11th.	3 3 8	3 35 9	7 31 1
12th.	3 3 21	3 35 7	7 36 52
Means	3 3 16	3 35 6	7 36 51

Face of the Sector Weſt.

	ε Bootes.	α Coro. Borealis.	α Lyræ.
15th.	3 6 47	3 38 34	7 33 30
17th.	3 6 58	3 38 34	....
18th.	3 6 45	3 38 22	7 33 20
20th.	....	....	7 33 40
Means	3 6 50	3 38 30	7 33 30
Means face eaſt	3 3 16	3 35 6	7 36 51
Means	3 5 3	3 36 48	7 35 10.5
Refractions	+ 3	+ 3.5	+ 7.5
Correct zenith diſtances	3 5 6	3 36 51.5	7 35 18
Mean declinations May 15th.	27 55 38 N.	27 23 54.1 N.	38 36 11 N.
Aberrations	— 0.7	— 3.2	— 11.5
Nutations	— 0.7	— 2.1	— 7.0
Semi-annual equations	+ 0.4	+ 0.4	+ 0.2
True declinations	27 55 37	27 23 49.2	38 35 52.7
Zenith diſtances applied	+3 5 6	+3 36 51.5	—7 35 18
Latitudes	31 0 43	31 0 40.7	31 0 34.7

Latitude

	°	′	″
Latitude by ε Bootis .	31	0	43
do. . α Coro. Borealis	31	0	40.7
do. . α Lyræ . .	31	0	34.7
Mean Latitude North . .	31	0	39.5

The difference of the reſults given by the two inſtruments appears to be 1″.6; but the radius of the large ſector, being more than three times that of the ſmall one, it may fairly be conſidered at leaſt three times as accurate; and as double the number of ſtars were taken with the large one, it is on that account entitled to double the accuracy:—hence if to five times the latitude given by the large ſector, the latitude given by the ſmall one be added, and the ſum divided by ſix, the quotient 30° 0′ 38″.1 will be the latitude in which each inſtrument has its due weight; from which it follows, that the obſervatory was too far north by 38″.1, or 3853.8 feet; but the end of the guide line was 3617.8 feet ſouth of the obſervatory,—hence the end of the guide line was too far north by 236 feet, which was carefully laid off to the ſouth, and the guide line corrected back as in the former caſes agreeably to Plate IX. From the termination of the meaſurement another guide, or compaſs line was carried on to the weſt ſide of the Chatahocha, or Apalachicola river the diſtance of 381 miles, and 7 perches, eaſt of high water mark on the Miſſiſſippi.

At the termination of the compaſs, or guide line on the Chatahocha, or Apalachicola river, the following obſervations were made.

July 25th. Arrived at the end of the guide line, in a heavy ſhower of rain.

26th. Cloudy with rain all day.

27th. Cleaned, and ſet up the clock.—Cloudy with rain.

28th. Cloudy with rain all day.—Thermometer 82° in the morning, fell to 80° at 10 o'clock A. M.

29th. Thermometer 74° in the morning. Thick fog. Thermometer 84° in the afternoon.

Put up both Sectors, with their Faces to the Eaſt.

30th. Thermometer 74° in the morning, roſe to 87°.

Obſerved

		°	′	″	
Obſerved zenith diſtance of	α Coro. Borealis	3	36	11	s.
do. . .	α Andromedæ	3	1	18.6	s.
do. . .	β Andromedæ	3	32	48	N.
do. ſmall ſector	. do .	3	34	1.5	N.
do. . .	Caſtor .	1	18	38.5	N.
do. . .	Pollux .	2	30	13	s.

31ſt. *Equal altitudes of the Sun.*

A. M. 8^h 44′ 49″. P. M. 3^h 16′ 15″.

		°	′	″	
Obſerved zenith diſtance of	α Coro. Borealis	3	36	8.5	s.
do. . . .	α Andromedæ	3	1	21	s.

Immerſion of the 3d ſatellite of ♃ obſerved at 16^h 8′ 18″. —Belts diſtinct, magnifying power 120.

		°	′	″	
Obſerved zenith diſtance of	β Andromedæ	3	32	49.5	N.
do. ſmall ſector	do. .	3	33	58.5	N.
do. . . .	β Tauri .	2	34	46.5	s.
do.	Caſtor .	1	18	41	N.
do. . . .	Pollux .	2	30	10	s.

Thermometer 74° at ſun riſe, roſe to 86°.

Aug. 1ſt. Thermometer 84° all laſt night.—Heavy rain about 1 o'clock in the morning, cleared off before 3 o'clock.

		°	′	″	
Obſerved zenith diſtance of	β Pegaſi .	4	0	26	s.
do. ſmall ſector	do. .	3	59	9	s.
do. . . .	α Andromedæ	3	1	22.5	s.
do. ſmall ſector	. . . .	3	0	19	s.

The above two obſervations are doubtful, the ſtar not being ſeen more than 3″ through the clouds.

Thermometer roſe to 88°, frequent light ſhowers.

2d. Thermometer 74° all laſt night, roſe to 84°.—Showery with thunder great part of the day.

Equal

Equal altitudes of the Sun.
A. M. $9^h\ 30'\ 13''$. P. M. $2^h\ 9'\ 50''$.

Obſerved zenith diſtance of α Lyræ (ſmall ſector) 7° 37′ 30″ N.

3d. Thermometer 75° all laſt night, roſe to 85°.—Clouds flying with great rapidity the fore part of the day from the N. W. cleared off in the afternoon.

			°	′	″	
Obſerved zenith diſtance of		α Coro. Borealis	3	36	7.5	S.
do.	ſmall ſector	α Lyræ .	7	37	36	N.
do.	. . .	β Pegaſi .	4	0	25	S.
do.	ſmall ſector	do. .	3	59	3	S.

The obſervations on β Pegaſi are doubtful, the ſtar was diſcerned for a few ſeconds only between the clouds as they paſſed by.

Cloudy the remainder of the night.—At 21^h the clouds diſappeared, at $22^h\ 15'$ the ſky was fine, at $22^h\ 20'$ I prepared to obſerve the zenith diſtance of Caſtor, but in leſs than 2 minutes, an extenſive cloud formed in the zenith, with ſeveral others to the northward, they all diſappeared in about 5 minutes but the obſervation was loſt.

Obſerved zenith diſtance of Pollux . 2° 30′ 14″ S.

4th. Thermometer 73° all laſt night, roſe to 87° in the afternoon.

			°	′	″	
Obſerved zenith diſtance of		α Coro. Borealis	3	36	8.5	S.
do.	(ſmall ſector)	α Lyræ .	7	37	12	N.
do.	. . .	β Pegaſi .	4	0	28	S.
do.	ſmall ſector	do. .	3	59	12	S.
do.	ſmall ſector	α Andromedæ	3	0	28	S.
do.	. . .	β Andromedæ	3	32	49	N.
do.	ſmall ſector	do. .	3	34	7.5	N.
do.	. . .	β Tauri .	2	34	47.5	S.
do.	. . .	Caſtor .	1	18	36.4	N.
do.	. . .	Pollux .	2	30	12	S.

5th.

5th. Thermometer 72° all laſt night, roſe to 84°.

Face of the large Sector Weſt.

		°	′	″	
Obſerved zenith diſtance of	α Lyræ (ſmall ſector)	7	37	36	N.
do. . .	β Pegaſi do.	3	59	24	S.
do. . .	α Andromedæ do.	3	0	16	S.
do. . .	β Andromedæ do.	3	34	1	N.

6th. Thermometer 71° all night, roſe to 79°. —Cloudy all day, clear in the evening.

Face of the ſmall Sector Weſt.

		°	′	″	
Obſerved zenith diſtance of	β Pegaſi .	4	2	9	S.
do. ſmall ſector	do. .	4	3	36	S.
do. . .	α Andromedæ	3	3	5.5	S.
do. ſmall ſector	do. .	3	4	30	S.
do. . .	β Andromedæ	3	31	5	N.
do. ſmall ſector	do. .	3	29	30	N.
do. . .	Pollux .	2	30	0.5	S.

7th. Thermometer 70° all night, roſe to 82°. —Cloudy part of the forenoon and rain in the evening.

Obſerved zenith diſtance of β Pegaſi . 4° 2′ 7″.5 S.

At 14^h the ſtars were inſtantly covered by clouds, which were followed by heavy rain.

8th. Thermometer 70° all night, roſe to 79°. —Heavy rain till 7 o'clock in the evening, cleared off at 8^h P. M.

		°	′	″	
Obſerved zenith diſtance	β Pegaſi .	4	2	6.5	S.
do. ſmall ſector	do. .	4	3	21	S.
do. . .	α Andromedæ	3	3	4.5	S.
do. ſmall ſector	do. .	3	4	15	S.
do. . .	β Andromedæ	3	31	5.5	N.
do. ſmall ſector	do. .	3	30	01	

Aug. 9th. Thermometer 70° in the morning, roſe to 75°.—Heavy rain all the forenoon, cleared off at noon.—Thunder-guſt in the afternoon, clear in the evening.

				°	′	″	
Obſerved zenith diſtance of	α Lyræ	(ſmall ſector)		7	32	45	N.
do. . . .	β Pegaſi	.	do.	4	3	22.5	S.
do. . .	α Andromedæ		do.	3	3	4.5	S.
do. ſmall ſector	do.	.	.	3	4	27	S.
do. . .	β Andromedæ		.	3	31	7.5	N.
do. ſmall ſector	do.	.	.	3	29	31	N.

At 19ʰ 20′ a cloud formed in the zenith which in a few minutes extended in a belt almoſt to the eaſtern and weſtern horizon, at 20ʰ it diſappeared, by this circumſtance the obſervation on β Tauri was loſt.

			°	′	″	
Obſerved zenith diſtance of	Caſtor	.	1	16	57.5	N.
do. . .	Pollux	.	2	31	58.5	S.

The obſervations on Caſtor, and Pollux are ſomewhat doubtful, each of them being ſeen but once, and that for a few ſeconds only between the clouds which moved with great rapidity from the weſt, to the eaſt.

10th. Thermometer 70° all laſt night, raiſed to 81°.—Rain at noon.

At 5ʰ 55′ prepared to obſerve the zenith diſtance of α Coro. Borealis,—in two minutes a ſpace of ſeveral degrees about the zenith was obſcured by a cloud from the weſt, at 6ʰ 6′ the ſky was ſufficiently clear but the ſtar had paſſed the field of the inſtrument.

				°	′	″	
Obſerved zenith diſtance of	α Lyræ	(ſmall ſector)		7	33	4.5	N.
do. . .	β Pegaſi		do.	4	3	31.5	S.

Cloudy the remainder of the 24 hours.

11th. Thermometer 74° all laſt night, roſe to 86°.—Cloudy with thunder from 3^h P. M. till ſome time in the night.

12th. Thermometer 76° at day light, roſe to 85°. —Beautiful ſky till 7^h A. M. when it became very cloudy from the N. W.—heavy rain from 1 o'clock P. M. till 9 o'clock A. M. of the

13th. Thermometer 72° at ſun riſe, roſe to 81°. —Clear a ſhort time about 9^h A. M.—Cloudy with frequent ſhowers of rain the remainder of the day.

14th. Thermometer 74° at ſun riſe, roſe to 82°.

			°	′	″	
Obſerved zenith diſtance of	α Coro. Borealis	.	3	37	56	S.
do. ſmall ſector	α Lyræ	.	7	33	1.5	N.
do. . .	Pollux	.	2	32	0.5	S.

It was too hazy to diſcover Caſtor, and Pollux was ſcarcely diſcernible.

15th. Thermometer 74° at ſun riſe, roſe to 87°. —Fog during the morning.

			°	′	″	
Obſerved zenith diſtance of	α Coro. Borealis	.	3	37	56.5	S.
do. ſmall ſector	α Lyræ	.	7	33	4.5	
do. . .	β Tauri	.	2	36	32	S.
do. . .	Caſtor	.	1	16	54	N.

The obſervation on Caſtor is very doubtful being not ſeen more than 3″ between the clouds.

Obſerved zenith diſtance of Pollux . 2° 32′ 1″.5

16th. Thermometer 78° at ſun riſe, roſe to 88°. —Thunder-guſt in the afternoon.—Cloudy with rain the remainder of the 24 hours.

17th.

17th. Thermometer 73° at ſun riſe, roſe to 87°. —Cloudy all day and night.

Obſerved zenith diſtance of β Tauri . 2° 36′ 33″ s.

18th. Thermometer 70° at ſun riſe, roſe to 81°.

Obſerved zenith diſtance of α Coro. Borealis 3° 37′ 59″.5 s.

Cloudy during the night.

19th. Thermometer 70° at ſun riſe, roſe to 74°. —Showery all the afternoon.

Obſerved zenith diſtance of β Tauri 2° 36′ 30″.5 s.

After this obſervation it was cloudy the remainder of the day.

20th. Thermometer 71° at ſun riſe, roſe to 80°. —The morning remarkably fine and clear, wind from the eaſt,—at 9^h A. M. it almoſt inſtantly became cloudy from the ſouth, and between noon and 1 o'clock, a guſt of rain accompanied with large hail ſtones from the S. W. paſſed about four miles to the north of our camp.

End of the obſervations made on the Chatahocha.

		h	′	″	Daily loſs. ″
Clock too ſlow mean time July 31ſt.	.	0	5	22	
do. . . Aug. 2d.	.	0	5	46	. . 12

Longitude weſt from Greenwich by the immerſion of the 3d ſatellite of ♃ on the 31ſt of July 5^h 37′ 59″.

Refult of the Obfervations made with the Large Sector on the Chatahocha, for the determination of the latitude.

The Zenith Diftances when arranged ftand as below.

	β Andromedæ. ° ′ ″	β Tauri. ° ′ ″	Caftor. ° ′ ″	Pollux. ° ′ ″	α Coro. Borealis. ° ′ ″	β Pegafi. ° ′ ″	α Andromedæ. ° ′ ″
Face of the Sector Eaft.							
July 30th.	3 32 48 N.	2 34 45.5 S.	1 18 35.5 N.	2 30 13 S.	3 36 11 S.	....	3 1 18.6 S.
31ft.	3 32 49.5	2 34 46.5	1 18 41	2 30 10	3 36 8.5	....	3 1 21
Auguft 1ft.	....	....	....	....	....	4 0 26 S.	3 1 22.8
3d.	....	....	....	2 30 14	3 36 7.5	4 0 25	....
4th.	3 32 49.5	2 34 47.5	1 18 36.4	2 30 12	3 36 8.5	4 0 28	....
Means	3 32 49	2 34 46.5	1 18 38	2 30 12.2	3 36 8.9	4 0 26.3	3 1 20.8
Face of the Sector Weft.							
6th.	3 31 5	....	....	2 32 0.5	....	4 2 9	3 3 5.5
7th.	....	....	....	....	....	4 2 7.5	....
8th.	3 31 5.5	....	....	....	....	4 2 7.5	3 3 3.5
9th.	3 31 7.5	....	1 16 57.5	2 31 58.5	....	....	3 3 45
14th.	....	....	....	2 32 0.5	3 37 56	....	....
15th.	....	2 36 32	1 16 54	2 32 1.5	3 37 56.5	....	....
17th.	....	2 36 33	....	....	....	....	....
18th.	....	....	....	....	3 37 59.5	....	....
19th.	....	2 36 30	....	....	....	....	....
Means	3 31 6	2 36 31.7	1 16 55.7	2 32 0.5	3 37 57.3	4 2 8	3 3 4.5
Means face eaft	3 32 49	2 34 46.5	1 18 38	2 30 12.2	3 36 8.9	4 0 26.3	3 1 20.8
Means	3 31 57.5	2 35 39.1	1 17 46.8	2 31 6.3	3 37 3.1	4 1 17.1	3 2 12.6
Refractions	+ 3.5	+ 2.6	+ 1.3	+ 2.5	+ 3.6	+ 4.0	+ 3.0
True zenith diftances	3 32 1.0	2 35 41.7	1 17 48.1	2 31 8.8	3 37 6.7	4 1 21.1	3 2 15.6

Mean

	β Andromedæ. ° ′ ″	β Tauri. ° ′ ″	Caſtor. ° ′ ″	Pollux. ° ′ ″	α Coro. Borealis. ° ′ ″	β Pegaſi. ° ′ ″	α Andromedæ. ° ′ ″
Mean declinations Aug. 8th.	34 33 17.2 N.	28 25 28.9 N.	32 18 51.3 N.	28 29 50 N.	27 23 53.5 N.	26 59 50.3 N.	27 59 7 N.
Aberrations	— 5.0	— 2.4	+ 0.8	+ 3.2	+ 13.7	+ 0.5	— 7.2
Nutations	— 2.7	+ 6.0	+ 8.4	+ 9.1	— 2.7	— 6.5	— 4.7
Semi. ann. equations . .	+ 0.4	— 0.4	— 0.4	— 0.3	0.0	+ 0.4	+ 0.4
True declinations . . .	34 33 9.9	28 25 32.1	32 19 0.1	28 30 2.0	27 24 4.5	26 59 44.7	27 58 55.6
True zenith diſtances applied	—3 32 1	+2 35 41.7	—1 17 48.1	+2 31 8.8	+3 37 6.7	+4 1 21.1	+3 2 15.6
Latitudes	31 1 8.9 N.	31 1 13.8 N.	31 1 12 N.	31 1 10.8 N.	31 1 11.2 N.	31 1 5.8 N.	31 1 11.2 N.

		°	′	″
Latitude by	β Andromedæ	31	1	8 9
do.	β Tauri	31	1	13.8
do.	Caſtor	31	1	12
do.	Pollux	31	1	10.8
do.	α Coro. Borealis	31	1	11.2
do.	β Pegaſi	31	1	5.8
do.	α Andromedæ	31	1	11.2
Mean latitude north	. . . .	31	1	10.5

Reſult

Refult of the Obfervations made with the Small Sector on the Chatahocha, for the determination of the Latitude.

The Zenith Diftances ftand as below.

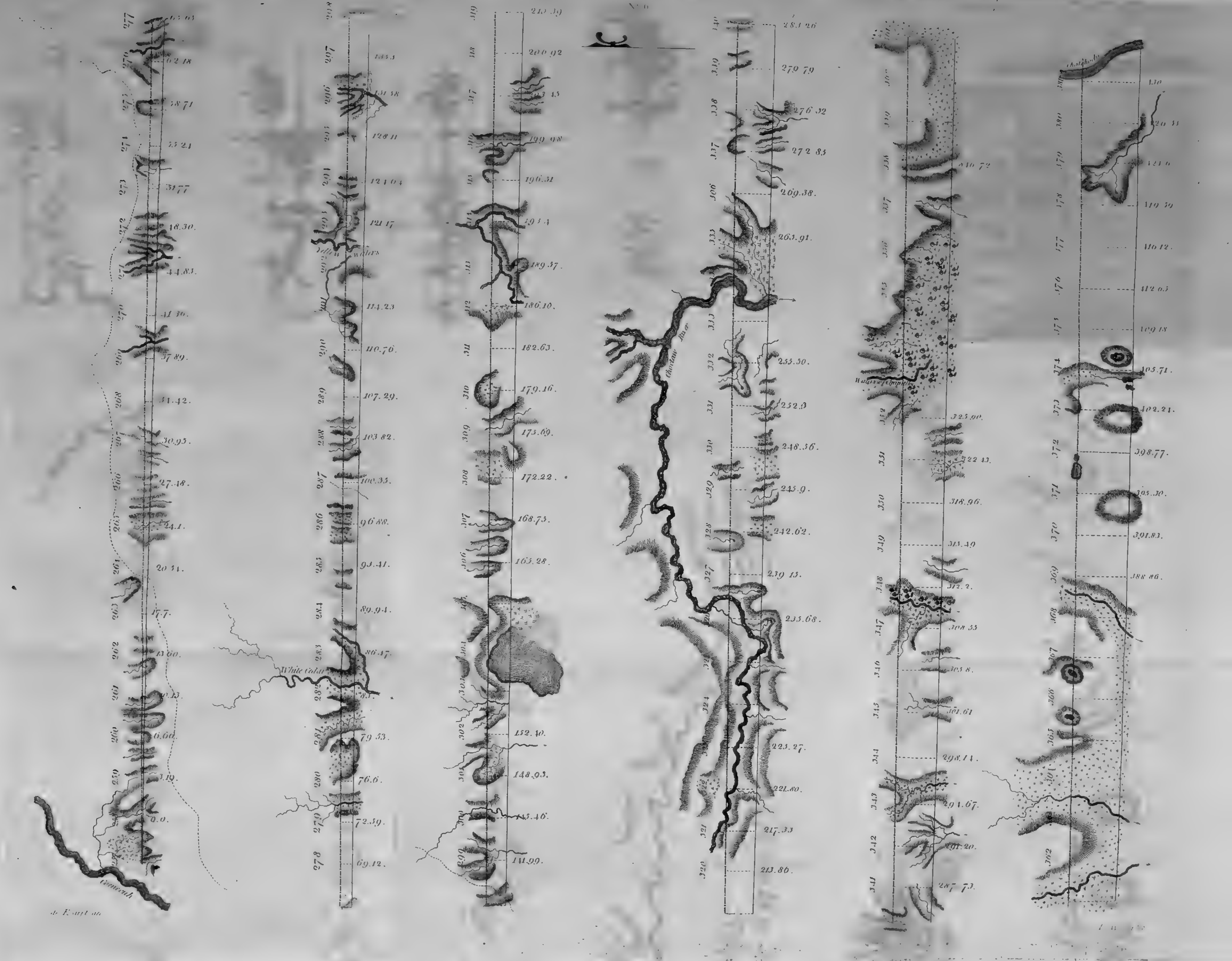
Face of the Sector Eaft.

	β Andromedæ. ° ′ ″	α Lyræ. ° ′ ″	β Pegafi. ° ′ ″	α Andromedæ. ° ′ ″
July 30th.	3 34 1.5 N.	. . . .	. . . .	. . . .
31ft.	3 33 58.5	. . . .	. . . .	. . . .
Auguft 1ft.	. . . .	. . . .	3 59 9 S.	3 0 19 S.
2d.	. . . .	7 37 30 N.	. . . .	. . . .
3d.	. . . .	7 37 36	. . . .	. . . .
4th.	3 34 7.5	7 37 12	3 59 12	3 0 28
5th.	3 34 1.5	7 37 36	3 59 24	3 0 16
Means	3 34 2.2	7 37 28.5	3 59 15	3 0 21

Face of the Sector Weft.

	β Andromedæ. ° ′ ″	α Lyræ. ° ′ ″	β Pegafi. ° ′ ″	α Andromedæ. ° ′ ″
6th.	3 29 30	. . . .	4 3 36	3 4 30
8th.	3 30 1	. . . .	4 3 21	3 4 15
9th.	3 29 31	7 32 45	4 3 22	3 4 27
10th.	. . . .	7 33 4.5	4 3 31.5	. . . .
14th.	. . . .	7 33 1.5	. . . .	. . . .
15th.	. . . .	7 33 4.5	. . . .	. . . .
Means	3 29 41	7 32 58.9	4 3 27.6	3 4 24
Means face eaft	3 34 2.2	7 37 28.5	3 59 15	3 0 21
Means	3 31 51.6	7 35 13.7	4 1 21.3	3 2 22.5
Refraction	+ 3.5	+ 7.6	+ 4.0	+ 3
True zenith diftance	3 31 55.1	7 35 21.3	4 1 25 3	3 2 25.5
Mean declination Auguft 8th.	34 33 17.2 N.	38 36 9.2 N.	26 59 50.3 N.	27 59 7 N.
Aberrations	— 5.0	+ 11.5	+ 0.5	— 7.2
Nutations	— 2.7	— 7.8	— 6.5	— 4.7
Semi-annual equations	+ 0.4	0.0	+ 0.4	+ 0.4
True declinations	34 33 9.9	38 36 12.9	26 59 44.7	27 58 55.5
True zenith diftances applied	—3 31 55.1	—7 35 21.3	+4 1 25.3	+3 2 25.5
Latitudes	31 1 14.8	31 0 51.6	31 1 10.0	31 1 21.0

Latitude



[illegible]

		°	′	″
Latitude by	β Andromedæ	31	1	14.8
do.	α Lyræ	31	0	51 6
do.	β Pegasi	31	1	10 0
do.	α Andromedæ	31	1	21 0
Mean latitude north		31	1	9.4

From the foregoing determinations it appears that the latitude given by the large sector, exceeds that given by the small one, 1″.1; but as the result given by the large one, all circumstances brought into view, may be considered five times as accurate as that by the small one: If therefore to five times the latitude given by the large sector, the latitude by the small one be added, and the sum divided by six, the quotient 31° 1′ 10″ may be taken as the true latitude of the observatory; which exceeds the parallel of 31° by 1′ 10″, or about 7110.5 feet, which distance was carefully laid off to the south, and the line corrected back as heretofore agreeably to plate X.—From the end of the last mentioned correction, a map, or chart of the river Chattahocha, or Apalachicola, was taken to the mouth of Flint river (see Plate N° XI.) but the mouth of Flint river not being a proper place for a course of observations, we encamped on a commanding eminence where the following observations were made.

Aug. 23d. Thermometer 91° in the afternoon.

24th. Set up the clock, and equal altitude instrument.—Thermometer 75° at sun rise, rose to 91°.

Began the observatory.

25th. *Equal altitudes of the Sun.*

A. M. 8h 35′ 23″. P. M. 3h 22′ 14″.

Thermometer 74° at sun rise, rose to 88°. —Finished the observatory and set up

Both Sectors, with their faces to the East.

Shower between 12 and 1 o'clock, cleared off in a short time, cloudy in the evening.

Observed zenith distance of Castor . 1° 37′ 42″ N.

26th.

26th. *Equal altitudes of the Sun.*
A. M. 9h 27′ 28″. P. M. 2h 29′ 34″.

Thermometer 76° at ſun riſe, roſe to 85°.—Shower of rain at noon, cloudy at 3 o'clock P. M. followed by a heavy rain. During this long continuation of rainy weather, the winds have been very light, and ſcarcely perceptible even when the clouds moved with prodigious rapidity. The winds have occupied no particular portion of the horizon, but have come from all quarters, and that in a ſmall portion of time.—The nights have generally been fairer than the days.

	°	′	″	
Obſerved zenith diſtance of Caſtor .	1	37	43	N.
do. . . Pollux .	2	11	7	S.

27th. Thermometer 74° at ſun riſe, roſe to 96°.

Equal altitudes of the Sun.
A. M. 8h 6′ 14″. P. M. 3h 50′ 8″.

			°	′	″	
Obſerved zenith diſtance of		α Lyræ (ſmall ſector)	7	56	18	N.
do.	. .	β Pegaſi . .	3	41	11.3	S.
do.	ſmall ſector	do. . .	3	40	0	S.
do.	. .	α Andromedæ .	2	42	8	S.
do.	ſmall ſector	do. . .	2	40	51	S.
do.	. .	β Andromedæ .	3	52	1.5	N.
do.	ſmall ſector	do. . .	3	52	53	N.
do.	. .	β Tauri . .	2	15	37	S.
do.	. .	Caſtor .	1	37	44	N.
do.	. .	Pollux . .	2	11	8	S.

28th. Thermometer 74° at ſun riſe, roſe to 96°.

Equal altitudes of the Sun.
A. M. 8h 26′ 6″. P. M. 3h 29′ 42″.

At

At half paſt 4 o'clock P. M. the ſky to the north loſt its fine blue, and became of a whitiſh brown, which in a ſhort time extended over the whole hemiſphere, and broke into ſmall clouds.—The evening was very diſtreſſing, the atmoſphere hazy, and ſuffocating, and not a breath of air perceptible till about 8 o'clock P. M. when we had a light breeze from the eaſt, which cleared, and corrected the atmoſphere.

			°	′	″	
Obſerved zenith diſtance of		β Pegaſi .	3	41	13	S.
do.	ſmall ſector	do. . .	3	40	42	S.
do.	. . . .	α Andromedæ	2	42	8.5	S.
do.	ſmall ſector	do. . .	2	41	0	S.
do.	. . .	β Andromedæ	3	52	2.5	N.
do.	ſmall ſector	do. . . .	3	53	11	N.

29th. Fog in the morning, ſucceeded by flying clouds.—Thermometer 80° all laſt night—roſe to 93°.

Obſerved zenith diſtance of α Coro. Borealis 3° 17′ 4″ S.

Turned the face of the large Sector to the Weſt.

Obſerved zenith diſtance of α Lyræ (ſmall ſector) 7° 56′ 6″ N.

Turned the face of the ſmall Sector to the Weſt.

		°	′	″	
Obſerved zenith diſtance of	β Tauri . .	2	17	17.5	S.
do. . .	Caſtor .	1	36	0	N.
do. . .	Pollux .	2	12	49	S.

30th. Thermometer 74° at ſun riſe, roſe to 95°.

			°	′	″	
Obſerved zenith diſtance of		α Coro. Borealis	3	18	45.5	S.
do.	ſmall ſector	α Lyræ	7	53	9	N.
do.	. .	β Pegaſi	3	42	51	S.
do.	ſmall ſector	do.	3	43	46	S.
do.	. .	α Andromedæ	2	43	46	S.
do.	ſmall ſector	do.	2	44	48	S.
do.	. .	β Andromedæ	3	50	22	N.
do.	ſmall ſector	do.	3	49	39	N.
do.	. .	β Tauri	2	17	16	S.
do.	. .	Caſtor	1	36	3.5	N.
do.	. .	Pollux	2	12	47	S.

31ſt. Thermometer 76° at ſun riſe, roſe to 93°.

			°	′	″	
Obſerved zenith diſtance of		α Coro. Borealis	3	18	46	S.
do.	ſmall ſector	α Lyræ	7	52	55	N.
do.	. .	β Pegaſi	3	42	51	S.
do.	ſmall ſector	do.	3	43	33	S.
do.	. .	α Andromedæ	2	43	44.5	S.
do.	ſmall ſector	do.	2	44	38	S.
do.	. .	β Andromedæ	3	50	23	N.
do.	ſmall ſector	do.	3	49	26	N.
do.	. .	β Tauri	2	17	17	S.
do.	. .	Pollux	2	12	47	S.

Sept. 1ſt. Thermometer 74° at ſun riſe, roſe to 94°.

Equal altitudes of the Sun.
A. M. 8^h 18′ 37″. P. M. 3^h 34′ 41″.

			°	′	″	
Obſerved zenith diſtance of		α Lyræ (ſmall ſector)	7	52	42	N.
do.	. .	β Pegaſi do.	3	43	28	S.
do.	. .	α Andromedæ do.	2	44	38	S.
do.	. .	β Andromedæ do.	3	49	16	N.
do.	. .	Caſtor	1	36	3.5	N.

2d. Thermometer 75° at ſun riſe, roſe to 90°.

Equal altitudes of the Sun.
A. M. 8^h 27′ 24″. P. M. 3^h 25′ 20″.

Cloudy part of the afternoon.

3d.

3d. Thermometer 73° at ſun riſe, roſe to 91°. —Cloudy great part of the day and night.

4th. Thermometer 76° at ſun riſe, roſe to 89°. —Cloudy all the afternoon and night.

5th. Thermometer 74° at ſun riſe, roſe to 87°. —Several ſhowers of rain in the courſe of the day.

Between 13, and 14 hours, traced a meridian by γ Caſſiopeæ, and α Urſæ Minoris.

Emerſion of the 3d ſatellite of ♃ obſerved at $14^h\ 40'\ 35''$. —a little foggy, but the belts were pretty diſtinct, magnifying power of the teleſcope 120.

	h	′	″
Sirius paſſed the firſt fibre of the tranſit inſtrument at	19	30	8
The meridian at	19	31	2
The third fibre at	19	31	52

6th. Thermometer 73° at ſun riſe, roſe to 89°. —A fine clear morning, the ſky remarkably blue.

	h	′	″	
☉'s preceding limb on the meridian at	11	54	8	A. M.
Subſequent do. at	11	56	17	A. M.
Centre at	11	55	12.5	A. M.

When the above obſervation was made, the tremor was ſo exceſſive that there was no poſſibility of biſecting the meridional mark with preciſion, nor of examining the line of collimation with the neceſſary accuracy.—Thunder-guſt in the afternoon.

Immerſion of the 1ſt ſatellite of ♃ obſerved at $14^h\ 15'\ 7''$ —Belts diſtinct, magnifying power 120.

	°	′	″
Sirius paſſed the firſt fibre of the tranſit inſtrument at	19	26	11
The meridian at	19	27	6
The third fibre at	19	27	56

 7th.

7th. Thermometer 73° at ſun riſe, roſe to 86°. —Heavy ſhower at day break, cloudy great part of the day with a little rain.

	h	′	″
δ Draconis paſſed the meridian at . .	8	1	9
α Aquilæ do. . at . .	8	29	36

8th. Thermometer 73° at ſun riſe, roſe to 87°. —Shower at day break.

About 8 o'clock this morning the minute hand of the clock was moved by an impertinent young Indian. The glaſs having been unfortunately broken by which the hands were left expoſed.—The clock was then ſet by my watch.

	h	′	″	
☉'s preceding limb on the meridian at	11	53	27	A. M.
Subſequent do. at	11	55	35	A. M.
Centre at	11	54	31	A. M.

Shower in the afternoon.

	h	′	″
δ Draconis paſſed the meridian at .	7	57	10
☽'s weſtern limb on the meridian at .	8	0	34
α Aquilæ on the meridian at . .	8	25	36

The obſerved times, and diſtances of the ☽'s weſtern limb from Antares.

	h	′	″	°	′	″	
	8	41	14	39	51	0	
	8	42	28	39	51	20	
	8	43	42	39	52	0	Error of the Sextant add 11″.
	8	44	28	39	52	20	
	8	45	39	39	52	30	
	8	46	54	39	52	50	
Means	8	44	4	39	52	0	

The

The obſerved times, and diſtances of the ☽'s weſtern limb from Fomalhaut.

	h	′	″	°	′	″	
	8	59	5	45	18	0	
	8	59	51	45	17	40	
	9	0	31	45	17	20	
	9	1	18	45	17	10	Error of the Sextant add 11″.
	9	2	9	45	17	0	
	9	3	5	45	16	40	
	9	3	53	45	16	30	
	9	4	43	45	16	0	
Means	9	1	49	45	17	2	

9th. Thermometer 74° at ſun riſe, roſe to 90°. —Thick fog till 8h A. M.

	h	′	″	
☉'s preceding limb on the meridian at	11	53	6	A. M.
Subſequent do. at . .	11	55	16	A. M.
Centre at . . .	11	54	11	A. M.

♀'s weſtern limb on the meridian at . . 2h 13′ 45″

Equal altitudes of the Sun.

A. M. 8h 10′ 23″. P. M. 3h 37′ 26″.

Theſe equal altitudes are doubtful 3 or 4 ſeconds from fog and clouds.

The obſerved times, and diſtances of the ☽'s weſtern limb from Antares.

	h	′	″	°	′	″	
	6	49	30	52	26	20	
	6	51	11	52	27	0	
	6	52	12	52	27	20	
	6	52	58	52	28	0	Error of the Sextant add 8″.
	6	53	36	52	28	20	
	6	54	31	52	28	20	
	6	55	37	52	28	30	
Means	6	52	48	52	27	41	

The

The obferved times, and diftances of the ☽'s weftern limb α Aries.

	h	′	″	°	′	″	
	8	31	55	95	30	20	
	8	32	55	95	30	0	
	8	33	45	95	29	40	
	8	35	7	95	29	20	Error of the Sextant add 8″.
	8	36	4	95	29	0	
	8	36	53	95	29	0	
	8	37	59	95	28	40	
Means	8	34	57	95	29	26	

☽'s weftern limb on the meridian at . 8h 56′ 20″

10th. Thermometer 71° at fun rife, rofe to 82°. —Foggy.

	h	′	″
Sirius on the firft fibre of the tranfit inftrument at	19	11	16
The meridian at	19	12	9
The third fibre at	19	13	0

11th. Thermometer 74° at fun rife, rofe to 91°.

Note. The obfervation on Sirius muft have been entered wrong, or the clock moved about 45″ forward during my abfence yefterday.

Cloudy all the afternoon with a little rain.

	h	′	″
Immerfion of the 2d fatellite of ♃ obferved at	13	12	0
Emerfion of do. at . . .	15	40	32

—Night clear, belts diftinct, magnifying power 120.

	h	′	″
Sirius paffed the firft fibre of the tranfit inftrument at .	19	7	16
The meridian at	19	8	10
The third fibre at	19	9	1

12th. Thermometer 74° at fun rife, rofe to 89°. Thunder-guft at noon.

Equal

Equal altitudes of the Sun.
A. M. 8h 23′ 0″. P. M. 3h 24′ 37″.

These equal altitudes are doubtful 6 or 7 seconds, on account of clouds which have intervened every afternoon since the 7th.

	h	′	″
δ Draconis passed the first fibre of the transit instrument at .	7	40	11
The meridian at	7	42	15
The third fibre at	7	44	26

α Aquilæ passed the first fibre of the transit instrument at .	8	9	50
The meridian at	8	10	41
The third fibre at	8	11	50

Immersion of the 3d satellite of ♃ observed at 16h 6′ 50″.—The night remarkably clear and fine, and I do not remember ever to have seen the satellites, and belts, more beautifully defined.—Magnifying power 120.

	h	′	″
Sirius passed the first fibre of the transit instrument at .	19	3	19
The meridian at	19	4	13
The third fibre at	19	5	3

13th. Thermometer 76° at sun rise, rose to 91°.

	h	′	″	
☉'s preceding limb on the meridian at	11	52	28	A. M.
Subsequent do. at . . .	11	54	36	A. M.
Centre at	11	53	32	A. M.

Equal altitudes of the Sun.
A. M. 8h 9′ 48″. P. M. 3h 36′ 56″.

	h	′	″
δ Draconis passed the first fibre of the transit instrument at .	7	36	12
The meridian at	7	38	16
The third fibre at	7	40	28

α Aquilæ passed the first fibre of the transit instrument at .	8	5	52
The meridian at	8	6	43
The third fibre at	8	7	32

Immersion

Immerſion of the 1ſt ſatellite of ♃ obſerved at $16^h\ 9'\ 20''$.—Belts middling diſtinct, magnifying power 120.—The ſatellite diſappeared uncommonly quick after it began to loſe its luſtre.

	°	′	″
Sirius paſſed the firſt fibre of the tranſit inſtrument at	18	59	20
The meridian at	19	0	15
The third fibre at	19	1	6

14th. Thermometer 74° at ſun riſe, roſe to 91°.—Cloudy part of the afternoon.

♀'s weſtern limb on the meridian at . $2^h\ 2'\ 45''$

Equal altitudes of the Sun.
A. M. $8^h\ 21'\ 22''$. P. M. $3^h\ 24'\ 38''$.

	°	′	″
Sirius paſſed the firſt fibre of the tranſit inſtrument at	18	55	25
The meridian at	18	56	19
The third fibre at	18	57	9

15th. Thermometer 72° at ſun riſe, roſe to 92°.

	°	′	″	
☉'s preceding limb on the meridian at	11	51	47	A. M.
Subſequent do. at . .	11	53	55	A. M.
Centre at . . .	11	52	51	A. M.

Note. Before the above obſervation was made, upon examining the tranſit inſtrument I found the ſcrew which ſcrews the perpendicular axis was ſlackened, which probably in ſome degree affected the preceding obſervation upon Sirius.

	h	′	″
♀'s weſtern limb upon the meridian at . .	2	0	2
Sirius paſſed the firſt fibre of the tranſit inſtrument at	18	51	31
The meridian at	18	52	25
The third fibre at	18	53	15

16th. Thermometer 76° at ſun riſe, roſe to 96°.—Cloudy part of the afternoon.

☉'s pre-

	h	′	″	
⊙'s preceding limb on the meridian at	11	51	26	A. M.
Subfequent do. at	11	53	34	A. M.
Centre at	11	52	30	A. M.

	h	′	″
Sirius on the firft fibre of the tranfit inftrument at	18	47	38
The meridian at	18	48	31
The third fibre at	18	49	22

End of the obfervations made at this ftation.

Examination of the meridian by the tranfits of δ Draconis, and α Aquilæ.

	h	′	″
Mean A. R. δ Draconis in time to the beginning of 1799.	19	12	27.9
Aberration and preceffion, Sept. 7th.		+	1.8
Nutation . . . do.		—	0.3
True A. R. δ Draconis	19	12	29.4
Mean A. R. α Aquilæ in time to the beginning of 1799	19	40	58.1
Aberration and preceffion, Sept. 7th.		+	2.8
Nutation . . . do.		—	0.7
True A. R. α Aquilæ	19	41	0.2
True A. R. δ Draconis	19	12	29.4
Difference	0	28	30.8
In 28′ 30″ fidereal time gains 4″.6 on mean folar time, which is therefore to be deducted		—	4.6
Difference in mean folar time	0	28	26.2
Obferved difference in mean folar time on the 7th. .	0	28	27
Error of the meridian to the eaft	0	0	0.8
Difference in A. R. between δ Draconis, and α Aquilæ on the 8th, mean folar time	0	28	26.2
Obferved difference on the 8th	0	28	26.0
Error of the meridian weft	0	0	0.2

	h	′	″
Difference in A. R. between δ Draconis and α Aquilæ on the 12th, mean folar time	0	28	26.5
Obferved difference on the 12th.	0	28	26
Error of the meridian to the weft	0	0	0.5

Difference in A. R. between δ Draconis, and α Aquilæ on the 13th, mean folar time	0	28	26.5
Obferved difference on the 13th	0	28	27.0
Error of the meridian to the eaft	0	0	0.5

Thofe ftars being well fituated to detect any error in the meridian, and as the error comes within the probable error of taking an obfervation, it may be confidered fufficiently correct.

Examination of the meridian by the equal altitudes* and tranfit of the ⊙'s centre on the 13th of September.

Equal altitudes of the Sun on that day.

	h	′	″
A. M. 8h 9′ 48″. P. M.	3	36	56
Add	12		
	15	36	56
Deduct forenoon's obfervation	—8	9	48
Divide by	2) 7	27	8
Half	3	43	34
Add forenoon's obfervation . . .	8	9	48
	11	53	22
Add equation for changes of the ⊙'s declination .		+	9.6
⊙'s centre on the meridian by equal altitudes at	11	53	31.6
⊙'s centre on the meridian by obfervation at .	11	53	32.0
Difference to the weft	0	0	0.4

The

* The equal altitudes before this day were taken with the equal altitude inftrument. The cup for holding the water with the roof, for making an artificial horizon being ftolen by the Indians, and not returned till the 12th. By a conftant practice of 16 years I find the equal altitudes taken from the artificial horizon rather more accurate, than when taken with the equal altitude inftrument.

The difference by the above obſervation likewiſe comes within the probable error of making an obſervation.

The rate of the clock's going at this ſtation.

			′ ″	daily loſs.	
Clock too ſlow mean time	Aug.	25th.	2 47.5	″ 1.9	By equal altitudes of the ⊙.
do.	.	26th.	2 49.4	1.5	
do.	.	27th.	2 50.9	0.1	
do.	.	28th.	2 51.0	2.0	
do.	Sept.	1ſt.	2 53.0	daily gain. 1.6	
do.	.	2d.	2 51.4	0.4	
do.	.	6th.	2 51	0.0	By tranſits of the ⊙'s centre over the meridian.
do.	.	8th.	2 51	daily loſs. 0.2	
do.	.	9th.	2 51.2		

On the 10th. between 10^h A. M. and 6^h P. M. the clock was altered about 45″ forward by accident, or otherwiſe.

		′ ″	daily loſs.	
Clock too ſlow mean time	13th.	2 7.4	″ 1	By the tranſit of the ⊙'s centre over the meridian.
do.	14th.	2 8.4	daily gain. 2.4	By equal altitudes of the ⊙.
do.	15th.	2 6.0	0.0	By the tranſits of the ⊙'s centre over the meridian.
do.	16th.	2 6.0		

Longitude of our obſervatory as deduced from the eclipſes of ♃ ſatellites and Lunar obſervations.

		h	′	″	
Sept. 5th.	By an Emerſion of the 3d ſatellite	5	38	58	Weſt from Greenwich.
6th.	. Immerſion of the 1ſt do.	5	39	18	
8th.	☽'s diſtance from Antares .	5	36	56	
	do. from Fomalhaut .	5	38	30	
9th.	. do. from Antares .	5	37	39	
	do. from α Aries .	5	38	8	
11th.	Immerſion of the 2d ſatellite .	5	37	29	
	Emerſion do. . .	5	36	35	
12th.	Immerſion of the 3d do. .	5	37	3	
13th.	do. . 1ſt do. .	5	39	20	

Refult of the Obfervations made with the large Sector, at our ftation near the mouth of Flint River, to determine the Latitude.

The Zenith diftances ftand as below.

Face of the Sector Eaft.

	β Andromedæ. ° ′ ″	β Tauri. ° ′ ″	Caftor. ° ′ ″	Pollux. ° ′ ″	α Coro. Borealis. ° ′ ″	β Pegafi. ° ′ ″	α Andromedæ. ° ′ ″
Auguft 25th.	. . . .	. . . .	1 37 42 N.	. . . .	. . . .	. . . .	. . . .
26th.	. . . .	. . . .	1 37 43	2 11 7 S.	. . . .	. . . .	. . . .
27th.	3 52 1.5 N.	2 15 37 S.	1 37 44	2 11 8	. . . .	3 41 11.3 S.	2 42 8 S.
28th.	3 52 2.5	. . . .	. . . .	. . . .	. . . .	3 41 13	2 42 8.5
29th.	. . . .	. . . .	. . . .	. . . .	3 17 4 S.	. . . .	. . . .
Means	3 52 2	2 15 37	1 37 43	2 11 7.5	3 17 4	3 41 12.1	2 42 8.2

Face of the Sector Weft.

	β Andromedæ. ° ′ ″	β Tauri. ° ′ ″	Caftor. ° ′ ″	Pollux. ° ′ ″	α Coro. Borealis. ° ′ ″	β Pegafi. ° ′ ″	α Andromedæ. ° ′ ″
	. . . .	2 17 17.5	1 36 0	2 12 49	. . . .	. . . .	. . . .
30th.	3 50 22	2 17 16	1 36 3.5	2 12 47	3 18 46	3 42 51	2 43 46
31ft.	3 50 23	2 17 17	. . . .	2 12 47	3 18 46	3 42 51	2 43 44
Sept. 1ft.	. . . .	. . . .	1 36 3.5	. . . .	. . . .	. . . .	. . . .
Means	3 50 22.5	2 17 16.8	1 36 2.3	2 12 47.7	3 18 46	3 42 51	2 43 45
Means face eaft	3 52 2	2 15 37	1 37 43	2 11 7.5	3 17 4	3 41 12.1	2 42 8.2
Means	3 51 12.2	2 16 26.9	1 36 52.6	2 11 57.6	3 17 55	3 42 1.5	2 42 56.6
Refractions	+ 3.8	+ 2.3	+ 1.6	+ 2.2	+ 3.3	+ 3.7	+ 2.7
True zenith diftances	3 51 16.0	2 16 29.2	1 36 54.2	2 11 59.8	3 17 58.3	3 42 5.2	2 42 59.3

Mean

	β Andromedæ. ° ′ ″	β Tauri. ° ′ ″	Caſtor. ° ′ ″	Pollux. ° ′ ″	α Coro. Borealis. ° ′ ″	β Pegaſi. ° ′ ″	α Andromedæ. ° ′ ″
Mean declinations Aug. 28th. .	34 33 18.2 N.	28 25 29.1 N.	32 18 51 N.	28 29 56.6 N.	27 23 52.1 N.	26 59 51.3 N.	27 59 8.1 N.
Aberrations	— 1.1	— 2.2	— 0.7	+ 0.5	+ 14.8	+ 4.8	+ 2.5
Nutations	— 2.6	+ 6.8	+ 8.4	+ 8.5	— 2.9	— 6.4	— 4.6
Semi-annual equations . . .	+ 0.4	— 0.4	+ 0.2	+ 0.1	— 0.5	+ 0.2	+ 0.4
True declinations	34 33 14.9	28 25 33.5	32 18 58.9	28 30 5.7	27 24 4.2	26 59 49.9	27 59 6.4
True zenith diſtances applied . .	—3 51 16	+2 16 29.2	—1 36 54.2	+2 11 59.8	+3 17 58.3	+3 42 5.2	+2 42 59.3
Latitudes N.	30 41 58.9	30 42 2.7	30 42 4.7	30 42 5.5	30 42 2.5	30 41 55.1	30 42 5.7

	°	′	″
Latitude by β Andromedæ	30	41	58.9
do. . β Tauri	30	42	2.7
do. . Caſtor	30	42	4.7
do. . Pollux	30	42	5.5
do. . α Coro. Borealis	30	42	2.5
do. . β Pegaſi	30	41	55.1
do. . α Andromedæ	30	42	5.7
Mean Latitude north	30	42	2.2

Reſult

Refult of the Obfervations made with the fmall Sector, at our ftation near the mouth of Flint River, to determine the Latitude.

The Zenith Diftances arranged ftand as below.

Face of the Sector Eaft.

	β Andromedæ. ° ′ ″	α Lyræ. ° ′ ″	β Pegafi. ° ′ ″	α Andromedæ. ° ′ ″
Aug. 27th.	3 52 53 N.	7 56 18 N.	3 40 0 S.	2 40 51 S.
28th.	3 53 11	. . . .	3 40 42	2 41 0
29th.	. . . .	7 56 6	. . . .	. . . .
Means	3 53 2	7 56 12	3 40 21	2 40 55.5
Face of the Sector Weft.				
30th.	3 49 39	7 53 9	3 43 46	2 44 48
31ft.	3 49 26	7 52 55	3 43 33	2 44 38
Sept. 1ft.	3 49 16	7 52 42	3 43 28	2 44 38
Means	3 49 27	7 52 55.3	3 43 36	2 44 41
Means face eaft	3 53 2	7 56 12	3 40 21	2 40 55.5
Means	3 51 14.5	7 54 33	3 41 58.5	2 42 48.2
Refractions	+ 3.8	+ 7.9	+ 3.7	+ 2.7
True zenith diftances	3 51 18.3	7 54 40.9	3 42 2.2	2 42 50.9
Mean declinations Auguft 28th.	34 33 18.2 N.	38 36 12.9 N.	26 59 51.3 N.	27 59 8.1 N.
Aberrations	— 1.1	+ 15.2	+ 4.8	+ 2.5
Nutations	— 2.6	— 7.8	— 6.4	— 4.6
Semi. ann. equations	+ 0.4	— 0.3	+ 0.2	+ 0.4
True declinations	34 33 14.9	38 36 20.3	26 59 49.9	27 59 6.4
True zenith diftances applied	—3 51 18.3	--7 54 40.9	+3 42 2.2	+2 42 50.9
Latitudes N.	30 41 56.6	30 41 39.4	30 41 52.1	30 41 57.3

Latitude

		°	′	″
Latitude by	β Andromedæ .	30	41	56.6
do. .	α Lyræ .	30	41	39.4
do. .	β Pegasi ,	30	41	52.1
do. .	α Andromedæ .	30	41	57.3
Mean Latitude North	.	30	41	51.3

From the result of the foregoing observations, the latitude of our observatory by the large sector, comes out 30° 42′ 2″.2 N. and by the small one 30° 41′ 51″.3 N. By proceeding as in the former cases where both sectors were used, and the due weight given each, the latitude appears to be 30° 42′ 0″.4, which we took for the true latitude of the observatory.

The ground about the mouth of Flint river not being fit for encamping on, in consequence thereof, we pitched on the nearest commanding eminence, from which with the least labour in falling the timber, the junction of the rivers might be discovered: In order to connect our work with the junction of the rivers, the following method was pursued. From the observatory A (see Fig. G, Plate XI.) a vista was opened to give us a view of the point of land B, between the rivers. The angle which the line AB made with the meridian AN, we had to determine by measurement, the astronomical circle which was admirably calculated for that purpose, was sent away a few days before (we were compelled by the Indians to leave the country) on account of its weight, as I was informed by the commissioner for His Catholic Majesty! To find the value of this angle, the triangle ANC was formed on the ground.—AN a portion of the meridian was equal to 396.125 feet, AC, a portion of the line in the direction of the junction of the rivers was equal to 496.623 feet, and NC the side opposite to the required angle, was equal to 336.583 feet*—the sides being given, the angle CAN comes out to the nearest second 45° 10′ 19″ west of north. The distance from A to B was found by measurement to be 369 perches, from which by the solution of a plane right-angled triangle, the difference of latitude will be found to be 260.14 perches, or about 42″.4, which added to the latitude of the observatory will give 30° 42′ 42″.8 for the latitude of the junction of the rivers.—The sides of the triangle, with the points of intersection were formed with the utmost accuracy by the transit instrument.

On the 17th day of September, at the time we were preparing to extend the line from the mouth of Flint river to the source of the St. Mary's, the hostile disposition

* The three decimal places annexed to the feet arose from taking the means of many measurements made on each line.

ſition of the Indians, and an attempt to plunder our camp, compelled us to relinquiſh our deſign, and leave the country. On the 9th day of December following we met at the town of St. Mary's, and took into conſideration the further proſecution of our buſineſs, and came to a concluſion,—that we could not attempt with any probability of ſucceſs, more than to determine the ſource of the St. Mary's, with its geographical poſition, until the waters ſhould ſubſide, and the ſwamps be dried by the ſummer heats, which could not be expected in leſs than eight months, added to an oppoſition we had a right to look for from the Indians.—In order to determine the geographical poſition of the river St. Mary's, we erected an obſervatory at Point Peter, near the mouth of the river, as a given point; from whence the latitude, and longitude of the ſource of the river might be determined by meaſurement, if we ſhould fail, either in carrying on our apparatus, or in obtaining a ſufficient number of obſervations for that purpoſe.

At Point Peter the following obſervations were made.

Dec. 14th. Set up the clock.

15th. Cloudy.

16th. Set up the ſmall Sector with the face to the Eaſt.

Thermometer 51° at ſun-riſe, roſe to 67°.

Equal altitudes of the Sun.
A. M. 9ʰ 14′ 59″. P. M. 2ʰ 41′ 7″.

These equal altitudes are doubtful a few ſeconds, but not more than 4.

Cloudy

Nº7


Chatahocha or
Apalachicola River
Fig. 17.
B
C
X
A
Scale 100 feet an inch.
C. de la Vgt. del
Lassen fc.

Cloudy all the afternoon after 3^h P. M. and continued ſo all night.

17th. Fog in the morning, cloudy all day.—Thermometer 57° at ſun riſe, roſe to 70°. Heavy rain at night.

18th. Thermometer 56° at ſun riſe, roſe to 64°.—Fine rain in the morning. Strong wind from the N. E.—Cloudy with rain all the afternoon and night.

19th. Thermometer 55° at ſun riſe, roſe to 69°.—Heavy fog early in the morning.—Flying clouds all day and rain in the evening.

20th. Thermometer 60° at ſun riſe, fell to 58°.—Cloudy all day, fine rain in the morning and a heavy rain at night.

21ſt. Thermometer 59° at ſun riſe, fell to 54° in the afternoon, cloudy with heavy rain moſt of the day.—Wind from the N. W. in the evening.

22d. Thermometer 54° at ſun riſe, roſe to 55°.—Cloudy early in the morning and in the evening.

Obſerved zenith diſtance of α Lyræ . 7° 55′ 37″ N.

Equal altitudes of the Sun.
A. M. 9^h 1′ 32″. P. M. 3^h 7′ 28″.

23d. Thermometer 54° at ſun riſe, roſe to 56°.—Cloudy all laſt night and this day with fine rain, wind S. W. cleared off in the evening with a N. W. wind.

			°	′	″	
Obſerved zenith diſtance of	β Tauri	.	2	15	3	S.
do. . .	Caſtor	.	1	38	12	N.
do. . .	Pollux	.	2	10	38	S.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 15h 40′ 51″.
Night clear, belts diſtinct, magnifying power 120.

24th. Thermometer 34° at ſun riſe, roſe to 54°.

Obſerved zenith diſtance of α Lyræ . 7° 55′ 37″ N.

Equal altitudes of the Sun.
A. M. 9h 22′ 17″. P. M. 2h 50′ 12″.

		°	′	″	
Obſerved zenith diſtance of	α Andromedæ	2	44	22	S.
do. . .	β Andromedæ	3	53	16	N.
do. . .	β Tauri .	2	14	51	S.
do. . .	Caſtor .	1	38	20	N.

25th. Thermometer 30° at ſun riſe, roſe to 51°.

Obſerved zenith diſtance of α Lyræ . 7° 55′ 46″ N.

Equal altitudes of the Sun.
A. M. 9h 20′ 21″. P. M. 2h 53′ 50″.

Obſerved zenith diſtance of	α Andromedæ	2°	41′	16″	S.
do. . .	β Andromedæ	3	53	16	N.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 10h 9′ 50″.
Night clear, belts diſtinct, magnifying power 120.

Obſerved zenith diſtance of Pollux . 2° 10′ 34″ S.

26th. Thermometer 41° at ſun riſe, roſe to 49°.
—Cloudy all day and night.

Turned the face of the Sector Weſt.

27th. Thermometer 50° at ſun riſe, roſe to 64°.

Obſerved zenith diſtance of α Lyræ . 7° 48′ 25″.

Equal altitudes of the Sun.
A. M. 9h 19′ 51″. P. M. 2h 57′ 42″.

Observed zenith distance of	α Andromedæ	.	2° 48′ 37″ S.
do. . .	β Andromedæ	.	3 45 48 N.

Emersion of the 2d satellite of ♃ observed at 7^h 16′ 0″. —Belts distinct, magnifying power 120.

			°	′	″	
Observed zenith distance of	β Tauri	.	2	22	20	S.
do. . .	Castor	.	1	30	52	N.
do. . .	Pollux	.	2	17	57	S.
do. . .	α Lyræ*	.	7	48	24	N.

28th. Thermometer rose to 80°.—Cloudy in the morning.—Wind S. E.

Observed zenith distance of	α Andromedæ	2° 48′ 33″ S.
do. . .	β Andromedæ	3 45 50 N.

29th. Thermometer 67° at sun rise, fell to 63° in the afternoon.—Heavy rain great part of the day.—At 10 o'clock P. M. wind shifted to the S. W. and blew with great violence,—became clear at short intervals.

			°	′	″	
Observed zenith distance of	β Tauri	.	2	22	21	S.
do. . .	Castor	.	1	31	0	N.
do. . .	Pollux	.	2	17	59	S.

30th. Thermometer 54° at sun rise, fell to 44° in the afternoon, and to 33° at 7^h P. M.—Strong N. W. wind with flying clouds.

In the evening finished our meridian by circum-polar stars, this work was begun on the evening of the 29th.

31st. Thermometer 25° at sun rise, rose to 44°.

O o 2 Equal

* On the meridian twice this day from sidereal time gaining on mean solar time.

Equal altitudes of the Sun.
A. M. $9^h\ 41'\ 37''$. P. M. $2^h\ 42'\ 19''$.

γ Caſſiopeæ paſſed the meridian at .	$6^h\ 11'\ 37''$
Pole ſtar at	6 19 8

1800.

Jan. 1ſt. Thermometer 28° at ſun riſe, roſe to 54°. —Wind N. E. ſcattering clouds from the S. E.

Emerſion of the 1ſt ſatellite of ♃ obſerved at $12^h\ 6'\ 43''$. —Belts diſtinct, magnifying power 120.

An immerſion of the 4th ſatellite is entered in the Nautical Almanac to happen at Greenwich at $17^h\ 18'\ 30''$, and the emerſion at $18^h\ 44'\ 22''$. As the immerſion was to happen but $1'\ 52''$ from the emerſion of the 1ſt ſatellite, it was a favourable opportunity to make both obſervations at one ſetting. At 12^h I placed myſelf at the teleſcope, and as ſoon as I had adjuſted the inſtrument to my eye, I thought the 4th ſatellite had loſt ſome of its luſtre. After noting the emerſion of the 1ſt ſatellite, I again applied myſelf to the inſtrument, but the 4th ſatellite ſtill continued viſible, and had altered but very little ſince I firſt obſerved it; it was very diſtinct at $12^h\ 42'$, and at 13^h had nearly if not quite recovered its luſtre.

2d. Thermometer 54° all day.—Heavy rain, wind N. E. till evening, ſhifted to the N. W. in the night when it became clear.

3d. Thermometer 39° at ſun riſe, roſe to 53°.

Equal altitudes of the Sun.
A. M. $9^h\ 27'\ 30''$. P. M. $3^h\ 1'\ 18''$.

Emerſion of the 1ſt ſatellite of ♃ obſerved at $6^h\ 35'\ 39''$. —Belts diſtinct, and the planet and ſatellites remarkably well defined, magnifying power 120.

Emerſion of the 2d ſatellite of ♃ obſerved at $9^h\ 55'\ 59''$. —Belts and ſatellites very diſtinct, magnifying power 120.

4th. Thermometer 36° at ſun riſe, roſe to 54°.

Equal

Equal altitudes of the Sun.
A. M. 9^h 48′ 45″. P. M. 2^h 41′ 38″.

5th. Thermometer 36° at fun rife.—Cloudy all day.

6th. Thermometer 34° at fun rife, rofe to 61°.

Equal altitudes of the Sun.
A. M. 9^h 30′ 21″. P. M. 3^h 9′ 3″.

7th. Thermometer 38° at fun rife.—Cloudy all day.

8th. Thermometer 40° at fun rife, rofe to 48°.

Emerfion of the 1ft fatellite of ♃ obferved at 14^h 3′ 12″ —Hazy, neither ♃ nor his fatellites well defined, magnifying power 120.

9th. Thermometer 38° at fun rife, rofe to 42°. —Fine rain part of the day, and rain with hail during the night—wind N. E.

10th. Thermometer 37° at fun rife, rofe to 40°. —Snow and hail the whole day! which continued till 10 o'clock in the evening, when the thermometer fell to 32°, the wind fhifted to N. W. and it became clear at midnight.

11th. Thermometer 28° at fun rife, rofe to 40°. —Snow five inches deep.

Equal altitudes of the Sun.
A. M. 9^h 36′ 25″. P. M. 3^h 4′ 24″.

12th. Thermometer 34° at fun rife, rofe to 67°. —Cloudy great part of the day.

13th. Thermometer 46° at fun rife, rofe to 57°. —Cloudy all day.

14th. Thermometer 40° at ſun riſe, roſe to 62°. —Cloudy.

15th. Thermometer 42° at ſun riſe, roſe to 61°. —Cloudy in the evening.

Equal altitudes of the Sun.
A. M. $9^h\ 49'\ 22''$. P. M. $2^h\ 57'\ 0''$.

16th. Thermometer 45° at ſun riſe, roſe to 67°.

17th. Thermometer 64° at ſun riſe, fell to 42° in the evening, cloudy in the morning, light ſhower at 11^h A. M. cleared off at noon with a moſt violent wind from the weſt, which ſhifted to the N. W. in the evening.

The obſerved times, and diſtances, of the ☉'s and ☽'s neareſt limbs.

	h	'	"	°	'	"	
	20	40	4	86	23	50	
	20	41	23	86	23	40	
	20	42	7	86	23	10	
	20	42	52	86	22	40	Error of the Sextant add 8″.
	20	43	34	86	22	30	
	20	44	10	86	22	00	
	20	44	48	86	21	55	
	20	45	30	86	21	30	
Means	20	43	3	86	22	39	

Repeated.

	h	'	"	°	'	"	
	21	1	29	86	16	0	
	21	1	58	86	15	50	
	21	2	35	86	15	30	Error of the Sextant add 8″.
	21	3	7	86	15	30	
	21	3	41	86	15	0	
	21	4	13	86	14	40	
Means	21	2	50	86	15	25	

18th.

18th. Thermometer 38° at ſun riſe, roſe to 58°.

Equal altitudes of the Sun.
A. M. 9h 45′ 10″. P. M. 3h 5′ 8″.

At 6h prepared to obſerve the eclipſe of ♃'s 4th ſatellite.—At about 6h 20′ the ſatellite began to loſe its luſtre, which gradually diminiſhed till about 6h 46′,—from that time it was not diſcernible with a magnifying power of 50, but diſtinct with 120.—at 7h 23′ 47″ it was evidently more bright, and at 7h 35′ had almoſt recovered its uſual brightneſs.

The obſerved times, and diſtances of the ☉'s and ☽'s neareſt limbs.

	h	′	″	°	′	″	
	20	46	32	73	9	30	
	20	47	35	73	9	0	
	20	48	12	73	8	50	
	20	48	44	73	8	30	
	20	49	20	73	8	15	
	20	50	6	73	8	0	Error of the Sextant add 8″.
	20	50	43	73	7	40	
	20	51	18	73	7	30	
	20	51	51	73	7	20	
	20	52	25	73	7	15	
	20	53	0	73	6	0	
Means	20	49	59	73	8	10	

Repeated.

	h	′	″	°	′	″	
	21	15	29	72	59	20	
	21	16	33	72	59	00	
	21	17	9	72	58	50	
	21	17	52	72	58	40	
	21	18	32	72	58	20	
	21	19	9	72	58	00	Error of the Sextant add 8″.
	21	19	40	72	57	40	
	21	20	22	72	57	30	
	21	20	54	72	57	20	
	21	21	20	72	57	0	
Means	21	18	42	72	58	10	

19th.

19th. Thermometer 37° at ſun riſe, roſe to 54°.

Equal altitudes of the Sun.
A. M. $10^h\ 1'\ 6''$. P. M. $2^h\ 50'\ 21''$.

Theſe equal altitudes are doubtful 2 or 3 ſeconds but not more, from the violence of the wind.

Rate of the clock's going at Point Peter.

1799.				′	″	Daily gain. ″
Clock too faſt mean time	Dec.	16th.	.	3	41.2	
do.	.	22d.	.	5	17.6	. . 19.4
do.	.	24th.	.	6	1.1	. . 21.7
do.	.	25th.	.	6	21.7	. . 20.6
do.	.	27th.	.	7	2.4	. . 20.3
do.	.	31ſt.	.	8	16.0	. . 18.4
1800. do.	Jan.	3d.	.	9	16.0	. . 20.1
do.	.	4th.	.	9	35.9	. . 19.6
do.	.	6th.	.	10	15.3	. . 19.7
do.	.	11th.	.	11	49.8	. . 18.9
do.	.	15th.	.	13	7.0	. . 19.3
do.	.	18th.	.	14	4.9	. . 19.3
do.	.	19th.	.	14	23.7	. . 18.3

Reſult of the Obſervations for the Longitude.

1799.		h	′	″	
By an emerſion of the 1ſt ſatellite of ♃ on Dec. 23d.		5	26	27	West from Greenwich.
25th.	do.	5	26	37	
27th.	2d. do.	5	25	27	
1800. Jan. 1ſt.	1ſt. do.	5	26	27	
3d.	do.	5	26	45	
do.	2d. do.	5	25	47	
17th.	By a lunar obſervation	5	26	56	
do.	do.	5	27	3	
18th.	do.	5	25	42	
do.	do.	5	26	3	

Reſult

Refult of the Obfervations made at Point Peter to determine the Latitude.

The Zenith diftances ftand as below.

Face of the Sector Eaft.

1799.	β Andromedæ ° ′ ″	β Tauri. ° ′ ″	Caftor. ° ′ ″	Pollux. ° ′ ″	α Lyræ. ° ′ ″	α Andromedæ. ° ′ ″
Dec. 22d.	. . . .	. . . . . .	. . . .	. . . .	7 55 37 N.	. . . .
23d.	. . . .	2 15 3 S.	1 38 12 N.	2 10 38 S.	. . . .	. . . .
24th.	3 53 16 N.	2 14 51	1 38 20	. . . .	7 55 37	2 41 22 S.
25th.	3 53 16	. . . .	. . . .	2 10 34	7 55 46	2 41 16
Means	3 53 16	2 14 57	1 18 16	2 10 36	7 55 40	2 41 19

Face of the Sector Weft.

	β Andromedæ	β Tauri.	Caftor.	Pollux.	α Lyræ.	α Andromedæ.
27th.	3 45 48	2 22 20	1 30 52	2 17 57	7 48 25	2 48 37
28th.	3 45 51	. . . .	. . . .	. . . .	7 48 24	2 48 33
29th.	. . . .	2 22 21	1 31 0	2 17 59	. . . .	. . . .
Means	3 45 49.5	2 22 20.5	1 30 56	2 17 58	7 48 24.5	2 48 35
Means face eaft	3 53 16	2 14 57	1 18 16	2 10 36	7 55 40	2 41 19
Means	3 49 32.7	2 18 38.7	1 34 36	2 14 17	7 52 2.2	2 44 57
Refractions	+ 3.8	+ 2.3	+ 1.6	+ 2.2	+ 7.9	+ 2.7
True zenith diftances . . .	3 49 36.5	2 18 41	1 34 37.6	2 14 19.2	7 52 10.1	2 44 59.7
Mean declinations Dec. 25th. . .	34 33 26 N.	28 25 28 N.	32 18 47 N.	28 29 47 N.	38 36 15 N.	27 59 13 N.
Aberrations	+ 10.8	+ 2	— 3.4	— 3.4	+ 1	+ 9
Nutations	— 1.7	+ 7	+ 8.6	+ 8.7	— 8	— 3.4
True declinations . . .	34 33 35.1	28 25 37	32 18 52.2	28 29 52.3	38 36 8	27 59 18.0
True zenith diftances applied .	—3 49 36.5	+2 18 41	—1 34 37.6	+2 14 19.2	—7 52 10.1	+2 44 59.7
Latitudes N. . . .	30 43 58.6	30 44 18	30 44 14.6	30 44 14.5	30 43 57.9	30 44 18.3

Latitude

		°	′	″
Latitude by β Andromedæ	.	30	43	58.6
do. β Tauri	.	30	44	18
do. Caſtor	.	30	44	14.6
do. Pollux	.	30	44	11.5
do. α Lyræ	.	30	43	57.9
do. α Andromedæ	.	30	44	18.3
Mean Latitude north	.	30	44	9.8*

Examination of the meridian by the tranſit of γ Caſſiopeæ and α Urſæ Minoris or the Pole ſtar.

	°	′	″
Mean A. R. γ Caſſiopeæ Dec. 31ſt 1799	11	11	11.3
Aberration		—	1.3
Nutation		—	23.3
True A. R. γ Caſſiopeæ	11	10	46.7

Mean A. R. Pole ſtar Dec. 31ſt 1799	13	6	47.0
Aberration		+	36.0
Nutation	—	4	30
True A. R. Pole ſtar	13	2	53
do. γ Caſſiopeæ	11	10	46.7
Difference	1	52	6.3

	′	″
The above difference is nearly, in mean ſolar time equal to	7	27
Obſerved difference on the 31ſt of Dec.	7	31
Difference	0	4

The difference between the calculated, and obſerved time, is ſo ſmall, that it is ſcarcely ſufficient with the very beſt inſtrument to be perceptible in the motion of the Pole ſtar. The meridian may therefore be conſidered as ſufficiently accurate for the following purpoſe.

In

* Although this reſult is deduced from obſervations made with the ſmall ſector only, it may be conſidered as ſufficiently accurate for the niceſt geographical purpoſes.

In order to determine the exact positions of the flag staff in the fort at Point Peter, the south end of Cumberland Island, and the north end of Amelia Island, the meridian was extended south from the observatory the distance of 99.12 perches.

		°	′	″	
From the observatory the bearing of the flag staff in the fort was	S.	22	23	00	E.
From do. to a signal on the north end of Amelia Island	S.	62	53	00	E.
From do. to do. on the south end of Cumberland Island	S.	65	30	30	E.
From the south end of the base the bearing of the flag staff in the fort was	S.	42	19	30	E.
From do. to the signal on the north end of Amelia Island	S.	66	33	00	E.
From do. to do. on the south end of Cumberland Island	S.	72	2	30	E.

From these data by plain trigonometry the distance from the observatory to the flag staff in the fort comes out	195.7	Perches.
From do. to the signal on the north end of Amelia Island	1421.9	
From do. to do. on the south end of Cumberland Island	828.7	

	°	′	″
Diff. of latitude between the observatory and flag staff	0	0	29.5
do. signal on Amelia Island	0	1	45.7
do. do. on Cumberland Island	0	0	56.0

	°	′	″	
The latitude of the flag staff is therefore	30	43	40.3	North.
do. north end of Amelia Island	30	42	24.1	
do. south end of Cumberland	30	43	13.8	

From which it appears that the junction of the Chatahocha, or Apalachicola, and Flint Rivers, and the entrance between Cumberland, and Amelia Islands into the sound, are precisely in the same parallel of latitude.

The angles were taken with the instrument already mentioned, made by Mr George Adams.

1800.

Feb. 6th. Ascended the St. Mary's as high as it was navigable for canoes.*

* We ascended the river with as little loading and baggage as possible.—I even left my hat and thermometer.

7th. Sent out a party to difcover the fource of the river or its communication with Okefonoke fwamp. Set up the clock.

8th. Cloudy with heavy rain.

9th. *Equal altitudes of the Sun.*
A. M. 9^h 2′ 46″. P. M. 2^h 53′ 18″.

10th. Cloudy all day with an appearance of rain.

11th. Shower at day break—Cloudy all day with cold N. wind.

12th. Smart froft, cold all day, and cloudy in the evening.

Equal altitudes of the Sun.
A. M. 8^h 46′ 1″. P. M. 3^h 10′ 15″.

The telefcope and tranfit inftrument arrived.

13th. Very cloudy, and cold in the morning:—heavy rain all the afternoon and night.

14th. Cloudy with fine rain in the forenoon: cleared off in the afternoon with a N. W. wind.

Set up both Sectors with the faces to the Eaft.

			°	′	″	
Obferved zenith diftance of	β Tauri	(fmall fector)	1	52	31	S.
do. . .	Caftor	.	1	58	6	N.
do. fmall fector	do.	. .	2	1	3	N.
do. . .	Pollux	. .	1	50	49	S.
do. fmall fector	do.	. .	1	47	49	S.
do. fmall fector	α Coro. Borealis	.	2	54	26	S.

15th. Very cool, ftrong wind from the N. W.

Obferved zenith diftance of β Andromedæ 4° 12′ 38″ N.

Equal

Equal altitudes of the Sun.
A. M. 8h 54′ 45″. P. M. 3h 1′ 24″.

Theſe equal altitudes are doubtful a few ſeconds (from the violence of the wind) but not more than four.

			°	′	″	
Obſerved zenith diſtance of		β Tauri . .	1	55	13	S.
do.	ſmall ſector	do. . .	1	52	35	S.
do.	. . .	Caſtor . .	1	58	10	N.
do.	. . .	Pollux .	1	50	46	S.
do.	. . .	α Coro. Borealis	2	57	16	S.
do.	ſmall ſector	do. . .	2	54	34	S.

The obſerved times, and diſtances, of the ☉'s and ☽'s neareſt limbs.

	h	′	″	°	′	″	
	19	48	31	90	56	30	
	19	49	35	90	56	00	
	19	50	28	90	55	40	
	19	51	8	90	55	30	Error of the Sextant add 5″.
	19	51	42	90	55	20	
	19	52	9	90	55	0	
	19	52	34	90	54	50	
	19	53	6	90	54	20	
Means	19	51	9	90	55	24	

16th. *Equal altitudes of the Sun.*
A. M. 9h 2′ 32″. P. M. 2h 53′ 29″.

Theſe equal altitudes are doubtful 2 or 3 ſeconds from the interference of clouds.

			°	′	″	
Obſerved zenith diſtance of		β Tauri .	1	55	9	S.
do.	ſmall ſector	do. .	1	52	36	S.
do.	. .	Caſtor .	1	58	7	N.
do.	ſmall ſector	do. .	2	0	51	N.
do.	. .	Pollux .	1	50	50	S.
do.	ſmall ſector	do. .	1	47	36	S.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 12h 5′ 40″. Night very fine, belts diſtinct, magnifying power 120.

Obſerved

Obſerved zenith diſtance of α Coro. Borealis		2° 57′ 19″ s.
do. ſmall ſector	do.	2 54 29 s.

17th. Cloudy in the morning and continued ſo at times all day.

Equal altitudes of the Sun.
A. M. 9ʰ 24′ 49″. P. M. 2ʰ 31′ 3″.

The above equal altitudes are doubtful 2 or 3 ſeconds on account of the clouds.

Hazy all the evening.

Obſerved zenith diſtance of Caſtor	.	1° 58′ 9″ N.
do. . .	Pollux .	1 50 50 s.

Between 14 and 15 hours traced a meridian by ε Urſæ Majoris and the Pole ſtar.

Obſerved zenith diſtance of α Lyræ (ſmall ſector) 8° 17′ 8″ N.

The obſerved times, and diſtances, of the ☉'s and ☽'s neareſt limbs.

	h	′	″	°	′	″	
	19	53	40	64	40	00	
	19	54	14	64	39	50	
	19	54	43	64	39	40	
	19	55	22	64	39	30	
	19	56	1	64	39	20	
	19	56	26	64	39	00	Error of the Sextant add 5″.
	19	56	49	64	38	50	
	19	57	21	64	38	40	
	19	57	59	64	38	40	
	19	58	38	64	38	30	
	19	59	10	64	38	20	
Means	19	56	24	64	39	7	

		h	′	″	
18th.	☉'s preceding limb on the meridian at	11	56	35	A. M.
	Subſequent do. at . .	11	58	48	A. M.
	Centre do. at . . .	11	57	41	A. M.

Obſerved

Obſerved zenith diſtance of β Andromedæ 4° 12′ 39″ N.

Equal altitudes of the Sun.
A. M. 8h 57′ 23″. P. M. 2h 58′ 20″.

Turned the Face of the ſmall Sector Weſt.

Cloudy at times all the afternoon and night.

Obſerved zenith diſtance of Caſtor (ſmall ſector) 1° 53′ 40″ N.

The obſerved times, and diſtances, of the ☉'s and ☽'s neareſt limbs.

	h	′	″	°	′	″	
	20	0	7	51	39	30	
	20	0	43	51	39	20	
	20	1	22	51	39	10	
	20	2	15	51	39	0	
	20	3	6	51	38	50	Error of the Sextant add 5″.
	20	3	42	51	38	40	
	20	4	27	51	38	20	
	20	4	59	51	38	0	
	20	5	37	51	37	50	
	20	6	14	51	37	40	
Means	20	3	15	51	38	38	

☽'s Subſequent limb on the meridian at . 20h 38′ 00″.

The obſerved times, and diſtances, of the ☉'s and ☽'s neareſt limbs.

	h	′	″	°	′	″	
	20	37	42	51	28	30	
	20	39	14	51	27	50	
	20	39	50	51	27	40	
	20	40	20	51	27	30	Error of the Sextant add 5″.
	20	41	2	51	27	20	
	20	41	29	51	27	00	
	20	41	59	51	26	50	
	20	42	30	51	26	40	
Means	20	40	31	51	27	25	

♀ paſſed

♀ paſſed the meridian at . . $21^h\ 11'\ 32''$ centrum.

19th. Smart froſt this morning, very cloudy at noon, clear at 2^h P. M.

Equal altitudes of the Sun.
A. M. $8^h\ 48'\ 44''$. P. M. $3^h\ 6'\ 49''$.

Turned the Face of the large Sector Weſt.

		°	′	″	
Obſerved zenith diſtance of β Tauri	.	1	56	56	S.
do. ſmall ſector do.	.	1	59	6	S.
do. . . Caſtor	.	1	56	17	N.
do. ſmall ſector do.	.	1	53	33	N.
do. . . Pollux	.	1	52	37	S.
do. ſmall ſector do.	.	1	55	20	S.
do. . . α Coro. Borealis		2	59	9	S.
do. ſmall ſector do.	.	3	1	42	S.

Night cold, ſharp froſt, and water froze within 9 feet of our fires.

	h	′	″	
♀ paſſed the meridian at . .	21	12	38	centrum.
☽'s ſubſequent limb paſſed the meridian at	21	28	16.5	
20th. ☉'s preceding limb on the meridian at	11	56	25	A. M.
Subſequent do. at .	11	58	38	A. M.
Centre at	11	57	31.5	A. M.

Obſerved zenith diſtance of β Andromedæ $4°\ 10'\ 50''$ N.

Equal altitudes of the Sun.
A. M. $8^h\ 30'\ 55''$. P. M. $3^h\ 24'\ 29''$.

		°	′	″	
Obſerved zenith diſtance of β Tauri	.	1	56	56	S.
do. . . Caſtor	.	1	56	19	N.
do. ſmall ſector do.	.	1	53	46	N.
do. . Pollux	.	1	52	35	S.
do. . α Coro. Borealis		2	59	8	S.
do. ſmall ſector do.	.	3	1	42	S.

Cold

Cold for this climate, at 7^h P. M. linen that was waſhed, and left out to dry, was frozen ſtiff, and ice nearly $\frac{1}{8}$th of an inch thick was formed within 9 feet of our fires, which were large, and kept up all night.

Obſerved zenith diſtance of α Lyræ (ſmall ſector) 8° 10′ 58″.

	h	′	″	
♀ paſſed the meridian at .	21	13	48	centrum.
☽'s ſubſequent limb on the meridian at	22	25	8	
21ſt. ☉'s preceding limb on the meridian at	11	56	20.5	A. M.
Subſequent do. at . .	11	58	33	A. M.
Centre at	11	57	26.7	A. M.

Equal altitudes of the Sun.
A. M. 8^h 50′ 59″. P. M. 3^h 4′ 18″.

			°	′	″	
Obſerved zenith diſtance of	β Andromedæ		4	10	49	N.
do. . .	β Tauri	.	1	56	56	S.
do. ſmall ſector	do.	.	1	59	27	S.
do. . .	Caſtor	.	1	56	19	N.
do. ſmall ſector	do.	.	1	53	40	N.
do. . .	Pollux	.	1	52	37	S.
do. ſmall ſector	do.	.	1	55	48	S.

	h	′	″	
♀ paſſed the meridian at	21	15	0	centrum.

22d. ☉'s preceding limb on the meridian at	11	56	18 A. M.	tremulous.
Subſequent do. at	11	58	38 A. M.	
Centre at . .	11	57	24 A. M.	

Equal altitudes of the Sun.
A. M. 8^h 53′ 59″. P. M. 3^h 1′ 9″.

♀ paſſed the meridian at . 21^h 16′ 13″.5 centrum.

23d. Very warm.

Equal altitudes of the Sun.
A. M. $9^h\ 25'\ 41''$. P. M. $2^h\ 29'\ 19''$.

♀ passed the meridian at . $21^h\ 17'\ 22''$ centrum.

		h	′	″	
24th.	☉'s preceding limb on the meridian at	11	56	10	A. M.
	Subsequent do. at	11	58	21	A. M.
	Centre at	11	57	15.5	A. M.

Equal altitudes of the Sun.
A. M. $8^h\ 41'\ 37''$. P. M. $3^h\ 13'\ 18''$.

Immersion of the 3d satellite of ♃ observed at $11^h\ 45'\ 38''$. —Belts distinct, magnifying power of the telescope 120.

♀ passed the meridian . $21^h\ 18'\ 30''$ centrum.

Very hazy, the planet at times not visible.

		h	′	″	
25th.	☉'s preceding limb on the meridian at	11	56	6	A. M.
	Subsequent do. at . .	11	58	16	A. M.
	Centre at	11	57	11	A. M.

Equal altitudes of the Sun.
A. M. $8^h\ 48'\ 13''$. P. M. $3^h\ 6'\ 32''$.

Emersion of the 1st satellite of ♃ observed at $8^h\ 30'\ 26''$. A little hazy, but the belts were middling well defined, magnifying power 120.

End of the astronomical observations at this station.

Rate

Rate of the Clock's going up the St. Mary's.

1800.				′	″	Daily gain. ″
Clock too ſlow mean time	Feb.	9th.	.	16	48.5	
do. . .		12th.	.	16	39.5	. . 3
do. . .		15th.	.	16	35.6	. . 1.3
do. . .		16th.	.	16	35.7	. . 0
do. . .		18th.	.	16	34.8	. . 0.4
do. . .		19th.	.	16	34.1	. . 0.7
do. . .		20th.	.	16	32.2	. . 1.9
do. . .		21ſt.	.	16	28.7	. . 3.5
do. . .		22d.	.	16	24.5	. . 4.2
do. . .		23d.	.	16	20.7	. . 3.8
do. . .		24th.	.	16	15.2	. . 5.5
do. . .		25th.	.	16	10.2	. . 5.2

Note, In the above ſtatement, where the equal altitudes, and the paſſage of the ⊙ over the meridian have not given the ſame error, a mean has been taken, however the difference in all caſes was ſo ſmall, that it might ariſe from a want of perfection in making the obſervations themſelves.

Reſult of the obſervations made up the St. Mary's for determining the longitude.

			h	′	″	
Feb.	15th.	By the ☽'s diſtance from the ⊙	5	29	18	West from Greenwich.
	16th.	*Emerſion* of the 1ſt ſatellite of ♃	5	29	7	
	17th.	By the ☽'s diſtance from the ⊙	5	29	55	
		do.	5	30	18	
	18th.	do.	5	30	10	
		do.	5	29	16	
	24th.	*Immerſion* of the 3d ſatellite of ♃	5	27	58	
	25th.	*Emerſion* of the 1ſt do. .	5	28	53	

Result of the Obſervations made with the large Sector, up the St. Mary's, to determine the Latitude.

The Zenith Diſtances ſtand as below.

Face of the Sector Eaſt.

1800.	β Andromedæ. ° ′ ″	β Tauri. ° ′ ″	Caſtor. ° ′ ″	Pollux. ° ′ ″	α Coro. Borealis. ° ′ ″
February 14th.	. . . . . .	. . . . . .	1 58 6 N.	1 50 49 S.	. . . . . .
15th.	4 12 38 N.	1 55 13 S.	1 58 10	1 50 46	2 57 16 S.
16th.	. . . . . .	1 55 9	1 58 7	1 50 50	2 57 19
17th.	. . . . . .	. . . . . .	1 58 9	1 50 50	. . . . . .
18th.	4 12 39	. . . . . .	. . . . . .	. . . . . .	. . . . . .
Means	4 12 38.5	1 55 11	1 58 8	1 50 48.7	2 57 17.5

Face of the Sector Weſt.

19th.	. . . . . .	1 56 56	1 56 16	1 52 37	2 59 9
20th.	4 10 50	1 56 56	1 56 19	1 52 35	2 59 8
21ſt.	4 10 49	1 56 56	1 56 19	1 52 37	. . . . . .
Means	4 10 49.5	1 56 56	1 56 18	1 52 36.3	2 59 8.5
Means face eaſt	4 12 38.5	1 55 11	1 58 8	1 50 48.7	2 57 17.5
Means	4 11 44	1 56 3.5	1 57 13	1 51 42.5	2 58 13
Refractions	+ 4.2	+ 2	+ 2	+ 1.9	+ 3
True zenith diſtances	4 11 48.2	1 56 5.5	1 57 15	1 51 44.4	2 58 16

Mean

	β Andromedæ.	β Tauri.	Caſtor.	Pollux.	α Coro. Borealis.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Mean declinations on the 18th.	34 33 28 N.	28 25 28 N.	32 18 44 N.	28 29 46 N.	27 23 47 N.
Aberrations	+ 2.1	+ 2.3	+ 0.3	— 0.9	— 14.7
Nutations	— 1.4	+ 7.3	+ 9.0	+ 9.0	— 4.1
Semi-annual equations	— 0.4	+ 0.3	+ 0.1	0.0	— 0.4
True declinations	34 33 28.3	28 25 37.9	32 18 53.4	28 29 54.1	27 23 27.8
True zenith diſtances applied	—4 11 48.2	+1 56 5.5	—1 57 15	+1 51 44.4	+2 58 16
Latitudes N.	30 21 40.1 N.	30 21 43.4 N.	30 21 38.4 N.	30 21 38.5 N.	30 21 43.8 N.

		°	′	″
Latitude by	β Andromedæ	30	21	40.1
do.	β Tauri	30	21	43.4
do.	Caſtor	30	21	38.4
do.	Pollux	30	21	38.5
do.	α Coro. Borealis	30	21	43.8
Mean Latitude North.		30	21	40.8

Reſult

Refult of the Obfervations made with the Small Sector, up the St. Mary's, to determine the Latitude.

The Zenith Diftances when arranged ftand as below.

Face of the Sector Eaft.

1800.	β Tauri. ° ′ ″	Caftor. ° ′ ″	Pollux. ° ′ ″	α Coro. Borealis. ° ′ ″	α Lyræ. ° ′ ″
Feb. 14th.	1 52 31 S.	2 1 3 N.	1 47 49 S.	2 54 26 S.	. . . .
15th.	1 52 35	. . . .	. . . .	2 54 34	. . . .
16th.	1 52 36	2 0 51	1 47 36	2 54 29	. . . .
17th.	. . . .	. . . .	. . . .	. . . .	8 17 8 N.
Means	1 52 34	2 0 57	1 47 42.5	2 54 29.7	8 17 8

Face of the Sector Weft.

	β Tauri.	Caftor.	Pollux.	α Coro. Borealis.	α Lyræ.
18th.	. . . .	1 53 40	. . . .	. . . .	. . . .
19th.	1 59 6	1 53 33	1 55 20	3 1 42	. . . .
20th.	. . . .	1 53 46	. . . .	3 1 37	8 10 58
21ft.	1 59 27	1 53 40	1 55 48	. . . .	. . . .
Means	1 59 16.5	1 53 39.7	1 55 34	3 1 39.5	8 10 58
Means face eaft	1 52 34	2 0 57	1 47 42.5	2 54 29.7	8 17 8
Means	1 55 55.2	1 57 18.3	1 51 38.2	2 58 4.6	8 14 3
Refractions	+ 1.9	+ 2	+ 1.9	+ 3	+ 8.2
True zenith diftances	1 55 57.1	1 57 20.3	1 51 40.1	2 58 7.6	8 14 11.2
Mean declinations Feb. 18th.	28 25 28 N.	32 18 44 N.	28 29 46 N.	27 23 47 N.	38 36 15.5
Aberrations	+ 2.3	+ 0.3	— 0.9	— 14.7	— 14.8
Nutations	+ 7.3	+ 9.0	+ 9.0	— 4.1	— 8.6
Semi. ann. equations	+ 0.3	+ 0.1	0.0	— 0.4	— 0.1
True declinations	28 25 37.9	32 18 53.4	28 29 54.1	27 23 27.8	38 35 52.0
True zenith diftances applied	+1 55 57.1	—1 57 20.3	+1 51 40.1	+2 58 7.6	—8 14 11.2
Latitudes N.	30 21 35.0 N.	30 21 33.1 N.	30 21 34.2 N.	30 21 35.4 N.	30 21 40.8 N.

Latitude

		°	′	″
Latitude by β Tauri	. . . . . .	30	21	35.0
do. Caſtor	. . . . . .	30	21	33.1
do. Pollux	. . . . . .	30	21	34.2
do. α Coro. Borealis	. . . . .	30	21	35.4
do. α Lyræ	. . . . . .	30	21	40.8
Mean latitude north	. . . .	30	21	35.7

The ſame number of ſtars were taken with each ſector; but the large one from the length of its radius, being at leaſt three times as accurate as the ſmall one, the latitude by the large one, was multiplied by three, and the latitude by the ſmall one added to that product, and the ſum divided by four, the quotient 30° 21′ 39″.5 was taken for the true latitude of the obſervatory.

This being the higheſt point to which we could aſcend the river, and the country ſo covered with water, that it was impoſſible with our few remaining broken down pack horſes to convey our apparatus by land to the ſource of the river; we therefore had to determine the geographical poſition of its ſource by a traverſe; the courſes of which are as follows: viz. beginning at the obſervatory A, (Plate XII.) where a hewn poſt was ſet up and ſurrounded by a large mound of earth, from thence N. 10° 1′ W. 4435.6 perches, thence S. 85° 14′ W. 115.6 perches, thence north 44.8 perches at the end of which a hewn poſt was ſet up, and ſurrounded by a mound of earth B.—Theſe courſes when tabled will ſtand as below.

Courſes.	N.	S.	E.	W.
N. 10° 1′ W. 4435.6 ps.	4368	. . . . . .	. . . . . .	771.2
S. 85° 14′ W. 115.6 ps.	. . . . .	9.6	. . . . . .	115.2
N. 44.8 ps.	44.8	. . . . . .	. . . . . .	. . . . .
	4412.8	9.6	. . . . . .	886.4
	— 9.6	. . . . . .	. . . . . .	. . . . .
	4403.2	. . . . . .	. . . . . .	886.4

The laſt mentioned mound of earth was thrown up on the margin of the Okefonoke ſwamp, and as near to it as any permanent mark could be placed on account of the water.

From Plate XII. upon which the above traverſe is laid down, it may be ſeen that the river St. Mary's is formed by the water draining out of the Okefonoke ſwamp along ſeveral marſhes, or ſmall ſwamps, which join into one, and form, or conſtitute the main branch or body of the river. The principal, or largeſt of thoſe ſwamps, or drains, is the moſt eaſterly one, and in which the current is the moſt viſible. This marſh, or drain is croſſed by the laſt courſe of the traverſe, which terminates at the mound B. From this mound north-eaſterly into the ſwamp, the water has but little, if any perceptible current. The ſource of the river is therefore in an indeterminate

determinate ſpace; and no ſpecific point could be fixed on, as the ſwamp is at all times almoſt impenetrable, and at this ſeaſon of the year abſolutely ſo without immenſe labour, and expence. It was therefore agreed that the termination of a line, ſuppoſed to be drawn N. 45°, E. 640 perches from the mound B, ſhould be taken as a point to, or near which, a line ſhould be drawn from the mouth of Flint river; which line when drawn, ſhould be final, and conſidered as the permanent boundary between the United States and His Catholic Majeſty, provided it paſſed not leſs, than one mile north of the mound B: but if upon experiment, it ſhould be found to paſs within leſs than one mile north of the ſaid mound, it ſhould then be corrected to carry it to that diſtance. To obtain as near as poſſible the courſe of the ſaid line, with the diſtance between the points to be joined, the following materials deduced from our previous operations were uſed. The longitudes made uſe of are from meaſurements, compounded with the eclipſes of the 1ſt ſatellite of Jupiter.

The longitude of the obſervatory near the mouth of Flint river by the eclipſes of the 1ſt ſatellite of ♃ is $5^h\ 39'\ 19''$ weſt from Greenwich. The longitude of our ſtation on Thompſon's Creek, by a mean of five good obſervations is $6^h\ 4'\ 48''$ weſt from Greenwich. From Thompſon's Creek to the Flint river obſervatory, the diſtance is 371.21 miles, which in the parallel of 31° is equal to $24'\ 57''$ in time, which deducted from the longitude at Thomſon's Creek, will leave $5^h\ 39'\ 51''$ for the longitude of the obſervatory near the mouth of Flint river; which diſagrees with the longitude by obſervation 32″ in time. Meaſurements when accurately executed, in a known parallel of latitude, are generally preferable to obſervations for diſtances, not exceeding 100 miles: yet in this caſe, the meaſurement is not entitled to that weight, being done in haſte, with a common chain, through thickets, ſwamps, and ponds, where pins of more than ordinary lengths had to be made uſe of, which involved an unſurmountable ſource of error: but not in ſo conſiderable a degree as to juſtify its rejection. It was therefore concluded, that if to twice the longitude of the obſervatory near the mouth of Flint river, the longitude by meaſurement from Thompſon's Creek be added, and the ſum divided by three, the quotient $5^h\ 39'\ 30''$ would be the longitude of the obſervatory near the mouth of Flint river, as correctly as it could be had from our materials: But the mouth of Flint river was found by meaſurement to be 260 perches, equal in time to 3″.3 weſt from the obſervatory; which added to the above determination, the decimal .3 being rejected, as unimportant, when errors much larger are unavoidable, will give $5^h\ 39'\ 33''$ for the longitude of the mouth of Flint river.—The latitude has already been ſettled at 30° 42′ 42″.8.

The longitude of the obſervatory at A, up the St. Mary's by obſervation is $5^h\ 29'$. The longitude of the obſervatory at Point Peter by four good obſervations is $5^h\ 26'\ 34''$: the difference of longitude by obſervation is 2′ 26″.—The difference of longitude between the obſervatories, by a traverſe taken for that purpoſe, was 37.45 miles which is equal to 2′ 32″. The traverſe being made under very unfavourable circumſtances, and conſiſted of an uncommon number of courſes, owing to the ſwamps, and ponds, (with which the country abounds), being full of water, and impaſſable:

paſſable: the mean 2′ 29″ was therefore taken for the difference of longitude, which added to 5^h 26′ 34″ the longitude of Point Peter will give 5^h 29′ 3″ for the longitude of the obſervatory at A.—The difference of latitude between A, and the mound B, has been ſhewn to be 4403.2 perches, and the difference of longitude 886.4 perches weſt: thence to the end of the line ſuppoſed to be drawn N. 45 E. 640 perches from the mound B, the difference of latitude will be 452.5 perches; which added to the difference of latitude between A, and B, will give 4855.7 perches, or 13′ 8″.5 nearly, which added to 30° 21′ 39″.5 the latitude of A, will give 30° 34′ 48″ for the latitude of the termination of the line ſuppoſed to be drawn from B.—From the obſervatory at A, to the mound B, the difference of longitude by meaſurement has been ſtated at 886.4 perches weſt, from thence to the termination of the line ſuppoſed to be drawn from B, the difference of longitude is 452.5 perches eaſt, which deducted from the weſting, will leave 433.9 perches weſt, which is equal to about 6″ in time, and when added to 5^h 29′ 3″ the longitude at A will give 5^h 29′ 9″ for the longitude of the termination of the line ſuppoſed to be drawn as above; which deducted from the longitude of the mouth of Flint river, will leave 10′ 24″ for the difference of longitude between the points.

There are now given

The latitude of the mouth of Flint river = . .	30° 42′ 42″.8
The latitude of the termination of the line ſuppoſed to be drawn from B	= 30 34 48
The difference of longitude between the mouth of Flint river, and the termination of the line ſuppoſed to be drawn from B	= 0^h 10′ 24″ = 2° 36′

To find the courſe, and diſtance between the given points, that is, between the mouth of Flint river, and the termination of the line ſuppoſed to be drawn from B, which is done as follows:

In the ſpherical triangle DEF, let DE repreſent the co. latitude of the mouth of Flint river = 59° 17′ 17″.2. FE the co. latitude of the termination of the line ſuppoſed to be drawn from B = 59° 25′ 12″, and the included angle DEF 2° 36′, being the difference of longitude between the given points.

For the required side.

	°	′	″			
Included angle . .	2	36	0			
Half	1	18	0	. .	S	8.3557835
Diff. of the sides . .	0	7	54.8			
Half	0	3	57.4	co. ar.	S	3.9389855
DE	59	17	17.2	. .	½ S	4.9671851
FE	59	25	12	. .	½ S	4.9674813
	89	39	44	.	Tangent	12.2294354
	89	39	44	co. ar.	S	0.0000075
½ Diff. of the sides . .	0	3	57.4	. .	S	6.0610145
	1	7	6.5		S	8.2904574
			2			
DF	2	14	13 = 155.2 miles nearly.			

For the angles.

	°	′	″			
FE	59	25	12			
DE	59	17	17.2			
Sum	118	42	29.2			
Diff.	0	7	54.8			
½ Sum . . .	59	21	14.6	co. ar.	S	0.0653339
½ Diff.	0	3	57.4	. .	S	7.0610145
Included angle . .	2	36	0			
½ Included angle .	1	18	0.0	.	c. Tang^t^.	11.6441047
½ Diff. of the angles .	3	22	24	. .	Tang^t^.	8.7704531
½ Sum of the sides .	59	21	14.6	co. ar.	c. S	0.2926586
½ Diff. of the sides .	0	3	57.4	.	c. S	9.9999997
½ Included angle . .	1	18	0	.	c. Tang^t^.	11.6441047
½ Sum of the angles .	89	20	14	. . .		11.9367630
½ Diff. of the angles .	3	22	24			
Greater angle . .	92	42	38			
Lesser angle . .	85	57	50			

From

From which it follows, that an arc of a great circle making an angle with the meridian at the mouth of Flint river from the south, towards the east of 87° 17′ 22″, being the supplement of the angle EDF, will strike the termination of the line supposed to be drawn from B; provided the distance be as before stated. But if the distance between the points, should either exceed the distance deduced from the previous operations seven miles, or fall short of it an equal number, the line will nevertheless pass within half a mile of the termination of the supposed line, and therefore fall within the space of uncertainty as to the real source of the river.

If a common surveying compass should be used, the before mentioned angle of 87° 17′ 22″ must be diminished at the rate of about 1′ 32″ for every three miles, to compensate for the difference of 1° 19′ 32″ between the supplemental angle already mentioned, and the angle DFE, to produce as near a coincidence as possible with the arc of a great circle.

After erecting the mound B, we descended the river, and encamped on the south end of Cumberland Island,* to prepare the report of our proceedings to both nations, and make our arrangements for leaving the country. At that encampment the following observations were made.

1800.

March 6th. Unloaded the vessel, encamped and set up the clock.

7th. Cloudy and very cold.

8th. Stormy with cold rain.

9th. Storm continues.

10th. Violent wind, and heavy rain.

11th. Cloudy in the morning, strong N. wind and fine rain.—Thermometer 49° in the morning, rose to 57°.

12th. Clear,—thermometer 47° in the morning, rose to 70°.

Equal altitudes of the Sun.

A. M. 8h 53′ 50″. P. M. 3h 6′ 55″.

13th. Thermometer 47° in the morning, rose to 76°.

* The most southern inclination of the United States on the Atlantic ocean.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 6^h 58′ 49″.—Evening very clear, the belts diſtinct, magnifying power 120.

14th. Thermometer 49° at ſun riſe, roſe to 78°.

Equal altitudes of the Sun.
A. M. 8^h 54′ 6″. P. M. 3^h 5′ 57″.

15th. Thermometer 51° at ſun riſe, roſe to 84°.

Emerſion of the 2d ſatellite of ♃ obſerved at 11^h 54′ 41″.—The planet was low and uncommonly tremulous—the belts indiſtinct, magnifying power 120.

16th. Thermometer 57° at ſun riſe, roſe to 81°.

Equal altitudes of the Sun.
A. M. 9^h 5′ 0″. P. M. 2^h 54′ 30″.

17th. Thermometer 60° at ſun riſe, roſe to 81°.

Equal altitudes of the Sun.
A. M. 9^h 7′ 24″. P. M. 2^h 51′ 57″.

The obſerved times, and diſtances, of the ☉'s and ☽'s neareſt limbs.

	h	′	″	°	′	″	
	19	45	15	82	10	20	
	19	45	59	82	10	0	
	19	46	38	82	9	50	Add for the error of the Sextant 7″.
	19	47	15	82	9	30	
	19	47	51	82	9	20	
	19	48	30	82	9	00	
Means	19	46	55	82	9	40	

Repeated.

No 8.
Okefonoke Swamp.
The source of the St. Marys is supposed to be within this dotted line
Fig 1
D
F
F

Repeated.

	h	′	″	°	′	″	
	20	15	10	82	0	30	
	20	15	51	82	0	10	
	20	16	22	82	0	0	
	20	16	49	81	59	50	
	20	17	29	81	59	40	Add for the error of
	20	18	4	81	59	30	the Sextant 7″.
	20	18	33	81	59	20	
	20	19	2	81	59	10	
	20	19	35	81	59	0	
Means	20	17	26	81	59	41	

18th. Thermometer 62° at ſun riſe, roſe to 81°. —Cloudy with thunder great part of the day attended with a little rain.

19th. Thermometer 61° at ſun riſe, roſe to 86°. —Cloudy part of the day.

The obſerved times, and diſtances, of the ☉'s and ☽'s neareſt limbs.

	h	′	″	°	′	″	
	20	14	6	56	37	00	
	20	14	45	56	36	50	
	20	15	44	56	36	40	
	20	16	33	56	36	30	Add for the error of
	20	17	11	56	36	20	the Sextant 7″.
	20	17	55	56	36	20	
	20	18	28	56	36	00	
Means	20	16	23	56	36	31	

20th. Thermometer 65° at ſun riſe, roſe to 82°.

Equal altitudes of the Sun.
A. M. 8h 44′ 35″. P. M. 3h 13′ 53″.

A thick

A thick fog towards evening from the S. E. —very cloudy at night.

21ſt. Thermometer 63° in the morning, roſe to 79°.

22d. Thermometer 60° at ſun riſe, roſe to 84°.

Equal altitudes of the Sun.
A. M. 8^h 50′ 17″. P. M. 3^h 7′ 53″.
Doubtful 3 or 4 ſeconds.

23d. Thermometer 61° at ſun riſe, roſe to 62°. —Cloudy great part of the day with a violent wind from the S. E.

24th. Thermometer 58° in the morning, fell to 56° in the afternoon, rain with a ſtrong wind from the S. E.

25th. Thermometer 56° at ſun riſe, roſe to 70°. —Flying clouds great part of the day.

Emerſion of the 3d ſatellite of ♃ obſerved at 7^h 1′ 3″.— Belts pretty diſtinct, magnifying power 120.

Diſcovered that the clock was conſiderably out of beat, owing to the poſt to which it was faſtened being moved by people inadvertently leaning againſt it in the tent:—The poſt being planted in looſe ſand, no better foundation to be had.

26th. Thermometer 50° at ſun riſe, roſe to 60°.

Equal altitudes of the Sun.
A. M. 8^h 44′ 23″. P. M. 3^h 13′ 0″.

Emerſion of the 4th ſatellite of ♃ obſerved at 8^h 8′ 57″. —Evening remarkably fine; magnifying power 200.—Although the ſatellite was too viſible to be miſtaken at the time above noted, it certainly had not fully recovered its luſtre

luſtre at 8^h 35′, it emerged cloſe to the 2d ſatellite, which gave me an excellent opportunity of judging of its brightneſs.

27th. Thermometer 54° at ſun riſe, roſe to 68°.

Equal altitudes of the Sun.
A. M. 8^h 39′ 41″. P. M. 3^h 17′ 35″.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 10^h 53′ 10″. —The planet very tremulous, and the belts ſcarcely diſcernible—magnifying power 120.

28th. Thermometer 61° at ſun riſe, roſe to 76°. —Cloudy in the afternoon.

29th. Thermometer 63° at ſun riſe, roſe to 81°. —Thunder and rain in the morning.

Equal altitudes of the Sun.
A. M. 8^h 42′ 54″. P. M. 3^h 14′ 0″.

30th. Thermometer 50° at ſun riſe, roſe to 75°.

Equal altitudes of the Sun.
A. M. 8^h 39′ 12″. P. M. 3^h 17′ 30″.

The obſerved times, and diſtances, of the ☉'s and ☽'s neareſt limbs.

	h	′	″	°	′	″	
	22	58	33	69	48	00	
	22	59	25	69	48	10	
	23	0	8	69	48	30	
	23	0	49	69	48	50	Add for the error of the Sextant 7″.
	23	1	26	69	49	15	
	23	2	12	69	49	40	
	23	3	3	69	50	10	
Means	23	0	48	69	48	56	

31ſt.

31ſt. Thermometer 53° at ſun riſe, roſe to 86°.
April 1ſt. Thermometer 57° at ſun riſe, roſe to 87°.

Equal altitudes of the Sun.
A. M. 8h 53′ 46″. P. M. 3h 2′ 57″.
Doubtful ſeveral ſeconds on account of clouds.

Immerſion of the 3d ſatellite of ♃ obſerved at 8h 1′ 17″. —The evening very fine, and the ſatellite loſt its luſtre, and diſappeared more gradually than I ever ſaw it before, —Magnifying power 120.

Emerſion of the ſame ſatellite obſerved at 11h 5′ 19″. —The planet was low, and tremulous, and the belts very indiſtinct, magnifying power as above.

2d. Thermometer 61° at ſun riſe.

Emerſion of the 2d ſatellite of ♃ obſerved at 6h 30′ 51″. —The belts were well defined, but the ſun having been ſet about 15 minutes and the day light being very ſtrong, on which account the obſerved time might be diminiſhed 10 or 15 ſeconds with propriety, magnifying power 120.

3d. Thermometer 66° at ſun riſe, roſe to 78°. —Cloudy all day with heavy rain, and thunder at night.
4th. Thermometer 63° at ſun riſe, roſe to 82°. —Cloudy all the forenoon.
5th. Thermometer 64° at ſun riſe, roſe to 84°.

Equal altitudes of the Sun.
A. M. 8h 39′ 11″. P. M. 3h 17′ 27″.

Emerſion of the 1ſt ſatellite of ♃ obſerved at 7h 13′ 19″. —Belts well defined, magnifying power 120.

6th. Thermometer 61° at ſun riſe, roſe to 85°.

Equal

Equal altitudes of the Sun.
A. M. $8^h\ 40'\ 57''$. P. M. $3^h\ 15'\ 48''$.

7th. Thermometer 62° at ſun riſe, roſe to 83°.
8th. Thermometer 65° at ſun riſe, roſe to 85°.
9th. Thermometer 70° at ſun riſe, roſe to 90°.

Equal altitudes of the Sun.
A. M. $8^h\ 23'\ 52''$. P. M. $3^h\ 32'\ 58''$.

Emerſion of the 2d ſatellite of ♃ obſerved at $9^h\ 9'\ 28''$. —A little hazy, magnifying power 120.

10th. Thermometer 62° at ſun riſe, roſe to 87°.

Equal altitudes of the Sun.
A. M. $8^h\ 57'\ 6''$. P. M. $2^h\ 59'\ 48''$.

Took down and packed up the inſtruments.

Rate of the Clock's going at the ſouth end of Cumberland Iſland.

			′	″	Daily gain. ″
Clock too ſlow mean time	March	12th.	9	44.3	
do.		14th.	9	31.6	6.3
do.		16th.	9	13.0	9.3
do.		17th.	8	59.6	13.4
do.		20th.	8	32.1	9.2
do.		22d.	8	4.4	13.9
do.		26th.	7	13.7	12.7
do.		27th.	6	58.7	15.0
do.		29th.	6	32.2	13.2
do.		30th.	6	19.7	12.5
do.	April	1ſt.	5	42.7	18.5
do.		5th.	4	32.2	17.6
do.		6th.	4	13.2	19.0
do.		9th.	3	16.4	18.9
do.		10th.	2	56.9	19.5

Refults of the obfervations, made for the longitude, at the fouth end of Cumberland Ifland.

			h	′	″	
March	13th.	*Emerfion* of the 1ft fatellite of ♃	5	26	29	West from Greenwich.
	15th.	do. . 2d . . .	5	26	33	
	17th.	By a lunar obfervation .	5	26	59	
	17th.	do. . . .	5	26	25	
	19th.	do.	5	27	25	
	25th.	*Emerfion* of the 3d fatellite of ♃	5	26	14	
	26th.	do. of the 4th do. by the Nautical Almanac	5	51	48	
		By de Lambre's Tables .	5	27	37	
	27th.	*Emerfion* of the 1ft fatellite of ♃	5	25	43	
	30th.	By a lunar obfervation .	5	26	6	
April	1ft.	*Immerfion* of the 3d fatellite of ♃	5	24	6	
		Emerfion . do. . . .	5	26	0	
	2d.	*Emerfion* of the 2d fatellite of ♃	5	26	49	
	5th.	do. . 1ft do. .	5	26	40	
	9th.	do. . 2d do. .	5	26	57	

By a mean of the 3 eclipfes of the 1ft fatellite of ♃, the longitude of the fouth end of Cumberland ifland comes out $5^h\ 26'\ 17''$ weft from Greenwich: By a traverfe from the obfervatory at Point Peter acrofs the found, the difference of longitude between that ftation, and the fouth end of Cumberland ifland is $10''$ nearly, which added to the longitude above, will give $5^h\ 26'\ 27''$ for the longitude of Point Peter; which is $7''$ lefs than by obfervation. But as there were more obfervations on the eclipfes of the 1ft fatellite taken at Point Peter, and a better agreement, that determination is entitled to the moft weight.—If therefore $2''$ be deducted from the longitude of the obfervatory at Point Peter as determined by obfervation, and $5''$ added to the longitude of the fouth end of Cumberland ifland as deduced from obfervation, the longitudes will ftand as below.

	h	′	″	
Longitude of the S. end of Cumberland ifland .	5	26	22	Weft from Greenwich.
Longitude of the obfervatory at Point Peter .	5	26	32	

Thefe longitudes are probably as correct as they can be had by obfervations, the refult of which depends upon a theory not yet abfolutely perfect: but thefe, with other deductions of a like nature in the foregoing work, may be further corrected when compared with correfponding obfervations, or others made about the fame time, at obfervatories whofe pofitions have been accurately fettled. The latitude of the fouth end of Cumberland Ifland has already been ftated at $30°\ 43'\ 13''.8$ N.

The

The obſervations being now brought to a cloſe, I have only to add, that they were made, and regiſtered with fidelity, and correctly copied from the original entries in my journal, without a ſingle alteration.—The errors of the clock, with its rate of going, as entered at the end of each courſe of obſervations, may readily be examined by the equal altitudes and other obſervations made for that purpoſe: and for fear miſtakes might happen, in reducing the obſerved *time* of an obſervation for the longitude, to either mean, or apparent, the original *entry as noted at the clock*, has in all caſes been retained;—ſo that any reſult, which depends upon an accurate knowledge of the time, may be re-examined, and corrected if found erroneous.

It is preſumed, that no apology will be neceſſary, for any ſmall inaccuracies which may be diſcovered in the aſtronomical obſervations, when it is conſidered that they were made at temporary ſtations, and the apparatus frequently expoſed to the weather, for want of tents, and other covering; and almoſt as frequently ſo injured by the tranſportation from one place, to another, through the wilderneſs, that if I had not been in the habit of conſtructing, and making inſtruments for my own uſe, our buſineſs muſt have been ſeveral times ſuſpended, till the repairs could have been made in Europe.

No. XXII.

Obſervations on the Figure of the Earth. By Joseph Clay, M. A. P. S.

THE ſubject of this paper was ſuggeſted to me by a peruſal of the "Studies of Nature," by Bernardin de St. Pierre. The poſitive manner in which that author aſſerts that the earth is a prolate ſpheroid, the arrogance with which he challenges refutation, and above all the erroneous theories which he has built on this aſſertion, ſeem to require all doubts to be removed by a mathematical demonſtration. It is known that degrees of latitude increaſe in length as we approach to the poles. Upon this ground, St. Pierre places his principal argument which in ſubſtance is that if two lines diverging from the centre of an ellipſis, intercept a part of the curve, the further that part is from the centre, the longer will it be; and converſely, as the arch of one degree is longer near the pole than an arch of one degree near the equator, the axis muſt be longer than the equatorial diameter. His error ariſes from ſuppoſing, that degrees of latitude are meaſured by the angles of ſemi-diameters of the meridian. This is not the caſe. The only mode of determining the latitude is by obſerving the altitude of the heavenly bodies, either by the mural quadrant or ſector or by Hadley's octant. Suppoſing the ſun to be the body altitude of which is taken, and ſuppoſing it to be in the equator and on the meridian, the complement of its altitude is equal to the latitude of the place of obſervation. The parallax of the ſun is ſo ſmall, that rays of light coming from it may without ſenſible error be conſidered as coming in parallel lines; this being premiſed, let two

two right lines *hlo* (Fig. 1.) and HLO reprefent two tangents to the fame meridian; and let *ſl* and SL reprefent two rays, parallel to each other, and to the common diameter of the meridian of the place and the equator; the angles *ſlh* and SLH will be the altitude of the fun at *l* and L as taken with Hadley's octant. Draw *zlm* and ZLM perpendicular to the refpective tangents through *l* and L and meeting each other in M, then will the angles *ſlz* and SLZ be the latitudes of *l* and L. Hence it appears that the latitude of a place is meafured by the angle formed by the common diameter of the meridian and equator, and a perpendicular to the horizon of the place; for the lines *ſl* and SL are parallel to the common diameter of the equator and meridian (by conftruction). Produce SL to T. The angle ST *l* is equal to the angle *ſlz*, and confequently to the latitude of *l* and the angle TLM (equal to SLZ) is equal to the latitude of L. The angle ST *l* is equal to the angles TLM and LMT taken together and confequently the angle LMT is equal to the difference between the two angles ST *l* and TLM, equal to the difference between the latitudes of the two places. That is, the difference of latitude between two places on the fame meridian, is meafured by the angle formed by the perpendiculars to the two horizons.*

By all the obfervations made at Greenwich and elfewhere, the altitudes of the heavenly bodies as obferved with the mural and plummet quadrants agree with thofe taken with the reflecting or Hadley's octant.† Now let ABDE be an ellipfis (Fig. 2.) and HLO a tangent, ZLT a perpendicular to that tangent *ſ*L a ray of light (the fun being in the equator and on the meridian) *ſ*LZ is the

* In this demonftration nothing, which has been before demonftrated, is, on that account alone, omitted.

† This part of the demonftration is neceffarily experimental, not mathematical.

the ſun's zenith diſtance, and conſequently equal to the latitude of the place. It is evident that bodies near the ſurface of the earth, are not attracted in lines paſſing through the earth's centre; but in lines perpendicular to the horizon; for if it were otherwiſe a plummet would hang in the direction QLC (paſſing through the centre of the ellipſis) and the latitude of the place would in that caſe be equal to the angle ſLQ: but this angle never would, except under the poles and at the equator, coincide with the angle ſLZ. It is plain, therefore, that the difference of latitude cannot, with any inſtrument, be meaſured by the angles between lines meeting in the earth's centre.

But as the difference of latitude is meaſured by the angle formed between the perpendiculars to the two horizons, it follows that the nearer the curve of the meridian approaches to a right line, the longer muſt the part of the arch be which ſubtends any given angle.

Beſides it is evident, that were the earth a plane, and of its actual diameter, no ſenſible difference would be obſerved in the ſun's altitude on any part of its ſurface, and of courſe the nearer the earth approaches to a plane, the leſs will be the difference of altitudes obſerved by two perſons at any given diſtance, and conſequently the degrees of latitude muſt be longer as the earth is flatter.

Independent of theſe circumſtances, let ABDE be an ellipſis of which AD and BE are the axes and C the centre. Make CF equal to AC. Draw AF which produce to G. Biſect AG in K. Draw KC which produce to L and R. Through L draw HLO parallel to AG and cutting AD and BE produced in O and H. Then by conics will HLO be a tangent to the curve in the point L. Through A draw AI perpendicular to AC and conſequently a tangent to the curve, and LT perpendicular to LO. Now becauſe FC is equal to AC and

FCA

FCA is a right angle, the angles FAC and AFC will each be half of a right angle. LOT will alſo be half of a right angle, becauſe LO is parallel to AF, and conſequently LTO is half of a right angle. If then the ellipſis repreſent a meridian of the earth IA and HO will repreſent the common ſections of that meridian and the horizons of two places; and AT, LT two perpendiculars to the horizons, and the angle ATL will be the difference of the latitude, (equal to 45°). But A is at the end of one of the axes of the ellipſis, and therefore the point L will repreſent a place in the latitude of 45°.

Since all the degrees of latitude increaſe in length as we approach to the pole, it is evident that the arch of 45° between the latitude of 45° and the pole, will be longer than the arch between the equator and the latitude of 45°. Now draw LS and LN parallel to BC and AC. Make BC = a, AC = c, LS = x, LN = y, LS = NC, and LN = CS. Then becauſe LOT is half of a right angle, and OSL is a right angle, OLS is alſo half of a right angle, therefore OS is equal to LS. In the ſame manner we prove HN equal to LN and conſequently HC equal to OC, put OC $(= x + y) = b$.

Then by conics $y : c :: c : b$ and $y = \frac{c^2}{b}$ and $b = \frac{c^2}{y}$

$x : a :: a : b$ and $x = \frac{a^2}{b}$ and $b = \frac{a^2}{x}$

Therefore $\frac{c^2}{y} = \frac{a^2}{x}$

and $y = \frac{c^2}{a^2} x$

but $b = \frac{a^2}{x} = x + y = \frac{a^2 + c^2}{a^2} x$

$a^4 = \overline{a^2 + c^2} \times x^2$

$x =$

$$x = \frac{a^2}{\sqrt{a^2 + c^2}}$$

$$y = \frac{c^2 x}{a^2} = \frac{c^2}{\sqrt{a^2 + c^2}}$$

$$b = \frac{a^2}{x} = \sqrt{a^2 + c^2}$$

Put $z =$ the length of the elliptic arch AL
$v =$ that of BL

$\dot{z} = \frac{\dot{x}}{a} \sqrt{\frac{a^4 - a^2 x^2 + c^2 x^2}{a^2 - x^2}}$ by the nature of the curve: put $a^2 - c^2 = d^2$ then $\dot{z} = \frac{\dot{x}}{a} \sqrt{\frac{a^4 - d^2 x^2}{a^2 - x^2}} = \frac{\dot{x}}{a} \times \frac{\sqrt{a^4 - d^2 x^2}}{\sqrt{a^2 - x^2}} = \frac{\dot{x}}{a} \times \frac{\overline{a^4 - d^2 x^2}^{\frac{1}{2}}}{\overline{a^2 - x^2}^{\frac{1}{2}}}$. $\therefore z =$ the fluent of $\frac{\dot{x}}{a} \times \frac{\overline{a^4 - d^2 x^2}^{\frac{1}{2}}}{\overline{a^2 - x^2}^{\frac{1}{2}}}$.

$$\overline{a^4 - d^2 x^2}^{\frac{1}{2}} = a^2 - \frac{d^2 x^2}{2\,a^2} - \frac{d^4 x^4}{8\,a^6} - \frac{d^6 x^6}{16\,a^{10}} - \frac{5\,d^8 x^8}{128\,a^{14}}, \text{ \&c.}$$

$$\overline{a^2 - x^2}^{\frac{1}{2}} = a - \frac{x^2}{2\,a} - \frac{x^4}{8\,a^3} - \frac{x^6}{16\,a^5} - \frac{5\,x^8}{128\,a^7}, \text{ \&c.}$$

The former of which ſeries being divided by the latter, the quotient is $a + \frac{c^2 x^2}{2\,a^3} + \frac{c^2 x^4}{8\,a^7} \times \overline{3\,a^2 + d^2} + \frac{c^2 x^6}{16\,a^{11}} \times \overline{5\,a^4 + 2\,a^2 d^2 + d^4} + \frac{c^2 x^8}{128\,a^{15}} \times \overline{35\,a^6 + 15\,a^4 d^2 + 9\,a^2 d^4 + 5\,d^6}$, &c. which multiplied by $\frac{\dot{x}}{a}$ becomes

$\dot{x} + \frac{c^2 x^2 \dot{x}}{2\,a^4} + \frac{c^2 x^4 \dot{x}}{8\,a^8} \times \overline{3\,a^2 + d^2} + \frac{c^2 x^6 \dot{x}}{10\,a^{12}} \times \overline{5\,a^4 + 2\,a^2 d^2 + d^4} + \frac{c^2 x^8 \dot{x}}{128\,a^{16}} \times \overline{35\,a^4 + 15\,a^4 d^2 + 9\,a^2 d^4 + 5\,d^6}$, &c. the fluent of which is

$x +$

$$x+\frac{c^2x^3}{3.2a^4}+\frac{c^2x^5}{5.8a^8}\times\overline{3a^2+d^2}+\frac{c^2x^7}{7.16a^{12}}\times\overline{5a^4+2a^2d^2+d^4}$$

$$+\frac{c^2x^9}{9.128a^{16}}\times\overline{35a^6+15a^4d^2+9a^2d^4+5d^6},$$ &c. and by ſubſtituting for x its value $\frac{a^2}{\sqrt{a^2+c^2}}$ or $\frac{a^2}{b}$.

$$z=\frac{a^2}{b}+\frac{a^2c^2}{3.2b^3}+\frac{a^2c^2}{5.8b^5}\times\overline{3a^2+d^2}+\frac{a^2c^2}{7.16b^7}\times\overline{5a^4+2a^2d^2+d^4}$$

$$+\frac{a^2c^2}{9.128b^9}\times\overline{35a^6+15a^4d^2+9a^2d^4+5d^6},$$ &c. again

$$\dot{v}=\frac{\dot{y}}{c}\sqrt{\frac{c^4+d^2y^2}{c^2-y^2}}.$$

Which thrown into a ſeries becomes,

$$\sqrt{c^4+d^2y^2}=c^2+\frac{d^2y^2}{2c^2}-\frac{d^4y^4}{8c^6}+\frac{d^6y^6}{16c^{10}}-\frac{5d^8y^8}{128c^{14}},$$ &c.

$$\sqrt{c^2-y^2}=c-\frac{y^2}{2c}-\frac{y^4}{8c^3}-\frac{y^6}{16c^5}-\frac{5y^8}{128c^7},$$ &c.

The former of which being divided by the latter becomes,

$$c+\frac{a^2y^2}{2c^3}+\frac{a^2y^4}{8c^7}\times\overline{3c^2-d^2}+\frac{a^2y^6}{16c^{11}}\times\overline{5c^4-2c^2d^2+d^4}$$

$$+\frac{a^2y^8}{128c^{15}}\times\overline{35c^6-15c^4d^2+9c^2d^4-5d^6},$$ &c. which being multiplied by $\frac{\dot{y}}{c}$ is

$$\dot{v}=\dot{y}+\frac{a^2y^2\dot{y}}{2c^4}+\frac{a^2y^4\dot{y}}{8c^8}\times\overline{3c^2-d^2}+\frac{a^2y^6\dot{y}}{16c^{12}}\times$$

$$\overline{5c^4-2c^2d^2+d^4}+\frac{a^2y^8\dot{y}}{128c^{16}}\times\overline{35c^6-15c^4d^2+9c^2d^4-5d^6}$$

the fluent of which is

$$v=y+\frac{a^2y^3}{3.2c^4}+\frac{a^2y^5}{5.8c^8}\times\overline{3c^2-d^2}+\frac{a^2y^7}{7.16c^{12}}\times\overline{5c^4-2c^2d^2+d^4}$$

$+ \frac{a^2y^9}{9.128\,c^{10}} \times \overline{35c^6 - 15c^4d^2 + 9c^2d^4 - 5d^6}$ and when $v = \frac{c^2}{b}$ the series becomes

$$v = \frac{c^2}{b} + \frac{a^2c^2}{3.2\,b^3} + \frac{a^2c^2}{5.8\,b^5} \times \overline{3c^2 - d^2} + \frac{a^2c^2}{7.16\,b^7} \times \overline{5c^4 - 2c^2d^2 + d^4}$$

$+ \frac{a^2c^2}{9.128\,b^9} \times \overline{35c^6 - 15c^4d^2 + 9c^2d^4 - 5d^6}$ but $z = \frac{a^2}{b} + \frac{a^2c^2}{3.2\,b^3}$

$$+ \frac{a^2c^2}{5.8\,b^5} \times \overline{3a^2 + d^2} + \frac{a^2c^2}{7.16\,b^7} \times \overline{5a^4 + 2a^2d^2 + d^4} + \frac{a^2c^2}{9.128\,b^9}$$

$$\times \overline{35a^6 + 15a^4d^2 + 9a^2d^4 + 5d^6}.$$

From a comparifon of thefe two equations, it will be feen that the law of continuation is the fame in both, excepting that in the value of v, the figns of the odd powers of d^2 are negative, whereas in the value of z all the figns are affirmative. The powers and coefficients of a, c, and d, in the correfponding terms are the fame; and to whatever number of terms the feries may be carried, it is evident that this will ftill be the cafe. Hence if a be greater than c every term, except the fecond, of the equation of the value of z, will be greater than the correfponding term of the equation of the value of v; confequently the fum of the feries $= z$ will be greater than the fum of the feries $= v$: that is, if a be greater than c, z will be greater than v. Converfely if z be greater than v, a will be greater than c. If $a = c$, d^2 will vanifh and the two feries will be equal to each other. If c be greater than a, d^2 will be negative, and the odd powers of d^2 in the feries $= z$, will in this cafe be negative, but in the feries $= v$ the odd powers of d^2 will become affirmative, and v will be greater than z; converfely if v be greater than z, c will be greater than a.

Hence,

Hence, if the arch AL exceed the arch LB, BC is greater than AC; but, if AD repreſent the axis of the earth, and BE the equatorial diameter, it is found by actual meaſurement, that each degree of the arch AL is greater than a degree of the arch BL, and conſequently the whole arch AL is greater than the whole arch BL, and therefore BC is greater than AC. Q. E. D.

No. XXIII.

Defcription of fome Improvements in the common Fire-place, accompanied with Models, offered to the confideration of the American Philofophical Society. By C. W. PEALE, *and his fon* RAPHAELLE.

Read March 17, 1797.

FIRE-places now in ufe, are often fubject to fmoke, and the unneceffary confumption of great quantities of fuel, without fufficiently warming the apartments, occafioned by the great quantity of heat efcaping through the funnels, confequently being loft in the external air; whereas thofe built after the models herewith fent, *are not liable to fmoke*, and emit the greateft quantity of heat into the apartments through *cheap, durable* and *falubrious materials*.*

The art of economizing fuel wholly confifts in preventing the efcape of heat and directing it where wanted. This is beft effected by taking fuch an entire command of the draught as that, when the combuftibles are inflamed fufficiently to continue them to ignition, their hafty deftruction may be prevented by leffening the draught as much as poffible without extinguifhing the fire.

Jambs confiderably flanting, as in the form given by the ingenious Count Rumford, are certainly the beft for throwing out heat, and with the addition of the fliding

* Only a part of thefe defigns are now publifhed, the remainder will form a more general effay of economizing fuel and labour, by various methods, for common ufe, and more efpecially for the kitchen; which are now put into practice at the Mufeum, and moft probably will be fo far improved as to render them much more interefting to the public, by further obfervations and management.

ſliding-mantle and valve, or damper, &c. will be found the moſt *comfortable*, *ſafe*, and *economizing*.*

Explanation of the Plate.

Figure A is the ſliding-mantle, made of ſheet-iron or copper; the frame of which may for ornament be covered with plates of braſs, and braſs may alſo cover as much of the grooves as are in ſight on each ſide of the fire-place in which the ſliding-mantle moves. The arms *a*, *a*, extend to ſuch a length as to free the marble and let the cord draw perpendicularly over the pullies *b*, *b*. The weights to balance the ſliding-mantle, and move freely behind the pilaſters or frame compoſing the frontice piece of the chimney.

The grooves which receive the tongues of the ſliding-mantle, as well as the pullies, muſt be fixed firmly in the brick work, and fitted to ſet cloſe to the wall forming the front of the chimney.—Theſe are covered by the wood work and marble ſlabs, which may be ornamented according to the prevailing faſhion.

The dotted lines ſhew the arms, lines, pullies and weights in figure B, with the ſliding-mantle drawn half way down to the hearth.

The frontice piece will be moſt convenient if made in two or more parts. That part extending above the projecting mantle-piece which is to cover the pullies and ſliding-mantle, needs only a ſmall projection and may be made of pannel work or an ornamental mirror. It ſhould be ſeparate from the other part of the breaſt work, in order to replace the cords when worn out.

Iron

* Theſe improvements are ſecured by a patent right to Charles and Raphaelle Peale, after the communication of the deſigns to the Philoſophical Society.

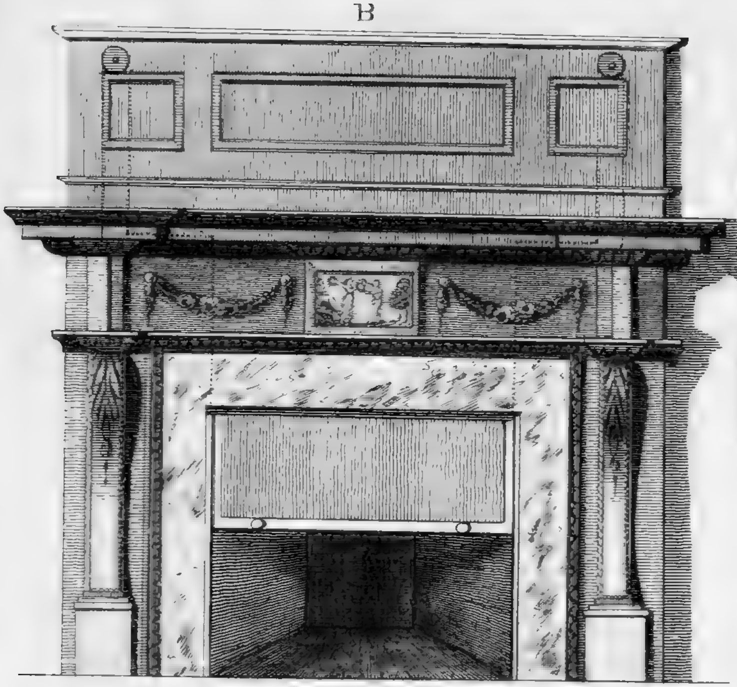
Iron hold-fafts drove into the brick work, to which the breaft work is fcrewed, is much preferable to the old method of putting wooden plugs which always fhrink with the drying of the mortar, and in a fhort time leave the frontice piece in a fhackling condition ; but if fcrewed to iron hold-fafts, are firm, and fuch parts as will be neceffary to remove occafionally, in order to renew the cords, may be taken down and replaced in a few minutes.

The marble cheeks as ufual are to be fixed firm to the brick work, covering a part of the grooves, which are to receive the fliding-mantle, but the upper or crofs piece of marble is detached from the arch, allowing the fliding-mantle to move behind it, but is fupported on the cheeks at each end ; and a piece of hoop-iron, the length of the marble, fcrewed to the wood work on the back part, will ftrengthen and keep the marble in its proper place.

The valve C made of fheet-iron, is placed about 10 or 12 inches above the opening of the fire-place in the throat of the chimney, and fitted to fhut clofe on the top of the brick work, which fhould be left flat. The pivots *c*, *c*, are on the inner front of the fire-place, and are received by the eyes *d*, *d*, which are faftened into the brick work. The reafon for hanging the valve to the front part of the chimney flue in preference to the back, is, that the foot which falls on the plate in fweeping the chimney, may fall through between the front wall and the valve, when opened. Befides there is more fafety in the efcape of heat paffing up the flue of the chimney at the back than in the front, for too often wood is placed in the brick work by thoughtlefs workmen, to the great danger of taking fire. *e*, is a rack, hinged on the under fide of the valve at *f*, the lower or rack end to move freely in an iron loop *g*, which is fixed in the jamb. The advantage of this method, is, that the valve can be moved with expedition

Plate XIII.

B



C

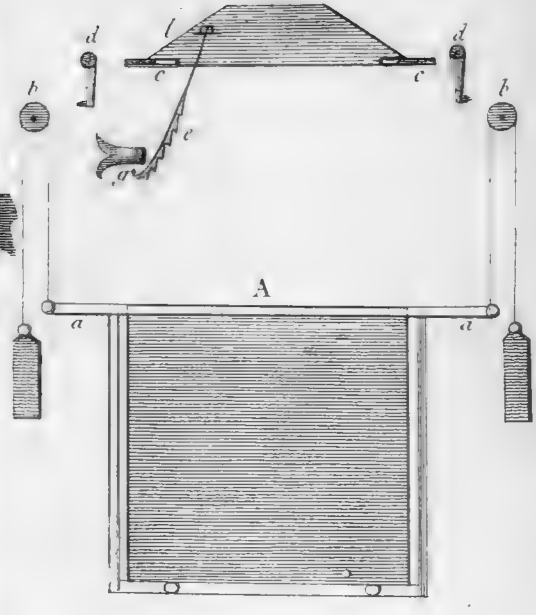


Fig. 2.

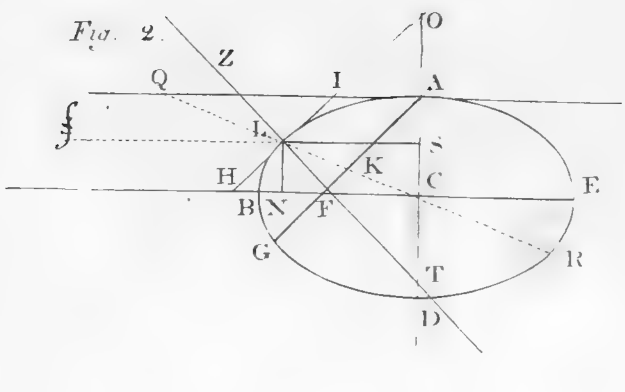
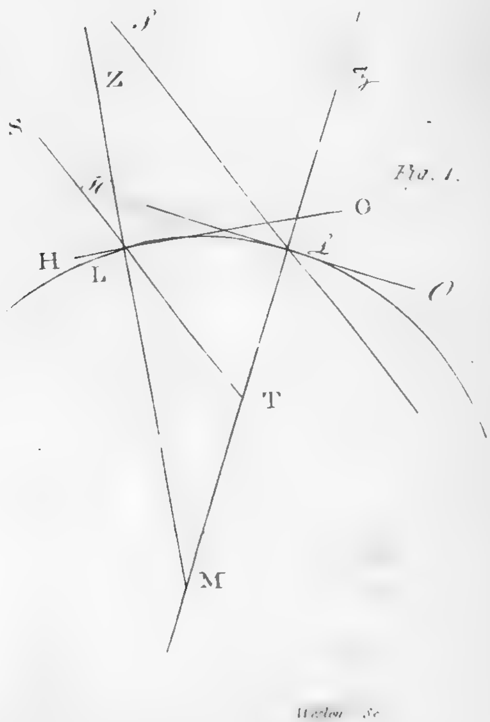


Fig. 1.



expedition if required, and if the notches forming the rack, are cloſe together the ſpace of opening for the draught may be more nicely adjuſted.

The back and cheeks of the fire-place may be made hollow, yet ſtrong, by alternately butting againſt the wall, in what is termed by the bricklayers, *flemiſh bond*,—and a ſmall hole made near the hearth of this hollowed way, communicating to the external air if convenient, if not, a hole may be made near the floor within the chamber, and other openings made in any convenient places higher than the opening of the fire-place, to let the heated air paſs from the back or inner part of the brick work into the chamber.

The conveniencies of this fire-place, are, that the fire may be kindled quickly, and after it burns freely, the valve or damper being lowered, leaving only an opening ſufficient to carry off the ſmoke, which in a well conſtructed chimney may generally be cloſed to an inch and half or two inches, but little heat will eſcape in the throat of the fire-place.

If the chimney is ſubject to ſmoke, it is an eaſy expedient to lower the ſliding-mantle ſo as to increaſe the draught.

But the ſafety from the dangers of fire with this fire-place is not of the leaſt importance, for whatever fire is left in the place at night, with the valve cloſe ſhut, and the ſliding-mantle lowered to join the hearth, the fire will be ſmothered. In like manner if by accident the ſoot takes fire in the flue of the chimney, no alarm follows, as it may inſtantly be extinguiſhed.

The laſt improvement which has been made, is to remedy the evil of the ſmoke, paſſing between the ſliding mantle and breaſt work and eſcaping through the crevices round the mantle piece.

A hole

A hole is made in the brick work in the middle, a little above the opening of the fire place forming a ſmall flue to let in the external air by which the ſmoke is driven back into the chimney. This has been found to have an admirable effect even in ſome chimnies which before had ſmoked ſo as to be deemed incurable.

DIRECTIONS TO THE BINDER.

Plate	1	to face page 80		N°.	4	to face page 242
	2	86			5	244
	3	88			6	258
	4	102			7	276
N°.	1	212			8	304
	2	220		Plate	13	322
	3	236				

N. B. In the plates referred to, as

N°ˢ. V. VI. VII. VIII. IX. X. XI. XII.
1. 2. 3. 4. 5. 6. 7. 8. are marked on the plates.

THE END.

ERRATA.

Page 199 line 28—after *branch* read *or mouth.*
201 — 18 & 20—before *S* read *c.* as in lines 17 and 19.
208 — 6—for *extremes* read *extreme differences.*
— 7—after *obſervations* read *when worked ſeparately.*
266 — 1—after *limb* read *from.*
287 — 29—after *Cumberland* read *Iſland.*

APPENDIX.

THE following papers, being tranſmitted by candidates for the premium which was offered by the ſociety " for the beſt method of preventing the premature decay of peach trees," were conſidered as very deſerving of public attention. It was therefore determined that the premium of *ſixty dollars* ſhould be divided between their reſpective authors, and that the papers ſhould be inſerted in the Tranſactions.

No. I.

Account of a Method of Preventing the premature Decay of Peach Trees. By JOHN ELLIS, of New-Jerſey.

THE decay of peach trees is owing to a worm, which originates from a large fly, that reſembles the common waſp: this fly perforates the bark and depoſits an egg in the moiſt or ſappy part of it. The moſt common place of perforation is at the ſurface of the earth, and as ſoon as the worm is able to move, it deſcends into the earth, probably from an inſtinctive effort to avoid the winter's froſt. This may be aſcertained by obſervation, the tract of the worm from the ſeat of the egg being viſible at its beginning, and gradually increaſing, in correſpondence with the increaſing ſize of the worm; its courfe is always downwards. The progrefs of the young worm is extremely flow, and if the egg is depofited at any confiderable diftance above the furface of the earth, it is long before the worm reaches the ground. The worms are unable to bear the cold of winter unlefs covered by the earth, and all that are above ground after froft are killed.

By this hiftory of the origin, progrefs and nature of the infect, we can explain the effects of my method, which is as follows: in the fpring, when the bloffoms are out, clear away the dirt fo as to expofe the root of the tree, to the depth of three inches; furround the tree with ftraw about three feet long, applied lengthwife, fo that it may have a covering one inch thick, which extends to the bottom of the hole, the but ends of the ftraw refting upon the ground at the bottom. Bind this ftraw round the tree with three bands, one near the top, one at the middle, and the third at the furface of the earth, then fill up the hole at the root, with earth, and prefs it clofely round the ftraw. When the white frofts appear, the ftraw fhould be removed and the tree fhould remain uncovered until the bloffoms put out in the fpring.

By this procefs the fly is prevented from depofiting its egg within three feet of the root, and although it may place the egg above that diftance, the worm travels fo flow that it cannot reach the ground before froft, and therefore is killed before it is able to injure the tree.

The truth of the principle is proved by the following fact—I practifed this method with a large number of peach trees, and they flourifhed remarkably, without any appearance of injury from the worm, for feveral years; I was then induced to difcontinue the ftraw with about twenty of them. *All thofe which are without the ftraw have declined, while the others which have had the ftraw continue as vigorous as ever.*

Defcription

Defcription of a Method of Cultivating Peach Trees, with a view to prevent their premature decay; confirmed by the experience of Forty-five Years, in Delaware State and the weftern parts of Pennfylvania. *By* THOMAS COULTER, Efq. of Bedford County, Pennfylvania.

THE death of young peach trees is principally owing to planting, tranfplanting, and pruning *the fame ftock*, which occafions it to be open and tender, with a rough bark, in confequence of which infects lodge and breed in it, and birds fearch after them, whereby wounds are made, the gum exudes, and in a few years the tree is ufelefs. To prevent this, tranfplant your trees as young as poffible, if in the kernel it will be beft, as there will then be no check of growth. Plant them fixteen feet apart. Plow and harrow between them, for two years, without regard to wounding them, but avoid tearing them up by the roots. In the month of March or April, in the third year after tranfplanting, cut them all off by the ground, plow and harrow among them as before, but with great care to avoid wounding or tearing them. Suffer all the fprouts or fcions to grow, even if they fhould amount to half a dozen or more, they become bearing trees almoft inftantaneoufly on account of the ftrength of the root. Allow no animals but hogs to enter your orchard, for fear of their wounding the fhoots, as a fubftance drains away through the leaft wound, which is effential to the health of the tree and the good quality of the fruit.

If the old ftock is cut away the third year after tranfplanting, no more fhoots will come to maturity than the old ftump can fupport and nourifh, the remainder will die before they bear fruit, and may be cut away, taking care not to wound any other ftock. The fprouts when loaded

loaded with fruit, will bend and reſt on the ground in every direction for many years, all of them being rooted as if they had been planted, their ſtocks remaining tough and their bark ſmooth for twenty years and upwards. If any of the ſprouts from the old ſtump ſhould happen to ſplit off and die, cut them away, they will be ſupplied from the ground by others, ſo that you may have trees from the ſame for 100 years as I believe. I have now trees from one to thirty-ſix years old, all from the ſame ſtump. Young trees formed in this manner will bear fruit the ſecond year, but this fruit will not ripen ſo early as the fruit on the older trees from the ſame ſtump. Three years after the trees are cut off, the ſhoots will be ſufficiently large and buſhy to ſhade the ground ſo as to prevent the growth of graſs that might injure the trees, therefore plowing will be uſeleſs and may be injurious by wounding them. It is alſo unneceſſary to manure peach trees, as the fruit of manured trees is always ſmaller and inferior to that of trees which are not manured. By manuring you make the peach trees larger and apparently more flouriſhing, but their fruit will be of a bad kind, looking as green as the leaves, even when ripe, and later than that of trees which have not been manured. Peach trees never require a rich ſoil, the poorer the ſoil the better the fruit: a middling ſoil produces the moſt bountiful crop. The higheſt ground is the beſt for peach trees, and the north ſide of hills is moſt deſirable, as it retards vegetation and prevents the deſtructive effects of late froſts, which occur in the month of April in Pennſylvania. Convinced by long experience of the truth of theſe obſervations, the author wiſhes they may be publiſhed for public benefit, and has been informed that Colonel Luther Martin and another gentleman, in the lower part of Maryland, have adopted a ſimilar plan with great advantage.